Measuring User Quality of Experience in Social VR systems

Francesca De Simone

Distributed & Interactive Systems Group

Centrum Wiskunde & Informatica
Amsterdam, the Netherlands

What is this talk about?

Virtual Reality (VR)

is a computer-generated experience that can simulate physical presence in real or imagined environments

[*Steuer, 1992*]

What is this talk about?

Social Virtual Reality (sVR)

allows multiple users to join a collaborative Virtual Environment (VE) and communicate with each other

[Mantovani, 1995; Waters et al. 1997]

i.e., Collaborative VR

What is this talk about?

Social Virtual Reality (sVR)

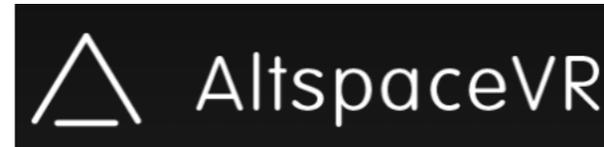allows multiple users to join a collaborative Virtual Environment (VE) and communicate with each other

[Mantovani, 1995; Waters et al. 1997]

✓Interaction between users
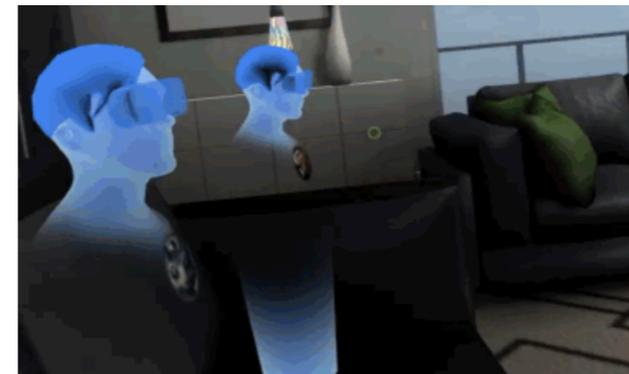
✓Interaction between users and VE

Some examples of sVR nowadays

Interaction in sVR

- ## User virtual representation

  - computer-generated avatars

  - virtual representation based on live captures [*Gunkel et al., 2017*]

- ## Interaction with the VE

  - manipulation of virtual objects

  - control over the appearance of the VE

  - control over the playout of additional media in the VE

User QoE in sVR

- Multiple dimensions:

  ▸ Presence & Immersion

  ▸ Usability

  ▸ Discomfort

  ▸ Cognitive load

  ▸ Quality of communication
    - social presence *[Bicocca et al. 2001]*
      ✓ co-presence
      ✓ psychological involvement
      ✓ behavioral engagement
   - audio-visual quality

Factors impacting QoE in sVR

- Avatar appearance

  - full vs partial body representation *[Heidicker et al, 2017; Smith et al, 2018]*

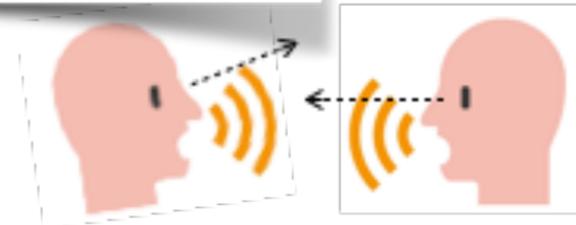 - puppet vs photo-realistic representation *[Latoschik et al., 2017]*

- Avatar behavioural realism

  - mapped vs animated body movements *[Heidicker et al, 2017; Roth et al., 2016]*

  - eye gaze *[Garau et al., 2003]*

  - facial expressions *[Latoschik et al., 2017]*

  - self-embodiment *[Slater et al. 2010; Waltemate et al. 2018]*
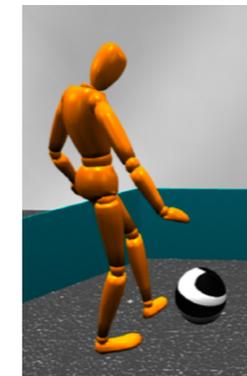
How to measure QoE in sVR

A variety of methods!

