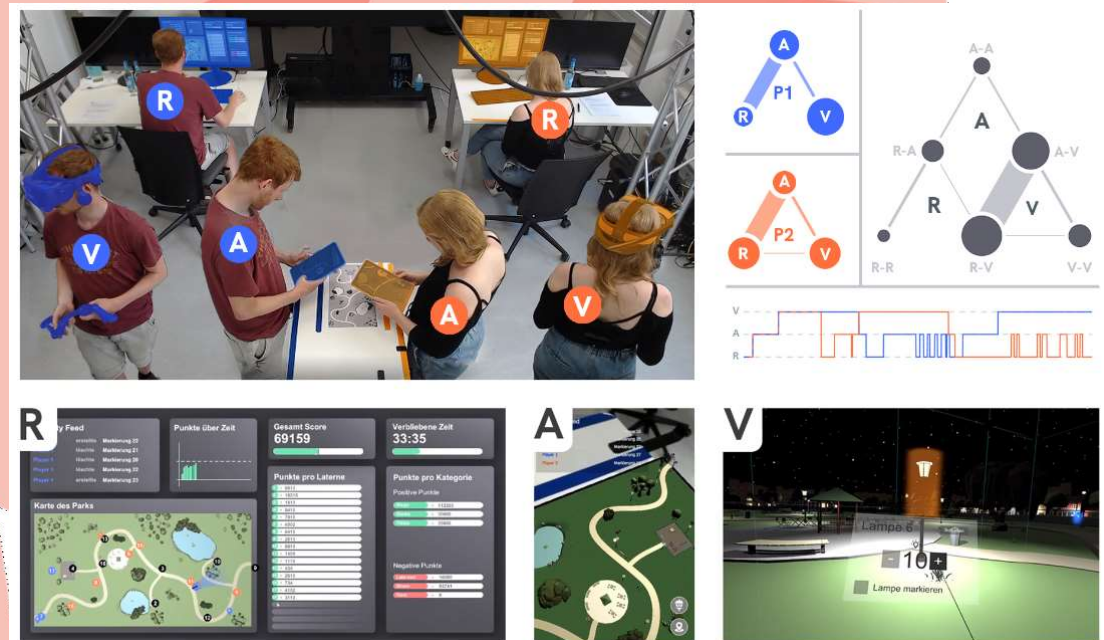


Collaborating Across Realities Analytical Lenses for Understanding Dyadic Collaboration in Transitional Interfaces

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Summary

1. Objectives – Challenges - Contributions
2. Related work and vocabulary
3. Study
4. Prototype
5. Results
6. Limitations & Conclusion

Objectives – Challenges - Contributions

Objectives :

1. Create a realistic task to study transition between modalities (AR, VR and screen).
2. Study transitions, collaboration and awareness.

Challenges :

1. Show importance of collaboration between transitional interfaces users.
2. Challenge of maintaining awareness and coherence in transitions in different locations.

Contributions :

1. TI prototype + study design on transition collaboration. Strategies of participants, perception of collaboration.
2. 4 lenses for collaboration

Vocabulary

(TI) Transitional Interfaces

« Cross-reality user interfaces. **Freely move** along reality-virtuality continuum during collaboration. »

(RCV) Reality-virtuality continuum

Switching between displays, input/output modalities, representation of data or functionality according to their preferences.

Co-context

Same context but don't see each other in real but see each other in "**virtual proximal embodiments**".

Cross-context

Separate by different context visible with "**virtual distal embodiments**".

Study

Goals :

1. Observe user behavior during a demanding collaborative activity
2. Identify recurring patterns and typical characteristics of the transitional collaboration.

