Spatial Attention Guidance for Deck Officers on Ship Bridges

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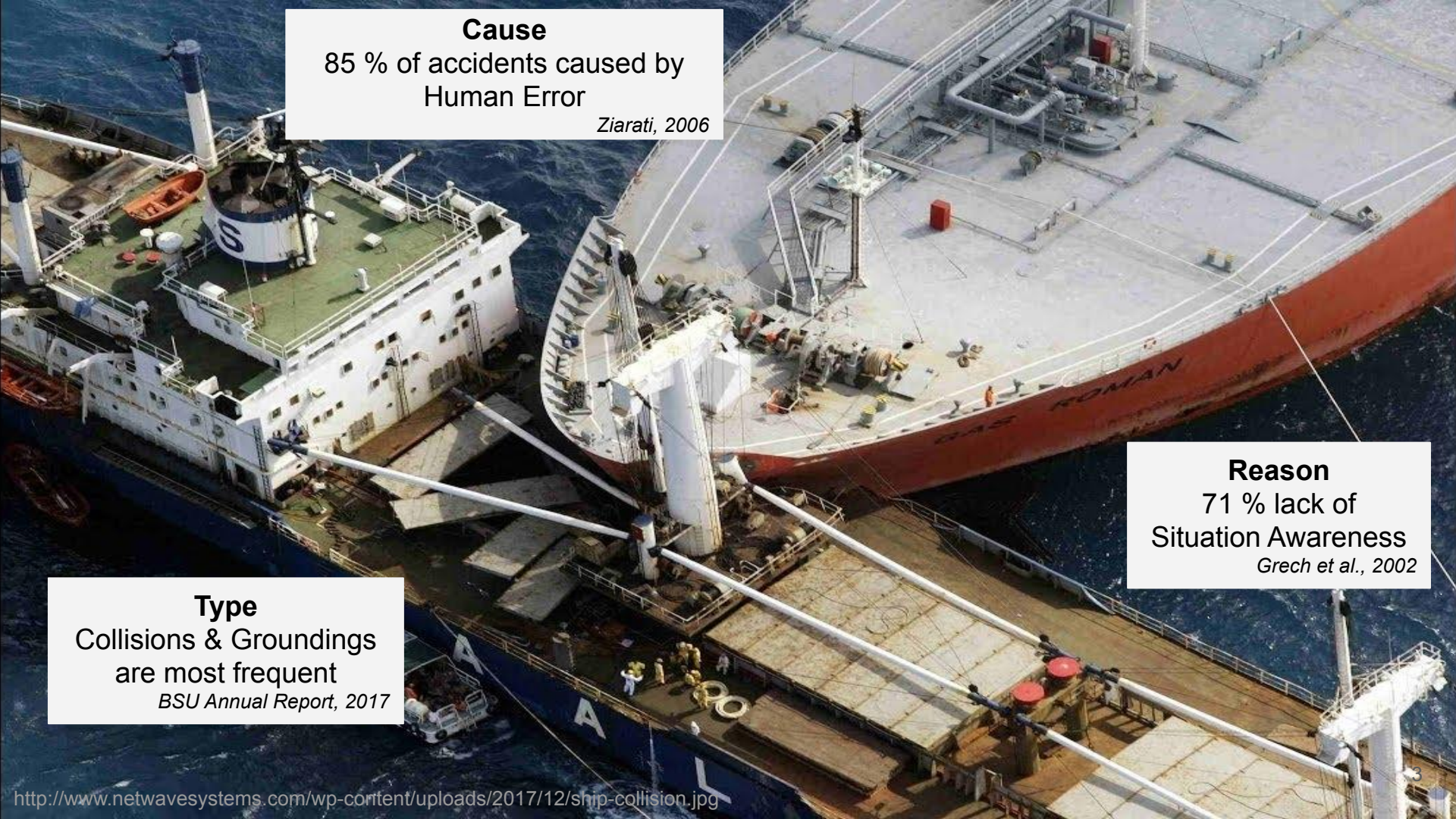
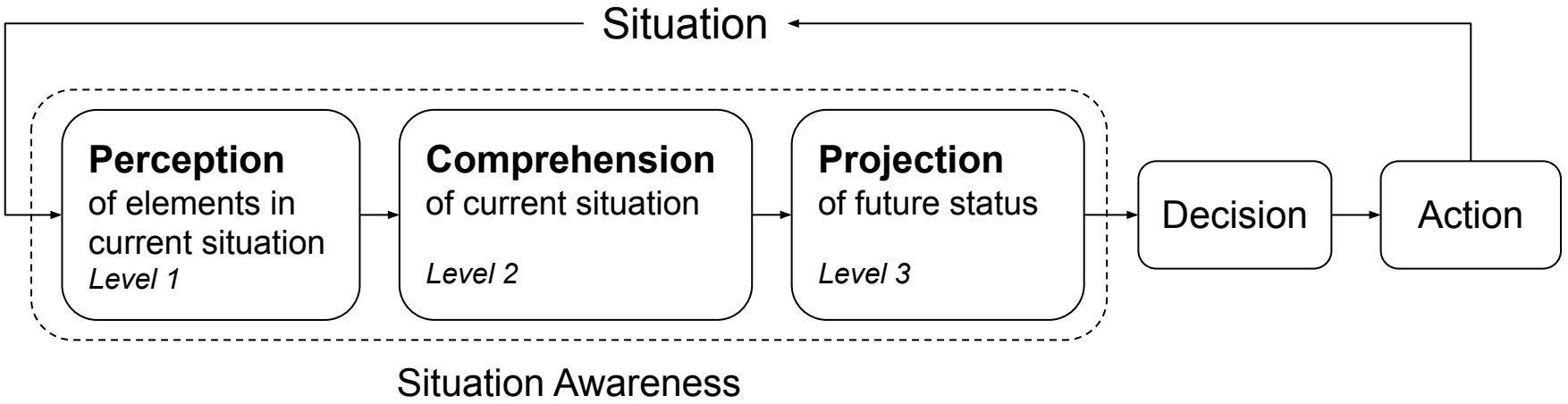
Agenda

