

Boredom, vigilance, and repetition during remote control room work for autonomous ships

ICMASS 2024


Erik Veitch

Researcher, Department of Design, NTNU

30 October 2024

Trondheim, Norway



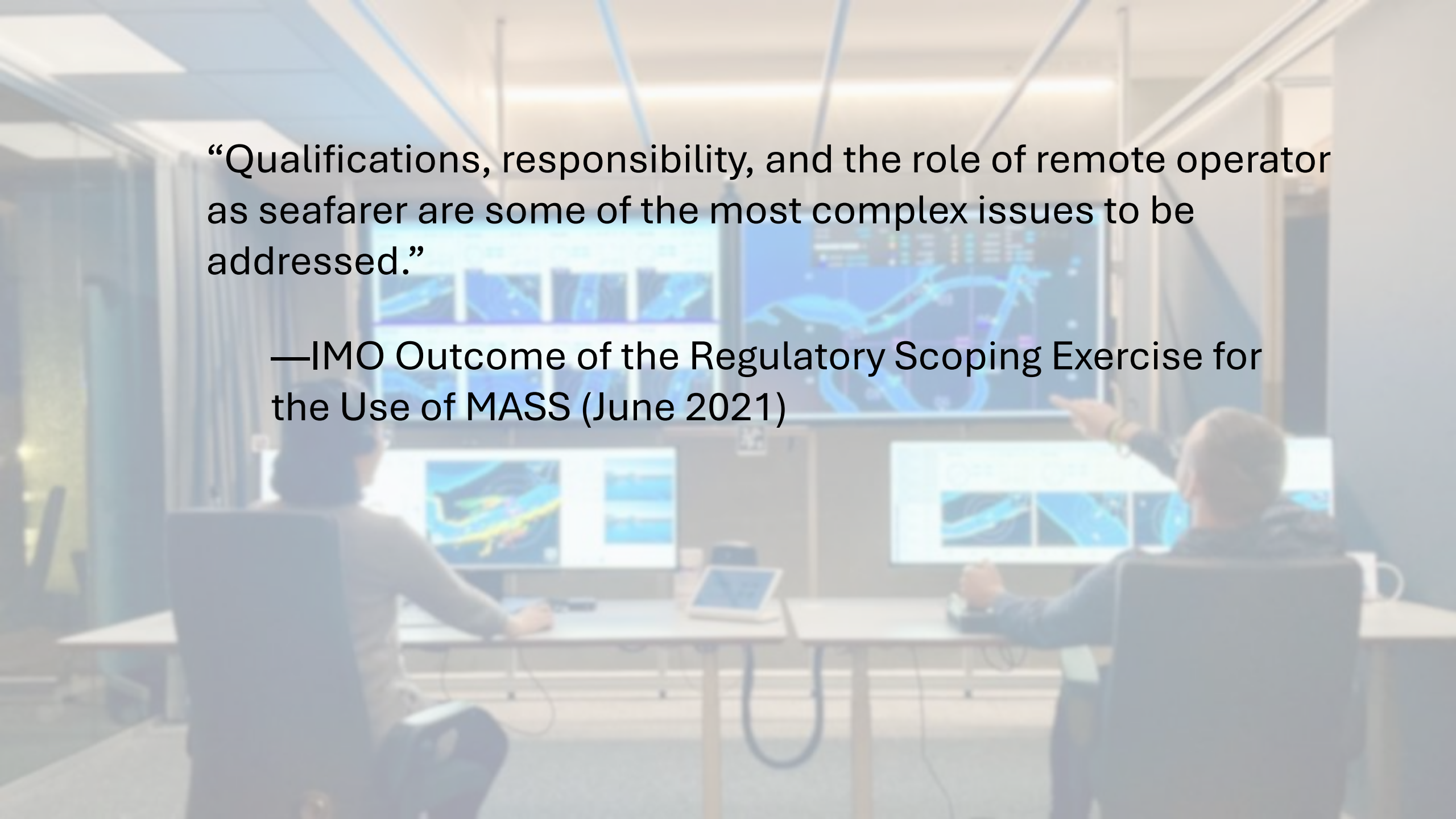
A modern control room with large digital screens displaying data and maps. Two people are seated at desks, interacting with the screens. The room has a high ceiling with exposed ductwork and large windows on the left side. The overall atmosphere is professional and high-tech.

Monitoring Remote control



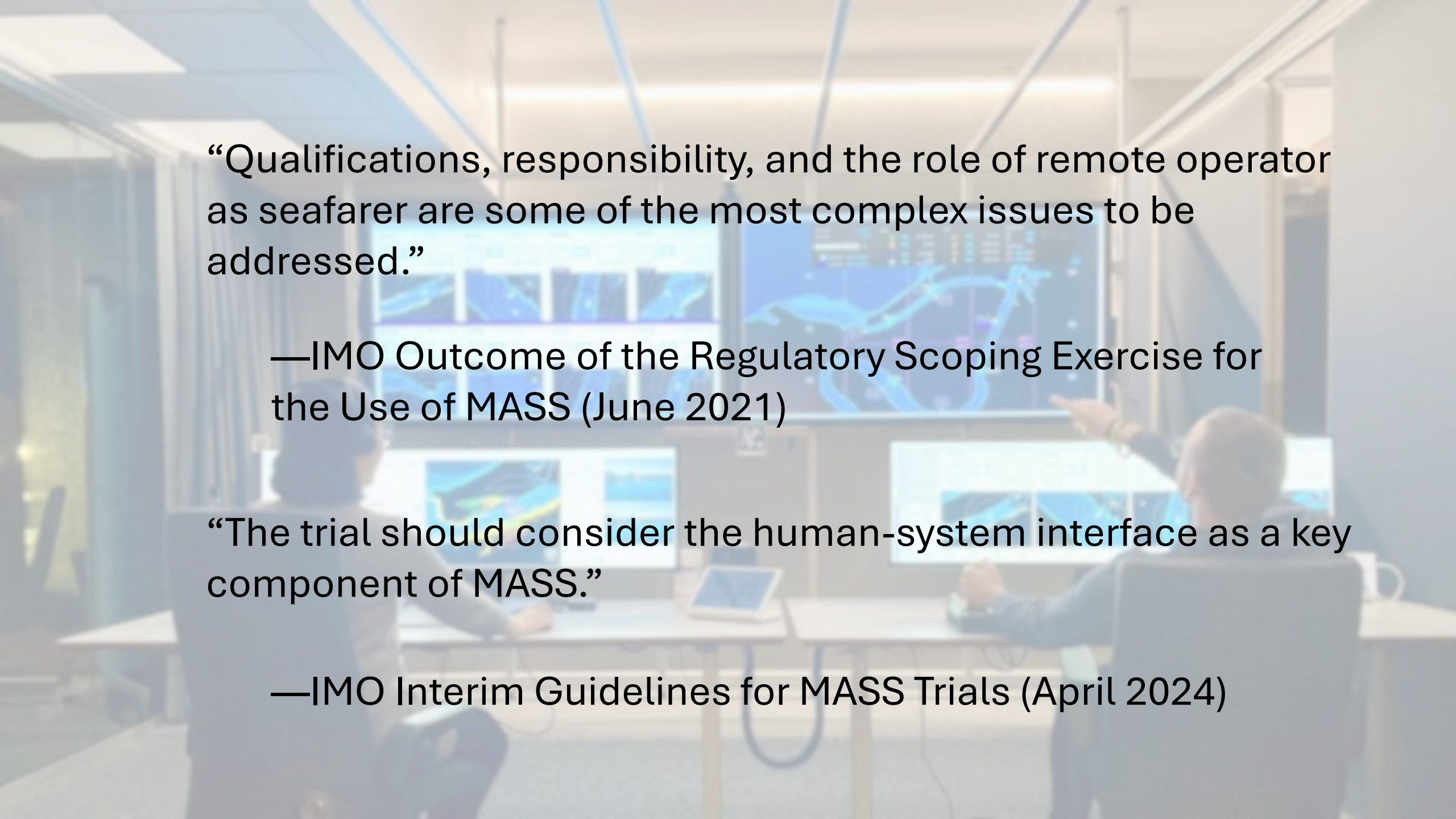
“Is ROC work boring?”





“Qualifications, responsibility, and the role of remote operator as seafarer are some of the most complex issues to be addressed.”

—IMO Outcome of the Regulatory Scoping Exercise for the Use of MASS (June 2021)



“Qualifications, responsibility, and the role of remote operator as seafarer are some of the most complex issues to be addressed.”

—IMO Outcome of the Regulatory Scoping Exercise for the Use of MASS (June 2021)

“The trial should consider the human-system interface as a key component of MASS.”