Task :

- Collaborative spatial optimization problem.
- Objectif for participants to design the illumination of a factitious, urban park
- They could discover these animals when walking through to navigate the park --> increased the spatial complexity
- Time limit



Experiment :

- 34 participants.
- Sign-up by pairs so they know each other.
- Explanation 10min + task 45min + questionnaire (personal experience & Affinity for Technology Interaction (ATI) questionnaire) + interviews (shared experience to consolidate & clarify observations)

Prototype

Context “Reality” :

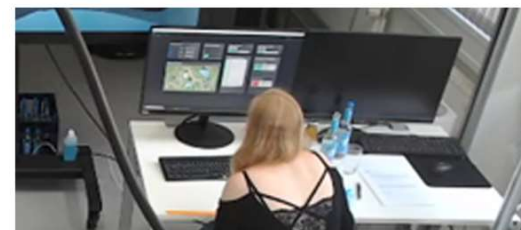
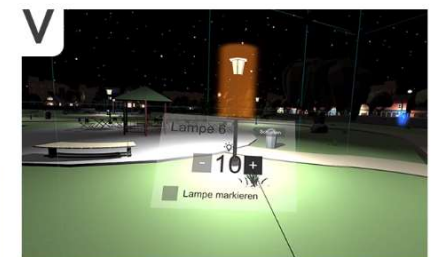
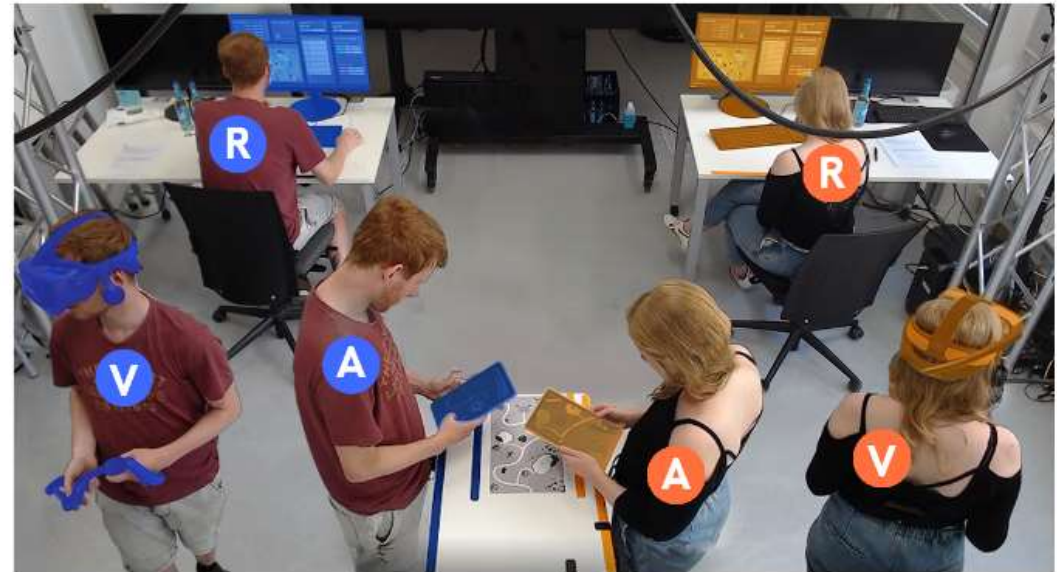
PC + screen. Mini map of the park + location of other + score, bar charts, figures + pins

Context “Augmented Reality” :

Hologram of the park + tablet to interact. Add lamps with gaze cursor and touch button on the tablet.

Context “Virtual Reality” :

VR visualization of the park at night. First-person experience. Teleportation + actual walking. Adjust brightness. See nocturne animals.



Prototype

Distribution of information and **functionalities** chosen to motivate participants to use transitions between different context and observe collaborative and transitional behavior.

Awareness clue :

- **where** : each participant see the location of other and their context.
- **what** : edited or brushed artifacts are highlighted. Team's latest actions.
- **who** : no need with two participants but color to differentiate their actions.

Talk and listen natural but **no collaborative activities**.

Qualitative Data :

- 3 cameras + microphone + screen streamer → centralize
- Write notes for interviews

Quantitative Data :

- participants position in virtual park
- current context
- scores
- events (mark location, changing context, placing lamps, change brightness)
- post-study questionnaire (individual work + workload as a team + workspace awareness + personal information).

Data

Data Validation

Correlation between score and number of transition
→ benefices of the prototype.

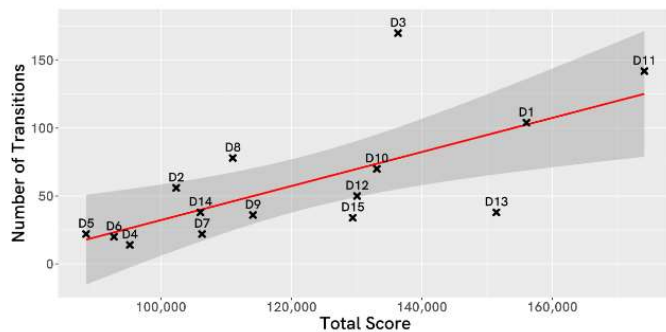


Figure 7: Correlation of total score and number of transitions.

