
THE UNIVERSITY
of ADELAIDE
REALISING THE BENEFIT OF
AUGMENTED REALITY FOR
MILITARY APPLICATIONS
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Realising the benefit of augmented reality for military applications

Australian Government
Department of Defence
Defence Science and Technology Group

THE UNIVERSITY of ADELAIDE

RHEINMETALL GROUP

University of South Australia

Flinders UNIVERSITY

THE UNIVERSITY OF WESTERN AUSTRALIA

THE UNIVERSITY OF MELBOURNE

Team

A/Prof Anna Ma-Wyatt (University of Adelaide) – Team leader

Expertise in eye movements, attention and human-autonomy teaming

Dr Justin Fidock (DST) Land Division

Expertise in human-autonomy teaming.

Prof Siobhan Banks (University of South Australia)

Expertise in fatigue

Mr Ben Kilsby and Mr Shane Ploenges (Rheinmetall)

Insight into current vehicles used by Land, as well as future technologies

Prof David Badcock (University of Western Australia)

Expertise in human vision, especially binocular vision and form processing

Prof Mike Nicholls (Flinders University)

Expertise in spatial attention

Prof Allison McKendrick (University of Melbourne)

Expertise in human vision, especially for compromised visual fields

Team

Postdoctoral fellow, split across:

Dr Heidi Long (experimental protocol and data analysis)

Dr James Baumeister (sim development)

Ms Jessica O'Rielly (experimental protocol and data analysis)

Dr Owen Gwinn (testing and data analysis)

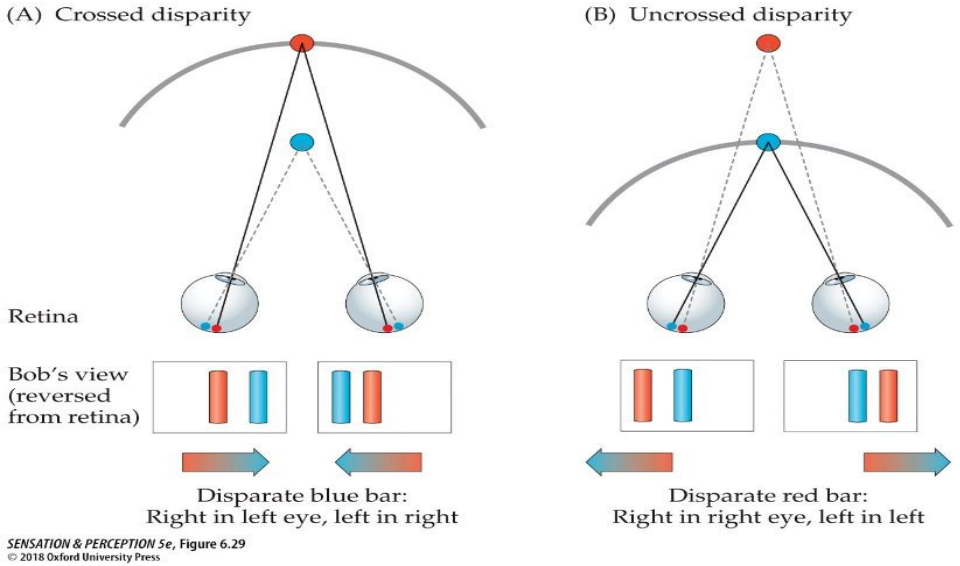
Dr Crystal Grant (data analysis)

Limits imposed by Vision

- Our eyes have different views of the world. (Demonstration)

- People use a variety of monocular and binocular cues as they interact with their environment.
- But AR relies heavily on one cue: binocular disparity.

Occlusion



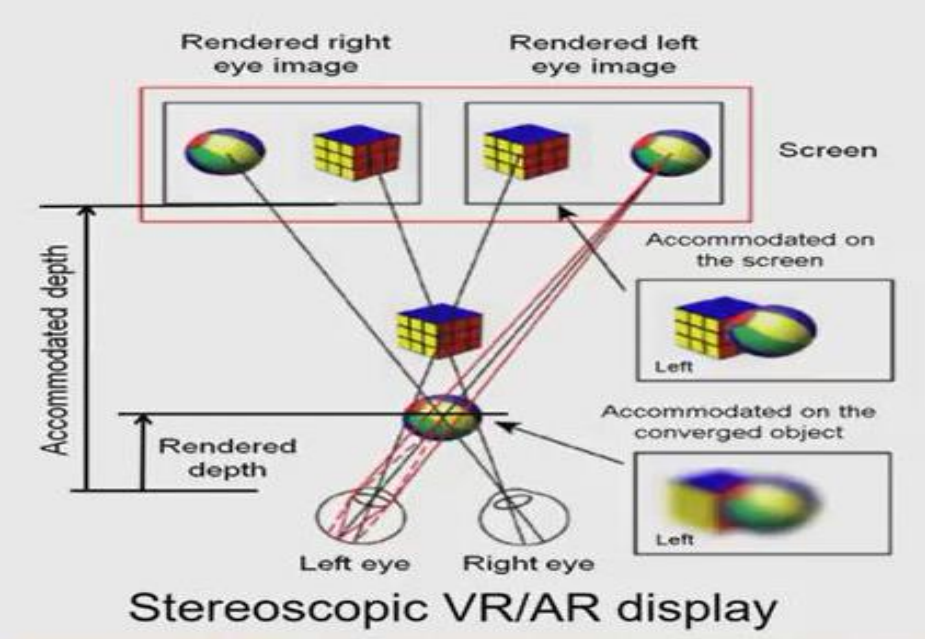
- Adjusting disparity allows us to place objects at different image depths.