—IMO Interim Guidelines for MASS Trials (April 2024)

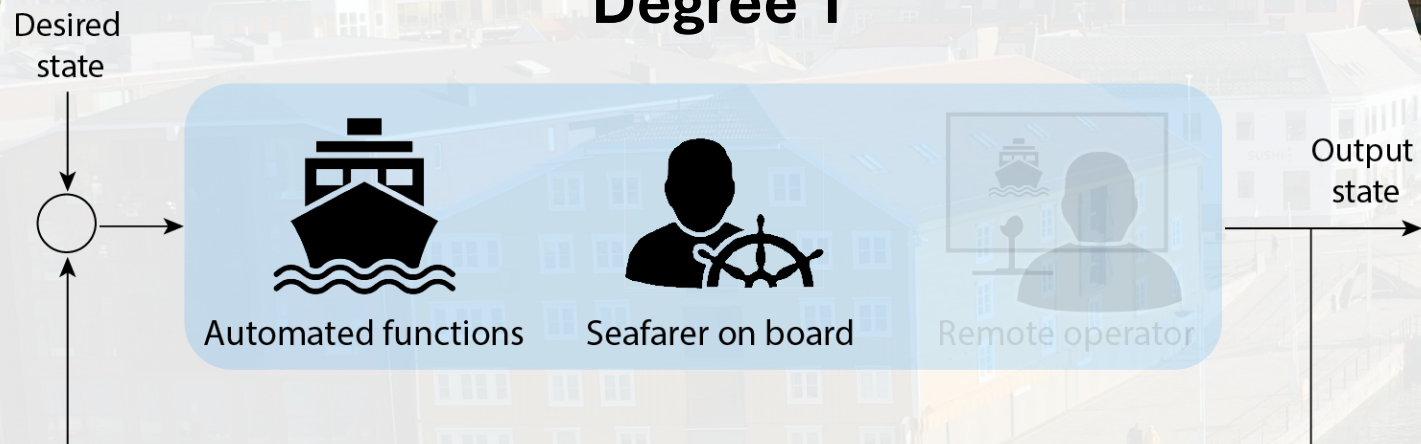


MASS



MASS

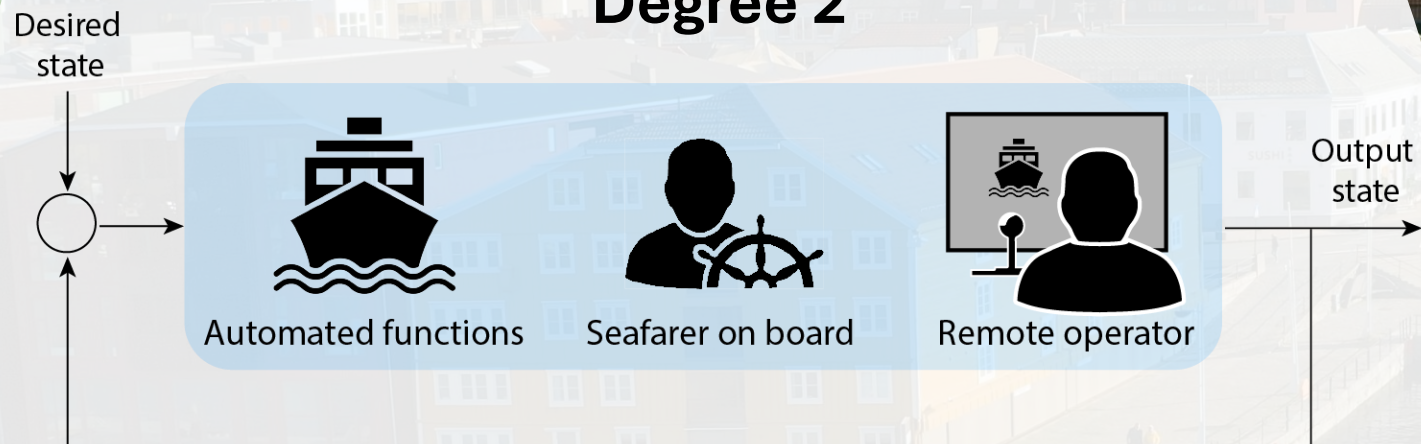
“Degree 1”



Ship with automated processes and decision support

MASS

“Degree 2”

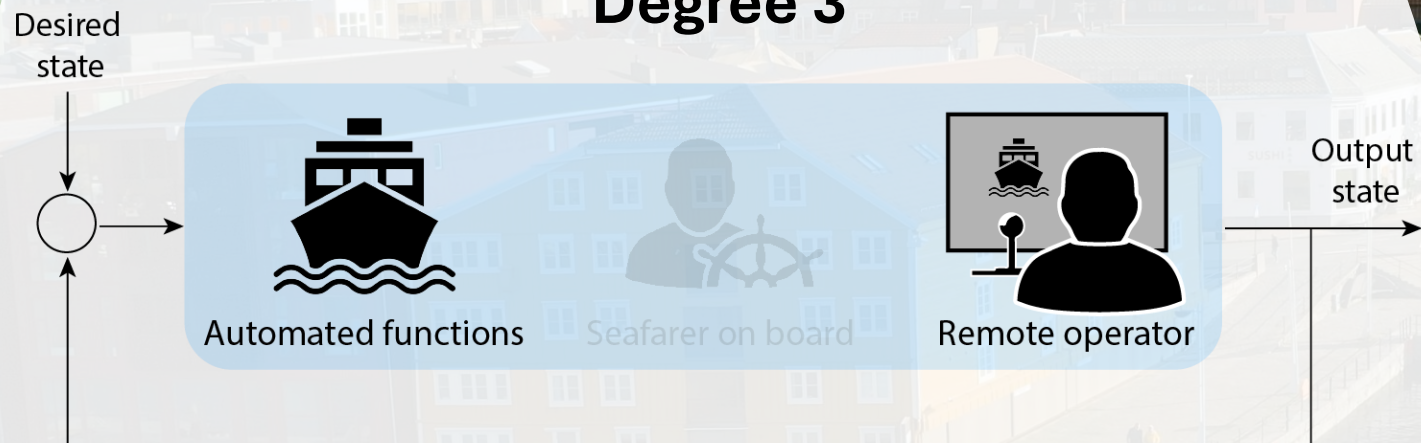


Remotely controlled ship with seafarers on board



MASS

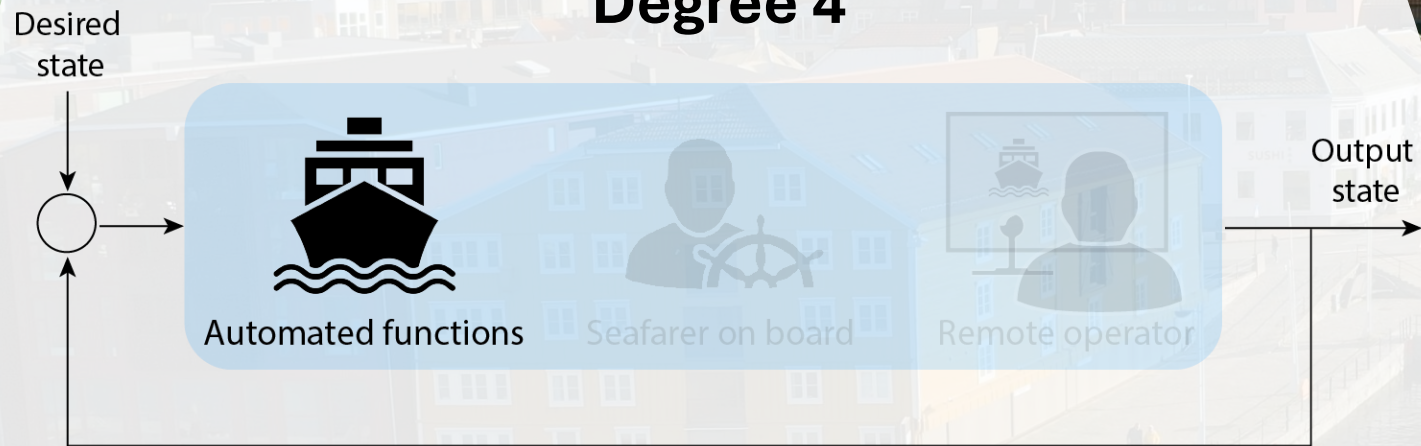
“Degree 3”



