Virtual Reality: Taking Sports Performance to the next Level

Professor Cathy Craig


INCISIV
Ulster University
Virtual Reality Research
@incisivsport
@Ulsterunipsych

HOW THE BRAIN CONTROLS MOVEMENT

>100 research publications:

nature JoCN

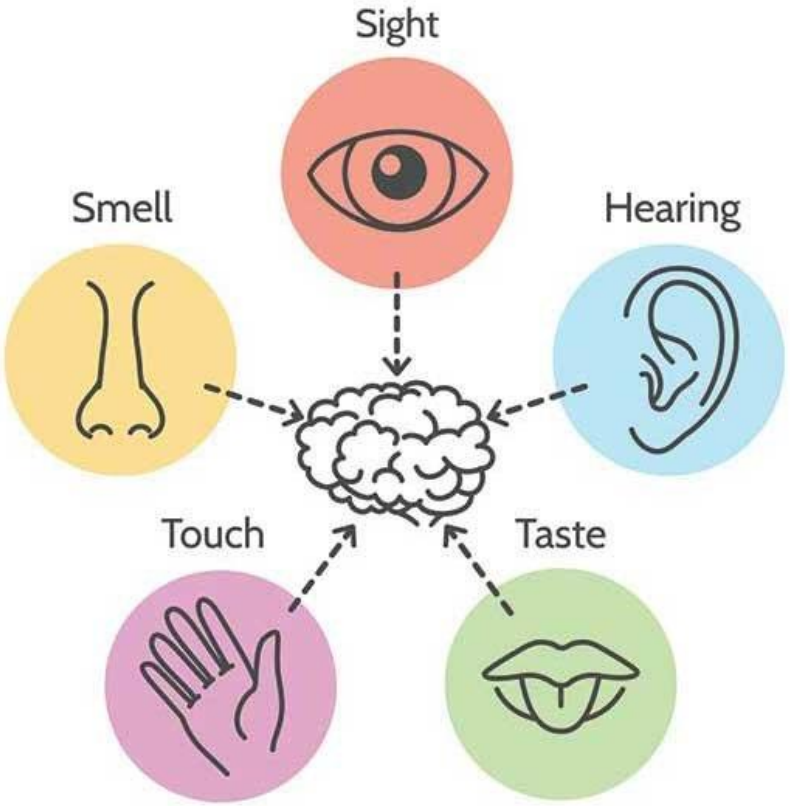
>£1.5M research funding:

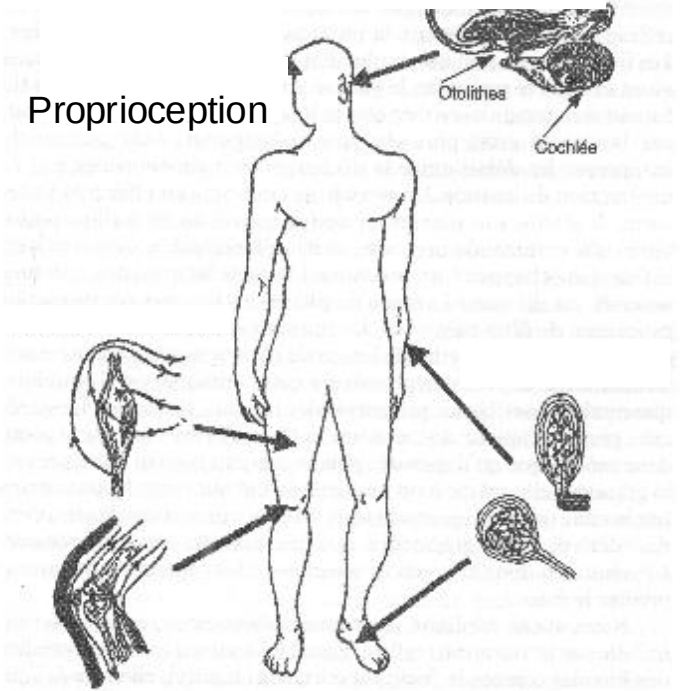
erc ROYAL ACADEMY OF ENGINEERING

Solutions validated with:

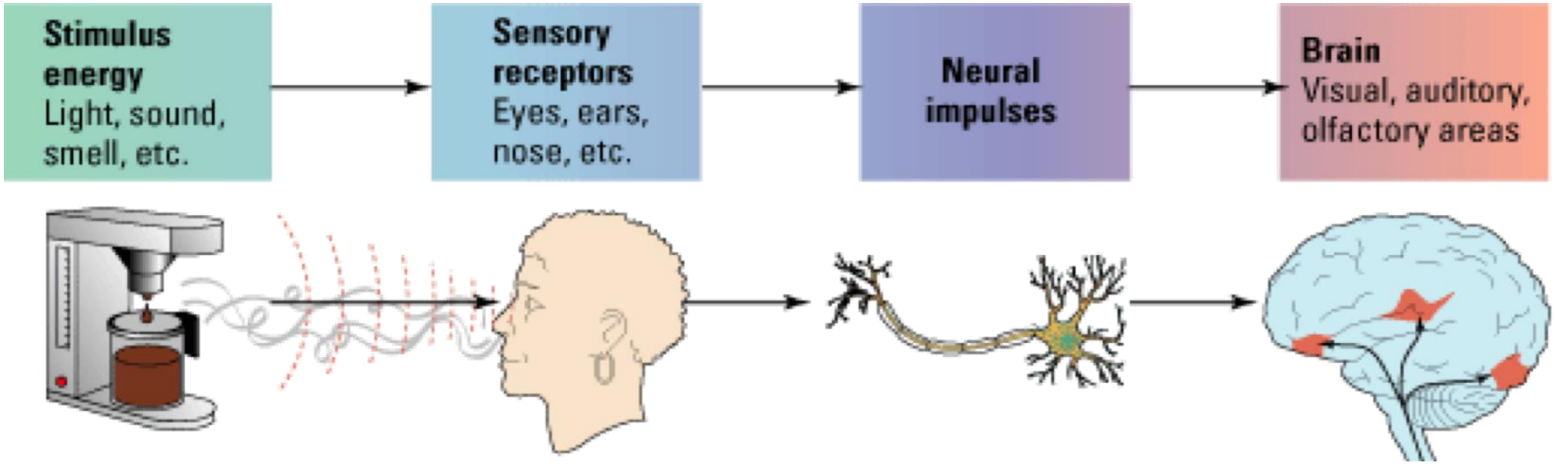
adidas ULSTER Rugby ECB AC Milan 1899

OUR SENSES CONNECT US TO THE OUTSIDE WORLD

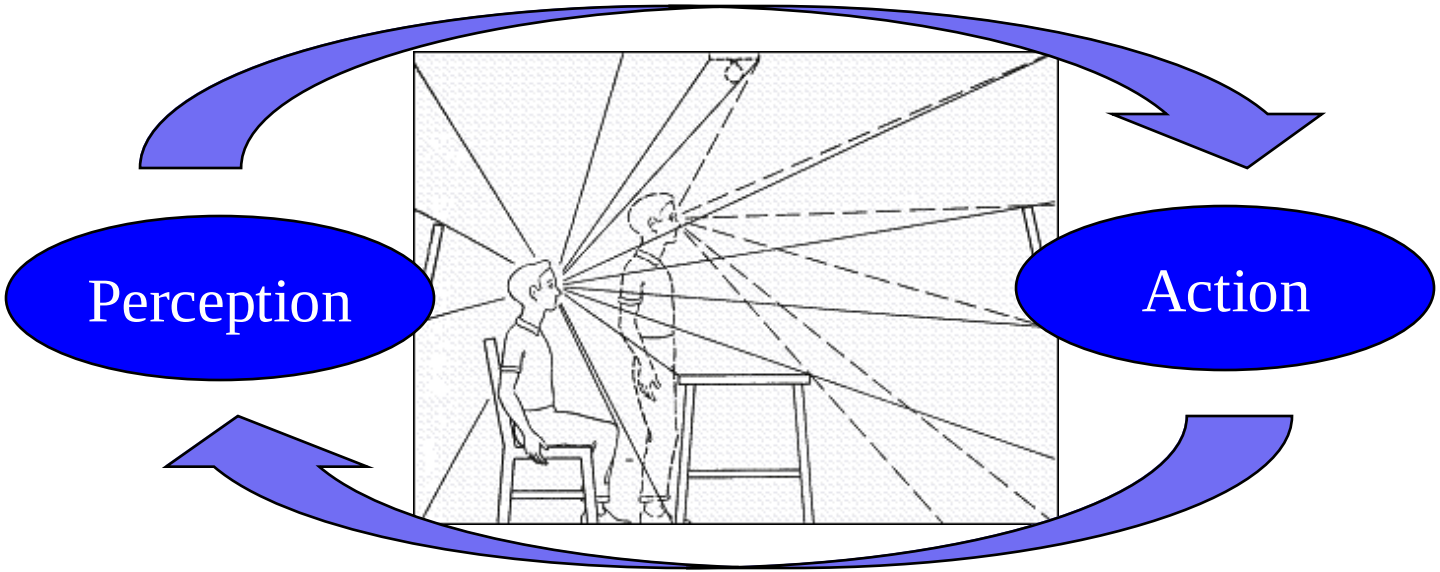




OUR SENSES ACT AS TRANSDUCERS



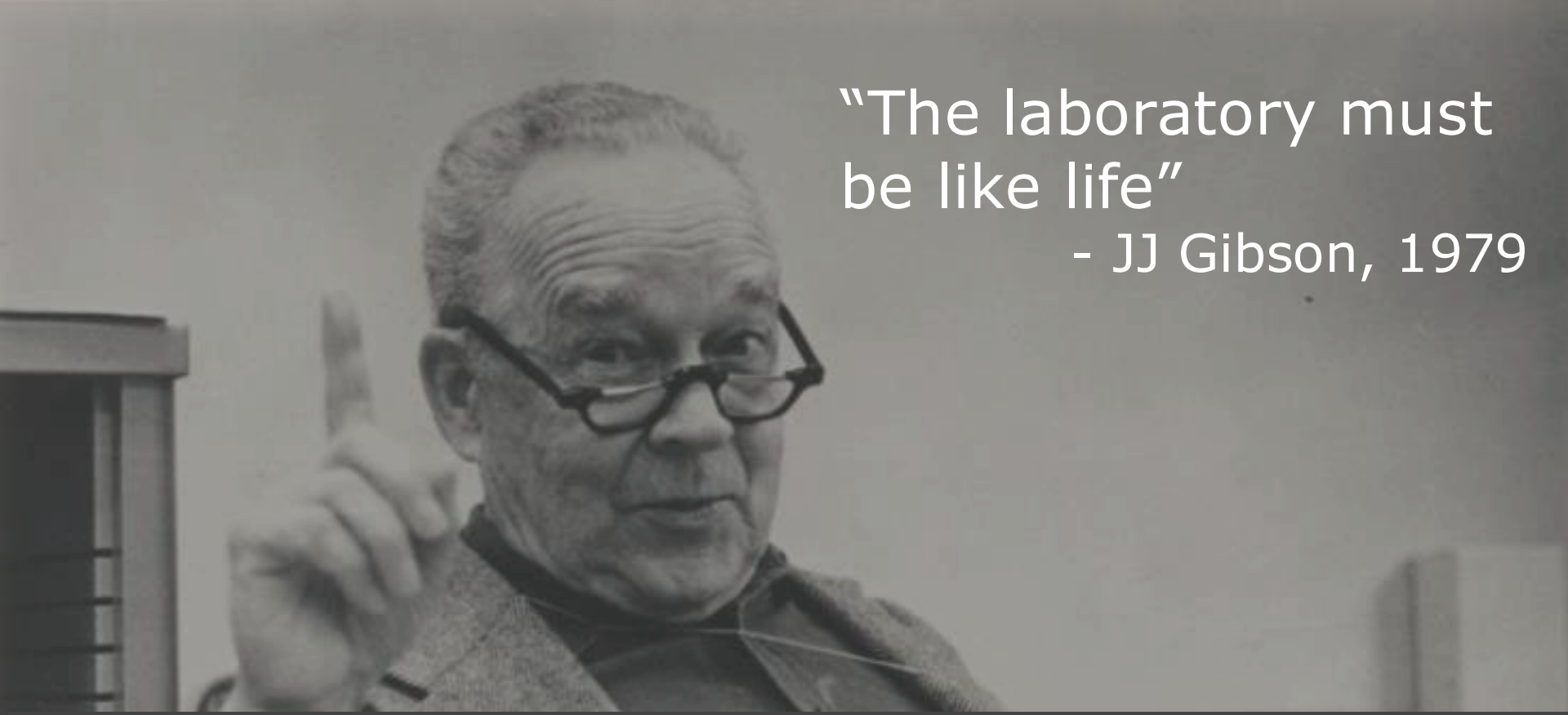
"WE MOVE TO PERCEIVE AND WE PERCEIVE TO MOVE"



FOOTBALL
CURVED FREE-KICKS

DOES BALL SPIN AFFECT ANTICIPATION?