Limits imposed by Vision

Around 30-40% have compromised stereo vision (implications: 3DTV)

We only have high resolution vision at the point we look at.

The distance we focus at is usually linked closely to the distance the two eyes are pointing at. AR/VR requires different distances for these things.



Hong Hua (2019)

Distorted depth perception *[Edgar et al. 94; Inoue and Ohzu, 1997; Davis 02; Swan et al. 06; Hoffman et al 2008]*

Artifacts: eye fatigue, diplopic vision, degraded oculomotor response, headache, etc. *[Mon-Williams et al. 05; Wann et al. 95]*

Our Research Questions

- How does the use of AR impact deployment of attention for Human Machine Interfaces?

- What effect does fatigue have on performance for these scenarios?

Stereo

Randot stereo test

Simple test – about 5min to administer

Suitable for adults and children

Fatigue

Sleep restriction

Repeated measures, within subjects design

Each participant completed the tasks while rested and under fatigue

Protocol

Stereo test

On each visit:

PVT

Demo in VR

PVT

VR driving

PVT

Quantifying impact of stereo and fatigue on performance

NASA TLX

Sleepiness

Simulator sickness questionnaire (SSQ)

PVT

Target detection

Eye movements

What will these tell us?

What effect does stereo have on performance?

What effect does fatigue have on performance?

What interactions do we see?

Side bar 2

Demographics

Handedness

Levels	Counts	% of Total	Cumulative %
Right	19	61.9 %	61.9 %
Ambidextrous	10	31.7 %	93.7 %
Left	2	6.3 %	100.0 %

Biological sex

Levels	Counts	% of Total	Cumulative %
Female	20	62.5 %	62.5 %
Male	11	34.4 %	96.9 %
N/A	1	3.1 %	100.0 %

Time spent playing games

Levels	Counts	% of Total	Cumulative %
<3-4 days	26	83.9 %	83.9 %
>3-4 days	2	16.1 %	100.0 %