Remotely controlled ship without seafarers on board

MASS

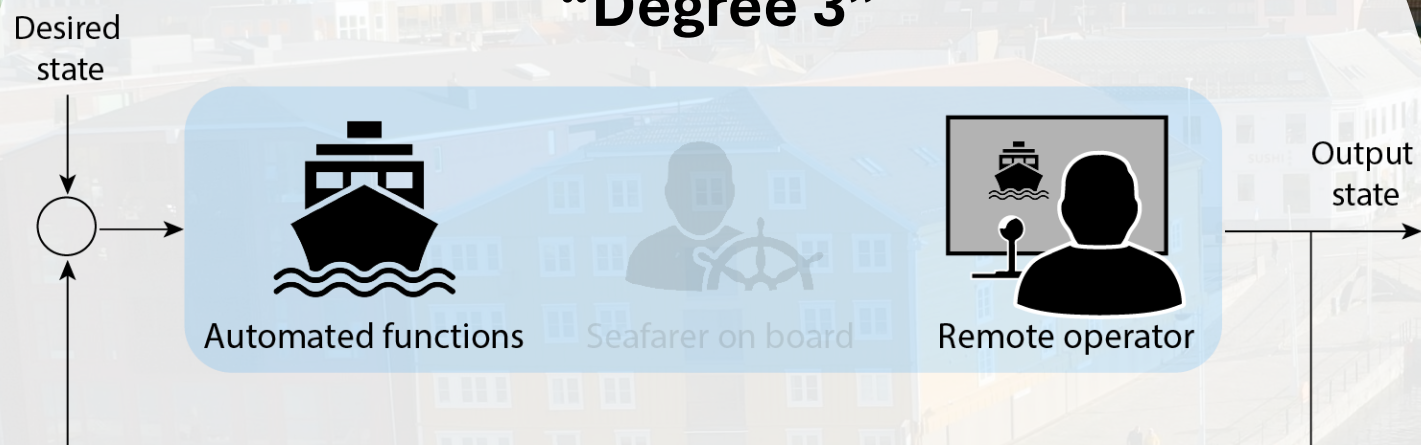
“Degree 4”



Fully autonomous ship

MASS

“Degree 3”

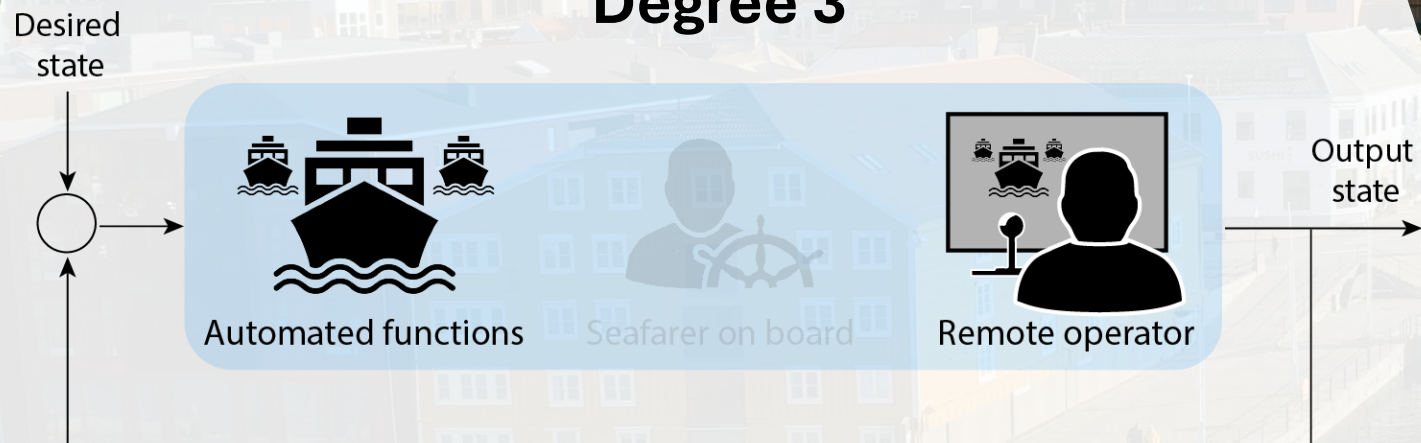


Remotely controlled ship without seafarers on board



MASS

“Degree 3”



Remotely controlled ship without seafarers on board

Fleet supervision







Experimental design

Virtual simulator

32 participants

Monitor the “milliAmpere2” ferry and take over control, if necessary.

Alarm signals failure in autonomy... remote operator must intervene.

Two groups: 5-min and 30-min

Methods

Two techniques:

1. Pupillometry
2. Questionnaire

Methods

Two techniques:

- 1. Pupillometry**
2. Questionnaire

Methods

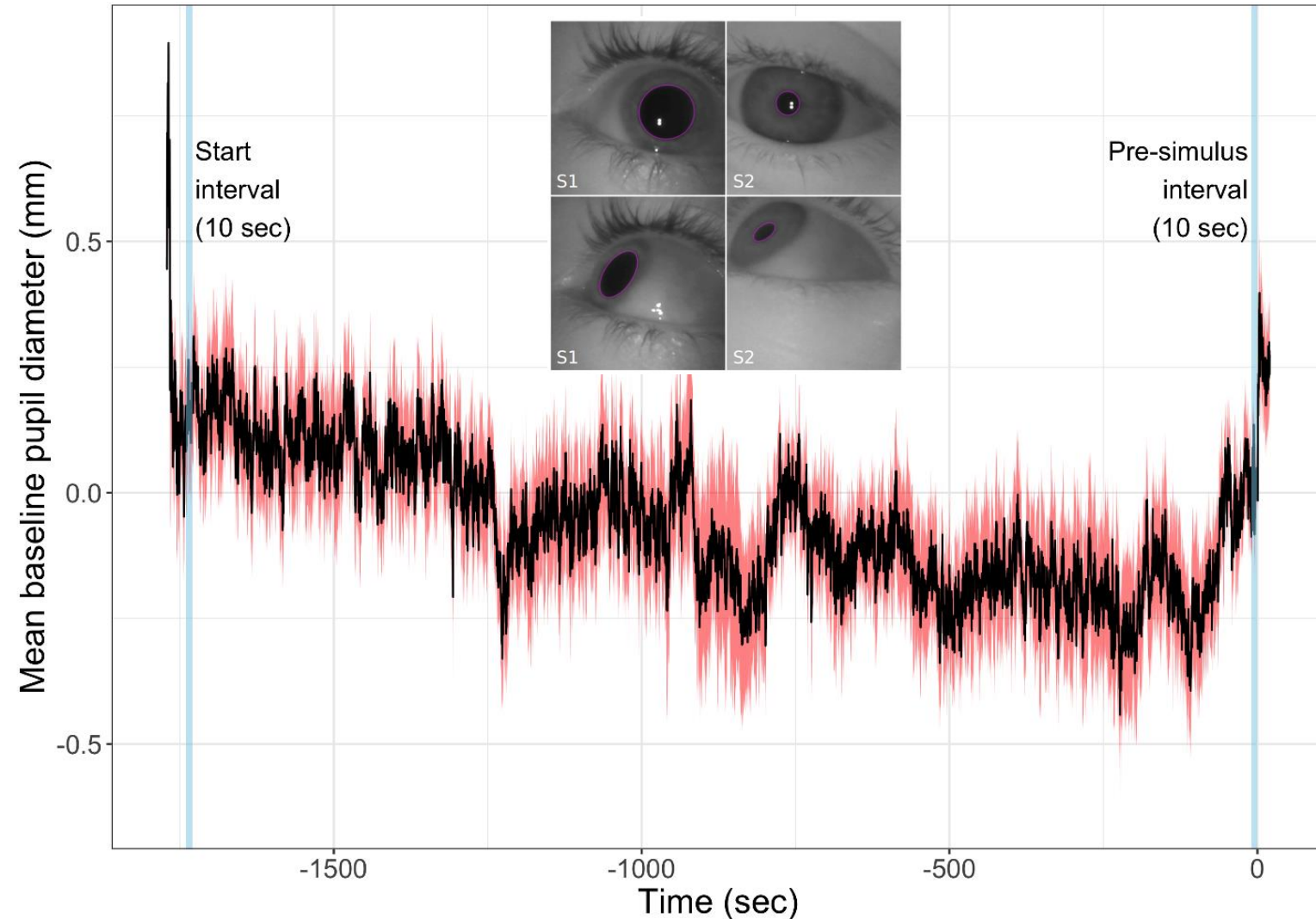
Two techniques:

- 1. Pupillometry**
2. Questionnaire



Pupil Labs “Pupil Core” (2022)

Mean Baseline Pupil Diameter: 30-min Group
Ribbon displays standard error (N = 15)



Methods

Two techniques:

1. Pupillometry

2. Questionnaire

Methods

Two techniques:

1. Pupillometry

2. Questionnaire

1 (not at all) 2 3 4 5 (very much)

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

van Tilburg & Igou (2012)

Affective states	Question items (To what extent do you ...)
Feelings	... feel restless and unchallenged at the same time?
Thoughts	... think that the situation served no important purpose?
Action tendencies	... feel like doing something completely different? ... feel like doing something more purposeful?
Actions	... wish to turn to a more meaningful activity?
Emotivational goals	... want to do something more meaningful? ... want to be challenged?

