

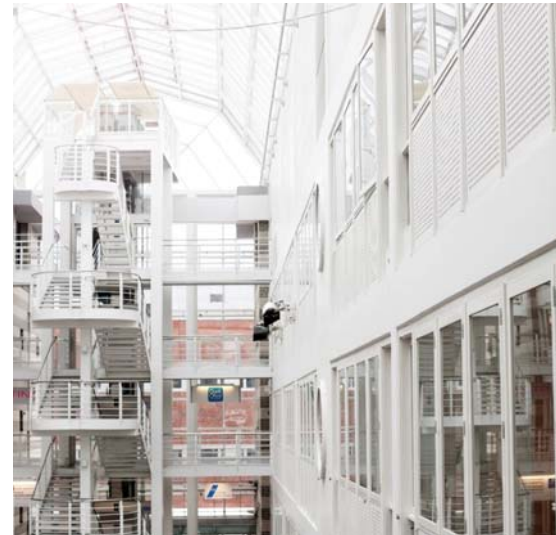
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# Quality of Experience for a Virtual Reality simulator

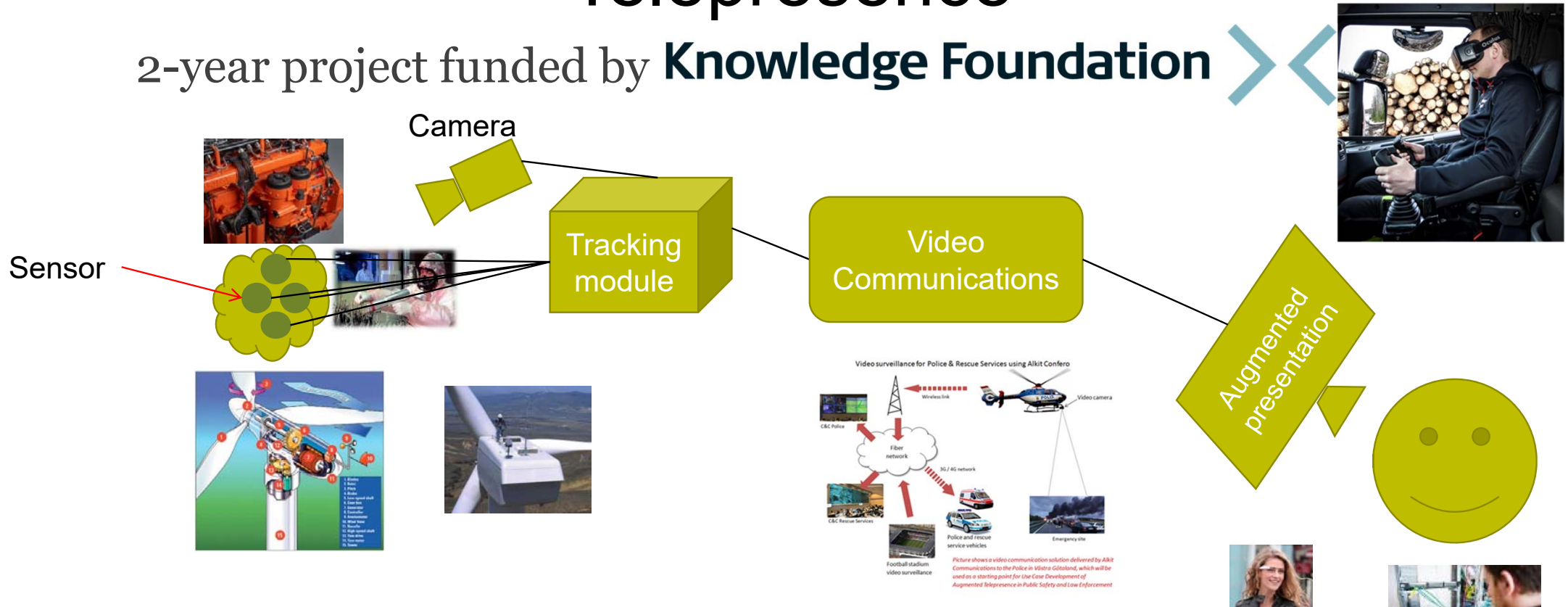
*Kjell Brunnström, Märten Sjöström, Imran Muhammad, Magnus Pettersson Mathias Johanson*

Research Institutes of Sweden  
**RISE ICT**  
Acreo



# Quality of Experience for Augmented Telepresence

2-year project funded by **Knowledge Foundation**



Partners: RISE Acreo, Mid Sweden University, HIAB and Alkit Communications



## Current study: use of VR-simulator version



- VR-ready ASUS ROG Strix GL702VM GTX 1060 Core i7 16GB 256GB SSD 17.3
- Unity 2017.3
- Estimated delay.
  - Display – 25 ms
  - Joystick – 80 ms

# Study overview

- Baseline study
  - Log loading task with VR-system as is
- Delay study
  - Screen delay and Joystick delay added