- Motivation
- Basic Idea
- Simulator Apparatus for Lab Studies
- Example Study: “Attention Guidance on Nautical Ship Bridges: Comparison of Moved and Static Acoustical Pointers”


Cause
85 % of accidents caused by Human Error
Ziarati, 2006
Reason
71 % lack of Situation Awareness
Grech et al., 2002
Type
Collisions & Groundings are most frequent
BSU Annual Report, 2017
http://www.netwavesystems.com/wp-content/uploads/2017/12/ship-collision.jpg

Decision Making: Situation Awareness



Endsley, 1995

SOURCES

What are the main factors for a lack of attention that lead to maritime accidents?

Accident Analysis

Accident Reports

- 535 full-text reports from Marine Accident Investigation Branch (UK)
- inconsistent document structure

Analysis Approach

- Natural Language Processing - understand confounding factors
- eight Demons of Situation Awareness: Data Overload, Misplaced Salience, … [Endsley, 2003]
- preparation, keyword extraction, synonym detection, context-aware queries

Accident Analysis

Results

Failed perception of information mainly caused by

- workload, fatigue, stress
- errant mental models
- attention tunneling
- and data overload

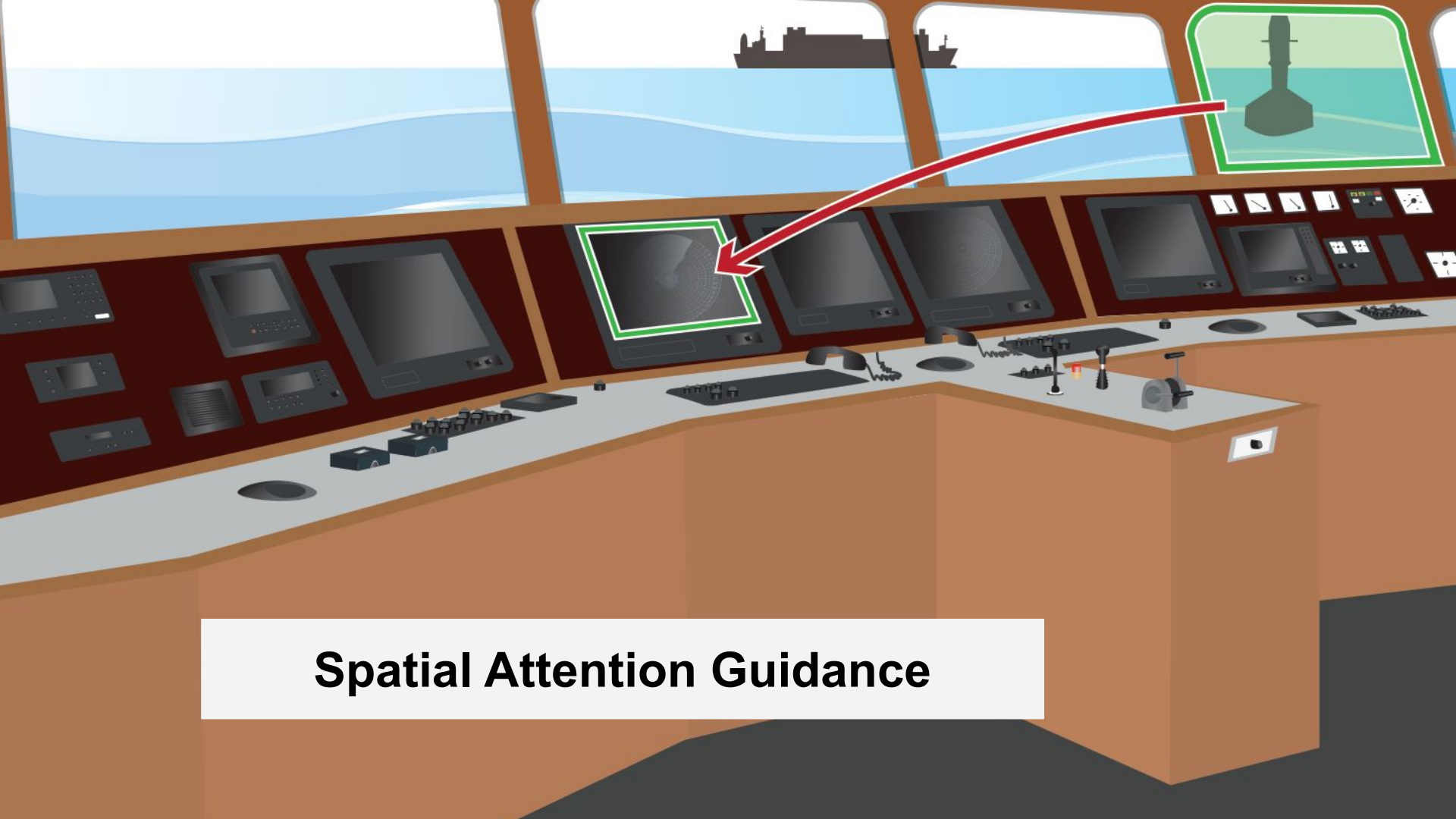
lead to accidents in the past.

T. C. Stratmann and S. Boll, „Demon Hunt - The Role of Endsley's Demons of Situation Awareness in Maritime Accidents", in Human-Centered and Error-Resilient Systems Development, pp. 203–212. Springer, 2016.

Deriving a Strategy

failed perception of information → monitoring assistance

- attention tunneling → shift attention (guidance)
- errant mental models → guide attention on regular basis
- workload, fatigue, stress → exogenous cues (multi-modal)
- and data overload → take care not to increase data overload