- ## Subjective assessment

  ✓ Questionnaires

    - Presence Questionnaire [Slater, Usoh & Steed 1999; Witmer & Singer, 1998; Schubert 2001; Meehan 2001; Thie 1998; JSC 2000; etc …]

    - Networked Minds Social Presence Questionnaire [Bicocca 2001]

    - NASA TLX Questionnaire (cognitive load) [NASA 1986]

    - Simulator sickness (discomfort) [Kennedy et al. 1993]

  ✓ Semi-structured interviews

- ## Objective assessment

  ✓ Analysis of:

    – verbal interactions
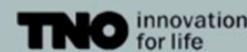
    – visual cues

    – gestures

    – body movements

  ✓ Physiological sensing

  ✓ Task performance

A use case: watching movies together in sVR

THE FEELING OF BEING THERE TOGETHER AND THE PHOTOREALISTIC QUALITY OF THE CONTENT

Scenario

Two users sitting in a Virtual Environment (VE), where they can interact with each other, and watching a movie trailer together on a virtual screen

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Two users sitting in a Virtual Environment (VE), where they can interact with each other, and watching a movie trailer together on a virtual screen
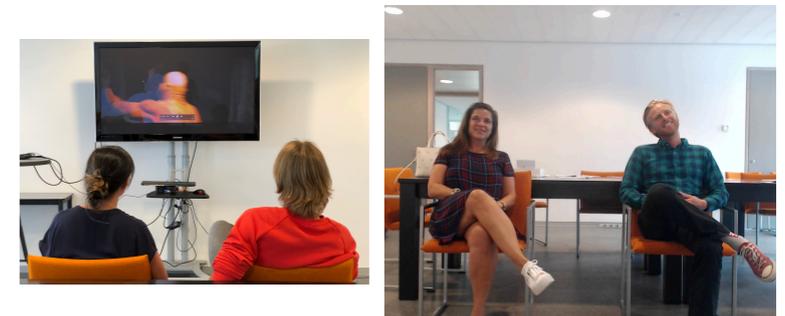
✓ 2 Social VR systems