# Baseline study - test procedure

- The person received written instructions about the procedure
  - They explained about the task
  - They told the test subjects that some people may feel discomfort or Nausea
  - They also told that they could stop whenever they wanted
- The test persons vision was tested (acuity, colour and 3D acuity)
- A pre-questionnaire including an SSQ was filled in by the test person
- A short training session was done to familiarize the test person with the task and environment (load twice one or two logs on to the truck)
- Main session
  - loading two piles (16 logs) of logs with a break inbetween.
  - Time elapsed for each session was noted.
- A post-questionnaire including an SSQ was filled in by the test person

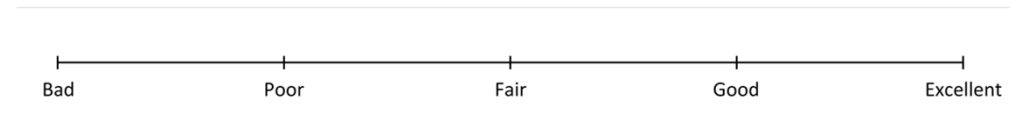
# Baseline test

- Scales used:

**How would you rate the picture quality? (circle the verbal option)**



**How would you rate the responsiveness of the system? (circle the verbal option)**



**How would you rate your ability to accomplish your task of loading the logs on the truck? (circle the verbal option)**



**How would you rate the immersion of the experience? (circle the verbal option)**



**How would you rate your overall experience? (circle the verbal option)**



# Baseline study

- Also used at the other studies

## SIMULATOR SICKNESS QUESTIONNAIRE

Kennedy, Lane, Berbaum, & Lilienthal (1993)\*\*\*

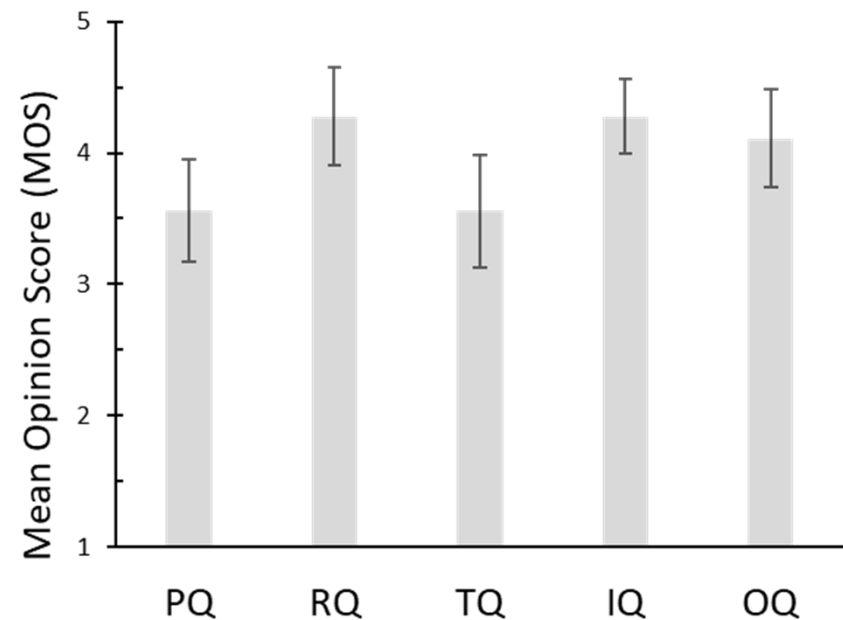
Instructions : Circle how much each symptom below is affecting you right now.

1. General discomfort	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
2. Fatigue	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
3. Headache	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
4. Eye strain	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
5. Difficulty focusing	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
6. Salivation increasing	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
7. Sweating	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
8. Nausea	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
9. Difficulty concentrating	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
10. « Fullness of the Head »	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
11. Blurred vision	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
12. Dizziness with eyes open	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
13. Dizziness with eyes closed	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
14. *Vertigo	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
15. **Stomach awareness	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>
16. Burping	<u>None</u>	<u>Slight</u>	<u>Moderate</u>	<u>Severe</u>



## Baseline study – Results

- Based on 17 test subjects (2/3 males and 1/3 females) recruited at RISE ICT. No previous experience in operating cranes.
- Average time: 27 min
- SSQ reports at most slight symptoms, so very low influence
- Except one person that got very nauseated after just one minute (did not participate in the test)

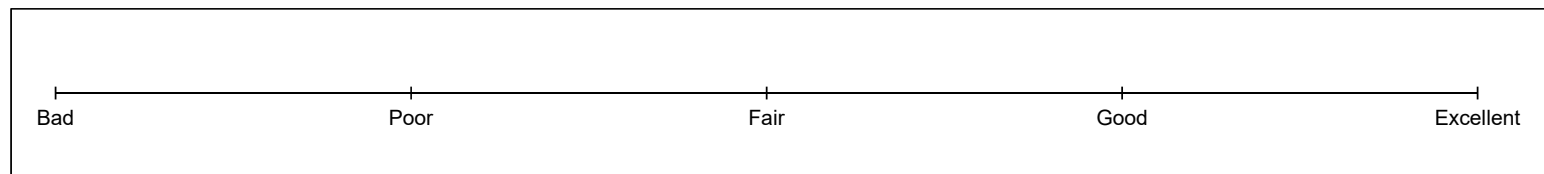


## Delay study - test procedure

- The person received written instructions about the procedure
- The test persons vision was self-reported by test persons
- A pre-questionnaire including an SSQ was filled in by the test person
- A short training session was done to familiarize the test person with the task and environment (load twice one or two logs on to the truck). Here also to get to sense the no-delay case
- Main session load logs for 20 min in 10 different 2 min periods with different delay
- After 1 min test subjects verbally report their experience
- A post-questionnaire including an SSQ was filled in by the test person
- Test person was thanked for its participation with a cinema ticket