Results

Two techniques:

1. Pupillometry
2. Questionnaire

Results

Two techniques:

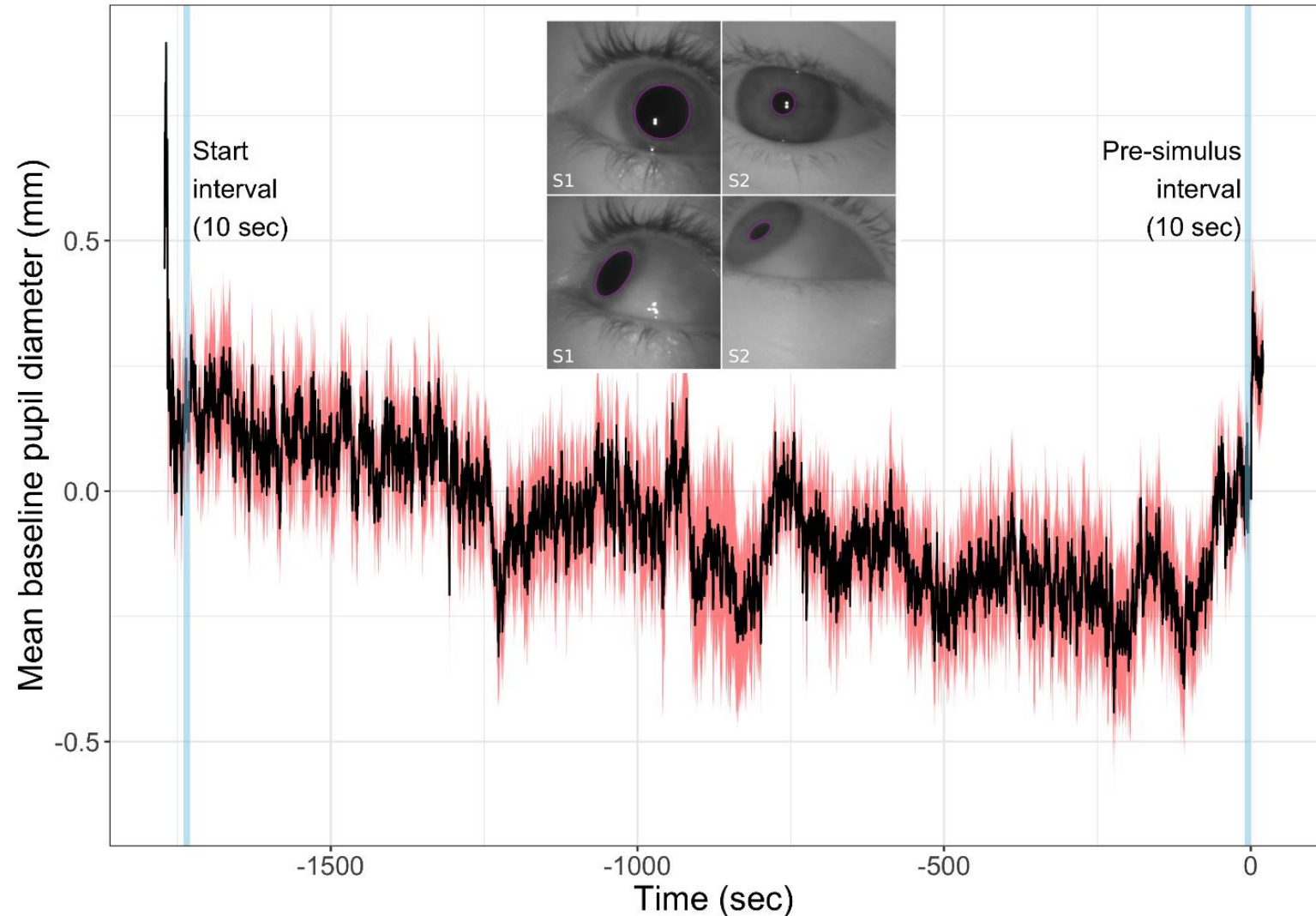
- 1. Pupillometry**
2. Questionnaire

Results

Two techniques:

- 1. Pupillometry**
2. Questionnaire

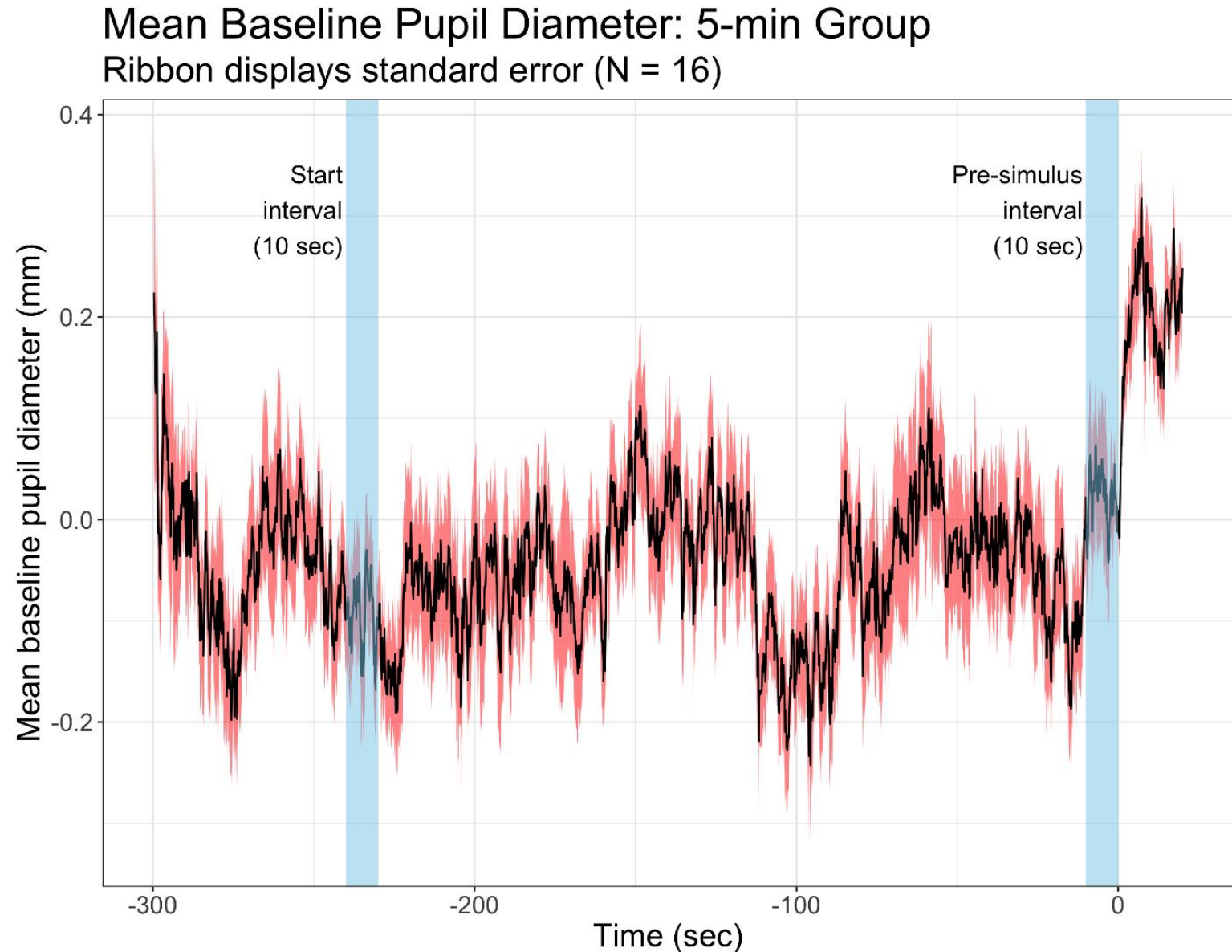
Mean Baseline Pupil Diameter: 30-min Group
Ribbon displays standard error (N = 15)



Results

Two techniques:

