

ABSTRACT

Graphs are successful means to present data. For visually impaired people, haptic-audio interfaces seem as an effective tool to acquire this information. For designing haptic graphs augmented by audio assistance it is necessary to determine, which information depicted by the graph are appreciated as important. A systematic investigation of the interaction between modalities in communication through graphs plays important role in identifying design principles for multimodal communication settings that facilitate efficient and effective communication of information.

INTRODUCTION

The aim of this research is

- to investigate the production of referring expressions in different modalities
- to detect the modality dependent differences and
- to provide best fitting verbal assistance to haptic graphs for visually impaired people with the aim of easing the comprehension of target information.

The long-term goal is to realize an automatic verbal assistance system that provides instantaneous support for (visually impaired) haptic explorers during their course of exploration.

Language Production for Verbally Assisted Haptic Graphs

Verbally assisted haptic-graph exploration is a task-oriented collaborative activity between two partners (Clark, 1996),

- ❖ a (visually impaired) explorer (E) of a haptic graph
- ❖ an observing assistant (A) providing verbal assistance
- ❖ Although A and E share a common field of perception, their perception and comprehension processes differ dramatically.
- ❖ The explorer and the assistant may have different internal representations of the graph line.

Visual Perception
 provides global and local access to information

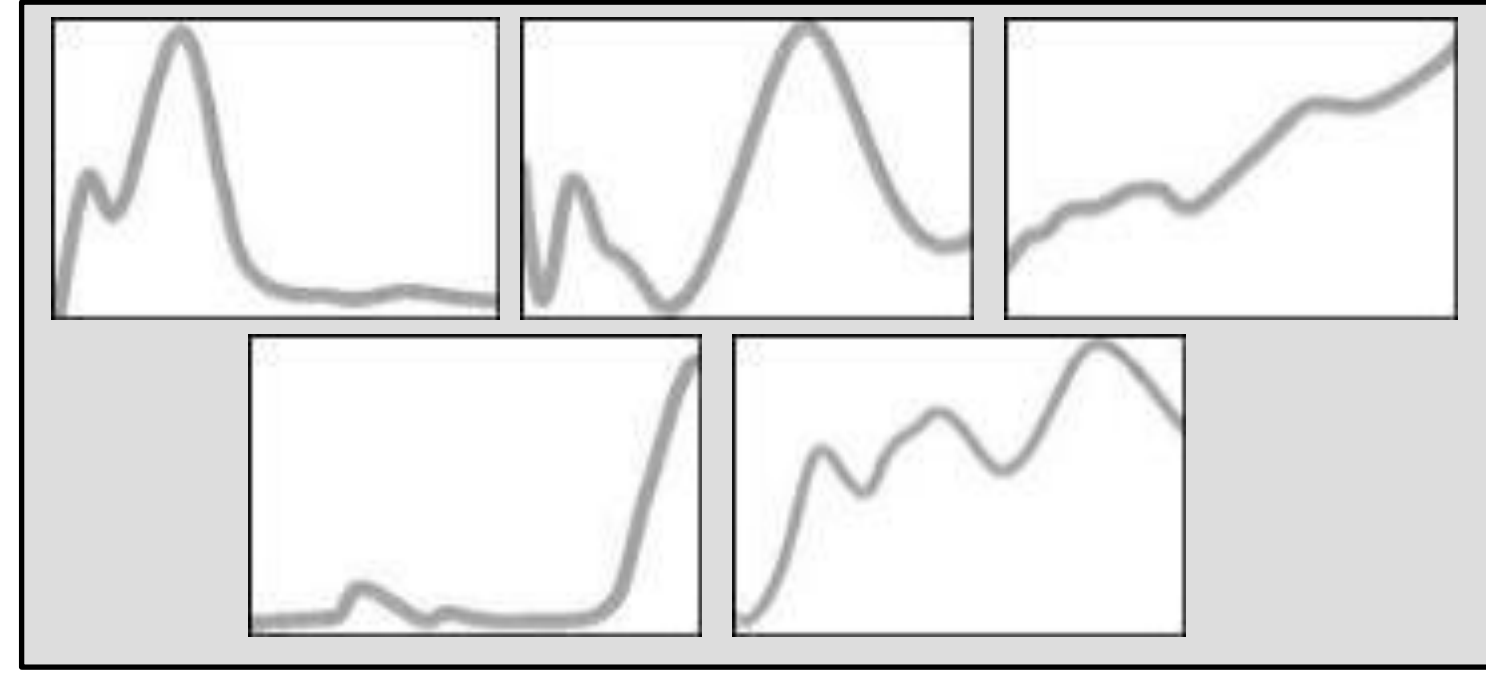
Haptic Perception
 Sequential and provides local access to information