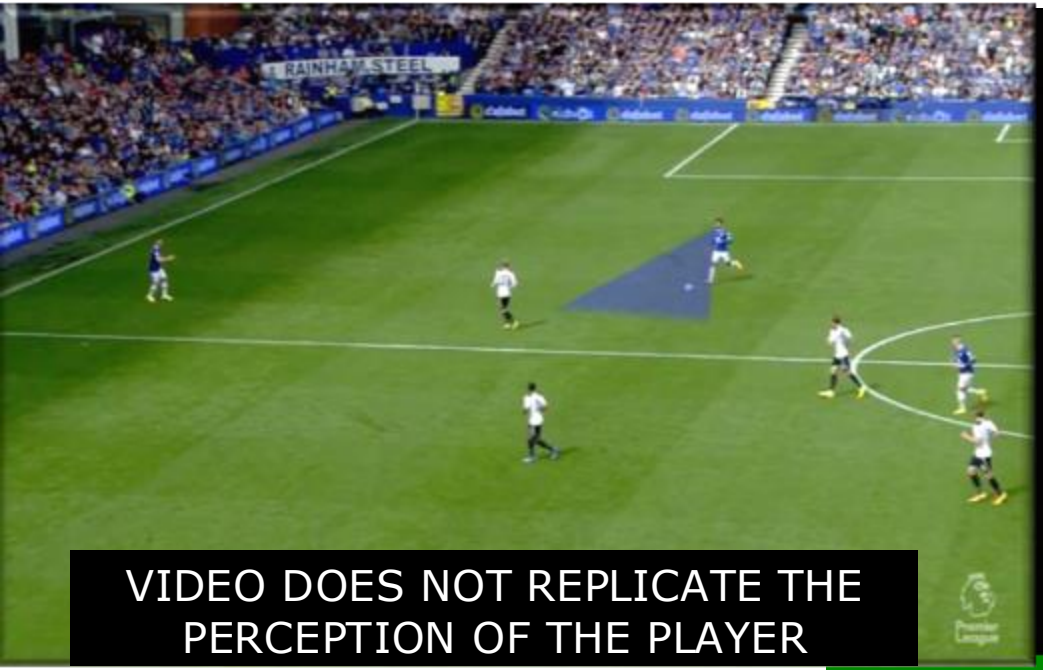
ROBERTO CARLOS 1997

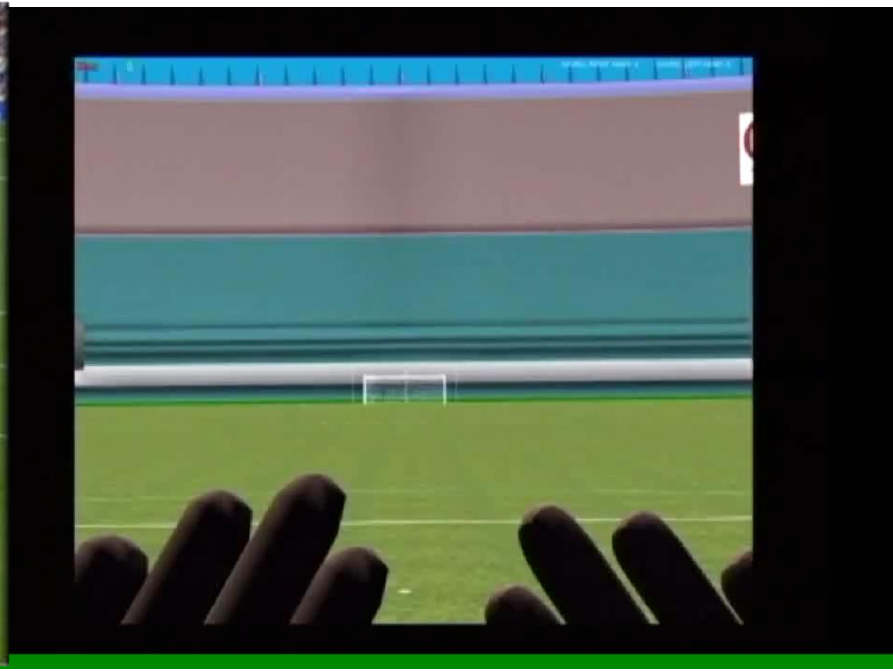


IMPORTANT: Behavioural realism

Participant responds as they would in real-life

VIRTUAL REALITY ACCURATELY RECREATES PERCEPTION OF THE GOALKEEPER



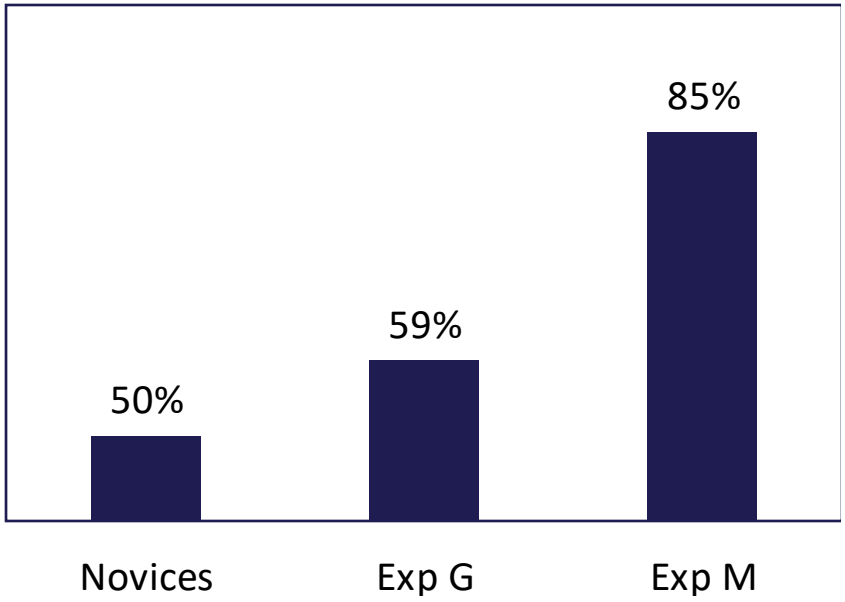


Dessing & Craig, 2010

SPIN MAKES IT DIFFICULT TO JUDGE BALL ARRIVAL POSITION

Novice

Expert



Dessing & Craig, 2010

FASTER REACTIONS ARE NOT ALWAYS BETTER

Dessing & Craig, 2010

THE ‘WALL’ OCCLUDES CRITICAL BALL FLIGHT INFORMATION

Valkanidis et al, 2020

VIRTUAL REALITY HELPS UNDERSTAND PERFORMANCE

Spin makes it more difficult to anticipate ball flight

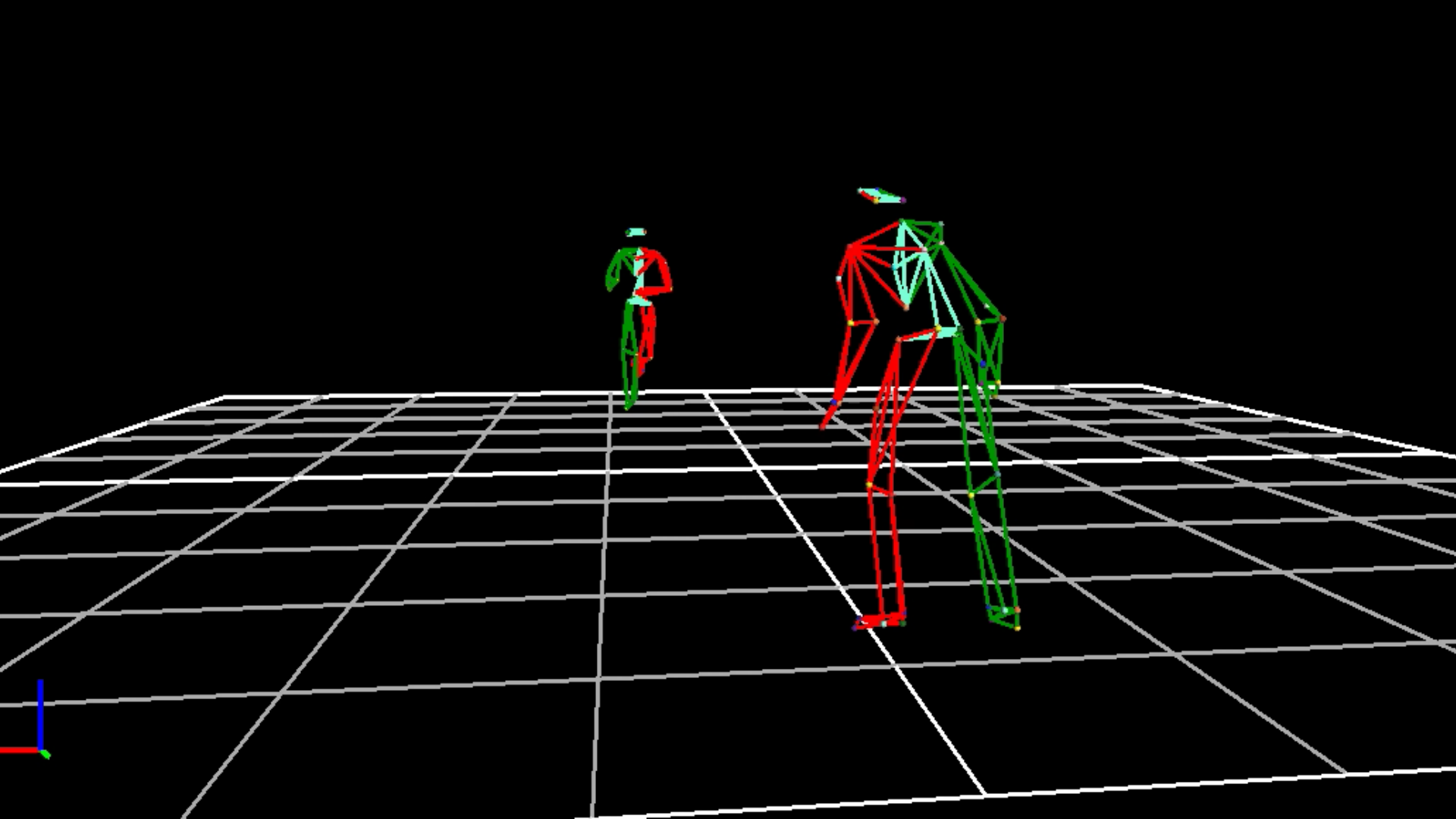
Faster reactions are **NOT** always better