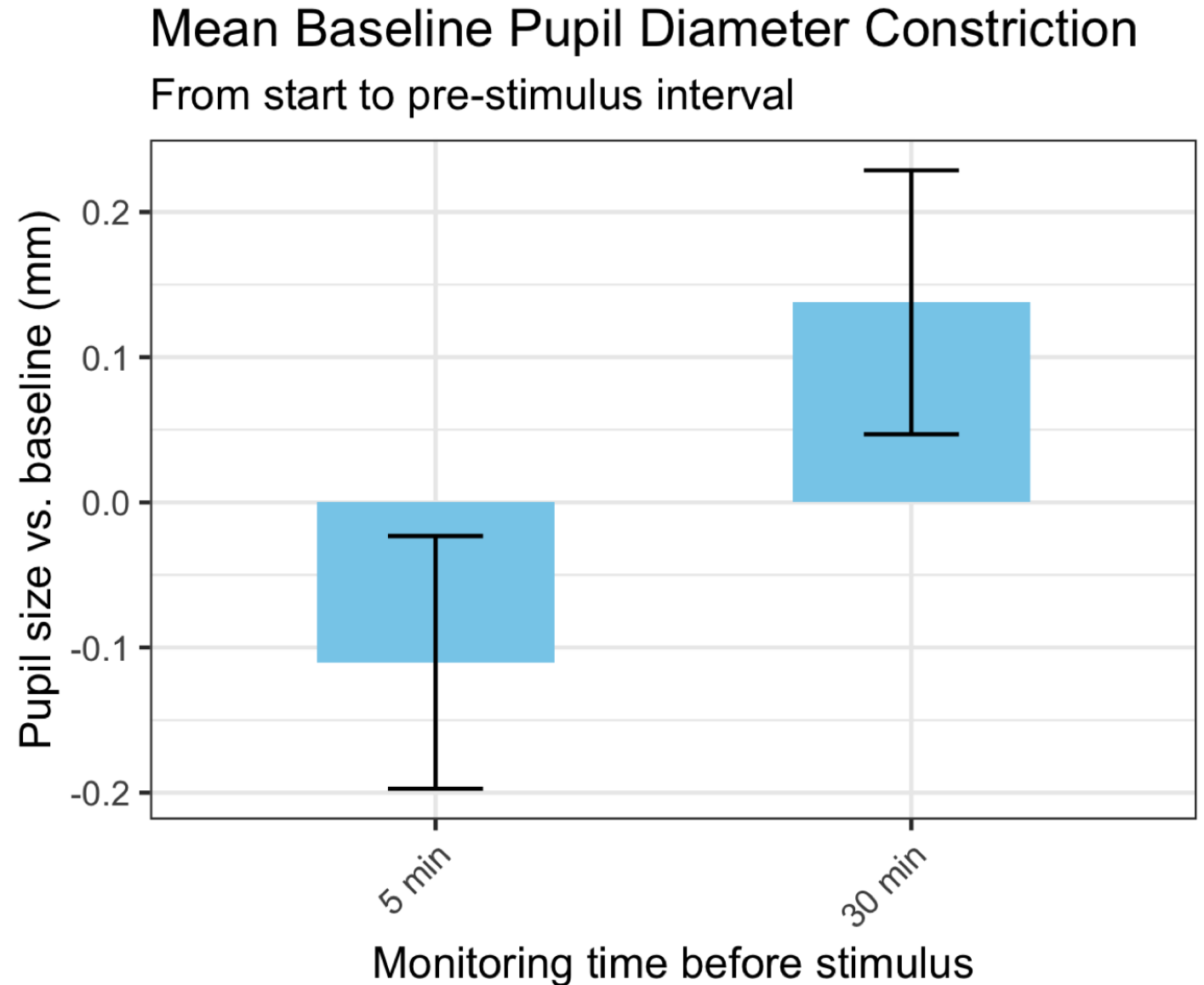
- 1. Pupillometry**
2. Questionnaire



Results

Two techniques:

- 1. Pupillometry**
2. Questionnaire



Results

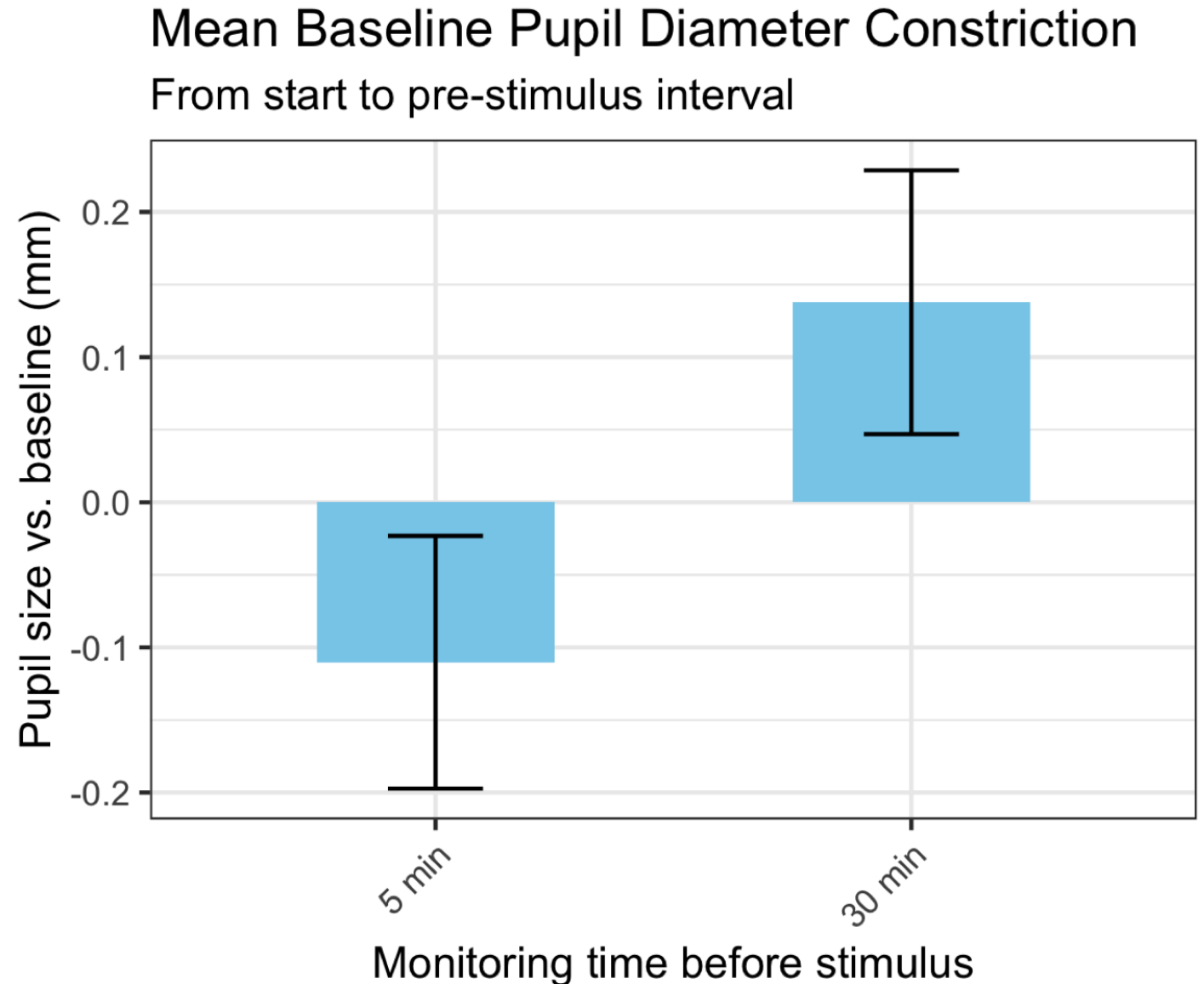
Two techniques:

1. Pupillometry

2. Questionnaire

30-min group:

Constriction of 0.13 mm



Results

Two techniques:

- 1. Pupillometry**
2. Questionnaire

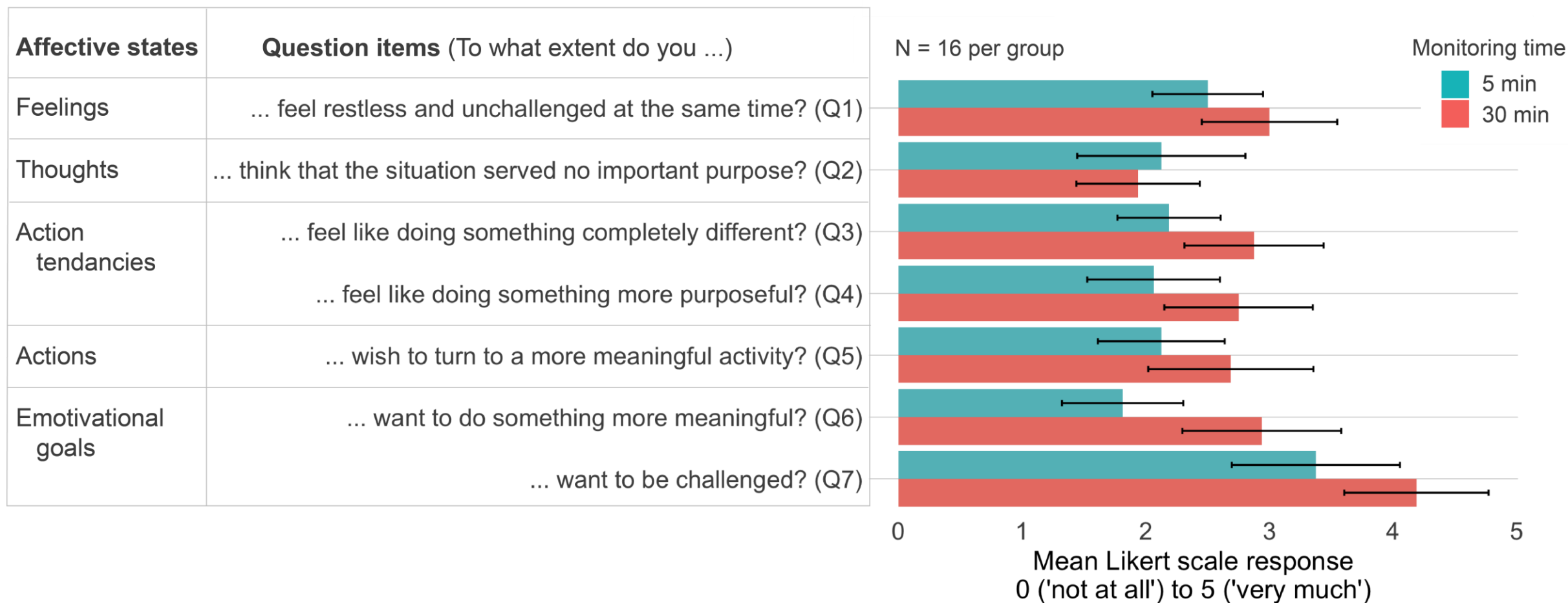
Results

Two techniques:

1. Pupillometry
- 2. Questionnaire**

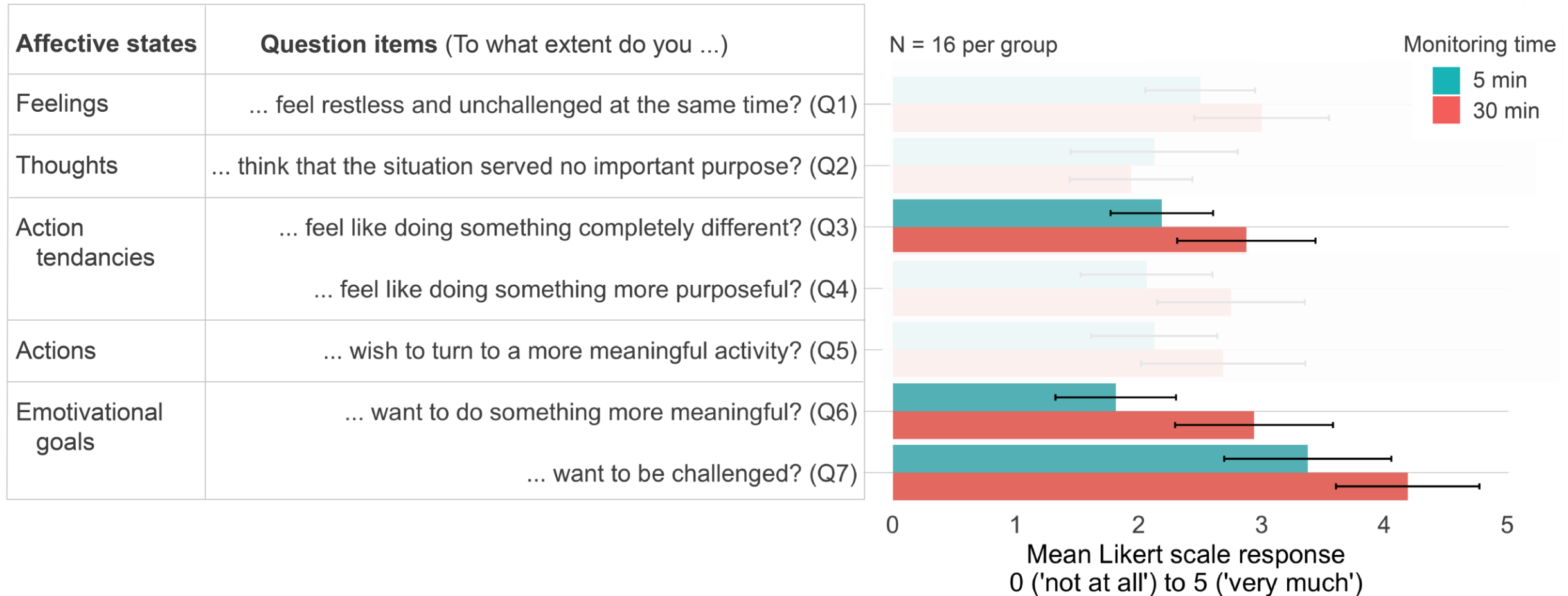
Results

van Tilburg & Igou Questionnaire Responses



Results

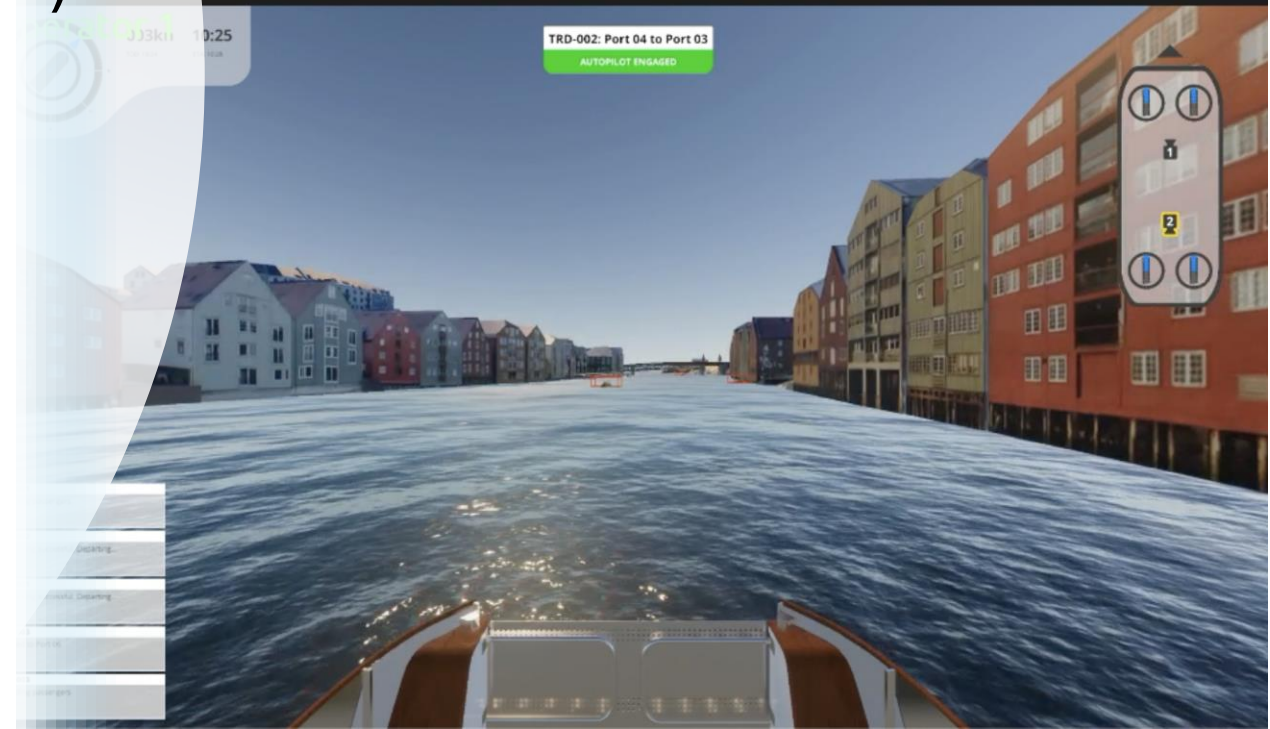
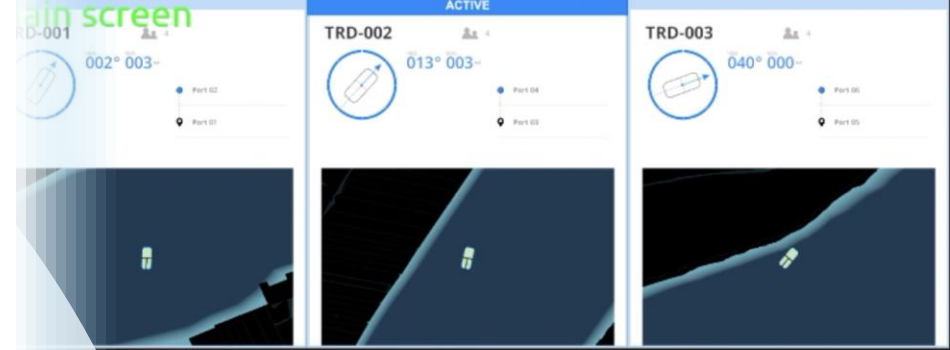
van Tilburg & Igou Questionnaire Responses



In summary...