## Delay study – scales

- How would you rate the picture quality?
  - How would you rate the responsiveness of the system?
  - How would you rate your ability to accomplish your task of loading the logs on the truck?
  - How would you rate your comfort (as in opposite to discomfort)?
  - How would you rate the immersion of the experience?
  - How would you rate your overall experience?
- 
- Scale was shown in the instructions



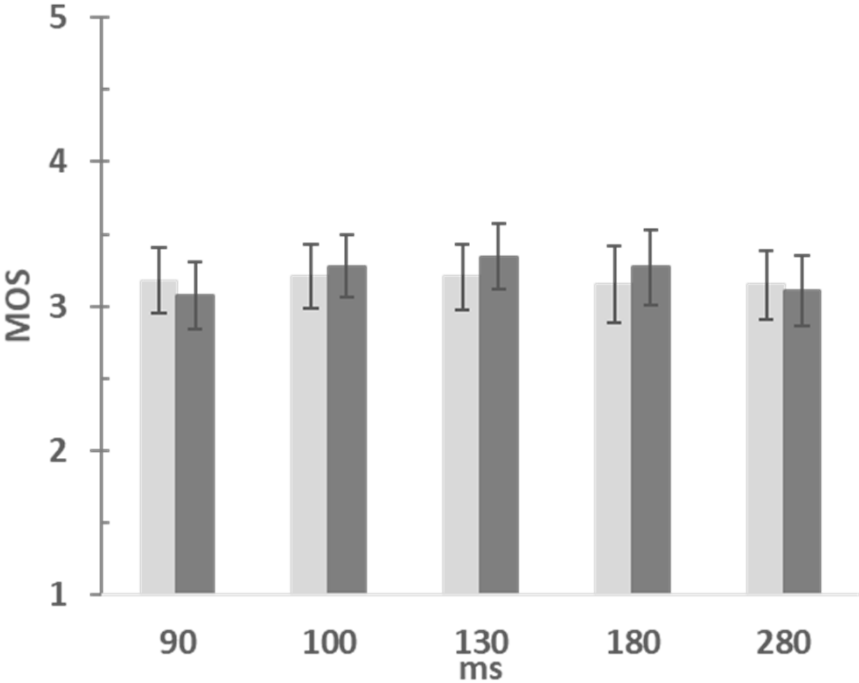
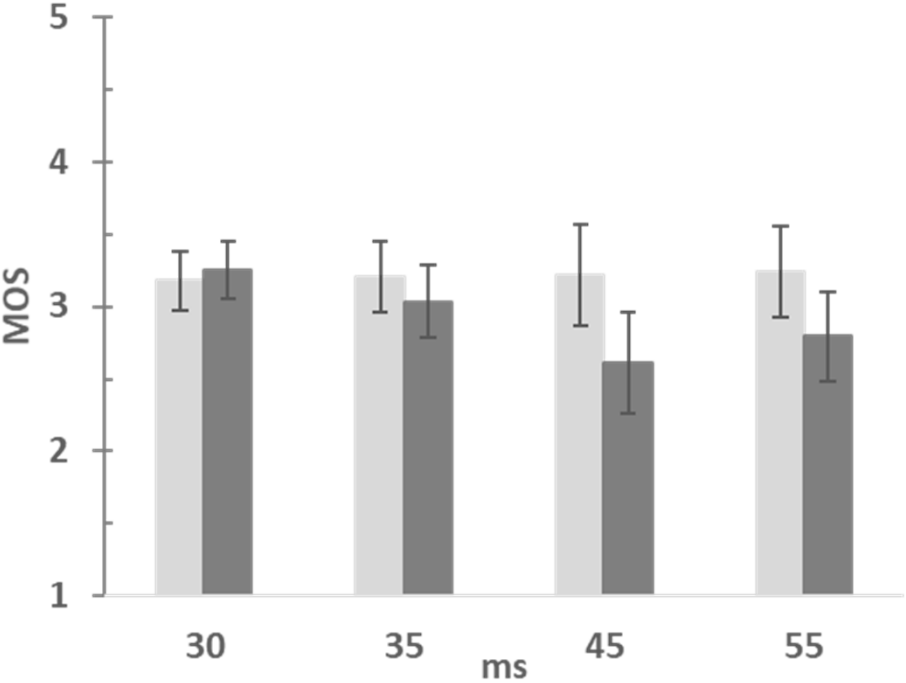
## Delay study – delay values

- Ten delay conditions (nine delay and one baseline-delay)
  - Reference condition: baseline-delay
  - Screen delay (ms): 5, 10, 20, 30
  - Joystick delay (ms): 10, 20, 50, 100, 200
  - Order randomized per test subject