The Wall can **negatively** impact performance

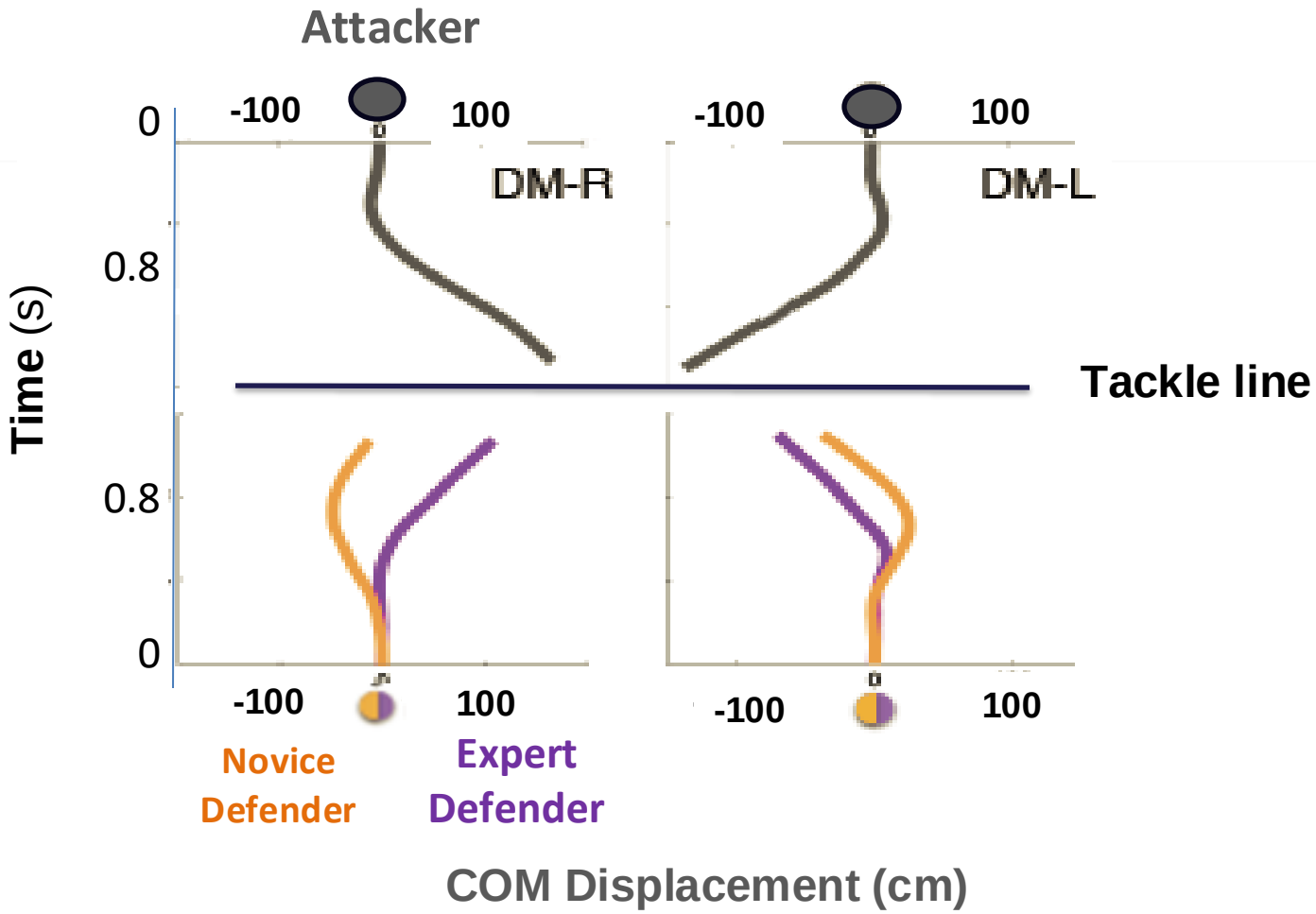
Dessing & Craig, 2010

Valkanidis, Craig et al 2020

RUGBY SIDE-STEPS

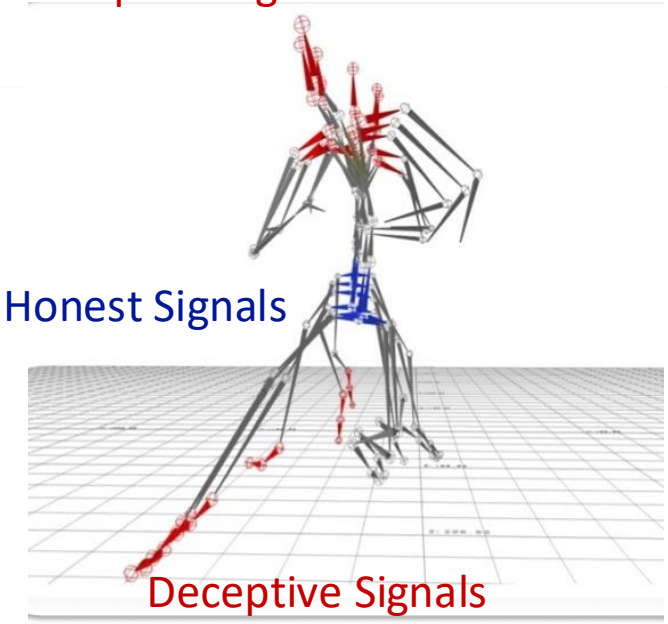



RTÉ ONE
RTÉ.ie

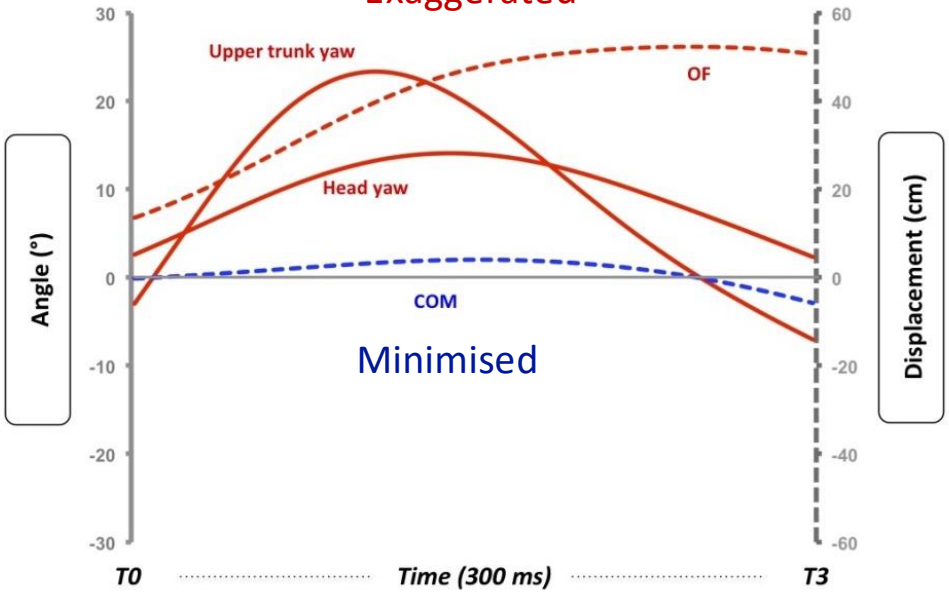


Brault et al, 2012

Deceptive Signals



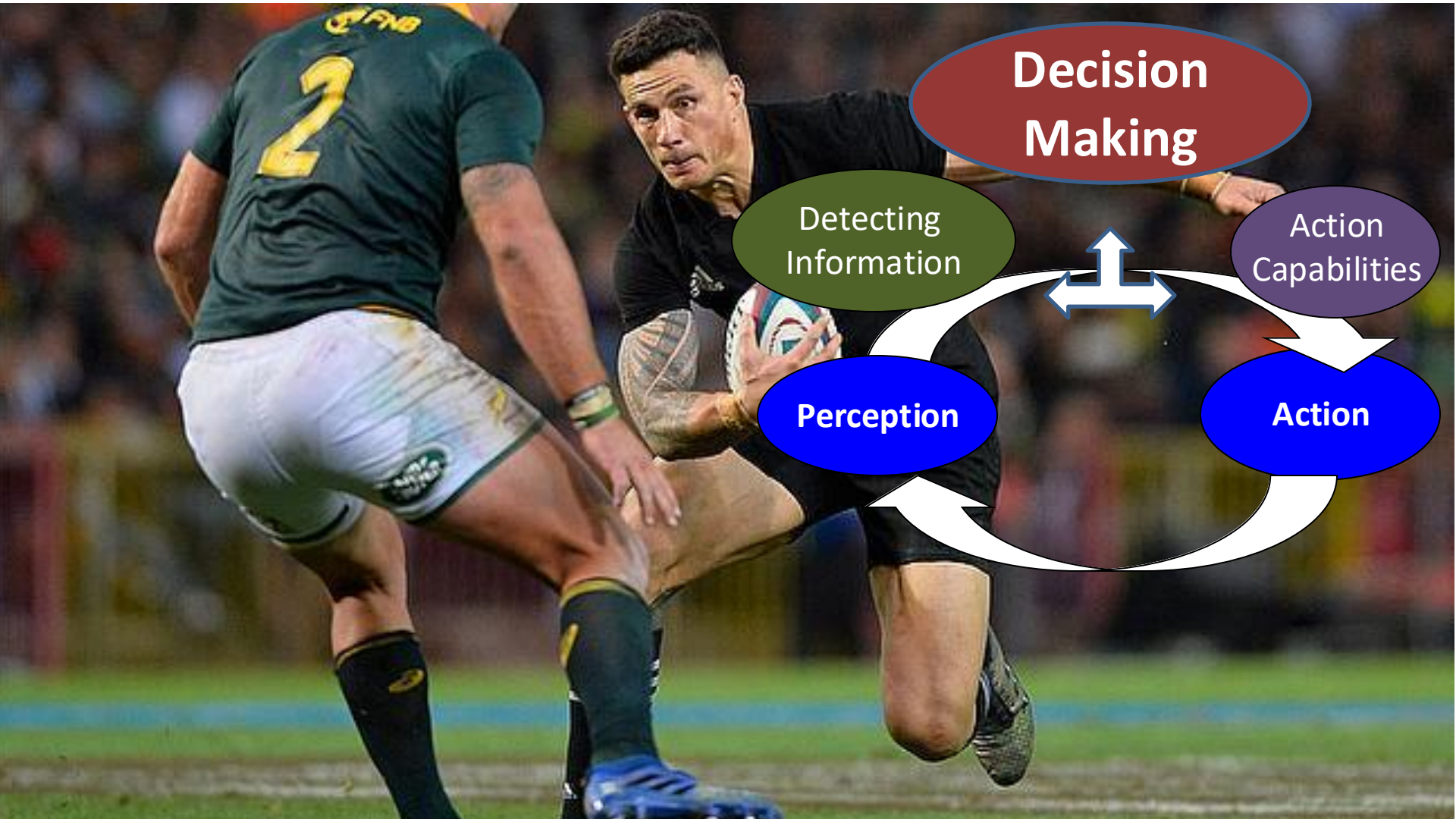
Exaggerated



Novices tune into Deceptive Signals

Experts tune into Honest Signals

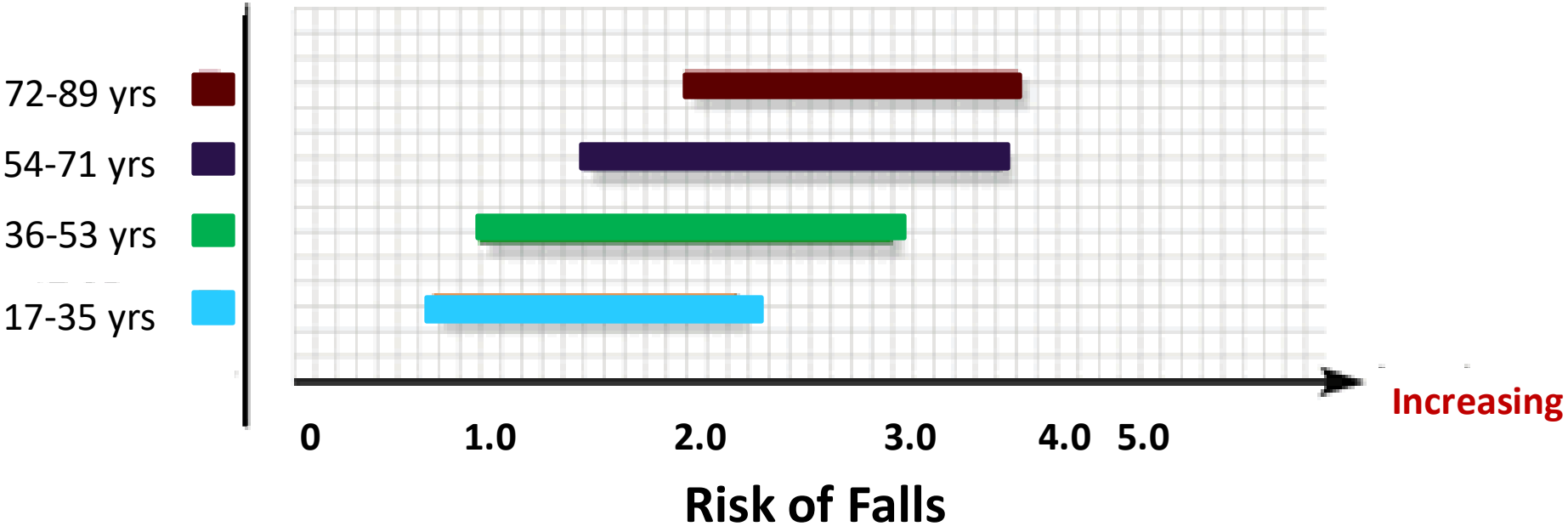
Brault et al, 2010


Decision Making
Detecting Information
Action Capabilities
Perception
Action

BALANCE & GAIT


“We don’t stop playing because we grow old;
We grow old because we stop playing.”
George Bernard Shaw