Spatial Attention Guidance

Design Space

Modality

- visual
- auditory
- tactile

Position

- onbody
- in environment

Combination Space

	Onbody	In Environment
Visual		
Tactile		
Auditory		

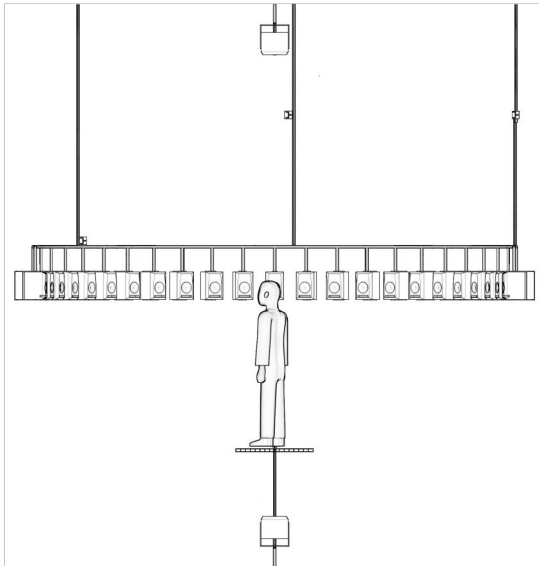
Evaluation Environment

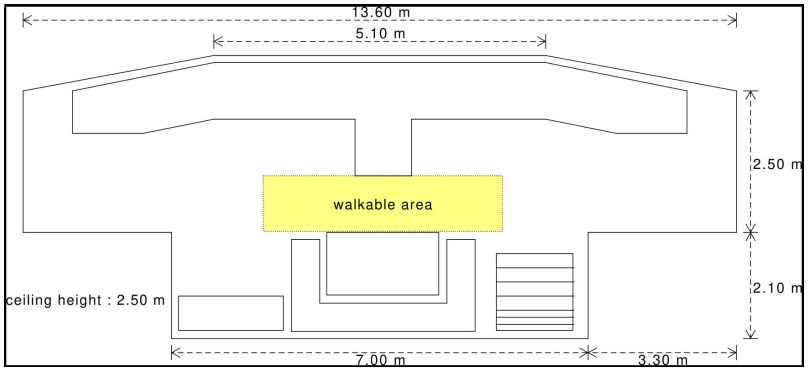
How can we simulate a ship bridge including its visual, auditory and tactile noise conditions in a lab environment?