EXPERIMENTAL DESIGN

Empirical Studies:

- 1. Set:** Single-User Study (in visual and in haptic modalities)
- 2. Set:** As a joint activity (a haptic explorer and an observing assistant)

Haptic Graph Stimuli: (Domain: Bird population)



Exploration Task:

1. Explore the graph
2. Ask for help (in a collaborative activity condition)

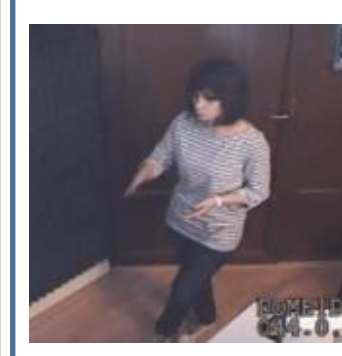
Post-Exploration Tasks:

- After exploration, they were asked
- (i) to produce single sentence summaries of bird population graphs to a hypothetical audience and
 - (ii) to draw the graph

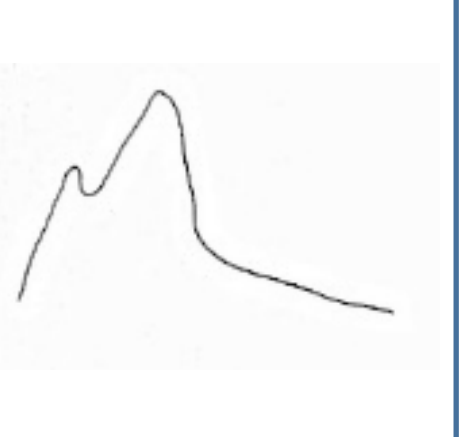
Verbal Description:

The population had a small peak, than a large peak and somewhere in the midfield it levels off