BALANCE ABILITY & AGEING



GAMIFICATION OF TRAINING

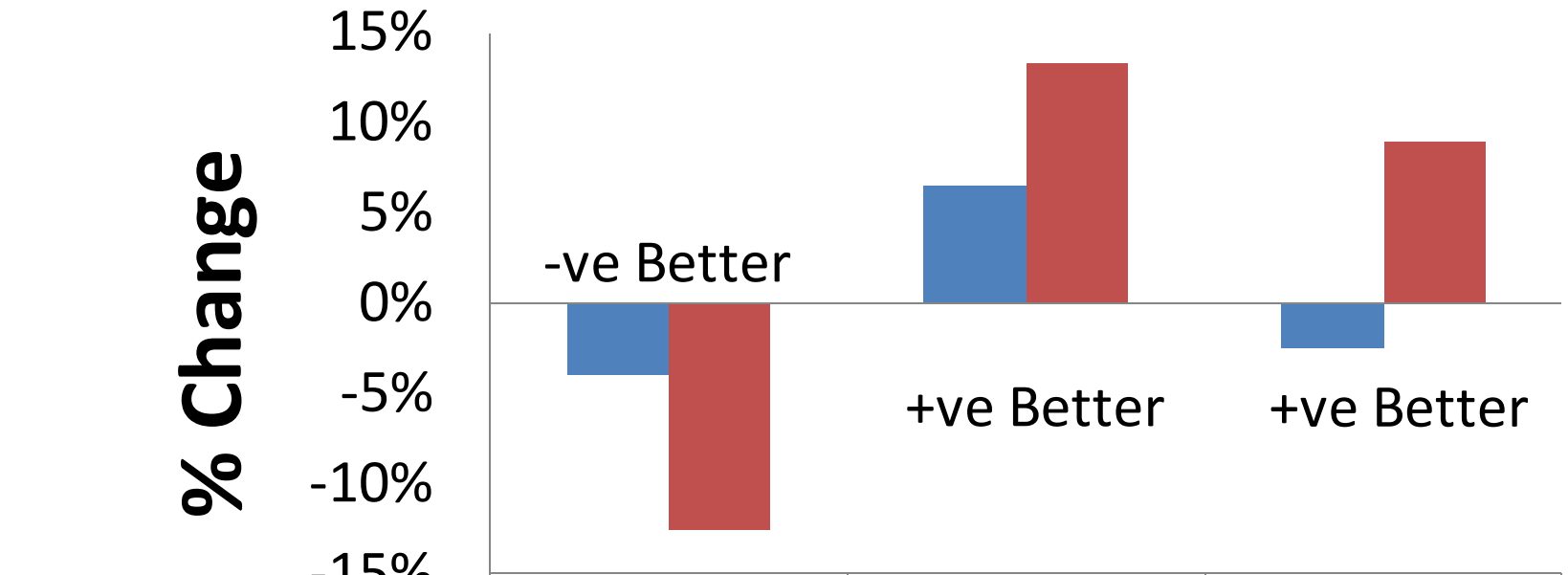
Balance Games

Nintendo Wii
Balance Board

Perception

Action

Young et al, 2011

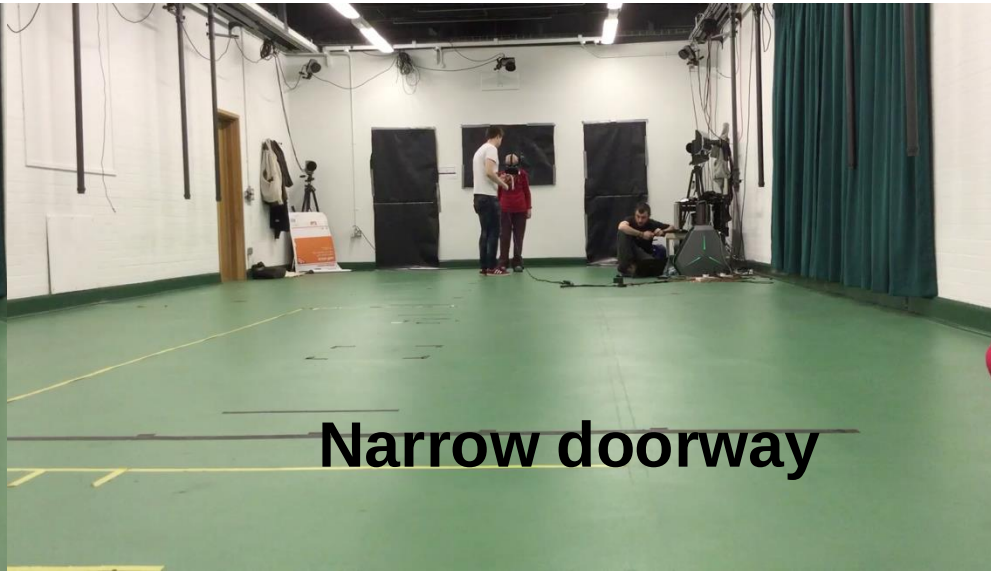


	FES	ABC	Berg
Control	-4%	6%	-2%
Balance Training	-13%	13%	9%

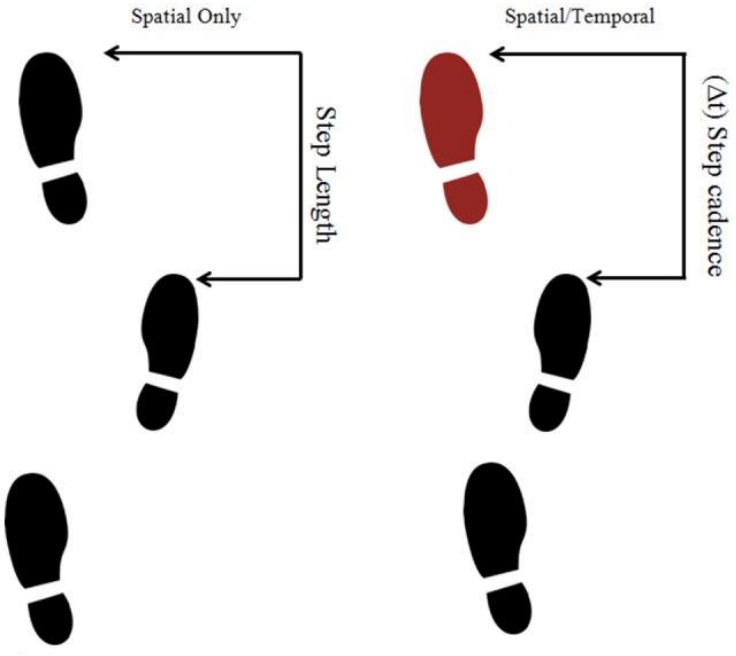
Young et al, 2011

VIRTUAL DOORWAYS PERCEPTION

VIRTUAL DOORWAYS ACTION



VIRTUAL FOOTSTEPS PERCEPTION GUIDES ACTION



"Virtual Reality can be used to induce Freezing of Gait"

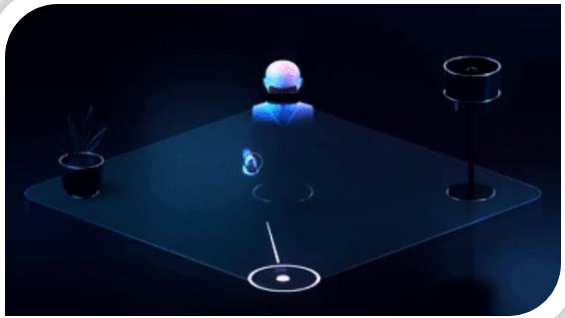
"Dynamic virtual footsteps can be used to improve stride length and cadence"

Gomez-Jordana et al (2018a, 2018b)

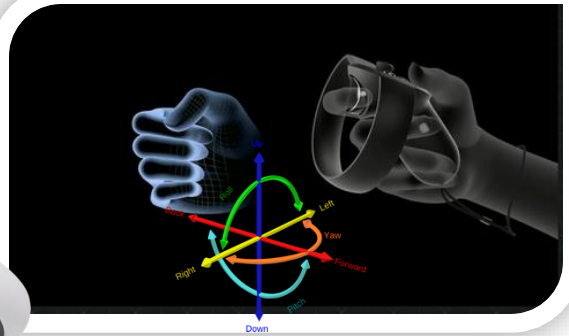

INCISIV
Ulster University
FROM RESEARCH TO REALITY
@incisivsport
@Ulsterunipsych

VR CONTROLLERS CAPTURE MOVEMENT PERFORMANCE

Accurate Head & Hand Tracking (<1mm)



6 Degrees of Freedom (rotational data)



diagnostics

MDPI

Article

Can We Use the Oculus Quest VR Headset and Controllers to Reliably Assess Balance Stability?

Cathy M. Craig [1,*], James Stafford [2], Anastasiia Egorova [3], Carla McCabe [4] and Mark Matthews [4]

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[3] School of Maths & Physics, Queen's University Belfast, Belfast BT7 1NN, UK; aegorova01@qub.ac.uk
[4] School of Sport, Ulster University, Belfast BT15 1ED, UK; c.mccabe@ulster.ac.uk (C.M.); m.matthews@ulster.ac.uk (M.M.)
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Abstract: Balance is the foundation upon which all other motor skills are built. Indeed, many neurological diseases and injuries often present clinically with deficits in balance control. With recent advances in virtual reality (VR) hardware bringing low-cost headsets into the mainstream market, the question remains as to whether this technology could be used in a clinical context to assess balance. We compared the head tracking performance of a low-cost VR headset (Oculus Quest) with a gold standard motion tracking system (Qualisys). We then compared the recorded head sway with the center of pressure (COP) measures collected from a force platform in different stances and different visual field manipulations. Firstly, our analysis showed that there was an excellent correspondence between the two different head movement signals (ICCs > 0.99) with minimal differences in terms