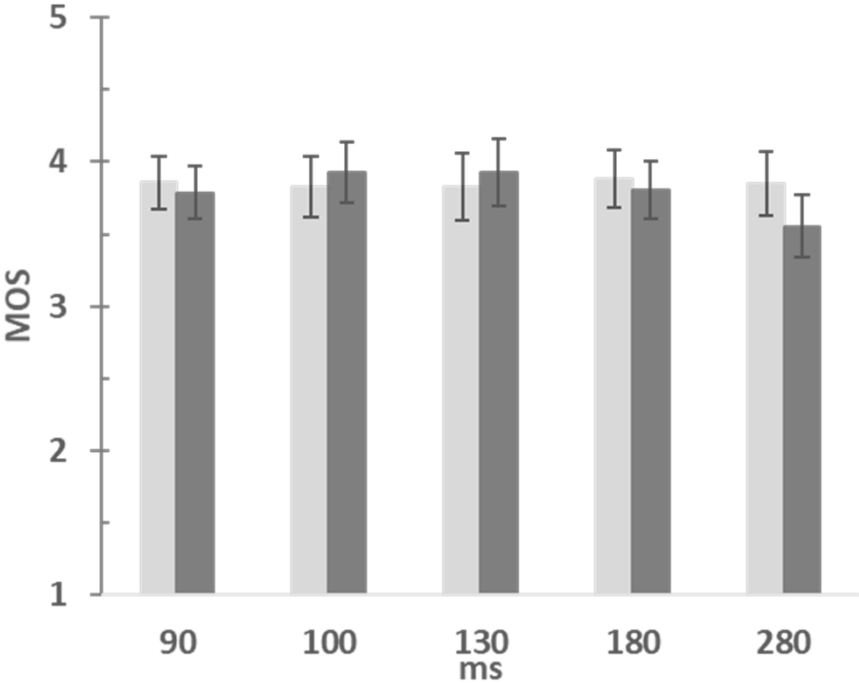
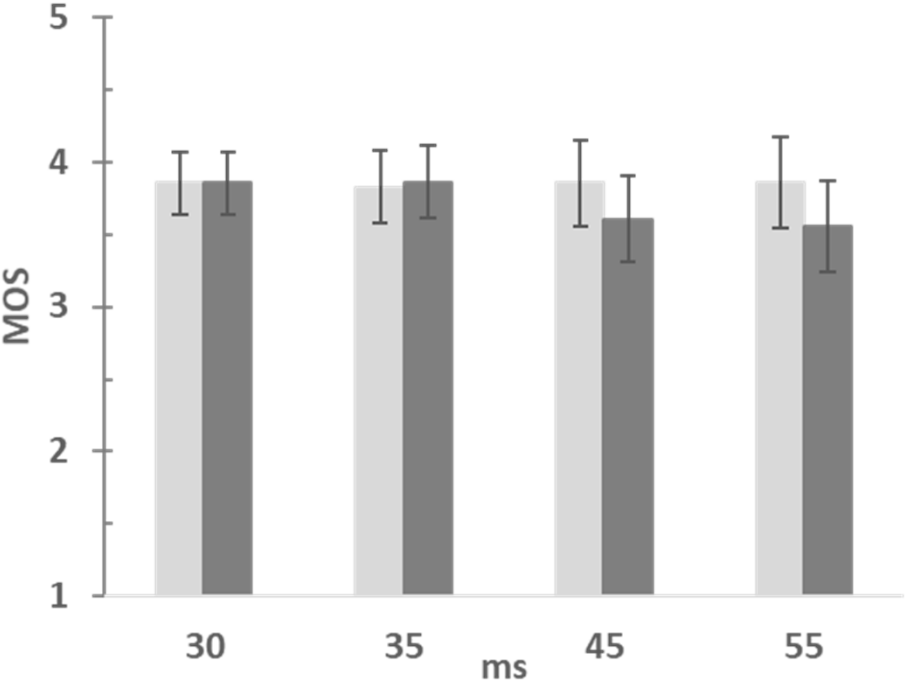
## Delay study – Results

- Based on 35 test subjects (2/3 males and 1/3 females) recruited at Mid Sweden University
- Age: 39 (mean), 21-61.
- Two were experienced in log loading
- 10 test persons did not complete their test
  - Their stop were connected to higher added Screen delay ( $\geq 20$  ms)
  - The ratings given before stopping has been included in the analysis and the other has been handled as “missing data points”