Team WorkLoad Questionary (TWLQ) → high demand for team collaboration, especially communication & coordination demand.

Study prototype and tasks afforded sufficiently **complex**, **meaningful**, and **realistic collaboration** in TIs. Participants **collaborated successfully** and **reported sufficient group awareness**.

1. Workspace awareness can be established in a TI
2. Simple designs of transitions and awareness cues can be sufficient
3. Verbal communication plays a critical role
4. In some cases, users' arousal by and enjoyment of changing contexts could outweigh the physical and temporal demands of switching devices in TIs.

Data

Data Analysis

Two-step analysis :

1. Identified characteristic commonalities and differences in transitional collaboration between the dyads.
 - Experimenter's log :behavior, patterns, themes of collaboration
 - One observation = 1 stick note + 1 color = 1 categories
 - Update each day
 - Result : 11 clusters and 4 chosen for step 2
2. Used different metrics and visualizations to quantitatively substantiate a selection of four of the observations from step 1.

Results

LENS #1 : Understanding Place and Distance in Transitional Collaboration

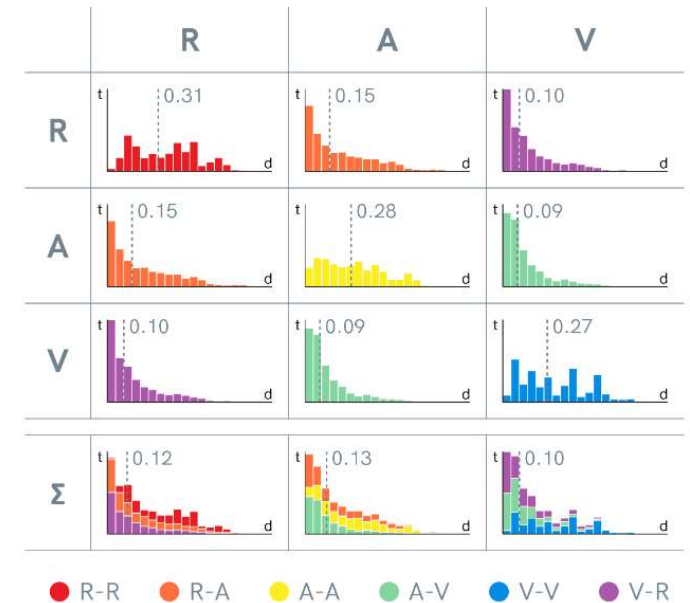
Measure distance between participants inside virtual park.

$$d = \frac{d_{eucl}(P_1, P_2)}{d_{max}}$$

Use matrices with context-specific histograms showing distributions of the virtual Euclidean distance d as analytical tools.

X-axis = distance normalized

Y-axis = % time



Conclusion :

Co-context collaborative : stand close in the park, view artifacts together, work “loosely-coupled”.

Cross-context : work “tightly coupled” --> smaller distance and tightly collaboration.

Results

LENS #2 : Temporal Patterns in Transitional Collaboration

Pattern :

1. Phase of exploration (strategies, functionalities, responsibilities) : majority moved through contexts in parallel
2. Phase of coordinated work : different frequencies of transition and individual work

Figure 12 : small multiples [39] of a **context time-diagram** representing the usage of contexts over time of each.

Frequency of transitions / number of transition.