30-min group experienced...

- Reduced cognitive activity
(in terms of pupillary constriction)
- Boredom
(in terms of meaning regulation)

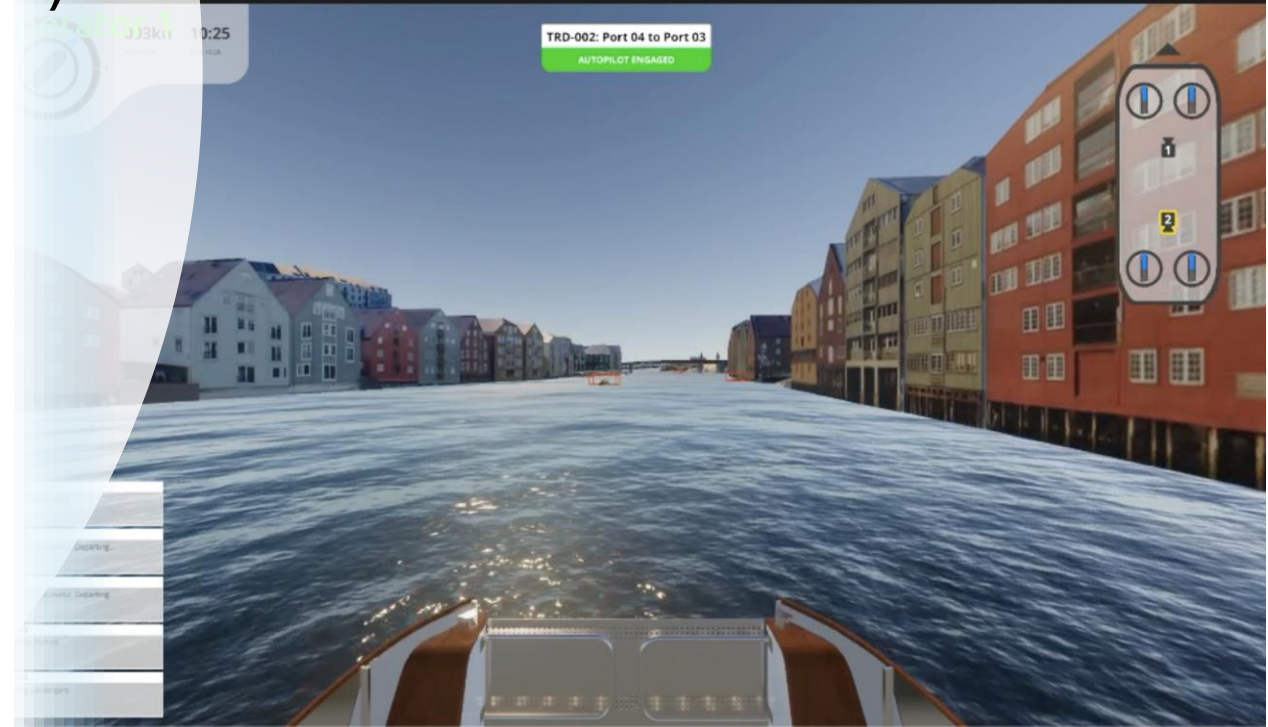
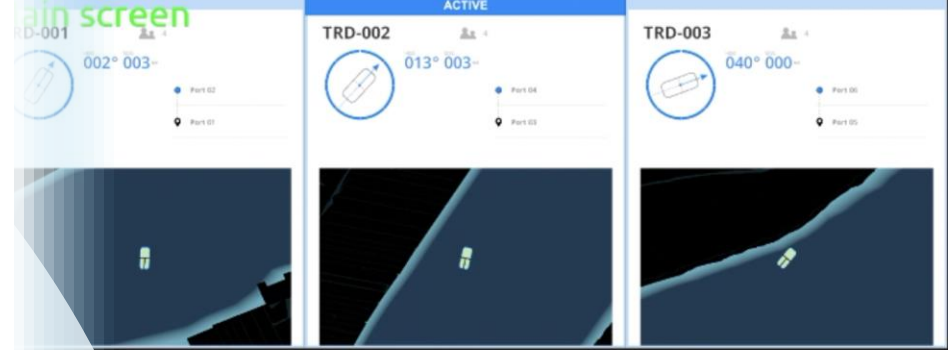


In summary...

30-min group experienced...

- Reduced cognitive activity
(in terms of pupillary constriction)
- Boredom
(in terms of meaning regulation)

Is ROC work boring?



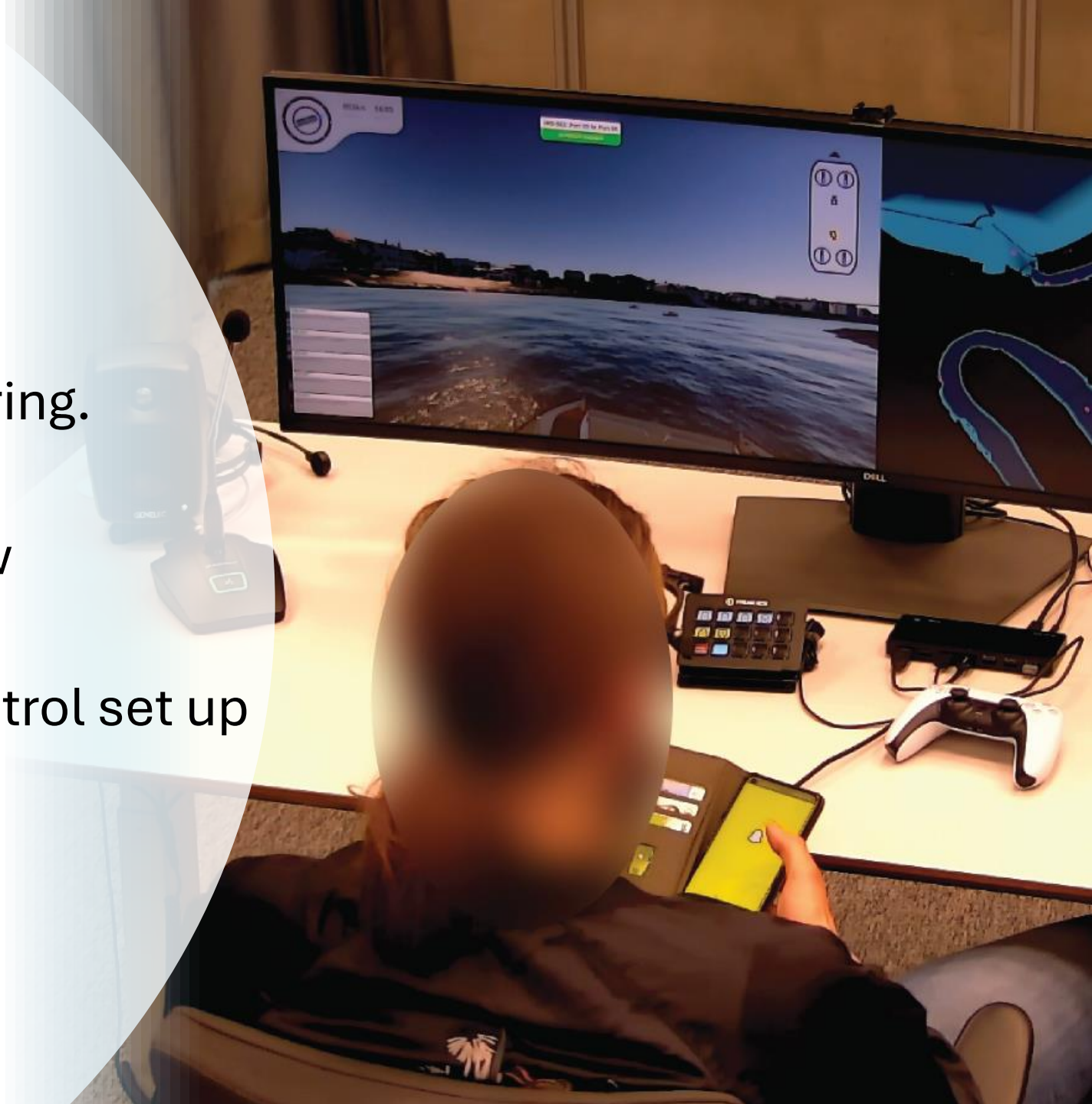
Implications

Humans are not good at monitoring.