INCISIV ENHANCING PERFORMANCE THROUGH PLAY

Train anticipation

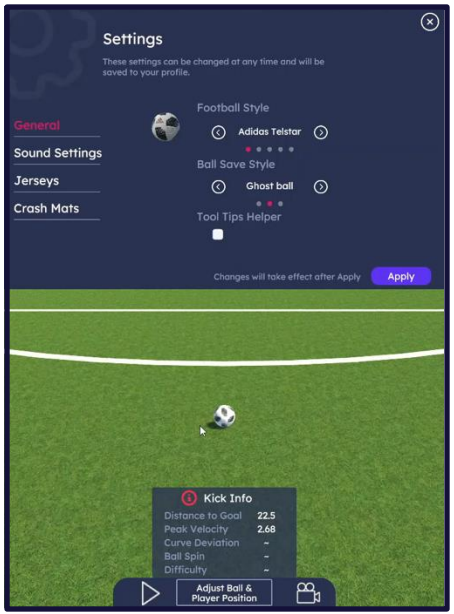
Train agility & evasion

Measure & improve neural fitness

TRAINING ANTICIPATION

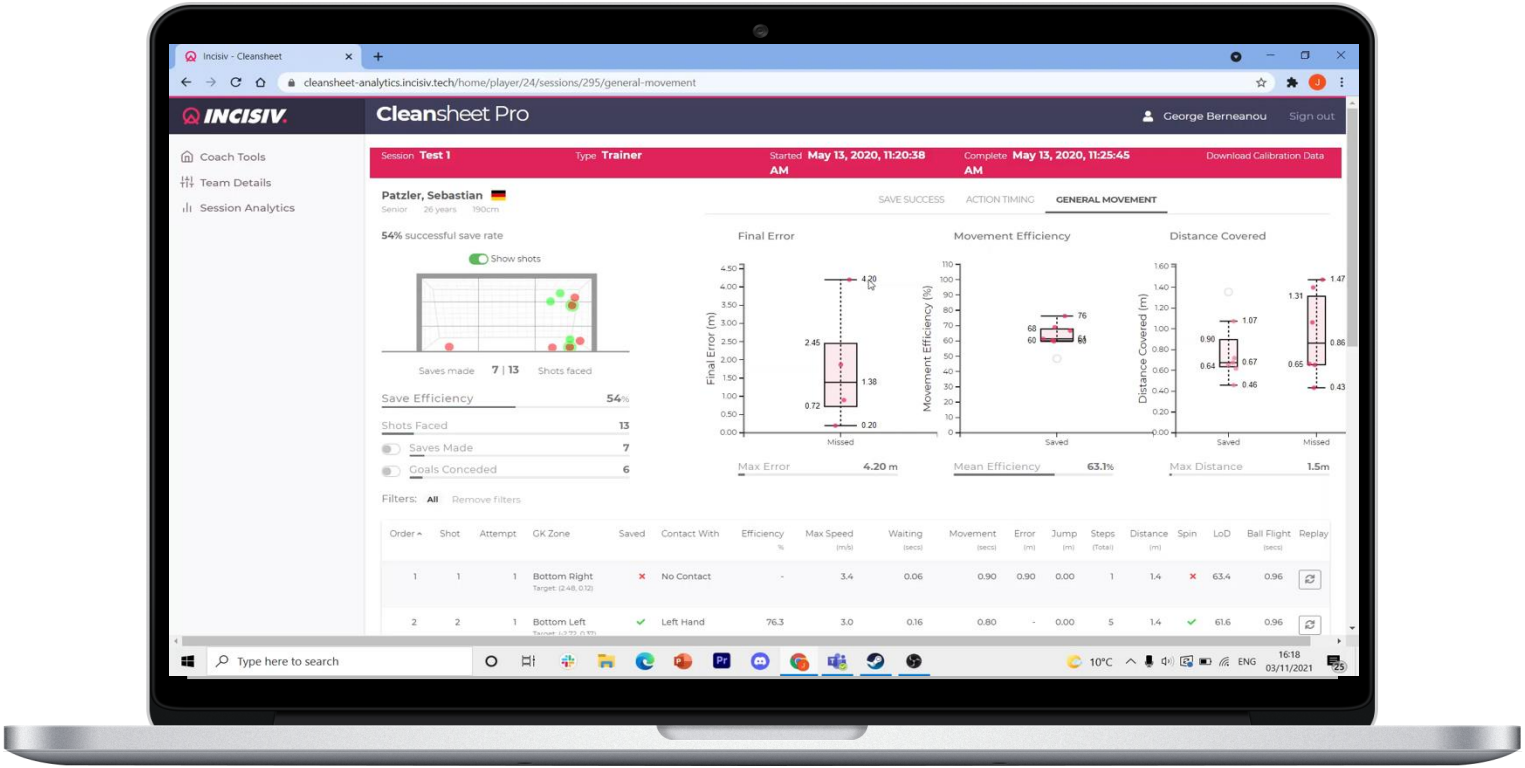

DH Sport+
VIRTUAL REALITY TRAINING FOR UNION SG GOALKEEPERS

TRAIN DIFFERENTLY – PRACTICE SAVING ANY TYPE OF SHOT

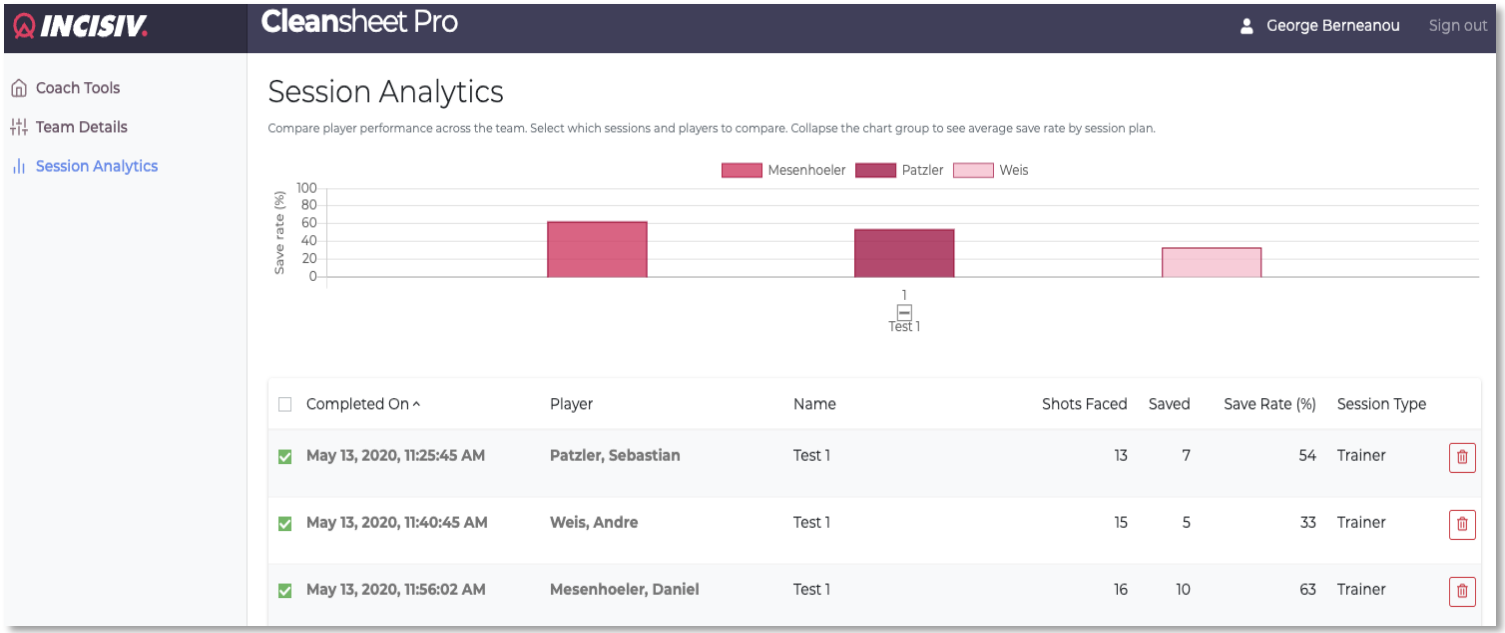


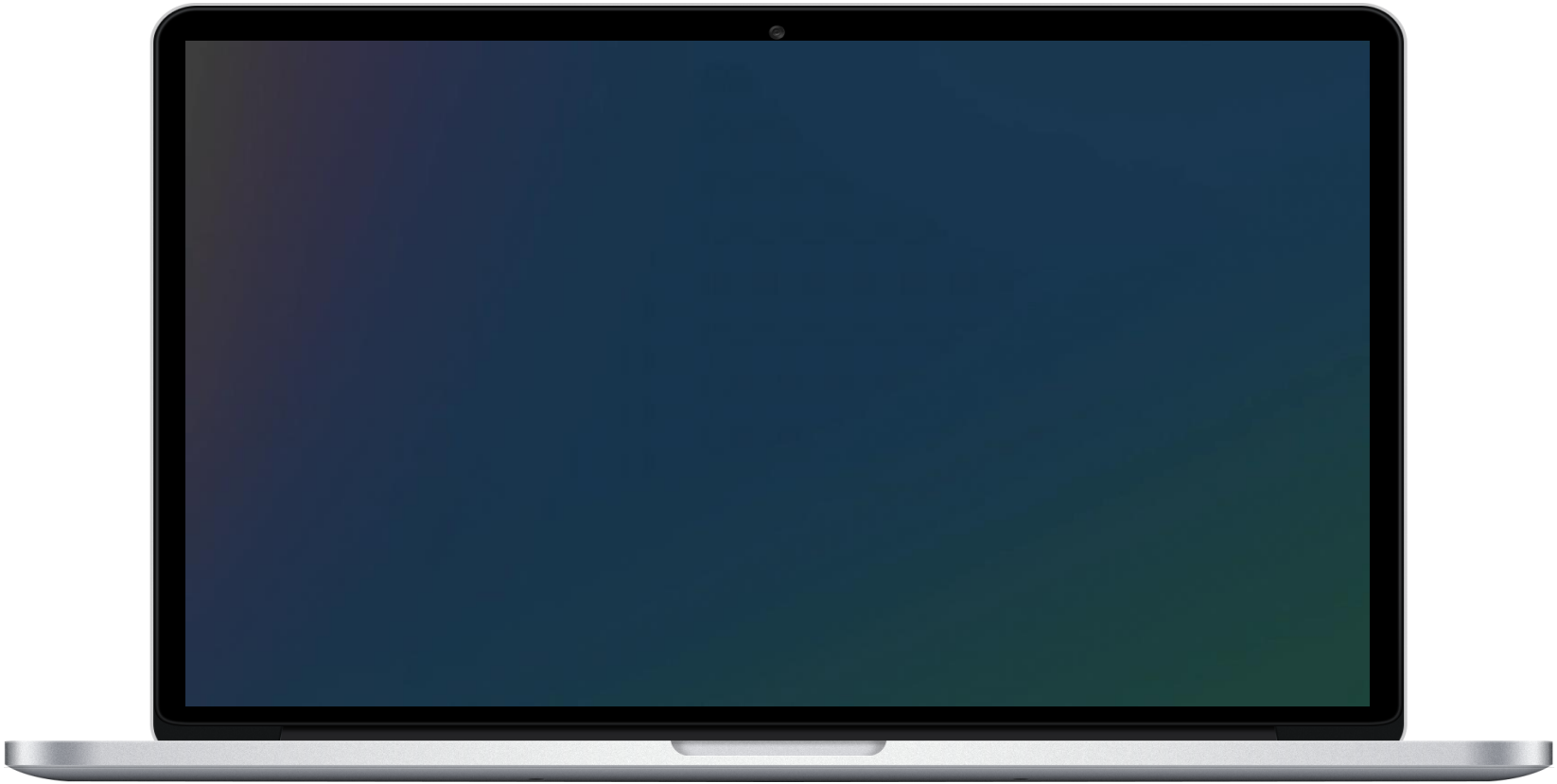
LEARN DIFFERENTLY USE INSTANT FEEDBACK TO CORRECT TECHNIQUE

ANALYSE DIFFERENTLY MEASURE WHAT THE EYES CAN'T SEE



COMPARE DIFFERENTLY – GIVE GOALKEEPERS EXACTLY SAME SHOTS





Mixed reality

CleanSheet Football

4.7 (826) • Sports • Simulation

Got me better

25 Oct at 02:13

This helped me to get more reaction and helped me get better goalkeeper so thanks to the creator that made this game.

Ruben Helpful | 1

Game is so good

19 hours ago

I got way better at gk in real life and the graphics are so good. Best game I have played yet in my 2 year vr experience!!