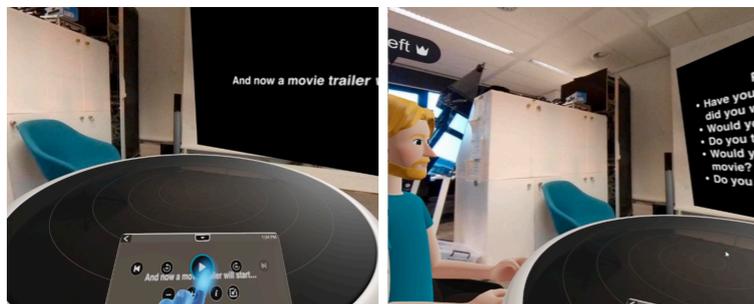✓ face2face experience as benchmark

Facebook Spaces
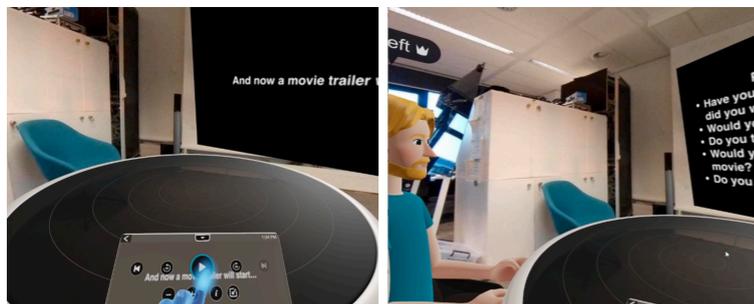
TNO

Face2Face

Video examples

Scope

✓ To compare the performance of different sVR systems

✓ To compare the sVR experience to the real one

✓ To implement a procedure to measure QoE in sVR

Facebook Spaces   TNO   Face2Face
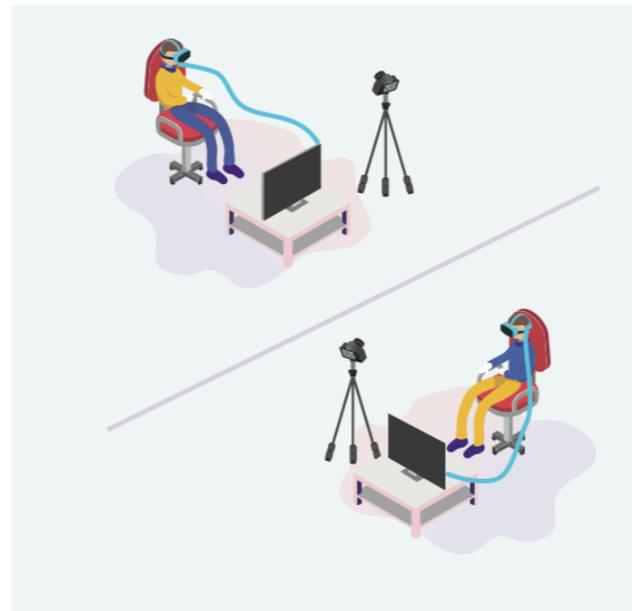
Test rooms & recording setup

Face2Face

Social VR

- **Recording set-up**
  - log of user's head rotation when wearing the HMD
  - capture of HMD viewport and audio channel
  - webcam to record user's body
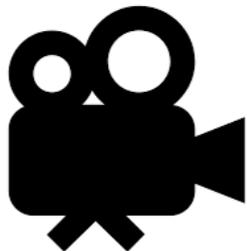
Study details

- Users
  - 16 pairs of users
  - users in a pair knew each other
  - users received monetary compensation

- Protocol
  - within-subjects design
    - each pair of users experienced all conditions, watching a different video trailer in each condition
  - fully counter-balanced test design

- Content
  - 3 action/science-fiction movie trailers (approx. same number of views on YouTube)
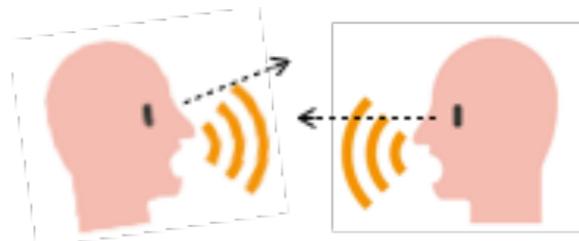
How do we measure QoE?

- Subjective assessment
  - ✓ Questionnaire
    - Quality of Interaction (10 questions)
    - Social connectedness (9 questions)
    - Presence/Immersion (5 questions)
  - ✓ Semi-structured interview

- Objective assessment
  - ✓ Analysis of verbal interactions
  - ✓ Analysis of visual patterns
  - ✓ Analysis of users' body movements

Process

1 hour

- ## Before
  - Explain what the experiment is about and its process
  - Consent form
  - General information form
  - Social Anxiety (SAD) form

- ## After each test condition
  - questionnaire to assess Quality of Interaction, Social connectedness, Presence/Immersion for VR, familiarity and appreciation of the trailer
  - simulator sickness questionnaire for VR