Speech-Accompanying Gesture

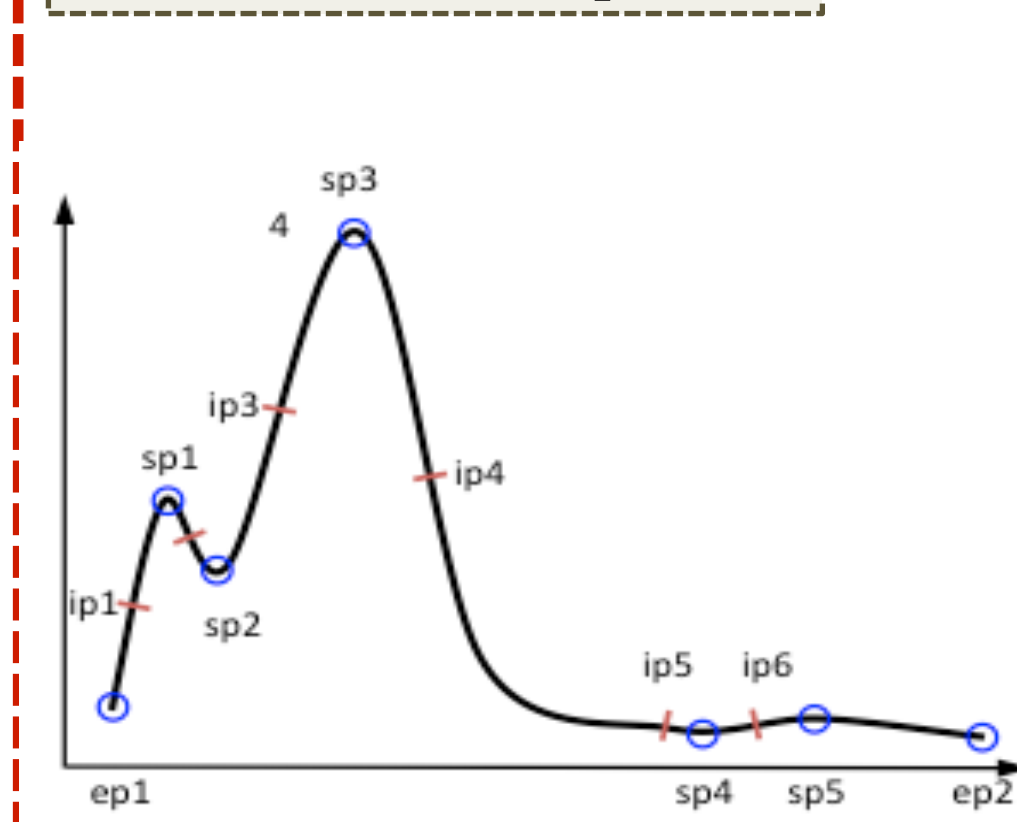


Drawing



Phantom Omni Haptic Device (recently Geomagic® Touch™)

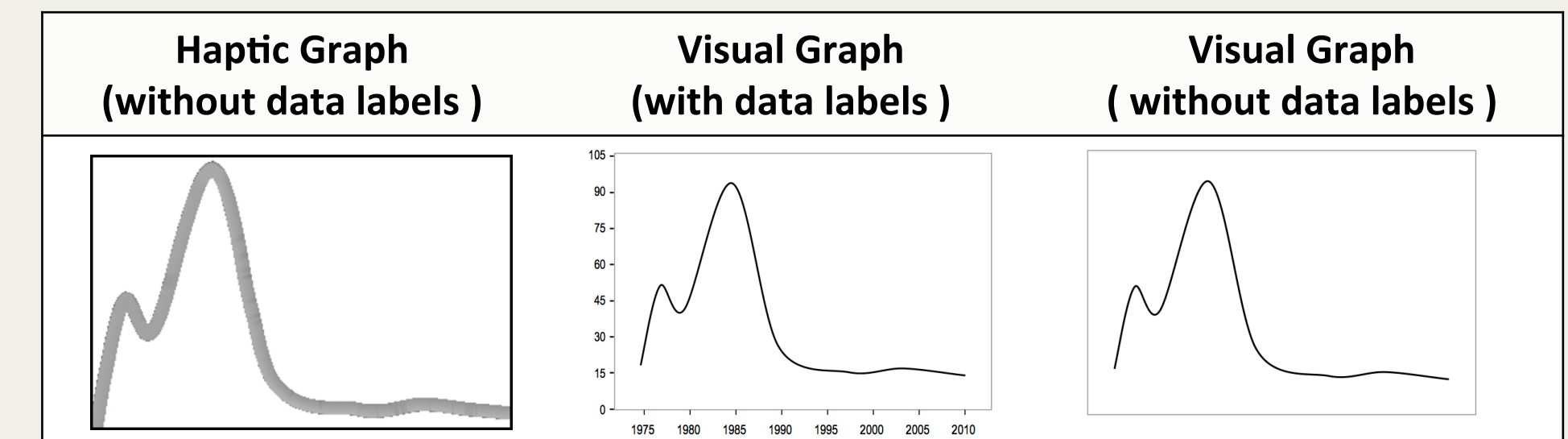
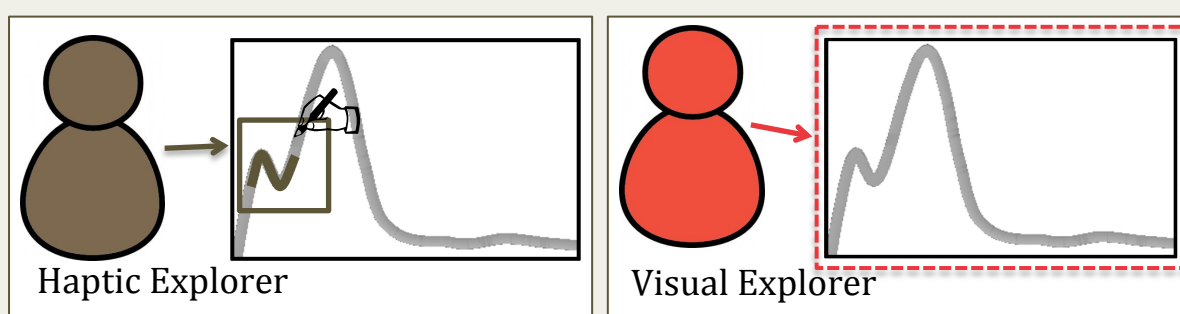
Qualitative Shape Landmark Description



Shape landmarks		
Landmark characteristics		Global properties
ep1	left end pt., local min.	higher than sp4, ep2
sp1	smooth pt., local max.	higher than ep1, sp2, sp4, sp5, ep2
sp2	smooth pt., local min.	higher than ep1, sp4, sp5, ep2
sp3	smooth pt., local max.	global max.
...
Shape segments		
Vertical orientation	Attribute Set (type, curved), (manner, steep), (direction, up)	
ep1-sp1	steeply upward	
...	...	