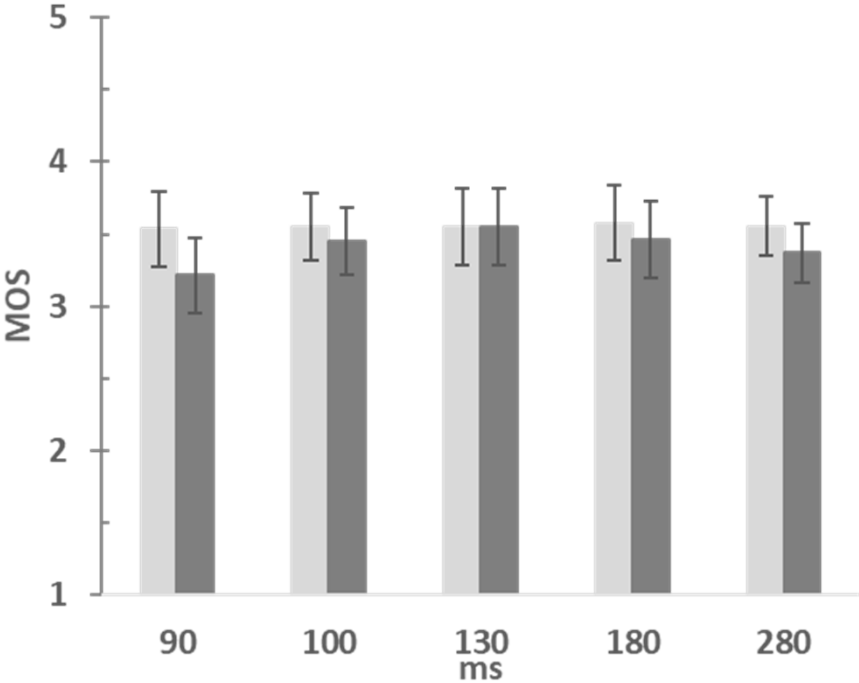
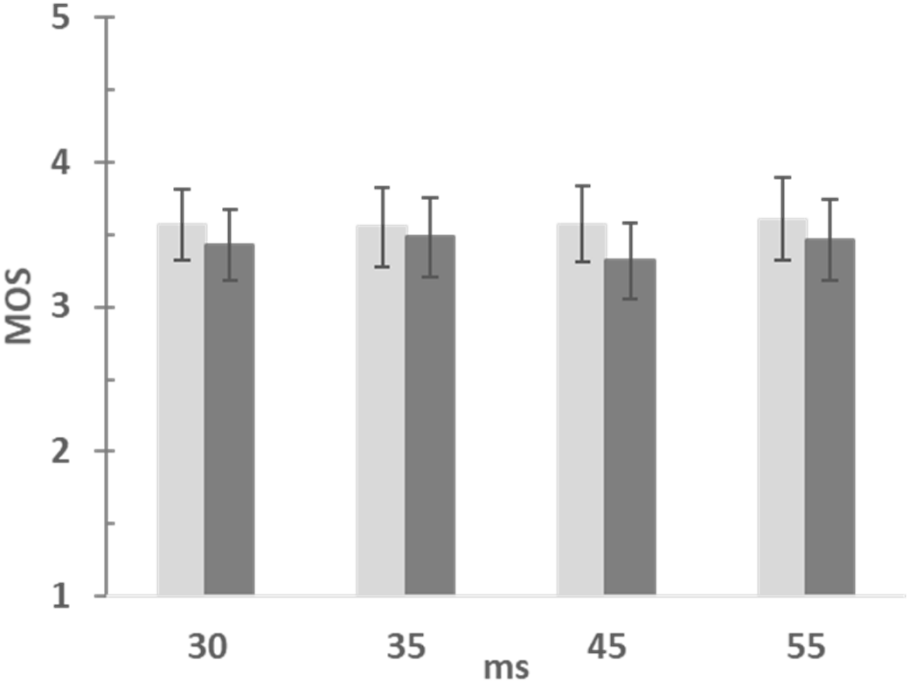
# Delay study – Picture Quality