- ## At the end
  - semi-structured interview

Results

Results: subjective data

Quality of Interaction (10 questions); Social connectedness (9 questions); Presence/Immersion (5 questions) — box plots for F2F, FB Spaces, and TNO conditions.
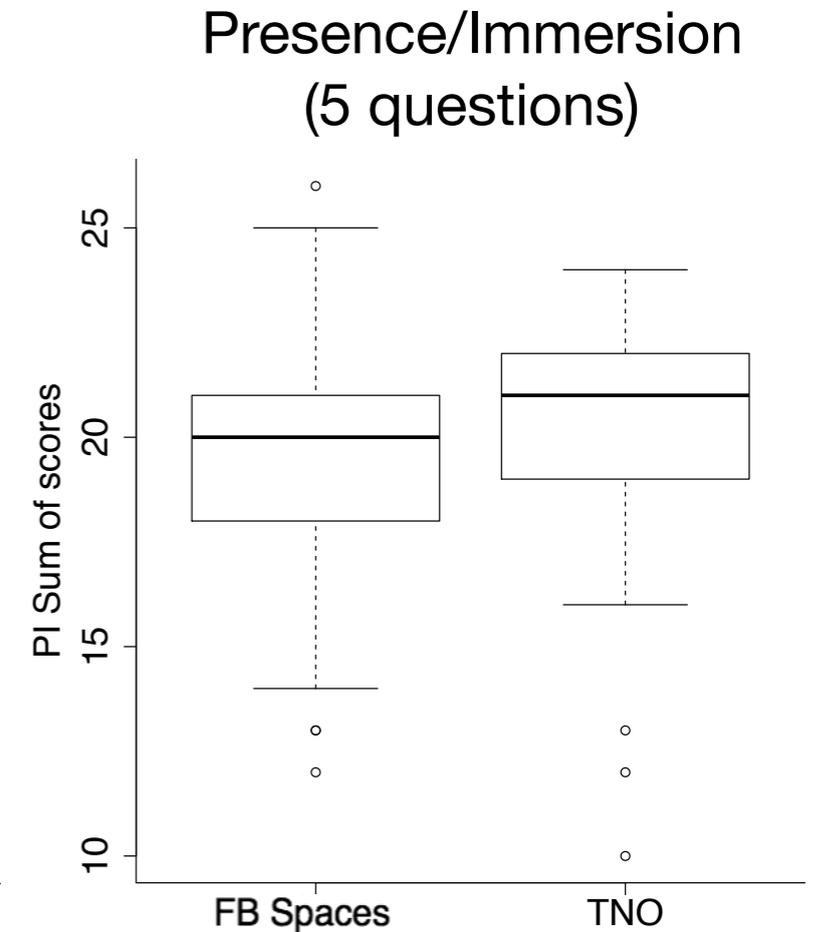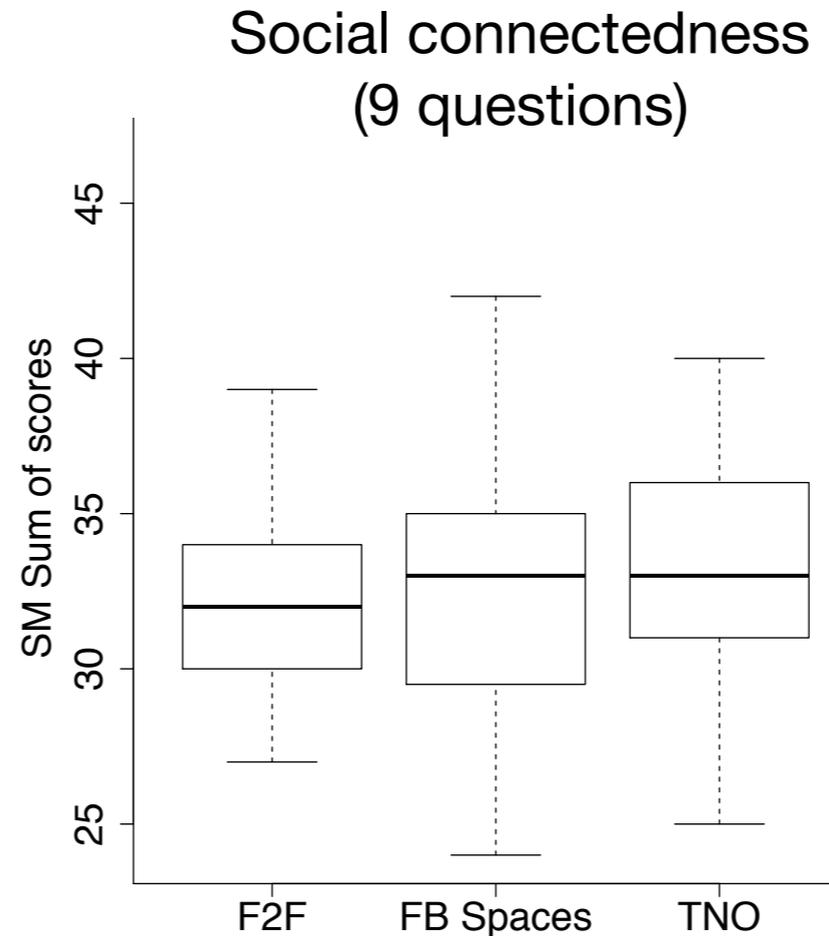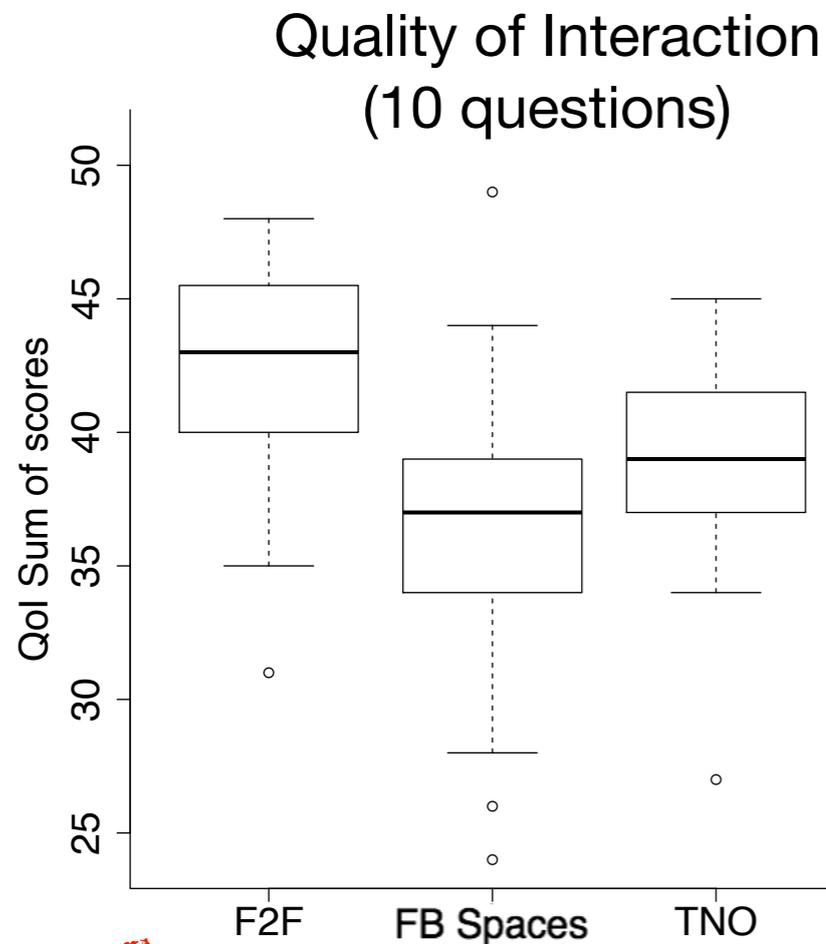
QoI shows statistically significant difference between:
- face2face & sVR conditions (p = .107e-08; .0005626)
- Facebook & TNO (p = .002691)