Visual vs. Haptic Perception

- Single user study
- 31 (blindfolded sighted) University students



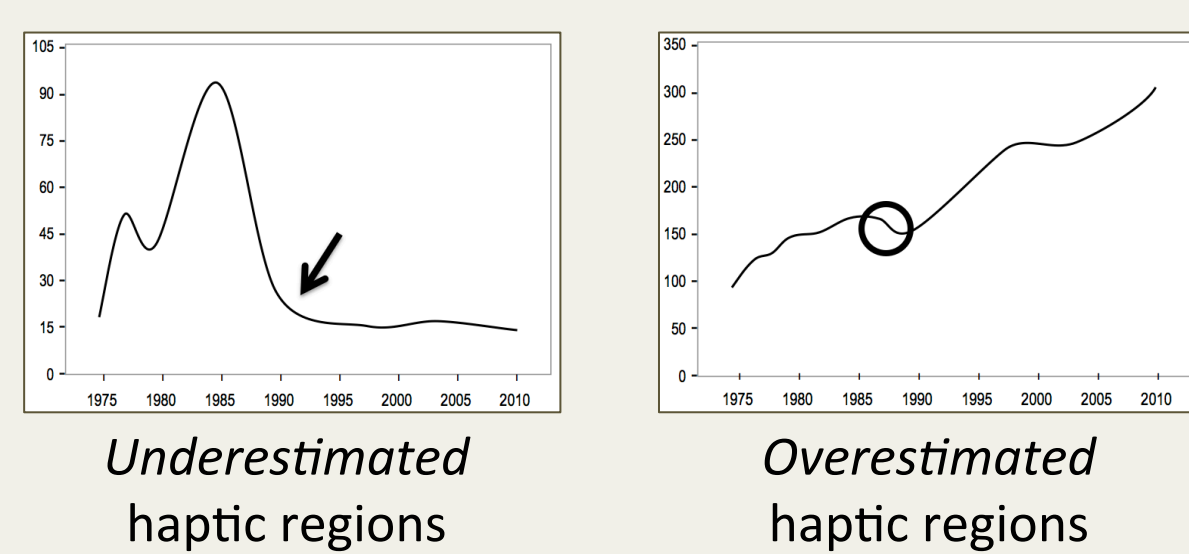
Speech-Accompanying Gestures

- More gesture production in haptic condition
- More single-direction (segmented) gestures for visually perceived graphs
- More multi-directional gestures for haptically perceived graphs

Verbal Descriptions - Referring Expressions

- Distinctive shape properties are helpful for segmentation
- Line segments were referred more compared to curvature landmarks
- Haptic explorers produce more modifiers (mainly shape adjectives)
 - In haptic condition; *staircase shape, exponential increase, wave shaped, valley phase*
 - In visual condition: *increasing/decreasing trend*

Haptic Saliency



(see Alaçam et al., 2013; Habel et al., 2013)