Randot Stereo groupings

Randot Stereo	Count
High (20-40)	14
Mid (50-100)	13
Low (140-400)	6

Results

NASA TLX

Sleepiness

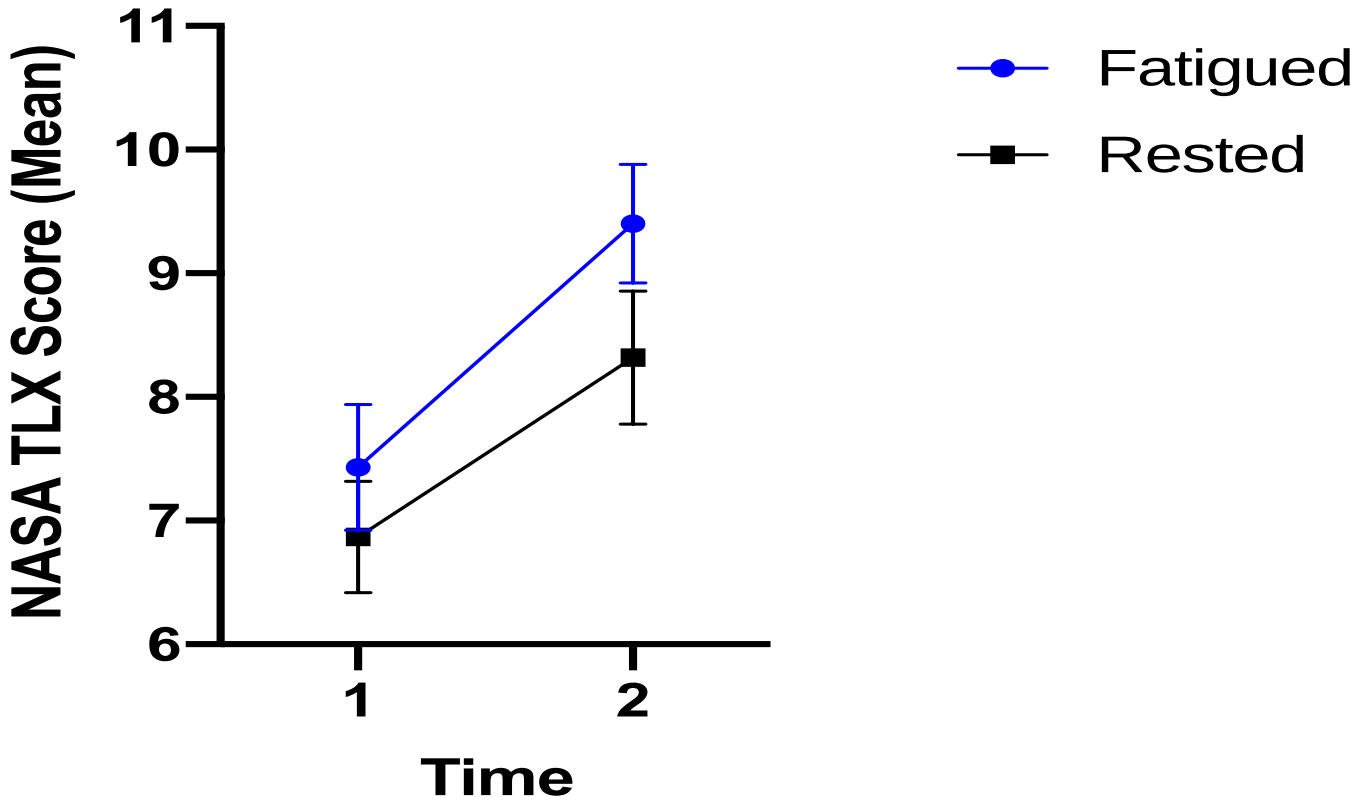