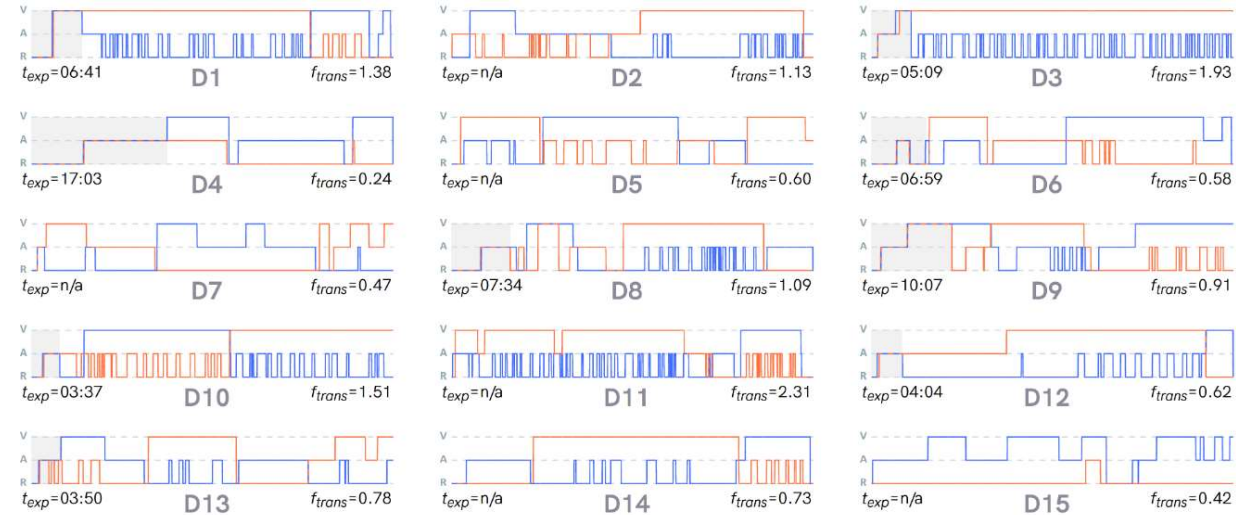


Figure 12: Visual Lens #2: Contexts over time of all dyads together with the transition frequency f_{trans} and the duration of the initial co-context exploration phase t_{exp} (where applicable). The duration of t_{exp} is also highlighted in light gray.

Results

LENS #3 : Group Use of Contexts

1 stay in a context + 1 switch between 2 others contexts --
> V + A/R to avoid time consumption OR R + A/V to have a global view.

Context triforme for notation and formalization of context's usage.

Nodes = context combinations

Edges = transitions / thickness= quantity percentage

No difference between P1 & P2

Fast overview of preferred context combination, co-context VS cross-context collaboration and frequently used transitions