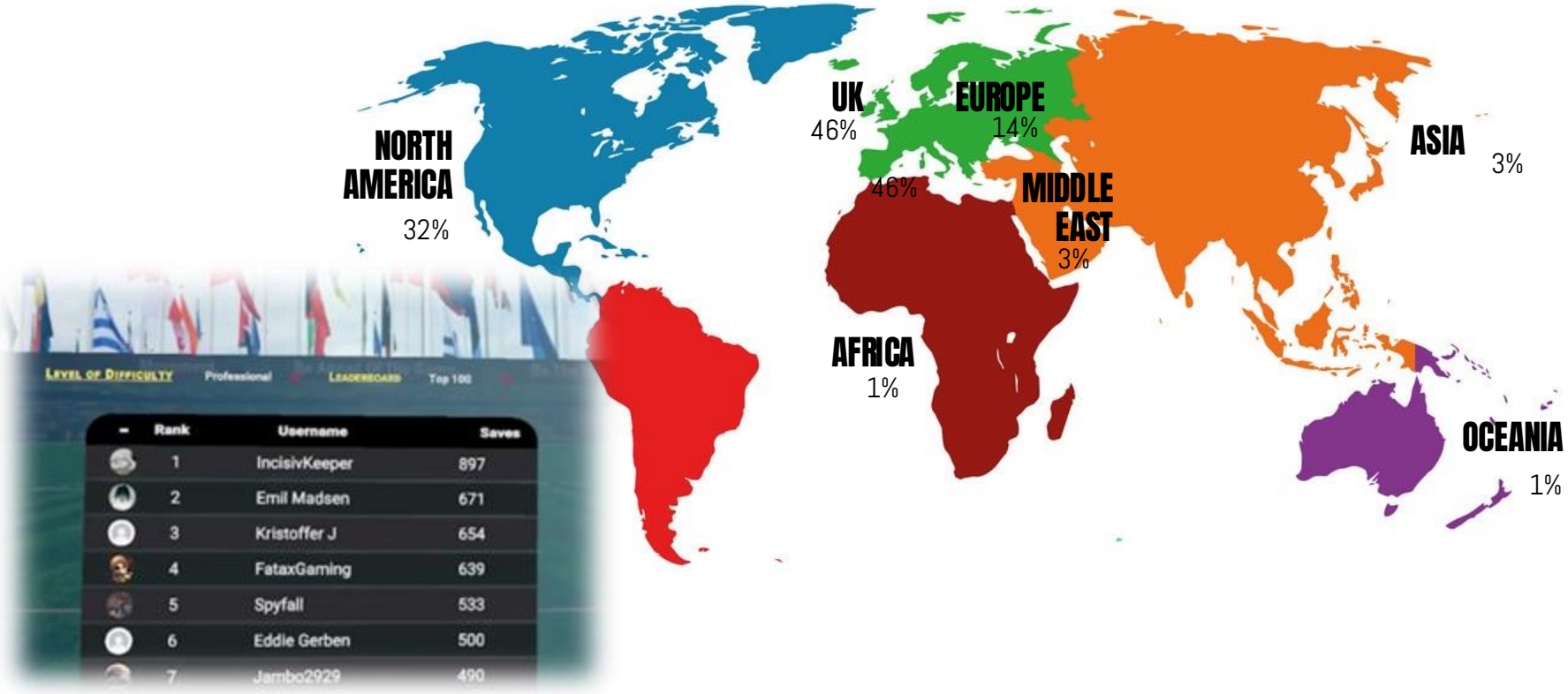
Great Game

6 Oct at 01:32

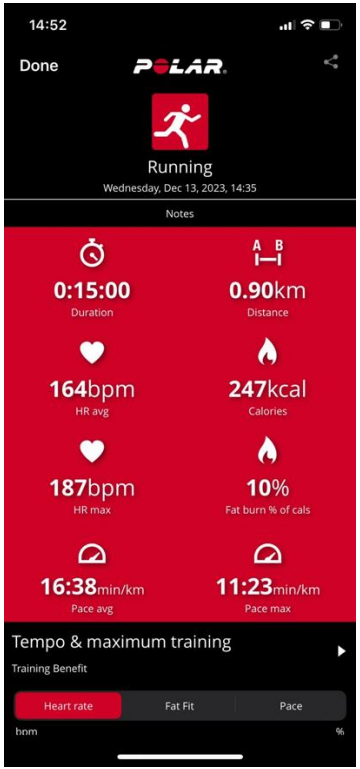
Even though I don't play goalie I find this game very enjoyable and it makes me feel more engaged with playing goalie. 1 suggestion for developer please add a story mode or career mode that would be really cool