SSQ

PVT

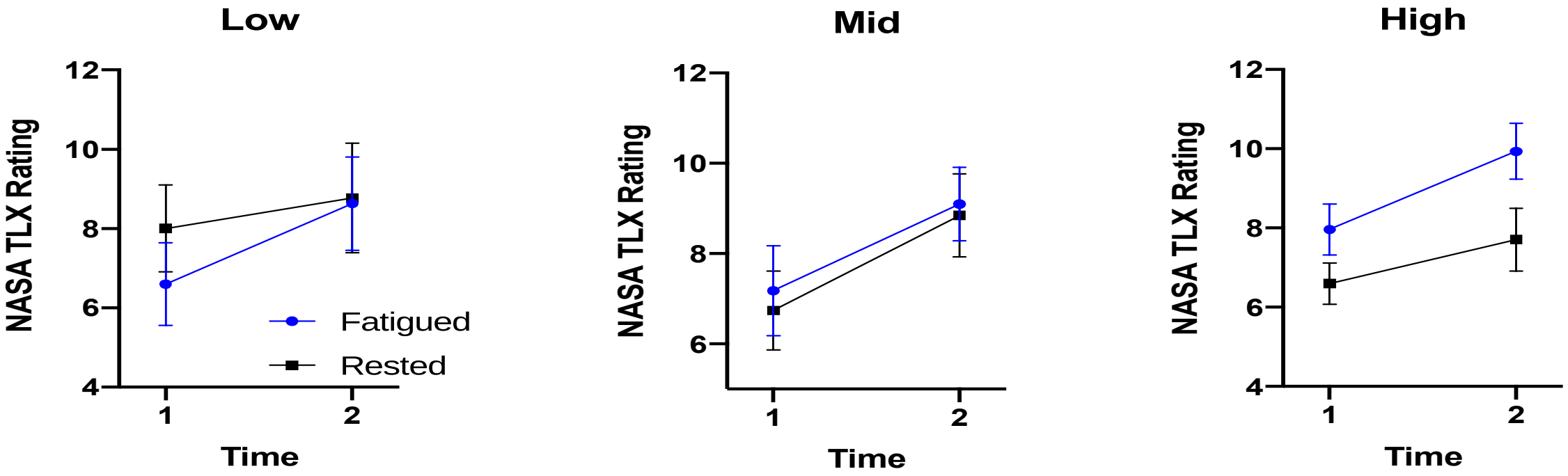
Target detection

Eye movements

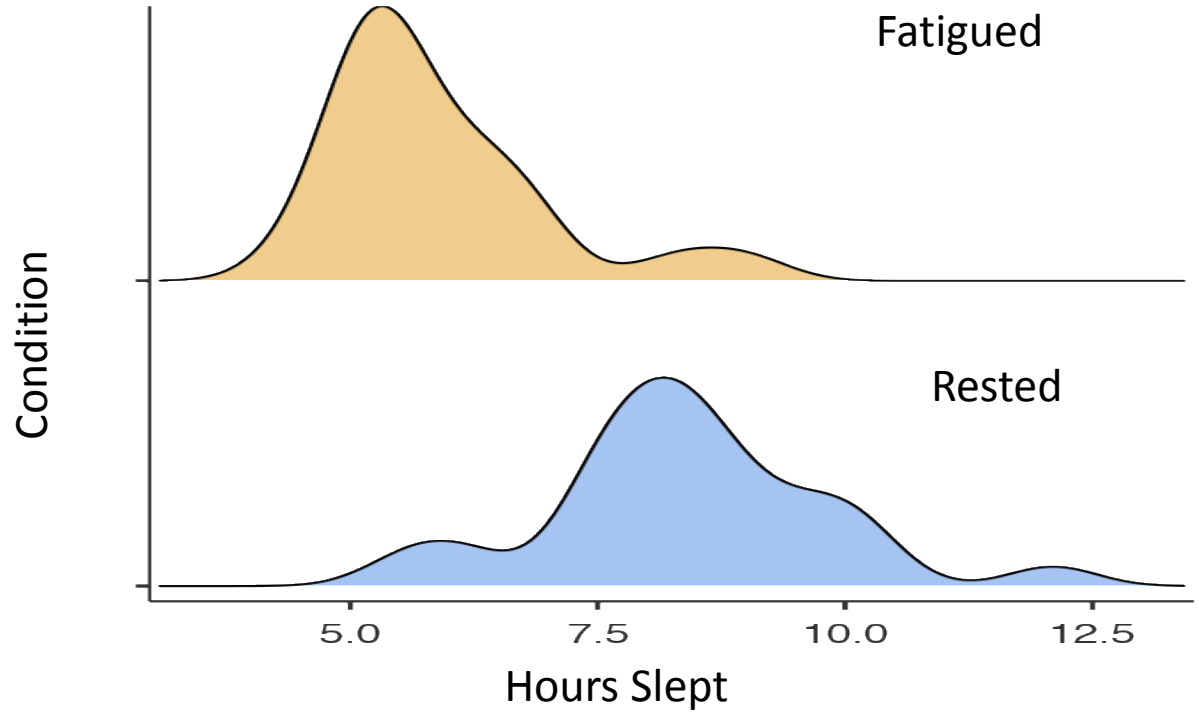
Perceived workload increased with fatigue