# Delay study – Responsiveness Quality

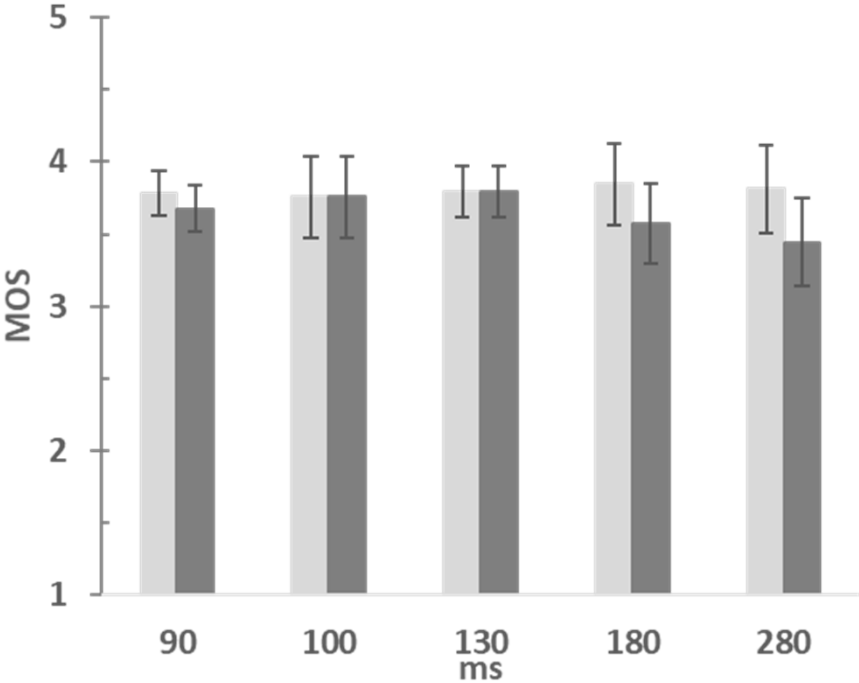
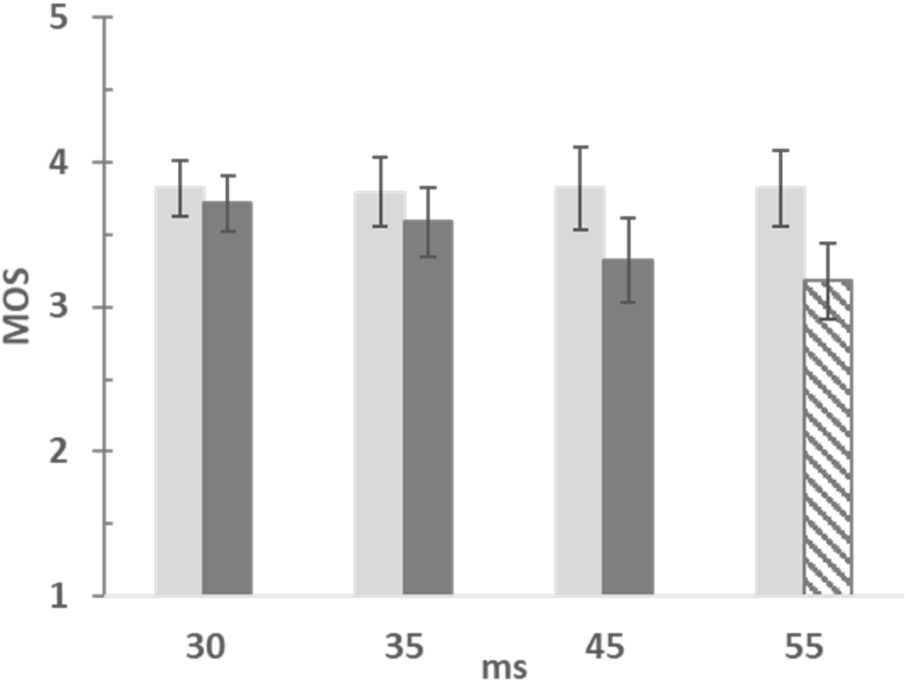


# Delay study – Task accomplishment Quality

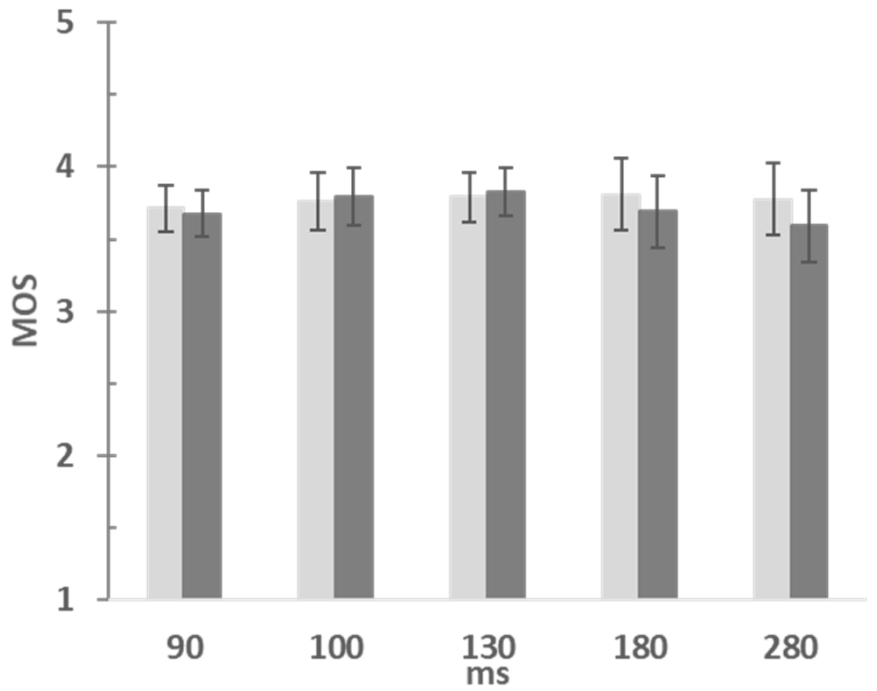
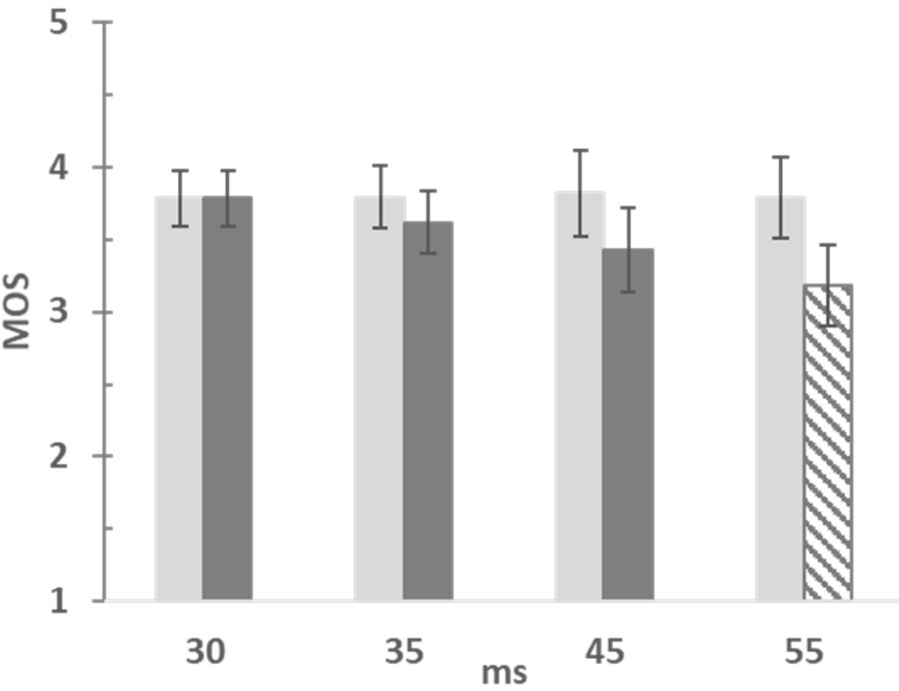




