

Establishing Awareness through Pointing Gestures during Collaborative Decision-Making in a Wall-Display Environment

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Questions – Challenges

Questions :

1. How mid-air pointing gestures are used by groups of four collocated participants to share awareness information during collaborative decision-making in a wall-display environment ?
2. How mid-air pointing gestures are used around wall-sized surfaces ?
3. How they support the sharing of awareness information with the aim of investigating how they can be replicated remotely on another display ?

Challenges :

1. Advance the current understanding on how users share awareness information in wall-display environments
2. Focusses on mid-air pointing gestures as a foundational part of communication.

Related works - Large interactive displays

- Enable large amounts of data to be presented in different scales and views.
- Support users to better identify details and gain more insights about the data.
- Cognitive and perceptual benefits.
- Enhance user performance and satisfaction for such tasks
- Multiple users can access and view content at the same time, and observe each other's interactions.
- Coordinate their activities, anticipate others' actions, and assist each other.
- Awareness information makes collaborators' actions and intentions clear and allows them to seamlessly align and integrate their activities with those of other group members.

Wall-sized displays have three common applications :

- navigating a single, very large object (3D molecule)
- comparing a large quantity of related visual content (photos)
- juxtapositioning data from different sources (compare)

Related works - Two most common types of awareness

Situation awareness : the acquisition and interpretation of information from the environment that is fundamental for subsequent decision making

Workspace awareness : monitoring the activity of others, which provides context for one's activities. Where others are working, what they are doing, and what they are going to do next.

Awareness information is crucial for coordinating actions, managing coupling, talking about the task, anticipating others' actions, and finding opportunities to assist one another.

- * people's bodies
- * workspace artefacts
- * conversation and gestures

Study

Goal :

- Analyse a broader set of behavioral pattern

Experiment :

- 24 persons (6 groups of 4).
- 360° immersive arena, 2m high, composed of 12 screens (8 used).
- Questionnaires :
 - ✓ familiarity with the 3 teammates
 - ✓ asked about the frequency of their usage of large interactive displays
 - ✓ how often they use similar pointing devices

Scenario :

- Decision-making scenario.
- Creating a control tower for experts and decision-makers to help managing medical supply chains during distress times.
 - ✓ Show different types of data
 - ✓ Integrate collaborative mechanisms
 - ✓ Be solvable by non-experts

4 task :

- Estimate and select equipment --> interpret, analyze and identify the best solution.
- Mechanism of collaboration : each participant has a resource

Study

Table 1: The four tasks of the decision-making scenario and the types of data they include.

Task	Description	Data	Predominant roles
1: Estimate future COVID numbers	Users need to read the news, estimate hospital and ICU occupancy, and adapt the sliders according to their estimation.	Line graphs, Text	Head of ICU
2: Select the protective equipment to restock	Users need to compare the numerical data in the table, discard items according to their individual information and choose the one with the lowest number.	Table with icons and numerical data, Text	CEO
3: Select one offer in the overview	Users first need to filter offers according to the personal information provided (Task 3.1) and then select the cheapest offer that fulfils all criteria (Task 3.2).	Scatterplot, Text	Head of ICU, Head of finance, Head of logistics, CEO
4: Select delivery option	Users need to go through the delivery options and select the one that fulfils all criteria. To do so, they need to read the details and check the trajectory on the map.	Table with icons, textual and numerical data, Map, Text	Head of finance, Head of logistics

Data

The decision-making process using three fixed cameras (top, front, and back cameras).

Audio-visual recordings of the study.

Analyze manually.

Annotate properly the gesture performance in **2 rounds** :

- subtype and duration
- referent and target

Excluded in our results touch-pointing gestures.



Figure 2: Three different camera angles (top, front and back) were recorded by fixed cameras in the lab and used for the annotation.

Results

Created a gesture typology :

- **Narrative pointing (NP)** : points sharply with the index finger or moves the finger towards a larger area of the display. **Speech accompanied** (read or explain). Longest duration.
- **Loose pointing (LP)** : user is not looking at the screen and holds the hand usually open or palm up. Vague communicative goals, are usually **not speech-accompanied** and are of very small duration.
- **Sharp pointing (SP)** : “stereotypical” pointing gesture with an index finger where a user points to a very specific area of the display

NP != SP (Narrative is not a succession of SPs because it is continuous)



NP: The user starts reading aloud the information on the screen by pointing the index finger at the text (a). He continues and moves his finger while reading (b,c). (G5, 13:04–13:11).



LP: The user loosely points when starting to explain his overall understanding of the table (G5, 13:20–13:22)



SP: The user points to the circle while saying: “That one” (G5, 16:44–16:46).

Results

Type	Hand Usage	Referent	Target	Duration
Narrative pointing (NP) (Figure 3a-c)	Pointing and moving index finger up/down or left/right	Full sentence / description of a value increase / decrease	A specific long area at the screen	Long
Loose pointing (LP) (Figure 3d)	Open palm, two fingers	Concept in total	A bit far of the screen	Mid
Sharp pointing (SP) (Figure 3e)	Index finger	Specific value / text	A specific small area/point at the screen	Short

LP is most frequent. Not necessarily for showing a specific area.

Why ? Larger distance to the screen and the scaling up of the data, users might perceive approximative pointing as sufficient and do not need to point at a specific area.

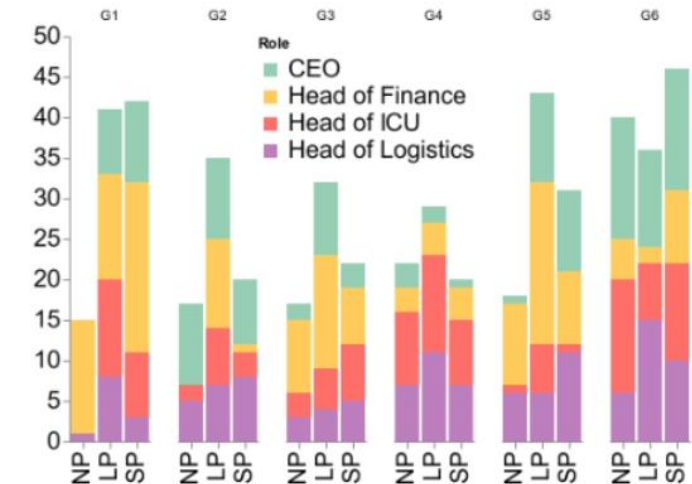


Figure 4: Bar chart with the number pointing gestures per group, subtype and role.

Discussion & Conclusion

- **Objectif** : observe the most relevant non-verbal cues to consider when designing awareness support for remote collaboration.
- **Three types pointing gestures** play an important role for establishing awareness during collocated decision-making at wall displays.
- The visualization of narrative pointing can be less precise than sharp pointing but should be shown for a longer duration to accompany the flow of the narration.
- **Co-speech gestures** are a very intuitive and expressive means of communication and therefore play a crucial role in collaborative decision-making.
- **Investigated mid-air pointing gestures and their subtypes** based on their communicative function as awareness cues.
- The **loose pointing** was most frequently used, followed by sharp pointing and narrative pointing.
- The reliance on gesture subtypes **varied across participants and groups**.
- Sometimes vague pointing was sufficient to support verbal negotiations.
- Other gestures have not been studied here.