Low stereo group report lower workload when fatigued



“Sleepier” after restricted sleep



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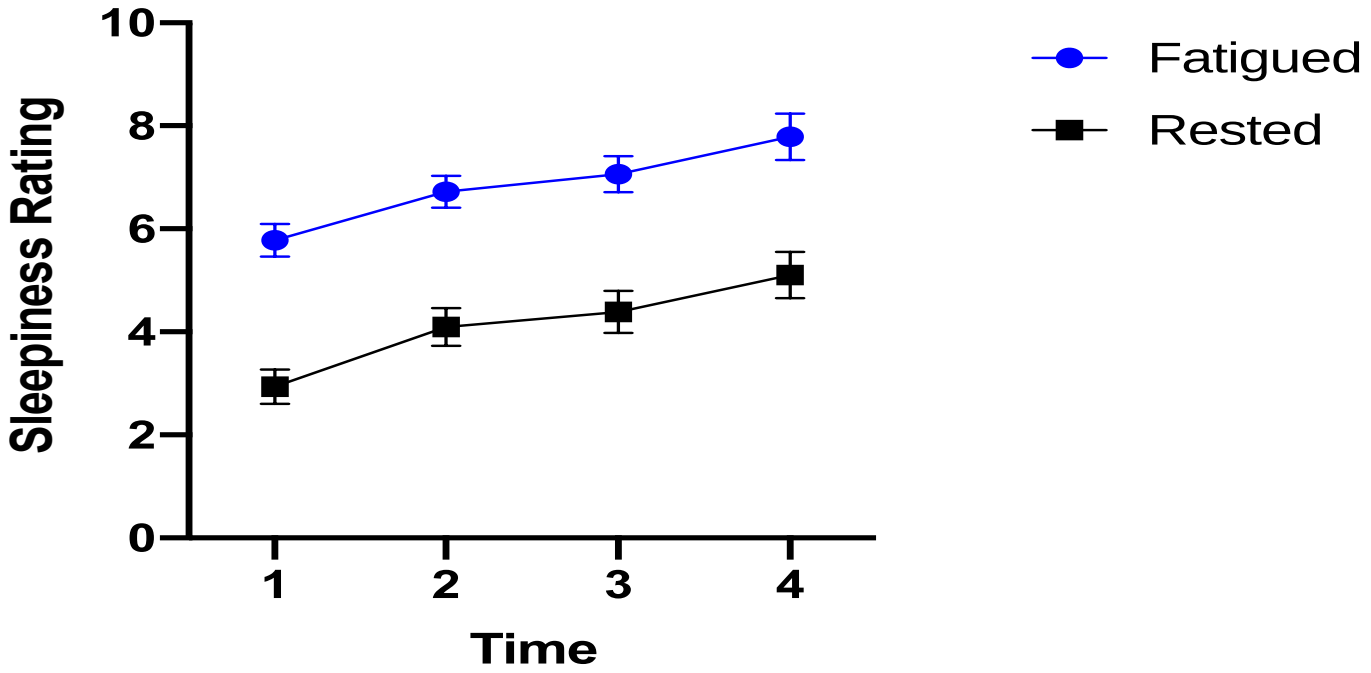
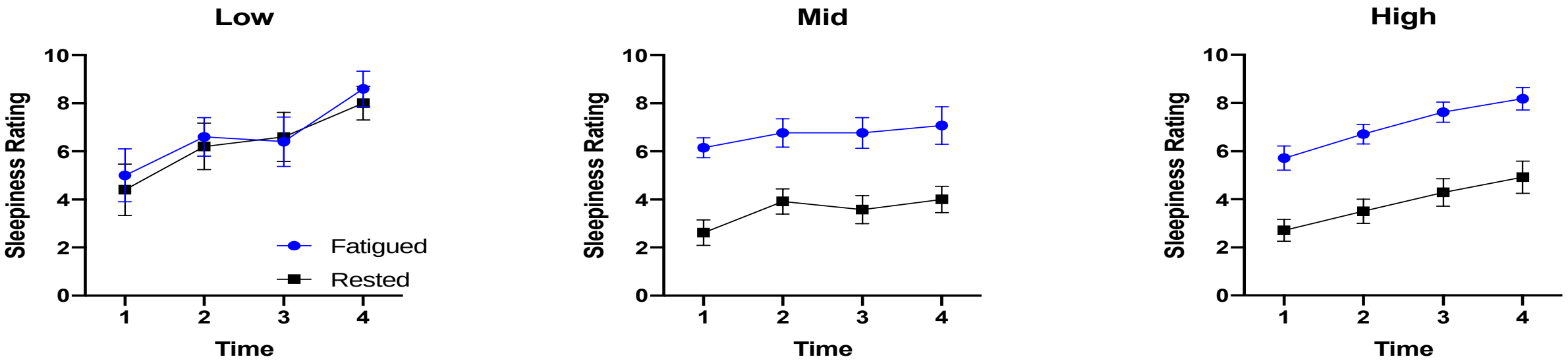
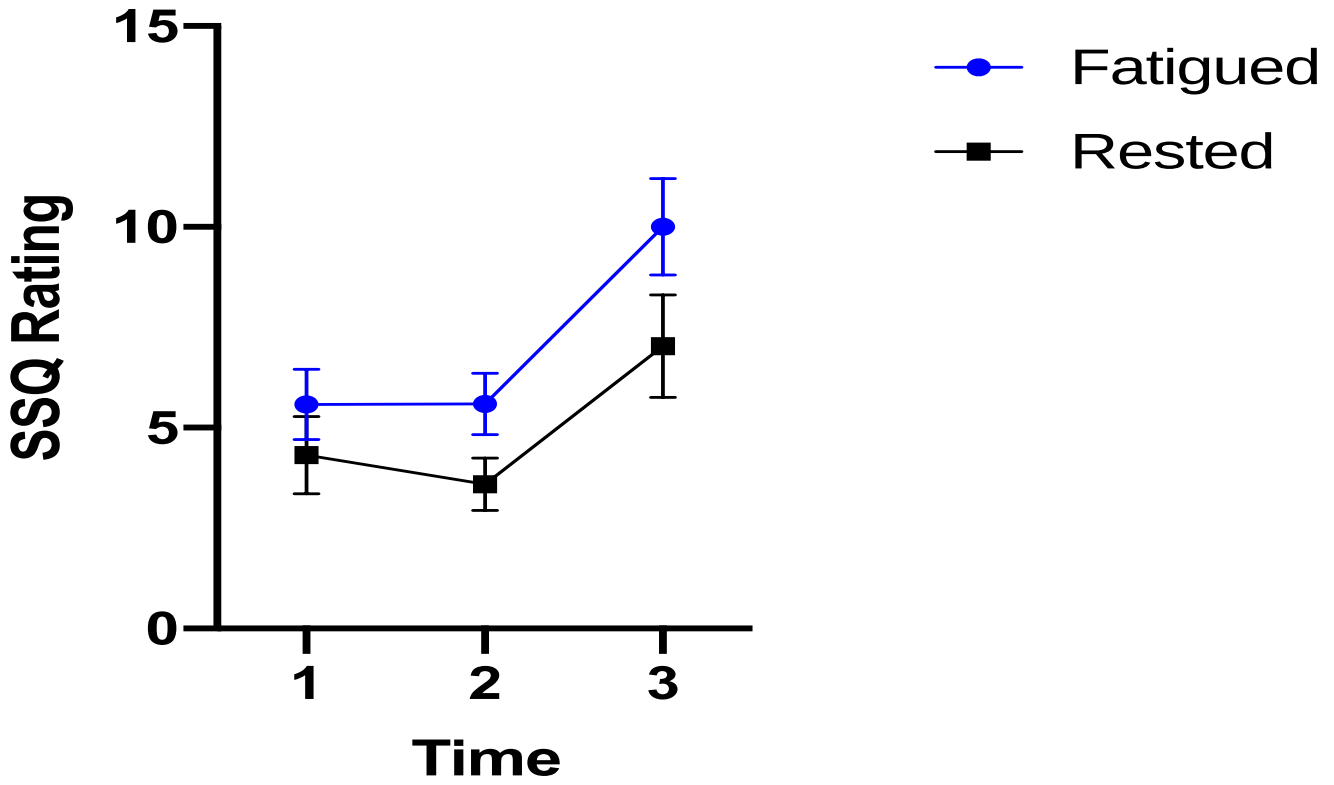