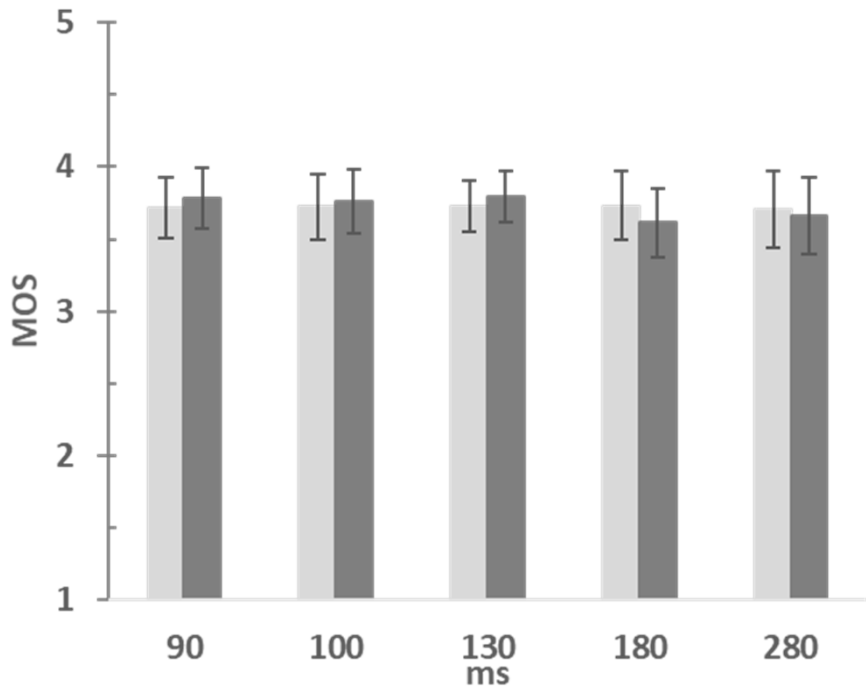
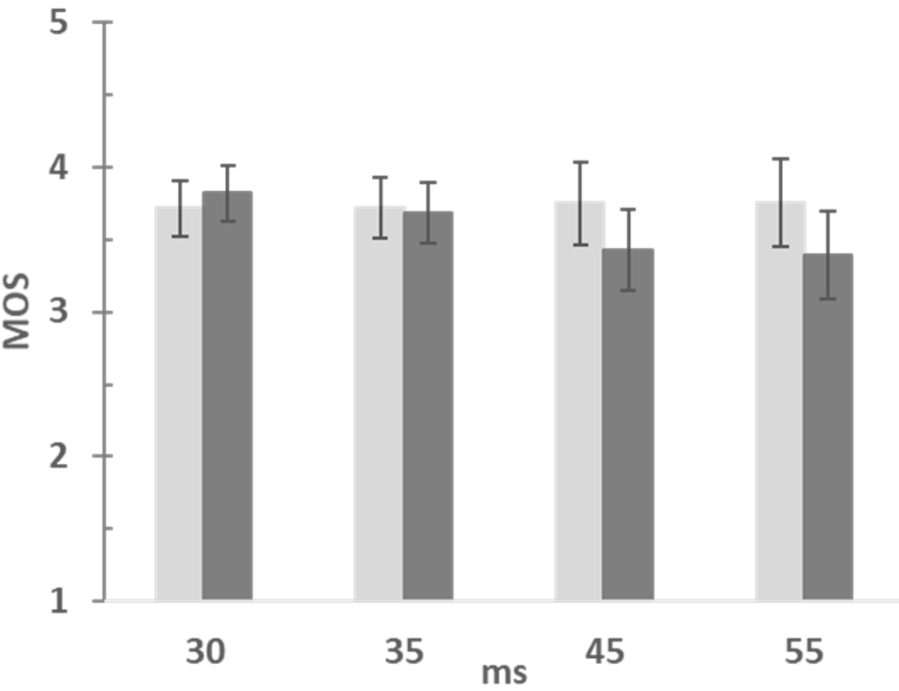
# Delay study – Comfort Quality