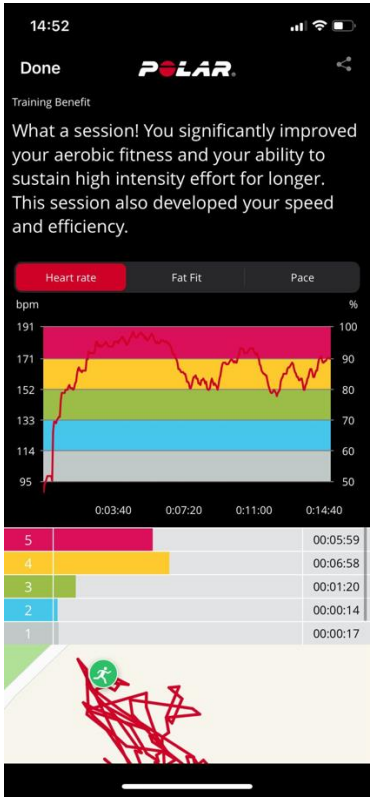
captain sigma Helpful | 1

IDENTIFYING TALENT ACROSS THE WORLD

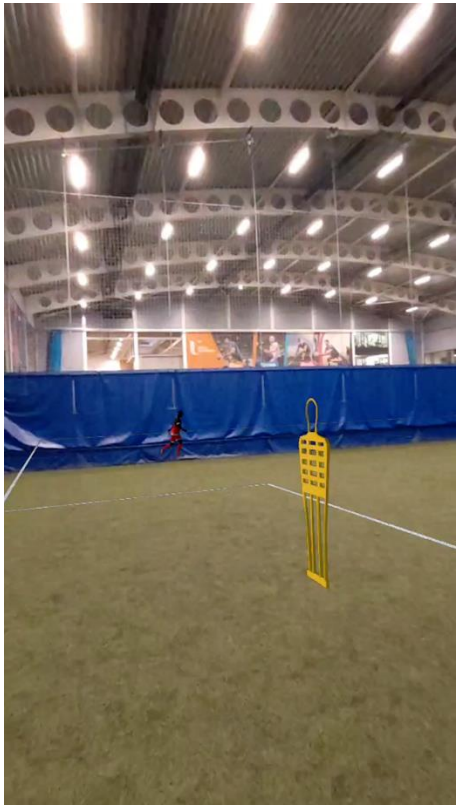


USING CLEANSHEET TO IMPROVE FITNESS



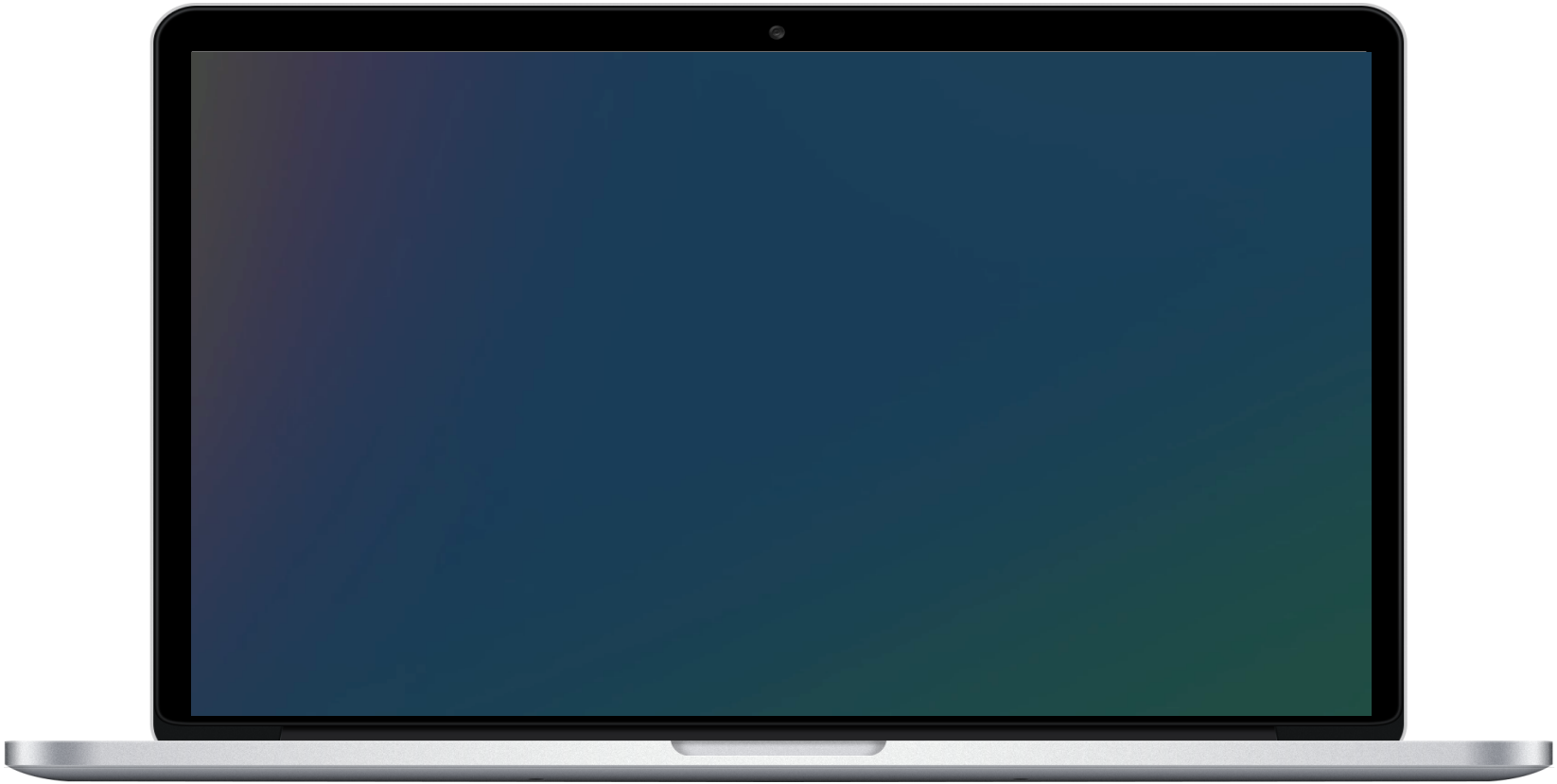


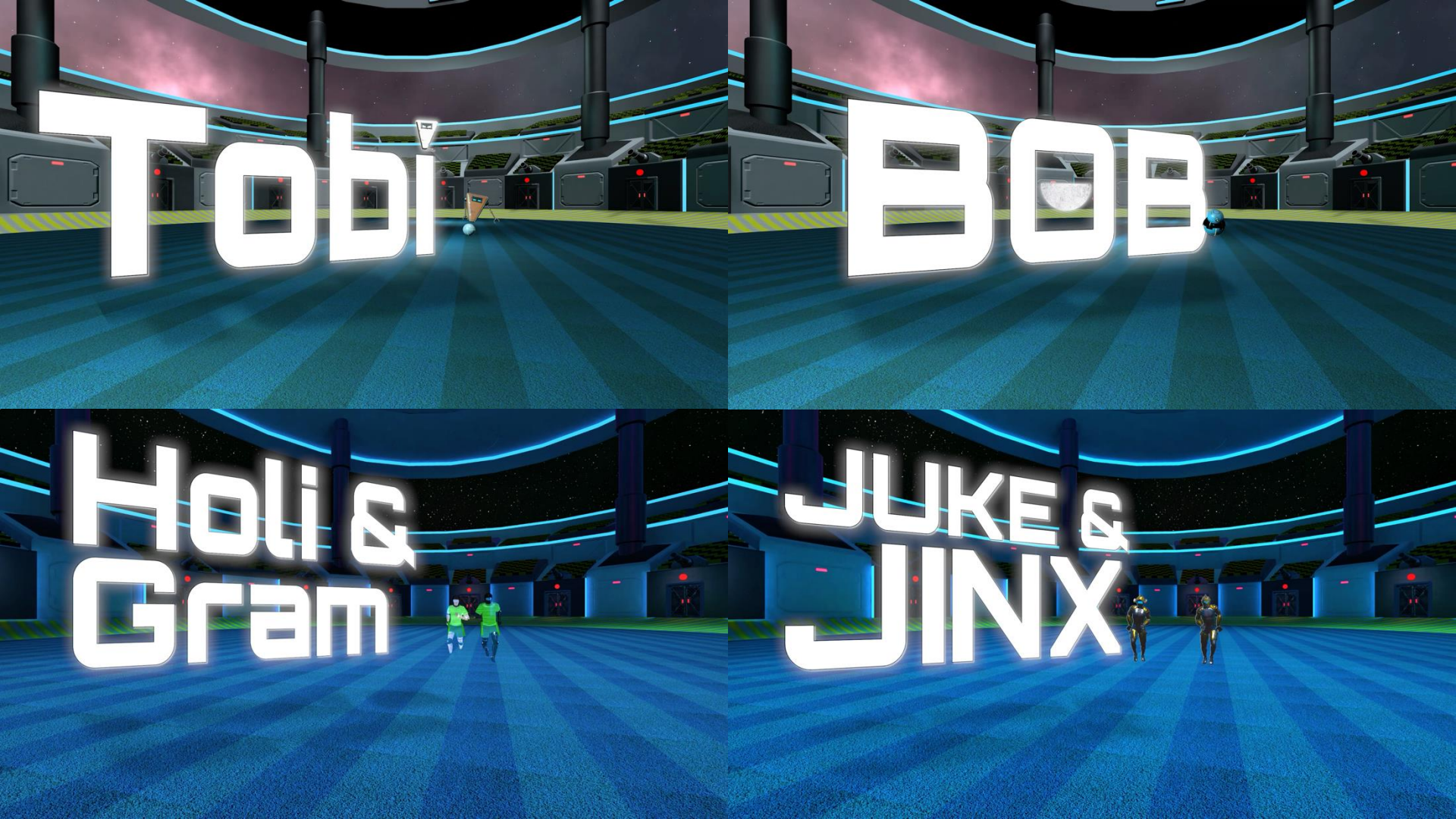
CLEANSHEET: MIXED REALITY



TRAINING AGILITY & EVASION

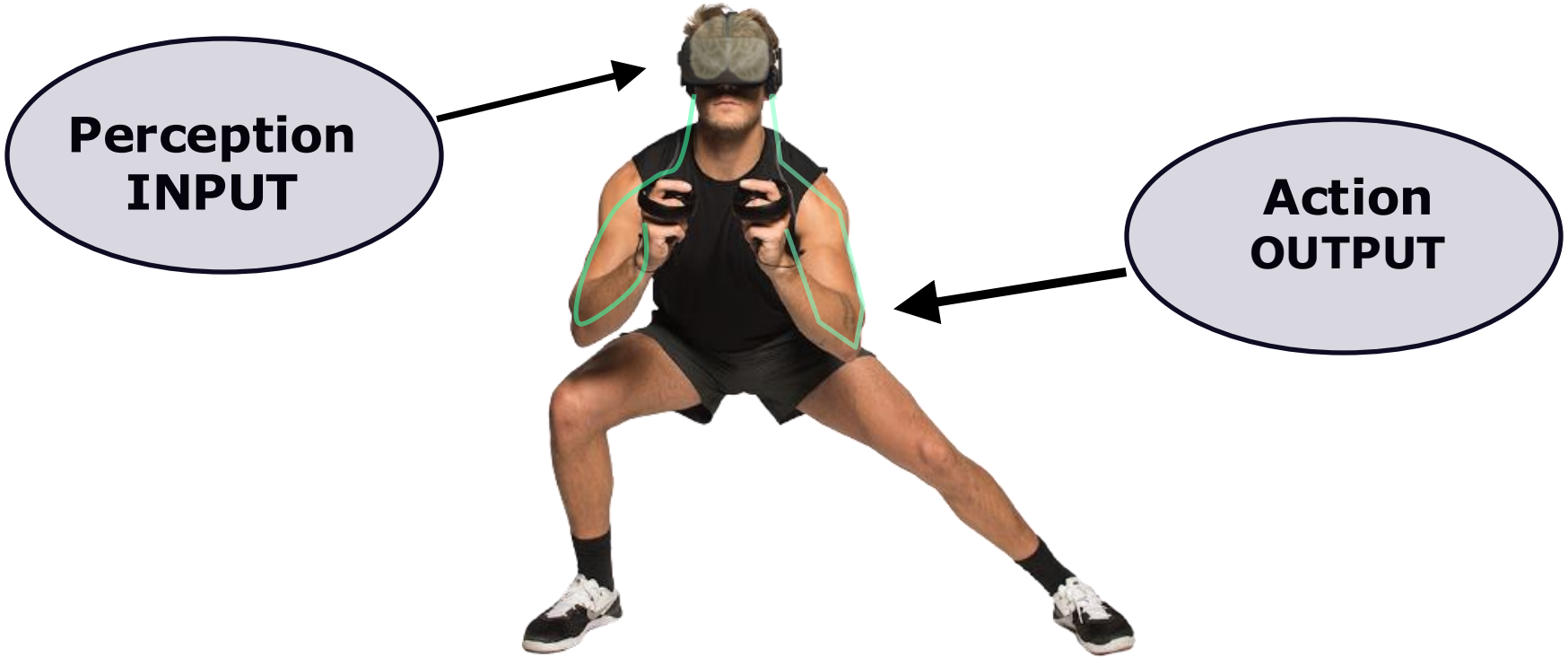

BIOLOGICAL MOTION
CAPTURING REALISTIC SIDESTEPS
MALE & FEMALE PLAYERS



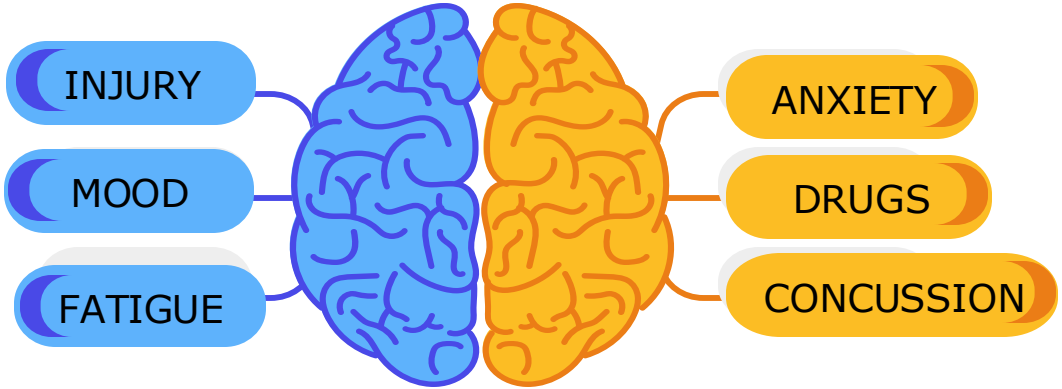

Tobi
Bob
Holi &
Gram
JUKE &
JINX

MEASURING & IMPROVING NEURAL FITNESS

VIRTUAL REALITY CAN MEASURE NEURAL FITNESS



NEURAL FITNESS AFFECTS PERFORMANCE



QMOViR.
Powered by INCISIV.

Profile

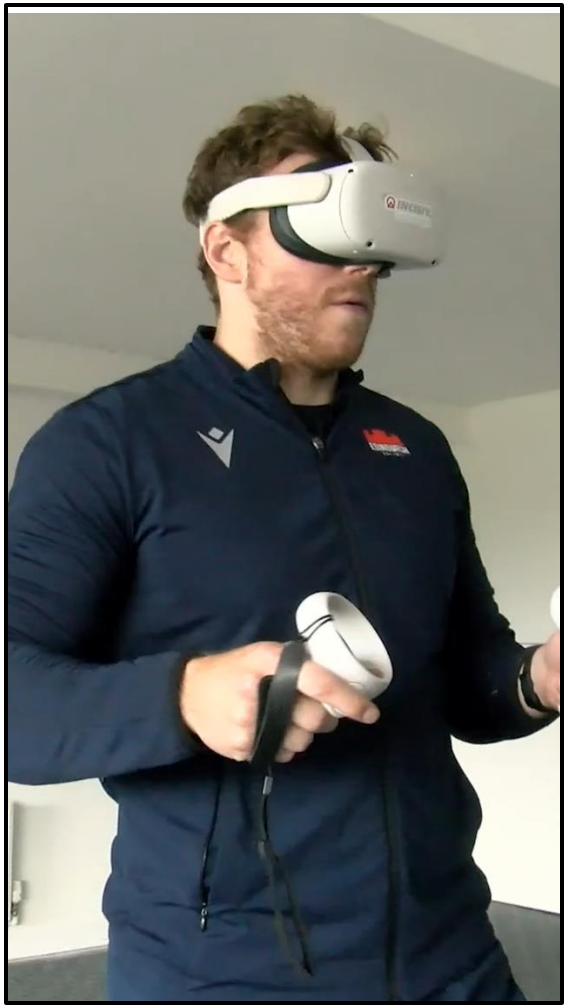
Rehabilitate

Train

PROFILING

- Suite of **sport specific VR tests**
- Profile and measure **neural fitness**
- **Benchmark performance** to different contexts (pre-post injury; team/population; sport; position; age; gender; level of development)

Quality data to identify opportunities for development



Player 2 days post Head injury

820109

28
Age

Professional
Level

Forward
Position

2
Baseline sessions

7
Post Injury sessions

2
Days since injury

05/02/2024
Post Injury

2023-2024
- [x] 3
- [ ] 4
- [ ] 5

BALANCE&GAIT | Rank: 6th

Primary | All

Left Sway (cm)	Right Sway (cm)	Time (s)	Sway Speed (cm/s)	Accuracy (%)
127	153	43.5	16.9	84
Baseline: 41	Baseline: 70	Baseline: 40.0	Baseline: 7.8	Baseline: 83

TANDEM BALANCE | DUAL-TASK BALANCE | TANDEM WALK

DECISION-MAKING | Rank: 9th

Primary | All

Accuracy (%)	Accuracy (%)
70	61
Baseline: 63	Baseline: 61

BALL POP | BALL POP EVEN

MANUAL DEXTERITY | Rank: 7th

Primary | All

Time (s)	Time (s)
61.4	58.0
Baseline: 58.2	Baseline: 74.9

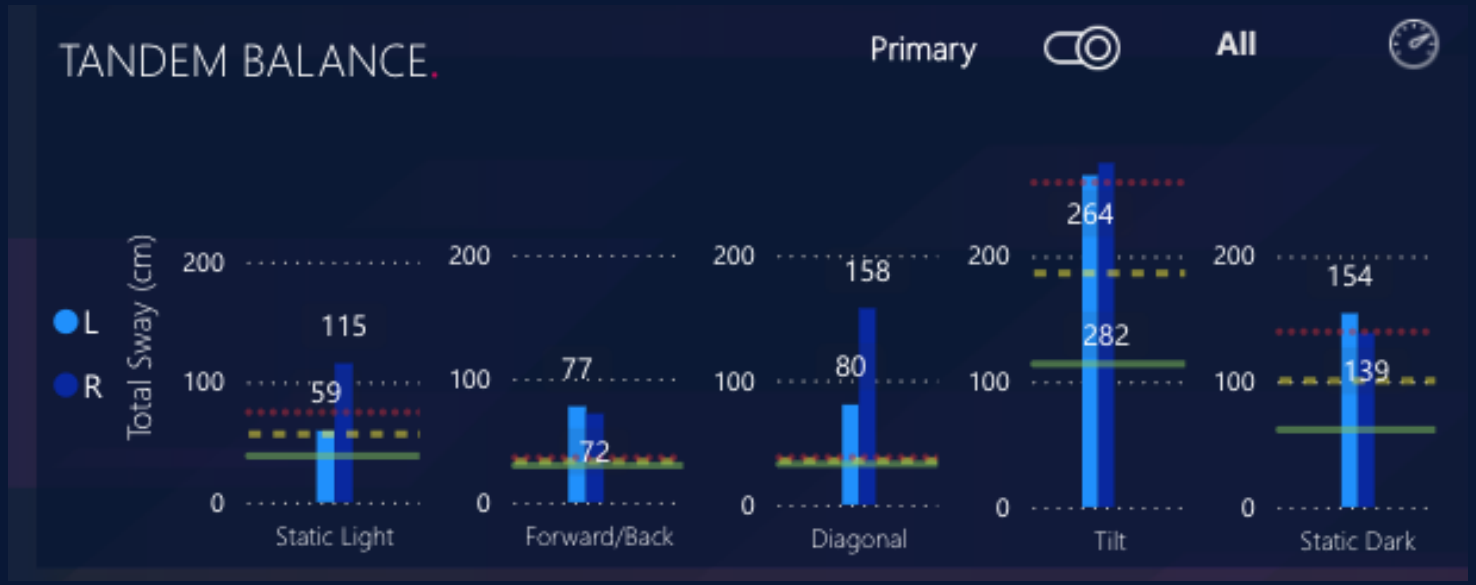
BUZZWIRE LEFT | BUZZWIRE RIGHT

MEMORY&COGNITION | Rank: 2nd

Primary | All

Accuracy (%)	Time (s)
77	129.1
Baseline: 85	Baseline: 136.2

DIGITS BACKWARDS


TANDEM BALANCE.
Primary
All
L
R
Total Sway (cm)
200
100
0
115
59
77
72
158
80
264
282
154
139
Static Light
Forward/Back
Diagonal
Tilt
Static Dark

REHABILITATION

- Increased **athlete engagement**
- **Progress tracked** independently
- **VR sessions customized** for each athlete

Athlete returns to competition quickly & safely

Stafford et al, 2022

PLAYER OVERVIEW.

Balance&Gait
Category

Tandem Balance R
Test

Total Sway
Metric

Session Type
- ☐ Baseline
- ☐ Post Injury

Category
- ◉ Balance&Gait
- ○ Decision-Making
- ○ Manual Dexterity
- ○ Memory&Cognition

Test
- ○ Dual-Task Balance
- ○ Tandem Balance L
- ◉ Tandem Balance R
- ○ Tandem Walk

Metric
- ◉ Total Sway

Results by Date

Metric	09 Sep 2021	10 Sep 2021	05 Oct 2021	07 Oct 2021	12 Oct 2021	14 Oct 2021	20 Nov 2021	**Average**
Total Sway	43.76	41.56	70.62	76.91	61.55	47.49	39.49	**54.48**

Charting Return to Play in Balance task

PLAYER OVERVIEW.