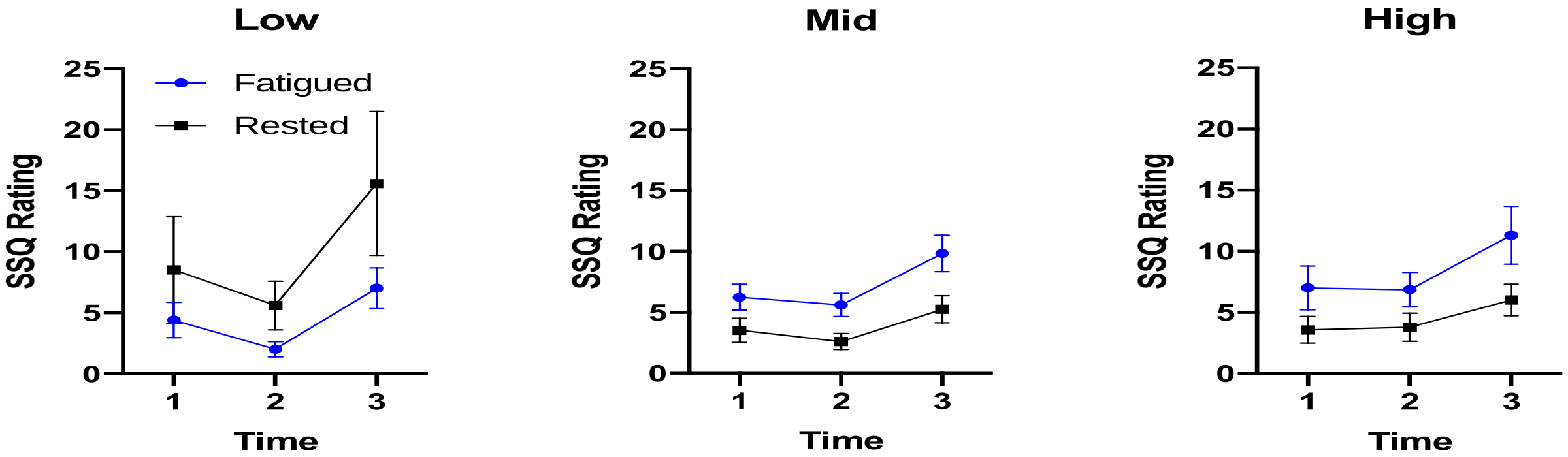
Low stereo participants report being less sleepy



SSQ increases with fatigue..