Results: subjective data

From semi-structure interviews:

- **Q1: Compared with the face-to-face experience, what was missing in the two social VR systems, in terms of interaction?**
  - FB avatar: low realism (47% of users)
  - TNO representation: missing eyes (37.5% of users), missing self representation (28.12% of users), missing eyes not a problem (40.6% of users)
  - FB controllers: annoying (21% of users)

- **Q2: Did you like the movie trailer watching experience?**
  - 50% of users expressed preference for TNO system to watch movies together
  - Other applications: gaming (40.6% of users), business meetings (28.12% of users)
  - sVR can be useful for long-distance relationships (50% of users)

- **Q3 Were you satisfied with the virtual environment?**
  - Problems with distances and dimensions (21.8% of users)
  - VE makes people anxious (34.3% of users)
  - I felt I was there (37.5% of users)

- **Q4: How do you think the social VR systems can be improved in the future?**
  - HMD ergonomics (28.12% of users)
  - Better user representation (21.8% of users)
  - Wider field of view (12.5% of users)

Results: objective data

Talking to each other
(% of time spent talking to
each other vs entire duration
of the experience)
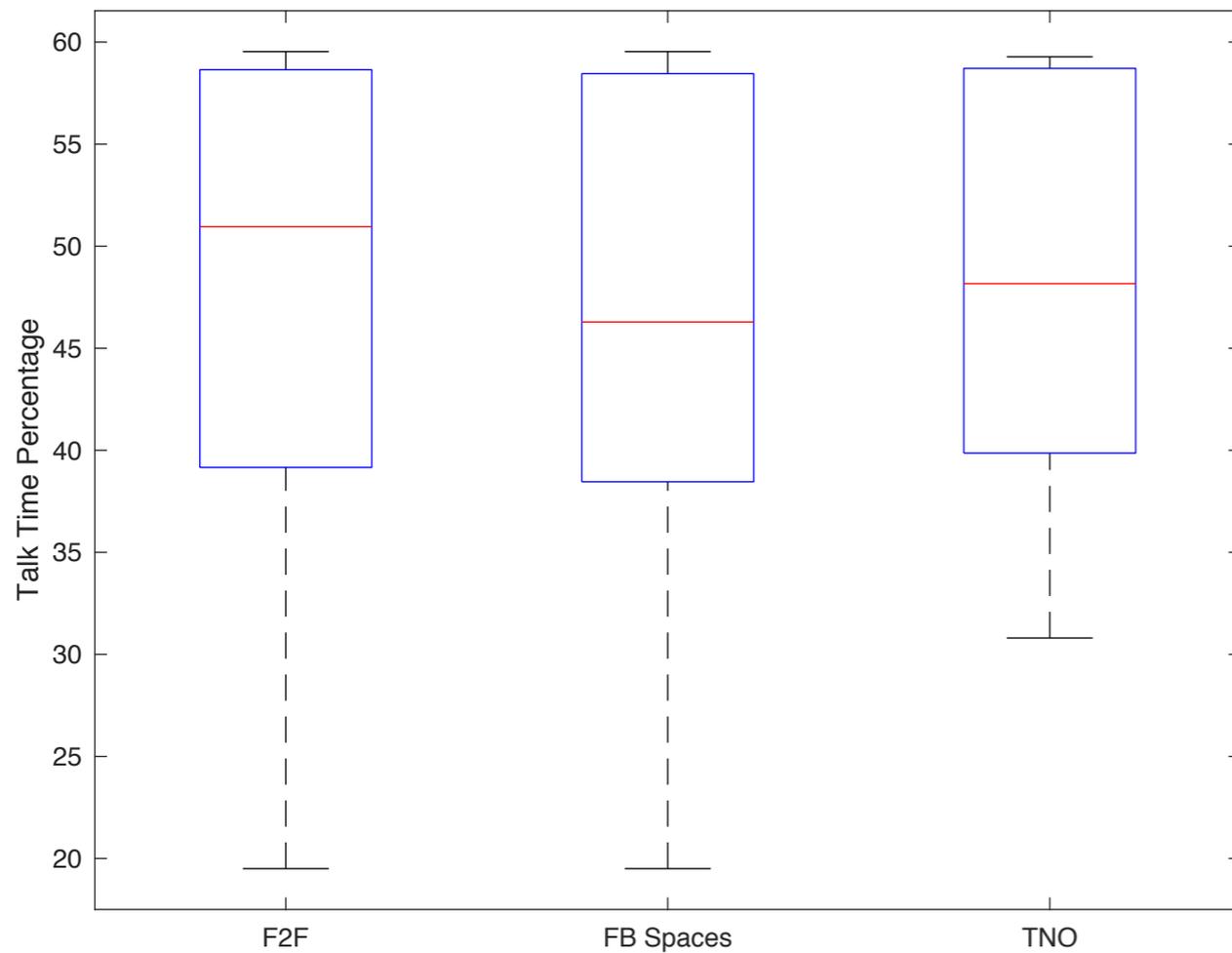
Looking at each other
(% of time spent looking at
each other vs entire duration
of the experience)