# Delay study – Immersion Quality



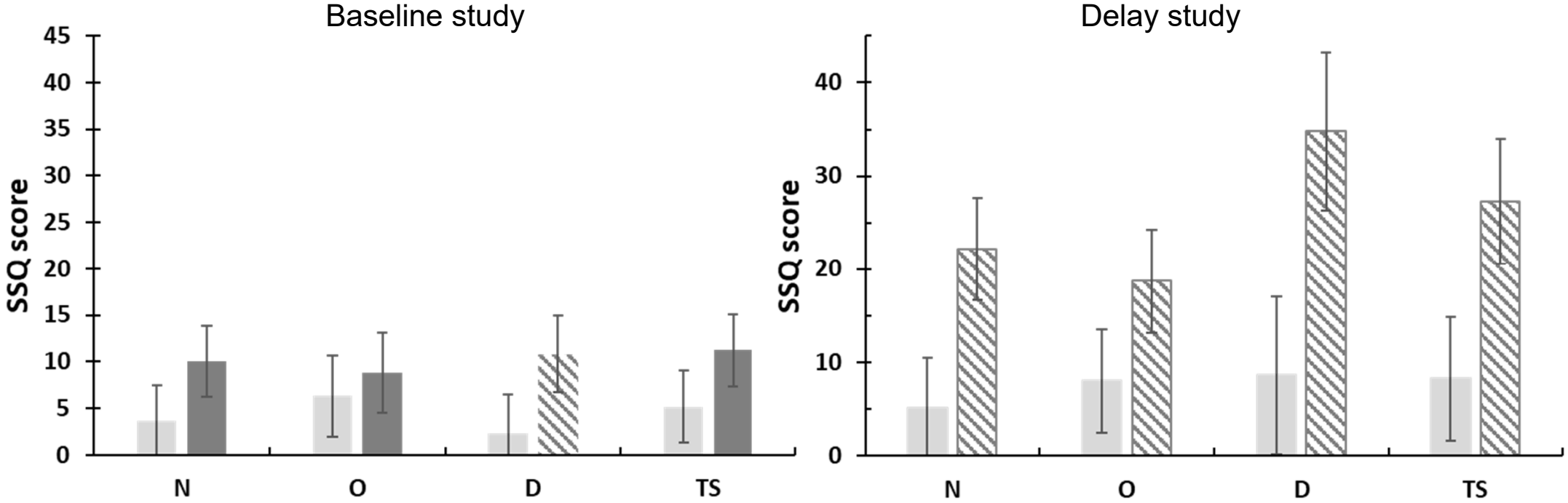
# Delay study – Overall Quality



# Simulator Sickness Questionnaire - SSQ

- Symptoms clustered according to Kennedy et al (1993)
  - Nausea (N) – nausea, stomach awareness, increased salivation and burping
  - Oculomotor (O) – eyestrain, difficulty focusing, blurred vision and headache
  - Disorientation (D) – dizziness and vertigo
  - Total Score (TS) – A total severity weighted sum of N,O and D

# Simulator Sickness Questionnaire - SSQ



## Summary and discussion

- Baseline study (based on 17 test subjects)
  - Picture Quality – Fair to Good
  - Responsiveness – Good
  - Task accomplishment Quality – Fair to Good
  - Immersive Quality – Good
  - Overall Quality – Good
  - SSQ – low increase of symptoms. Disorientation significantly higher but on a low level

# Summary and discussion – Delay study

- Based on 35 test subjects
- Picture Quality – Fair. Slightly decreasing with increasing Screen delay
- Responsiveness Quality – Almost Good. Slightly decreasing with increased delay especially on Joystick delay
- Task accomplishment Quality – Fair to Good. No clear trend
- Comfort Quality – Fair to Good. Decreasing with increasing delay, especially Screen delay. Studying when test subjects stopped it was after higher Screen delay 20 and 30 msec.
- Immersive Quality – Almost Good. Slightly decreasing with increasing delay, especially Screen delay.
- Overall Quality – Almost Good. Slightly decreasing with increasing delay, especially Screen delay.
- Overall test subjects did not clearly experience the actual delay – the effect was smaller than expected

# Discussion

## ■ Delay study

- The verbal feedback worked well in general, but took longer time than we anticipated, so the number of scales should be fewer next time.
- SSQ – Clear increase of symptoms. Disorientation significantly higher
- Higher Screen delay affected the test subjects most
- Quite a few test subjects did not complete the test.
  - We were very cautious for any discomfort and nausea, so that anyone could stop if symptoms appeared.
- All test subject were very happy leaving the test and enjoyed the experience



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# THANK YOU!

Kjell Brunnström

[kjell.brunnstrom@ri.se](mailto:kjell.brunnstrom@ri.se)

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