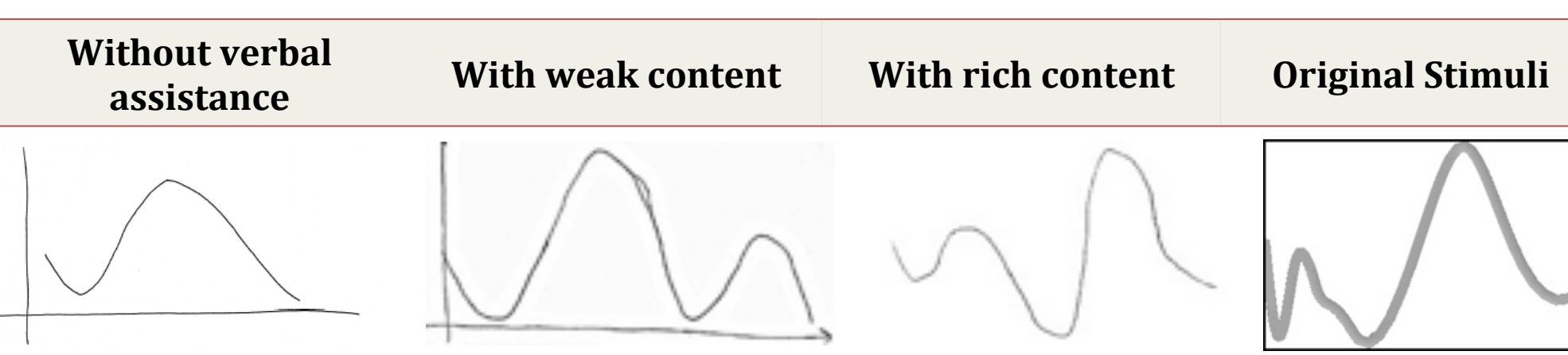
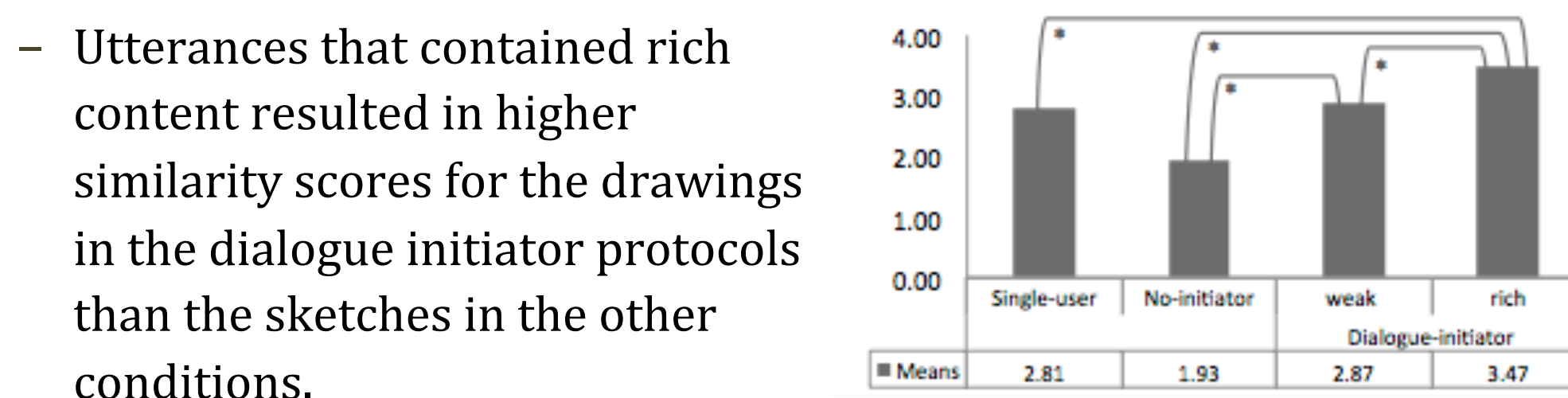
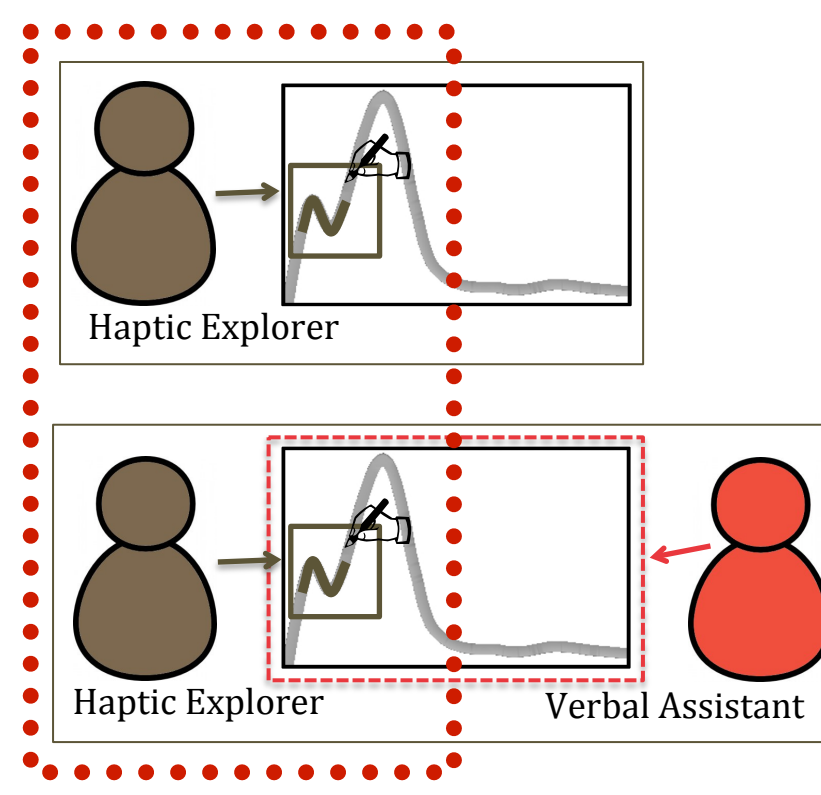
REFERENCES