Temporary results on
only 30% of data
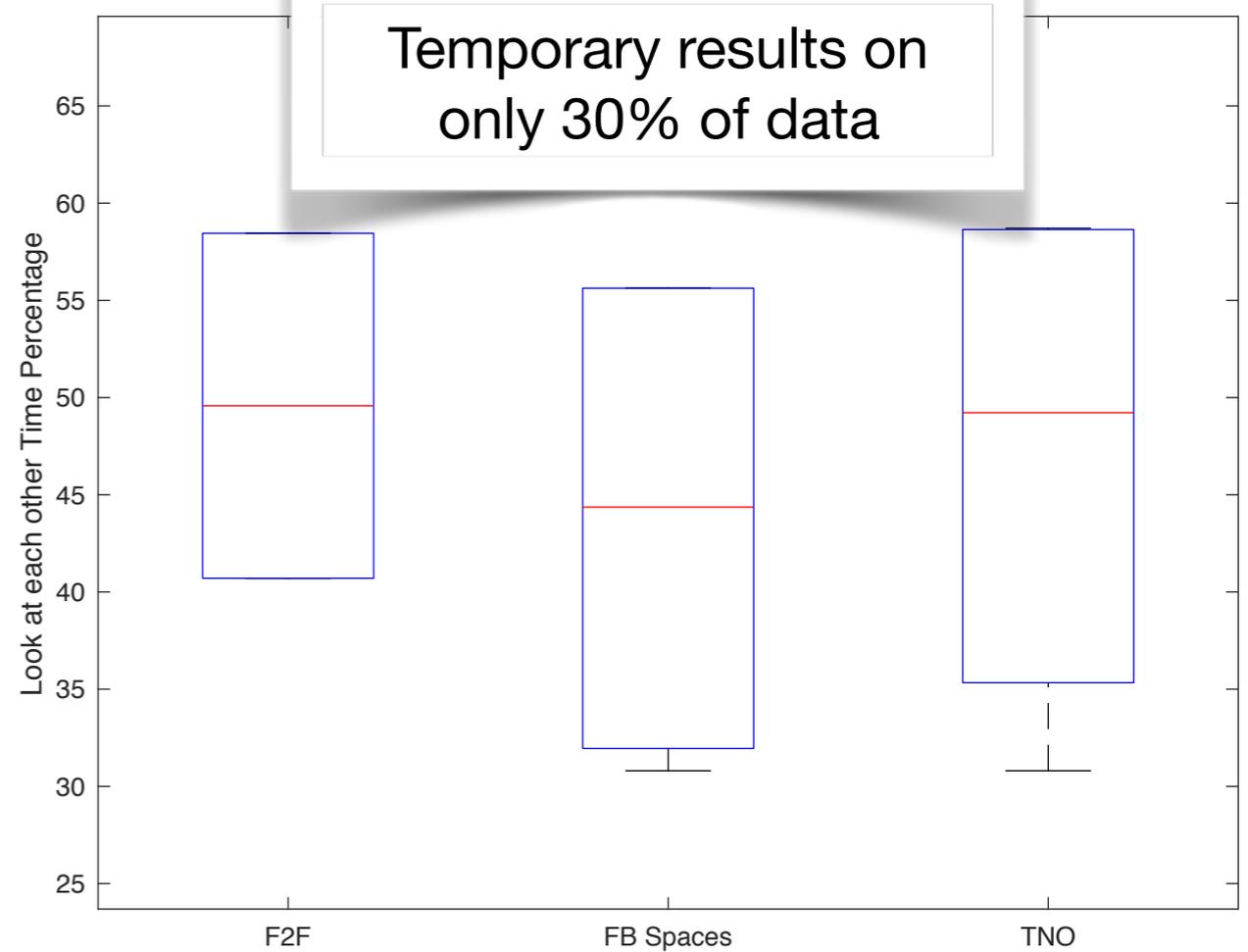
Results: objective data