..unless participants have compromised stereo

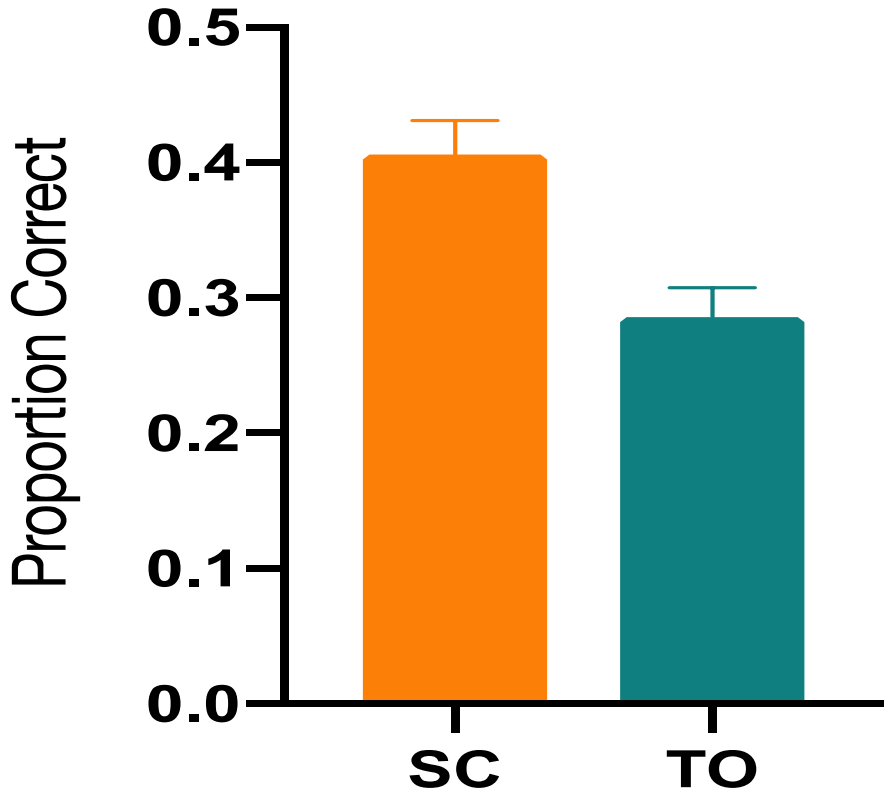


Fatigue impacts PVT, but stereo has little effect

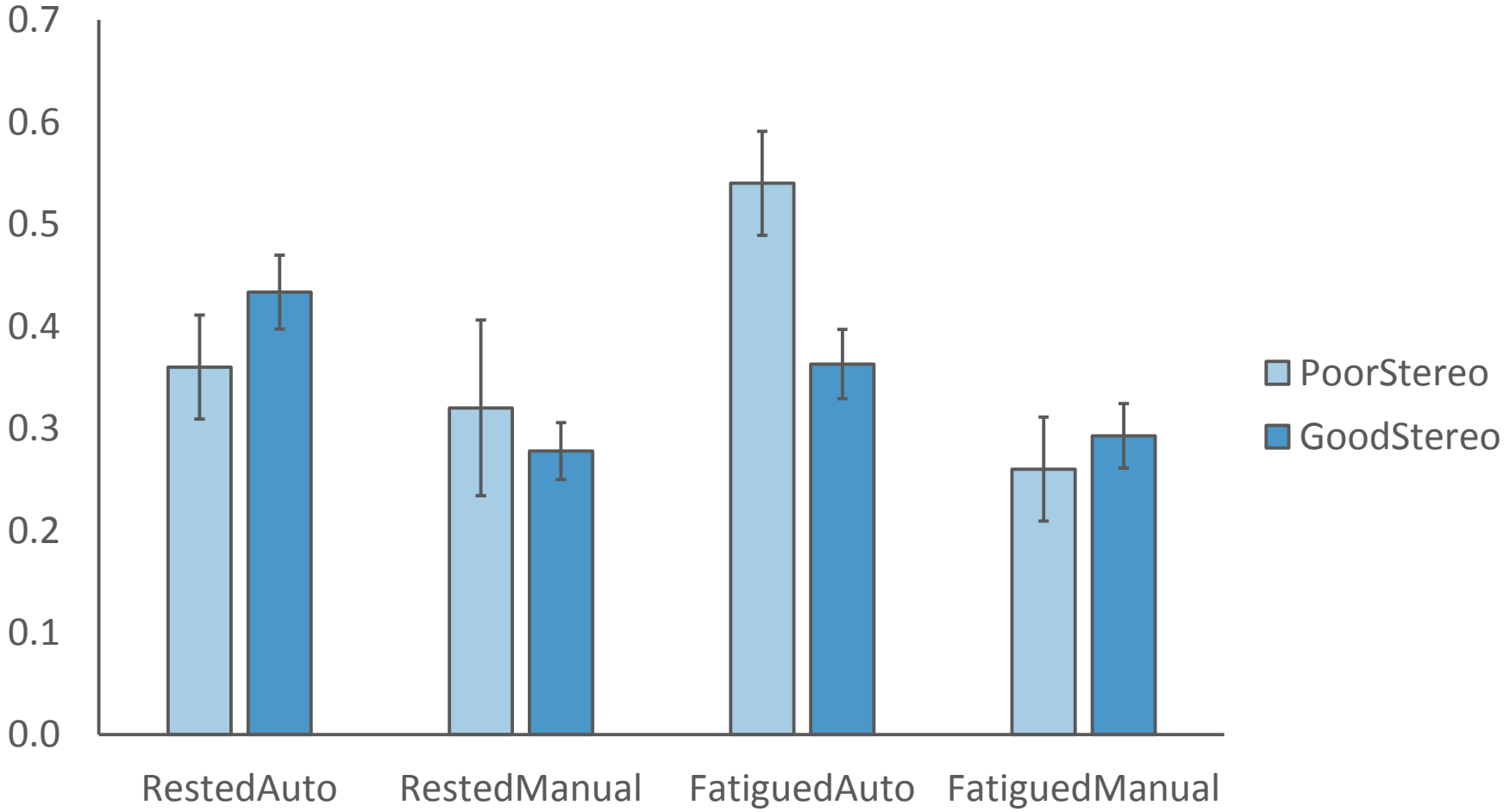
Significantly more lapses under fatigue

No significant difference of fatigue for false starts

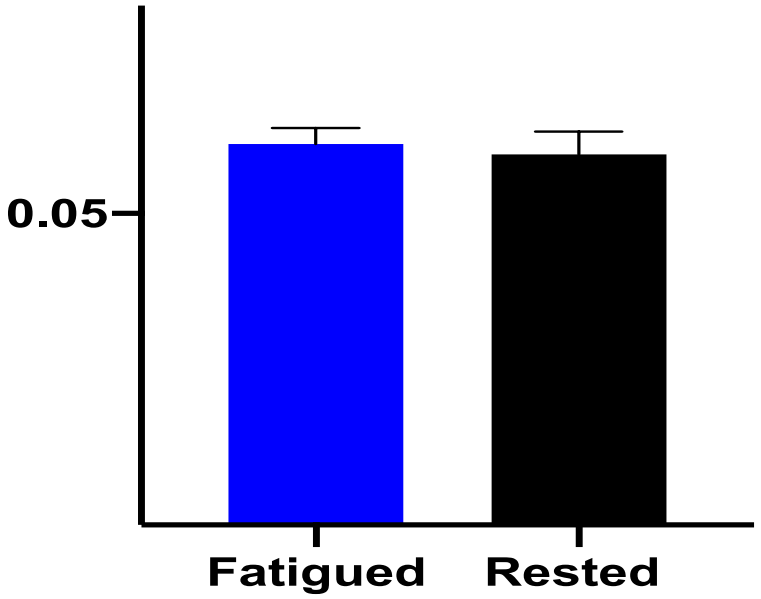
More targets detected during supervisory control than teleoperation



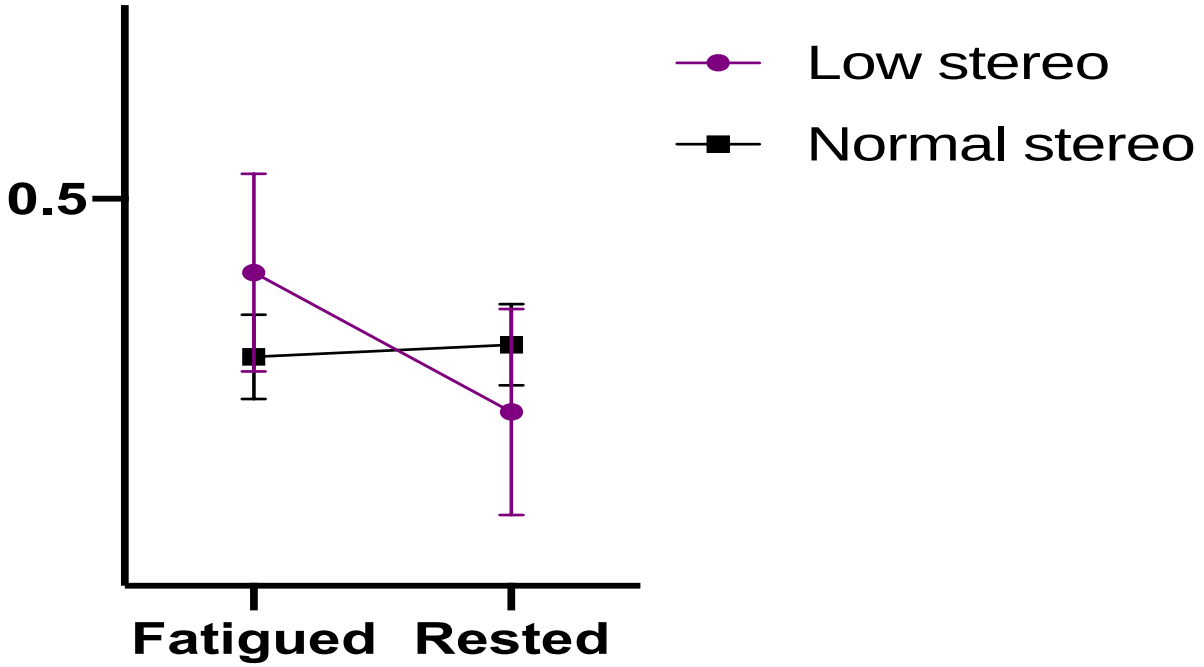
Significant interaction between fatigue, stereo condition and mode of control for target detection



Little effect of fatigue on eye movements



Interaction between stereo and fatigue for eye movements



Sidebar 3

Take homes?

Compromised stereo under fatigue does impact performance:

- **Lower SSQ ratings**
- **Lower workload**
- **Different eye movement metrics**
- **Some interesting interactions with fatigue and mode of control on target detection**

What next?

Screening for stereo to help inform crewing

Longer term quantification of performance – impact of fatigue and stereo over time

Use of machine learning to classify data to help characterise performance for monitoring and intervention

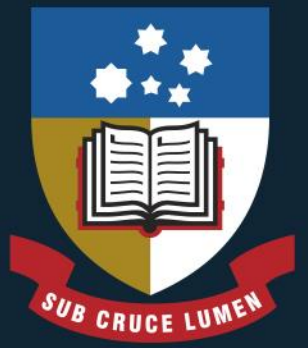
Realising the benefit of augmented reality for military applications









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