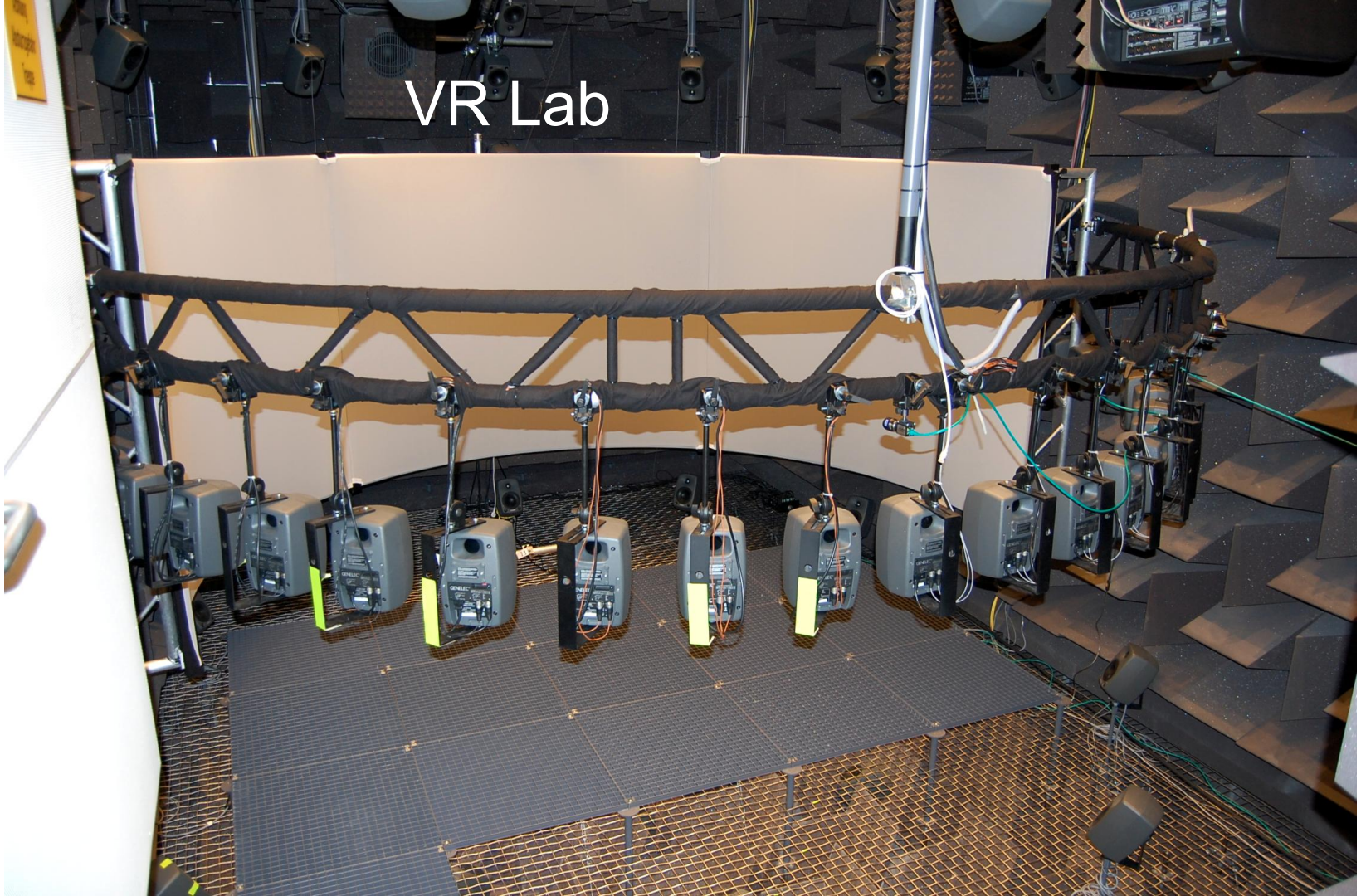
Scenario Simulator

Simulation of Bridge Acoustic

- room model based on real 2999 GT general cargo ship
- rendered with TASCAR - toolbox for acoustic scene creation and rendering (Grimm et al., 2015)
- VR Lab at University of Oldenburg







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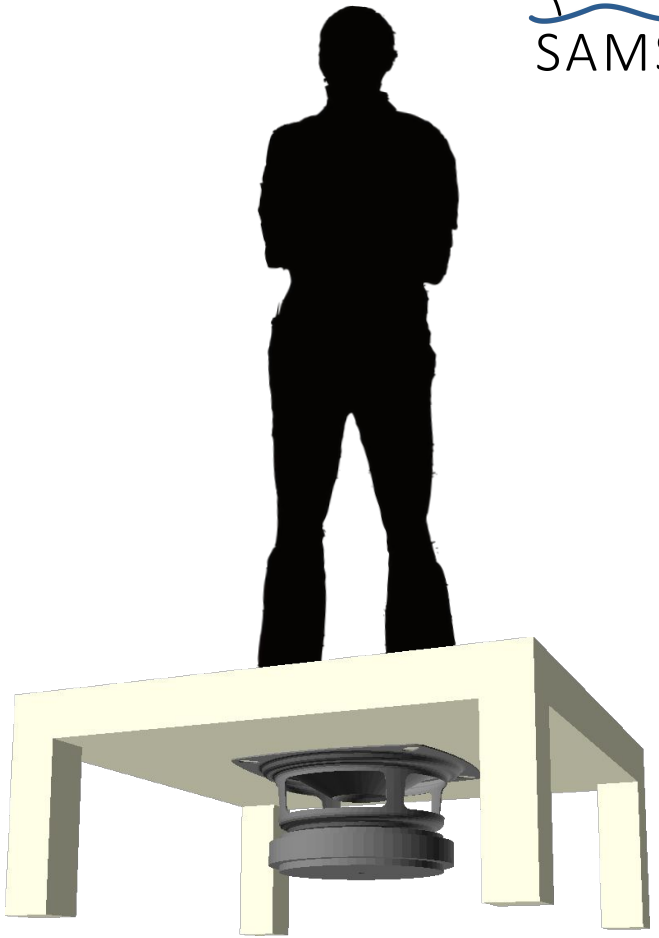
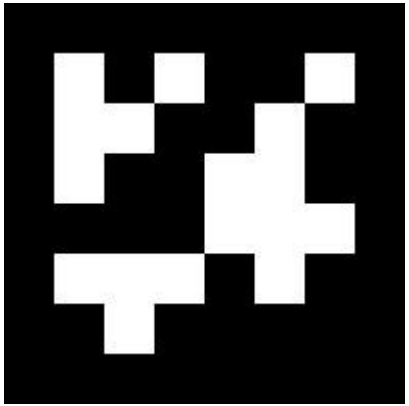
Simulation of Bridge Vibration

- simulates environmental vibration
- subwoofer attached to platform
- rendering low frequency audio signals (1-80 Hz)
- creates vibration and environmental noise at the same time
- renders audio signals as vibration



Assessment



Quantitative:

- Eye-Tracking: Tobii Pro Glasses 2
  - Attention Focus
  - Time to First Fixation
  - Arousal Time
  - Shift Time