User's body movements
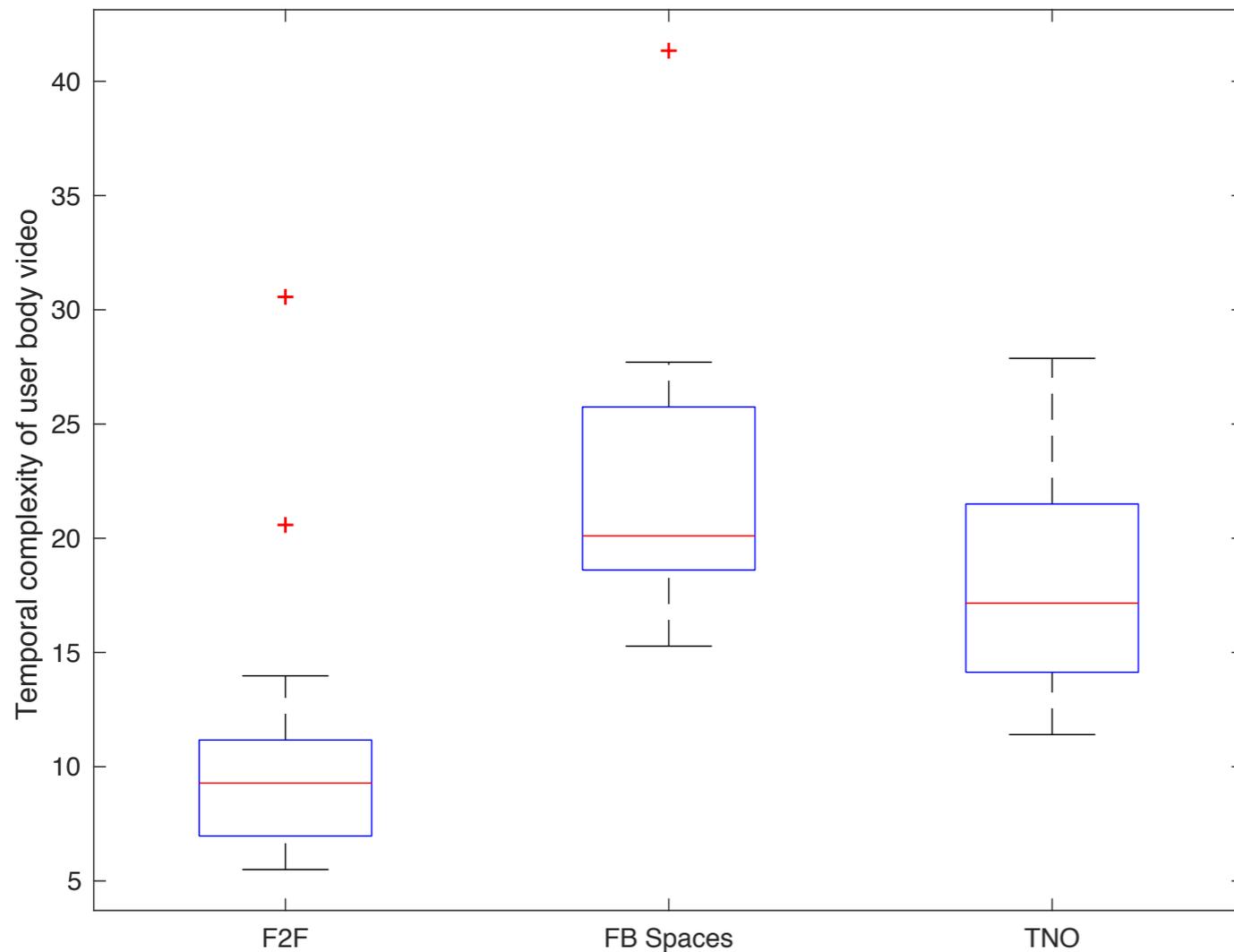
Statistically significant difference between:
- face2face & sVR conditions (p = .4799e-07; .0043)

- Effect of discomfort due to HMD?

- Visual navigation of VE?

Conclusions

- Based on preliminary analysis of our results:

  ✓ Considered sVR systems appear to deliver a social experience that is comparable to the real world one

  ✓ Majority of users preferred the realistic virtual user representation to the puppet

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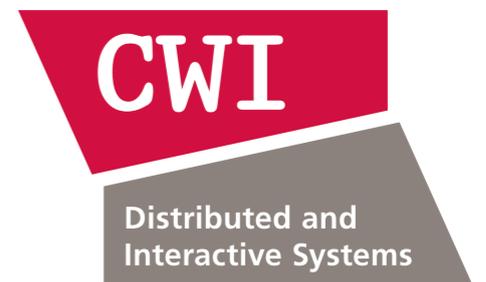

Study will be submitted to the IEEE VR 2019 conference

Thank you for your attention!

f.de.simone@cwi.nl

www.dis.cwi.nl

Joint work with my colleagues:
Jie Li, Abdallah El Ali, Thomas
Roggla, Yiping Kong, Pablo Cesar

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Useful readings

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