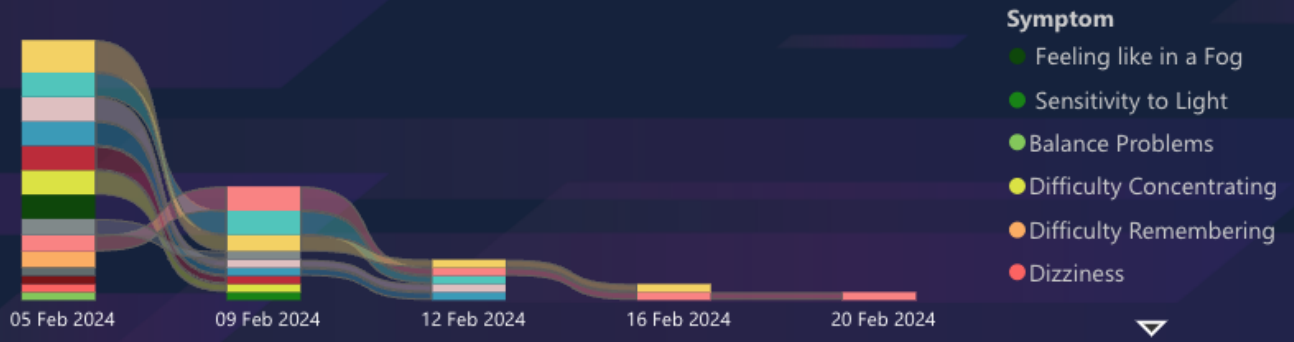
INCISIV.

820109

7
Post Injury

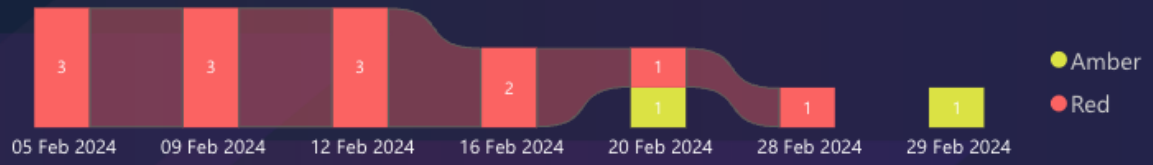
2
Baseline

Wellbeing per Session



Performance per Session

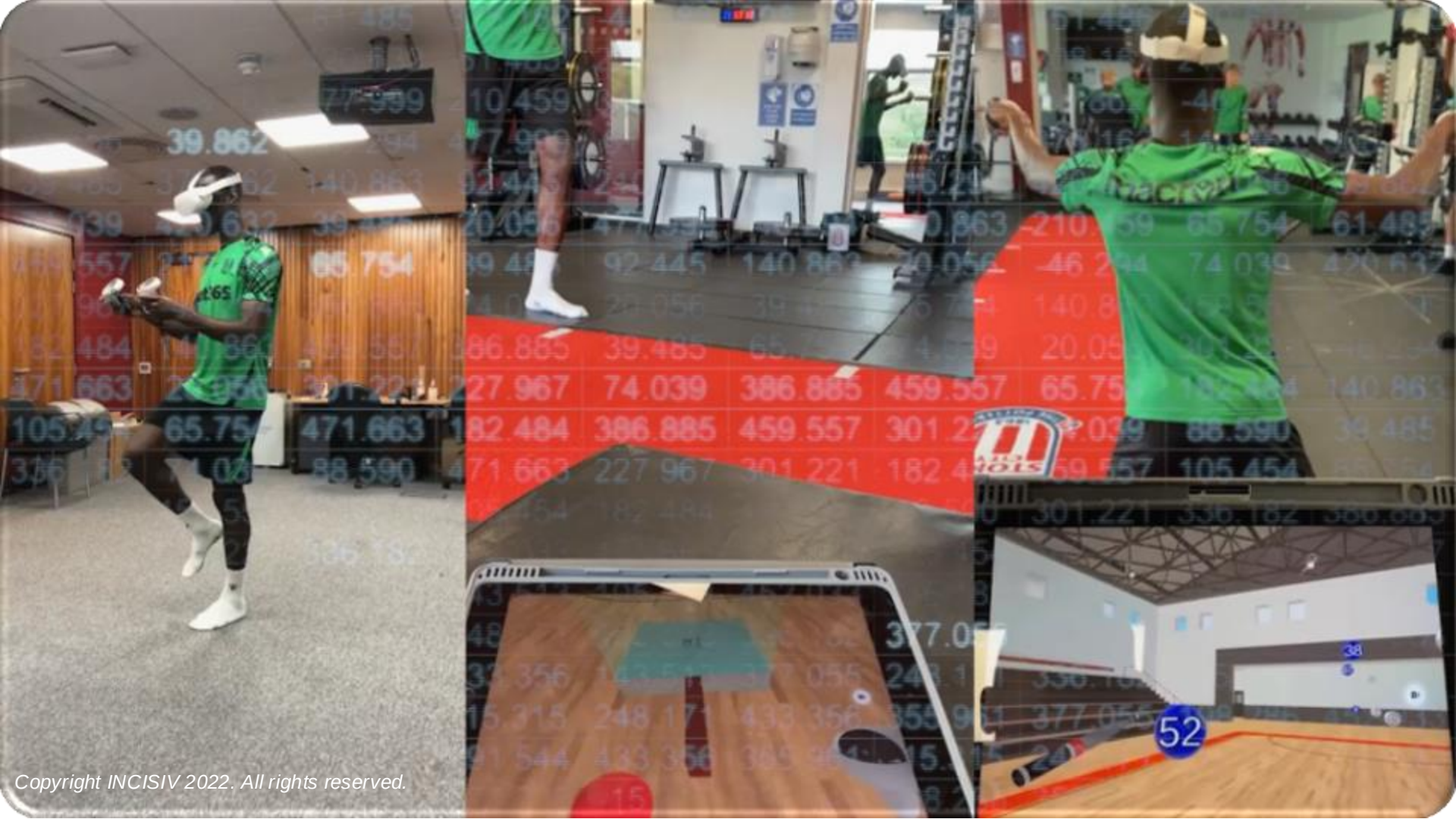
Primary All



Date
- 2023-2024

Symptom
- Select All
- Feeling like in a Fog
- Sensitivity to Light
- Balance Problems
- Difficulty Concentrating
- Difficulty Remembering
- Dizziness
- Do not Feel Right
- Drowsiness
- Fatigue or Low Energy
- Feeling Slowed Down
- Headache

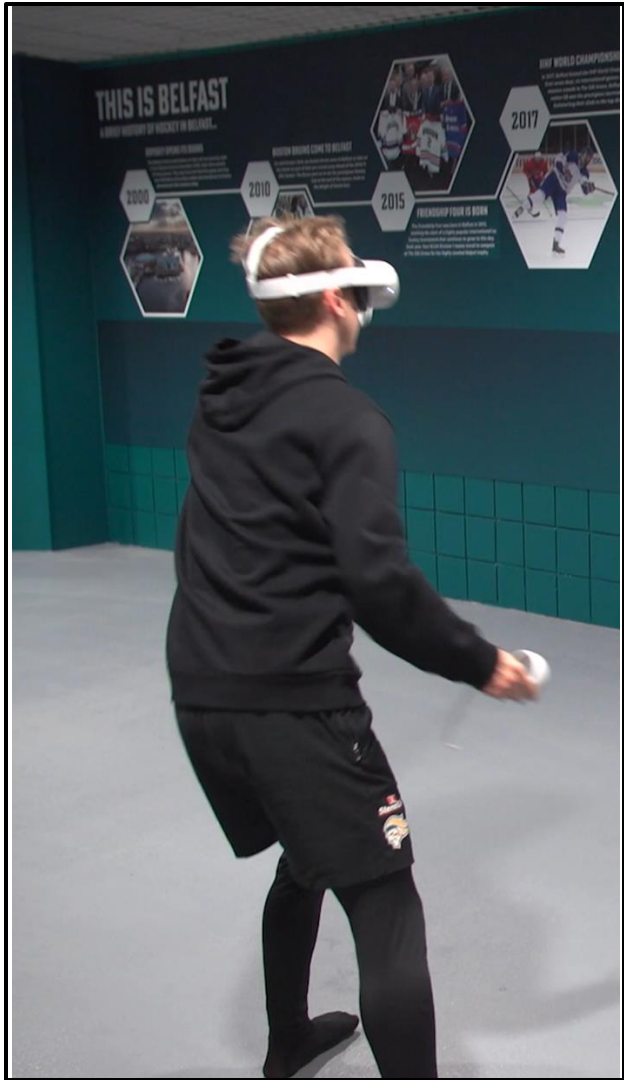
Symptom	05 Feb 2024	09 Feb 2024	12 Feb 2024	16 Feb 2024	20 Feb 2024	28 Feb 2024	29 Feb 2024	T
Feeling like in a Fog	3	0	0	0	0	0	0	
Sensitivity to Light	0	1	0	0	0	0	0	
Balance Problems	1	0	0	0	0	0	0	
Difficulty Concentrating	3	1	0	0	0	0	0	
Difficulty Remembering	2	0	0	0	0	0	0	
Dizziness	1	0	0	0	0	0	0	
Do not Feel Right	3	1	0	0	0	0	0	
Total	**32**	**14**	**5**	**2**	**1**	**0**	**0**	



TRAINING

- **Correct asymmetries** or biases (e.g. balance)
- **Address neural fitness gaps** by prescribing specific VR drills

Improved neural fitness (sensory/motor coordination) **to reduce risk of injury**



TEAM OVERVIEW.

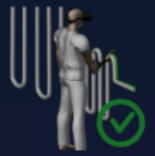
2021 | Jan | Feb | Mar | Apr | Jun | Sep | Oct | Nov | Dec

INCIS

BALANCE & GAIT | DECISION-MAKING | **MANUAL DEXTERITY** | MEMORY & COGNITION

OVERVIEW | **RESULTS**

BUZZWIRE RIGHT.



Average Results

UserId	Rank	Score	Time (s)	Acc. (%)	R Dom (%)
103489	1 ★	100	38.89	94	51%
111049	2	92	42.18	92	52%
122019	3	88	44.05	93	50%
147617	4	80	48.58	89	51%
155765	5	80	48.83	85	50%
104679	6	79	49.25	85	50%
180024	7	79	49.35	92	53%
154260	8	77	50.84	89	52%
153336	9	76	50.90	90	50%
163646	10	75	51.76	92	47%
126100	11	75	52.19	87	43%

104679
Hooker

MDR Rank: 6th

Balance

50% 50%

Better than 90% of players

Accuracy (%)

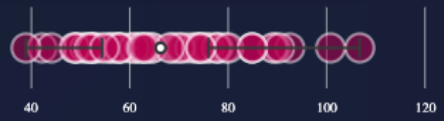
84 | 85

Time (s)

49.7 | 49.2

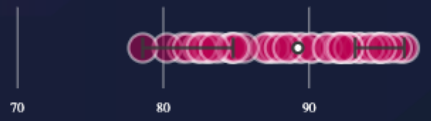
L R

94.23

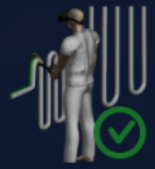


Accuracy (%)

78.59 80.57 82.56 84.55 86.53 88.52 90.50 92.49 94.48 96.4



BUZZWIRE LEFT.

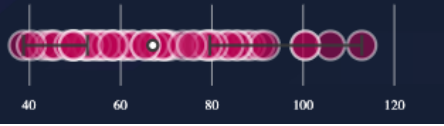


Average Results

UserId	Rank	Score	Time (s)	Acc. (%)	L Dom (%)
126100	1 ★	79	38.68	91	57%
103489	2	76	40.40	93	49%
125786	3	71	42.91	87	57%
122019	4	69	44.42	90	50%
111049	5	68	45.11	89	48%
163646	6	67	45.60	89	53%
128320	7	63	48.63	95	54%
155765	8	62	49.56	83	50%
134575	9	62	49.60	92	56%
169000	10	62	49.70	97	56%
104679	11	61	49.73	84	50%

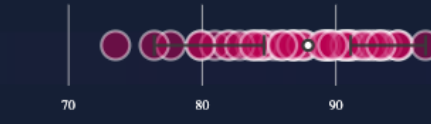
Time (s)

30.57 42.06 53.55 65.05 76.54 88.03 99.52 111.02



Accuracy (%)

74.48 76.84 79.21 81.58 83.94 86.31 88.68 91.04 93.41 95.7




BELFAST GIANTS
SCOTLAND

Obrigada!

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