Self-Rating:

- NASA-Task-Load-Index
  - Workload
- Situation Awareness Rating Technique
  - Situation Awareness

Cue Design for Spatial Attention Guidance

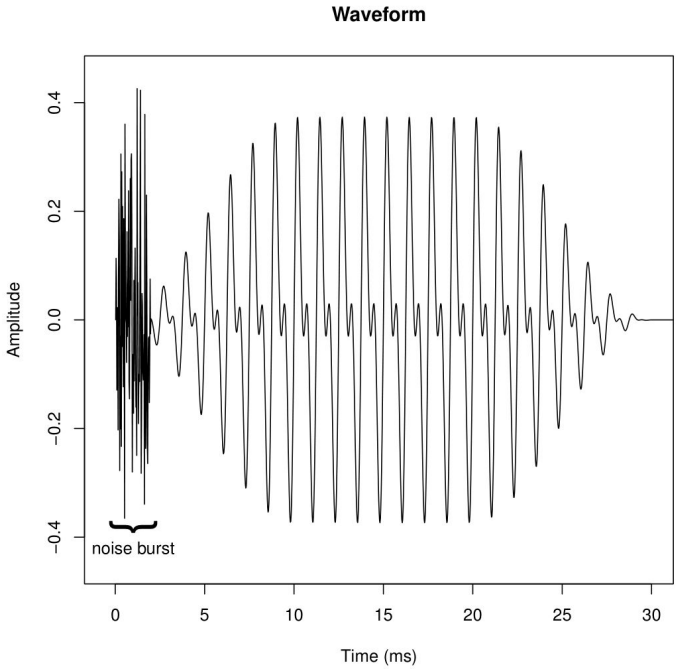
	Onbody	In Environment
Visual		
Tactile		
Auditory		

In Environment: Auditory


Sound at target position
Moving: Start at operator focus, move to target position

Auditory Attention Guidance

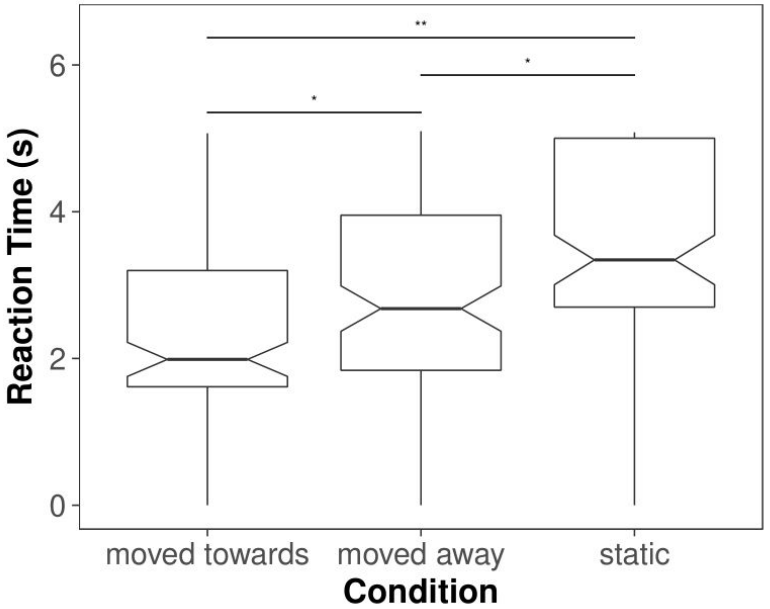
- within-subjects, 20 participants (4 female), 24 - 66 years (M = 32.45, SD = 9.32)
- **trained mariners or mariners in training**, in total 50.5 years of maritime working experience (M = 2.52,SD = 3.01)
- IVs: cue dynamic (**moving, static**), workload (regular, high)
- DVs: reaction time, error rate, **speech intelligibility**, annoyance, urgency, usability (SUS), Situation Awareness (SART)



Apparatus

Results

- moving acoustical pointers lead to faster reaction times than static acoustical pointers
- moving pointers were rated as less urgent and alarming, but also as slightly less pleasant and more annoying
- no significant difference in speech intelligibility



Submission to:
Human Factors: The Journal of the Human Factors and Ergonomics Society

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Thank you for attending my talk!

Feel free to ask questions.

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