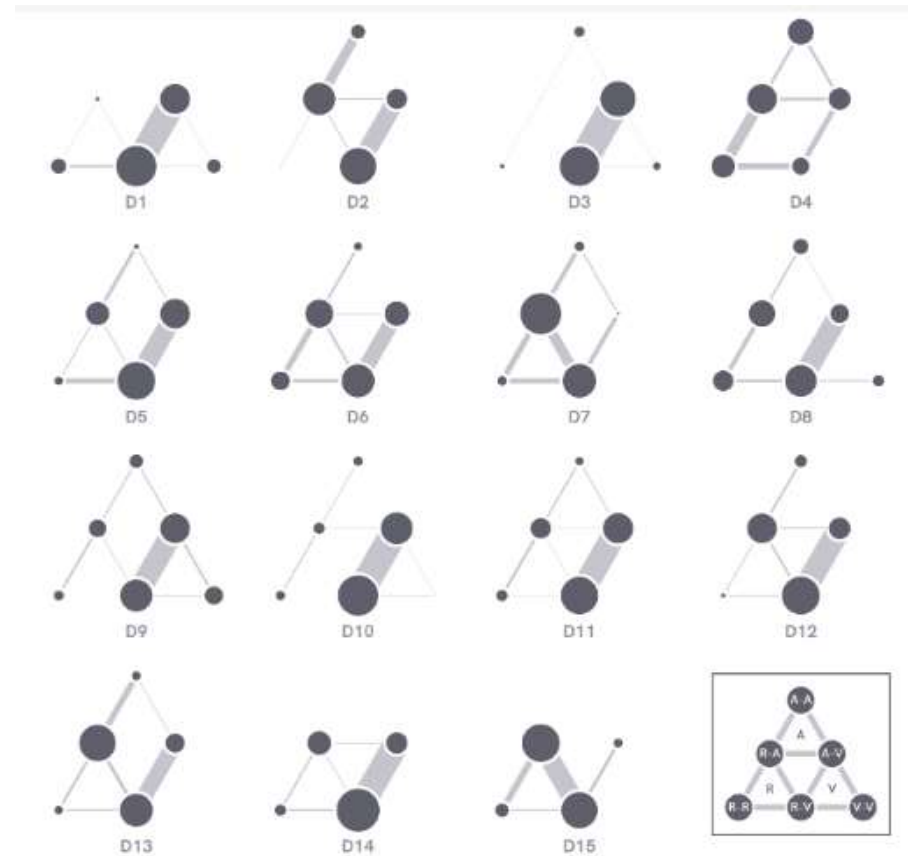


Figure 14: Visual Lens #3: All context triformes showing group usages of our TI. See legend in the bottom right corner.

Results

LENS #4 : Individual Use of Contexts

- Two roles : one change and the other stay in a context. Voluntary or not.
- Two change frequently.
- Measure asymmetry : describe individual patterns.

Context triforme

Nodes = context

Compare the 2 graph of triforme example D3 and D10 or D5 and D12.

Participant influence each other's usage patterns.

Need to considered individual behavior and group.

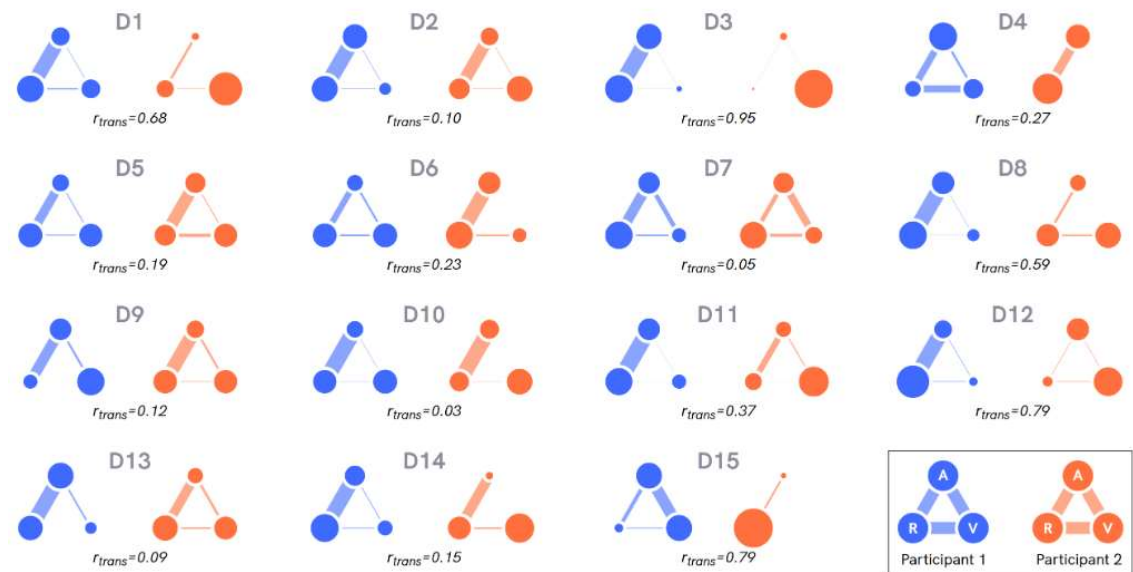


Figure 15: Visual Lens #4: Individual usages of our TI represented by our personal context graph and the ratio of r_{trans} of each dyad. See legend in the bottom right corner.

Limitations & Conclusion

Limitations

Observations limited to this specific task and design of this prototype

→ Should work on transitional collaboration in real-work tasks.

Limit with dyadic collaboration and three contexts

Quantitative Analyse

Interpret differently the data.

Qualitative Analyse

Calcul Euclidean distance is not necessary linked to close collaboration.

→ Better to study co-located, remote and hybrid collaboration

Conclusion

- **Methodological contribution** through transitional collaboration.
- Study **collaborative behavior**.
- **New tools** for analyzing transitional collaboration or evaluating TIs based on new metrics and visualizations.
- Task great for collaboration and awareness.
- **Analytical lenses** to identify and analyze various commonalities and differences between each dyads.
- **Findings about TI design** : affect performance of users and their perception of transitional collaboration.
- **Role of** awareness cues, verbal communication, task load and cost of device switching.