Approx. 20 min attention window

Issue is with the supervisory control set up

“Out-of-the-loop phenomenon”

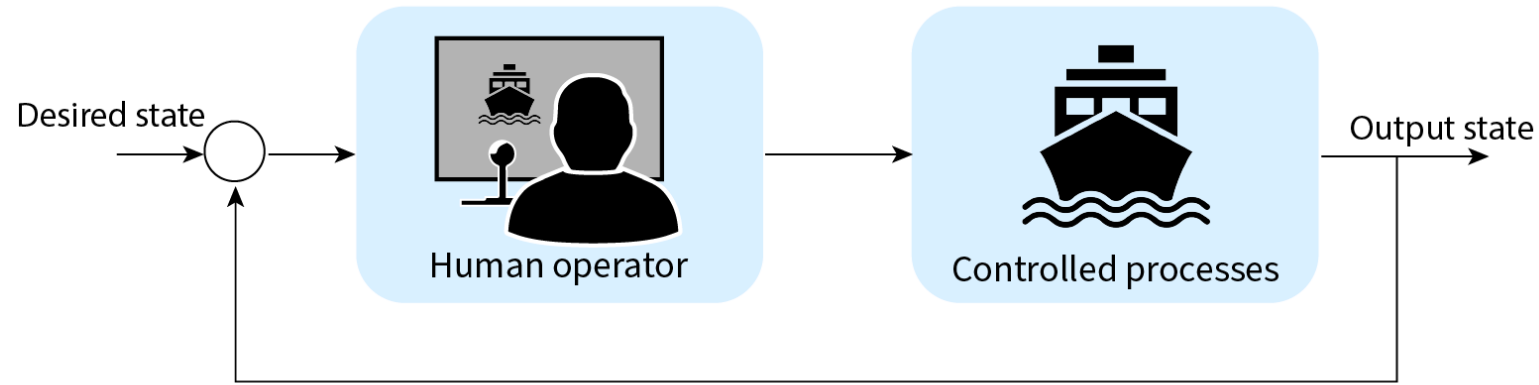


Implications

“Trade control” paradigm

Ex: Alarm tells operator to takeover

Results in out-of-the-loop phenomenon

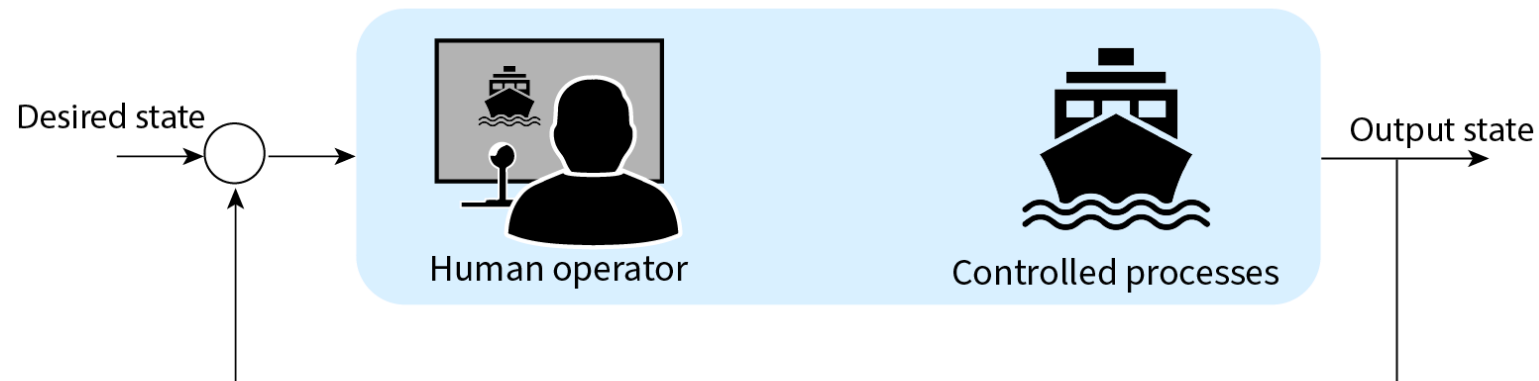


Vs.

“Share control” paradigm

Ex: Human adjusts heading while speed is automatically controlled

Interdependent operator and process



Conclusions

~~Is ROC work boring?~~

How to design ROC work so operator stays in the loop?

Conclusions

~~Is ROC work boring?~~

How to design ROC work so operator stays in the loop?

Must consider operators as dependent of the controlled process.

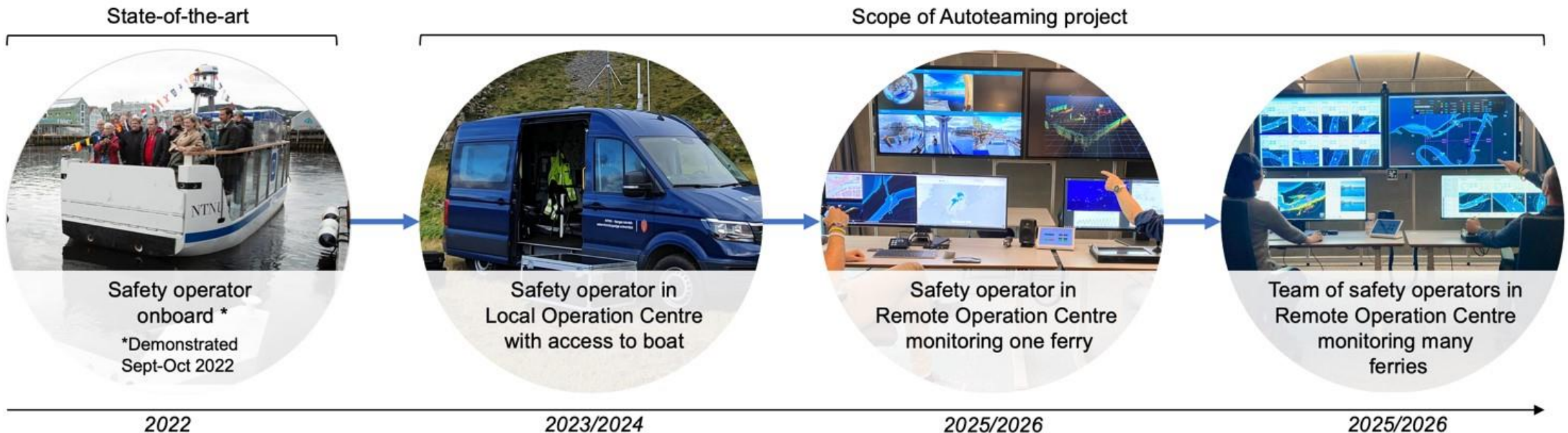
“Sharing control” (relieve, extend) more viable than “trading control” (backup, replace).

Remains to be seen how to implement.

The Autoteaming project

Norwegian Research Council, 2023-2026

Goal: to demonstrate “Autoremove” operational mode for multi-vessel operations



Thank you!

References:

- | | |
|----------------|--|
| milliAmpere2 | Eide E, Breivik M, Brekke E F, Eriksen B-O H, Wilthil E F, Helgesen Ø K, Thyri E H, Veitch E, Alsos O A and Johansen T A 2024 The autonomous urban passenger ferry milliAmpere2: Design and testing [In Press] <i>Journal of Offshore Mechanics and Arctic Engineering</i> |
| Pupillometry | https://pupil-labs.com/ |
| Questionnaire | van Tilburg W A P and Igou E R 2012 On boredom: Lack of challenge and meaning as distinct boredom experiences <i>Motivation and Emotion</i> 36 181–94 |
| Open simulator | github.com/Gemini-team/Gemini |

Contact:

Erik Veitch, NTNU (erik.a.veitch@ntnu.no)

Acknowledgements:

Autoteaming (Norwegian Research Council)