❖ Alaçam, Ö., Habel, C., Acartürk, C. (2013). Investigation of Haptic Line-Graph Comprehension Through Co-Production of Gesture and Language. In the Proceedings of Tilburg Gesture Research Meeting, 19-21 June 2013, Tilburg, Netherland.
 ❖ Alaçam, Ö., Acartürk, C. & Habel, C. (2014a). Referring Expressions in Discourse about Haptic Line Graphs. To be published in Proceedings of the 18th Workshop on the Semantics and Pragmatics of Dialogue. SemDial 2014 - DialWatt. Verena Rieser & Phillipe Muller (eds.)
 ❖ Alaçam, Ö., Habel, C. & Acartürk, C. (2014b). Verbally Assisted Haptic Graph Comprehension: The Role of Taking Initiative in a Joint Activity. To be published in the Proceedings from the 2st European Symposium on Multimodal Communication, University of Tartu, Estonia, August 6-8, 2014.
 ❖ Alaçam, Ö., Habel, C. & Acartürk, C. (2014c). Perspective Alignment during the Course of Verbally Assisted Haptic Graph Comprehension. To be published in the online Proceedings of the RefNet Workshop 2014 on Psychological and Computational Models of Reference Comprehension and Production. Edinburgh, UK. 31 August 2014.
 ❖ Clark, H. H. (1996). Using language (Vol. 4). Cambridge: Cambridge University Press
 ❖ Habel, C., Alaçam, Ö., Acartürk, C. (2013). Verbally assisted comprehension of haptic line graphs: referring expressions in a collaborative activity. In Proceedings of the CogSci 2013 Workshop on Production of Referring Expressions, Berlin.

The Effect of Having a Verbal Assistance

Conditions:

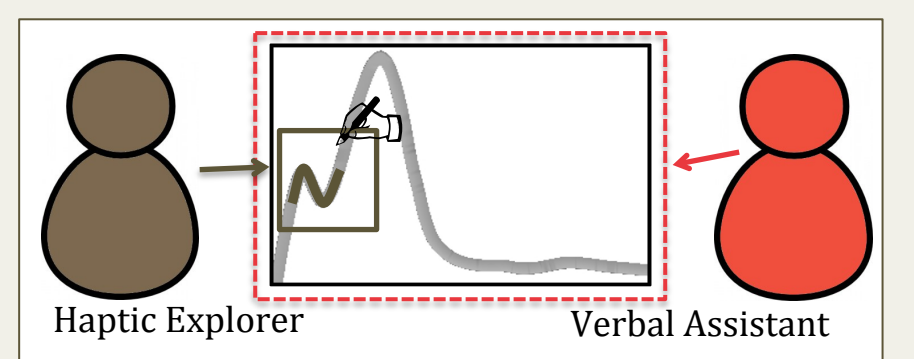
- 1- Single-user condition (9 students)
- 2- As a Joint Activity (13 students)
 - No-Initiator (no-request for help)
 - Dialogue Initiator
 - Assistance with weak content (*navigational or confirmative*)
 - Assistance with rich content (*enriched with modifiers*)



(see Alaçam et al., 2014b)

Information (Attribute) Update

- 30 (blindfolded sighted) University Students : 15 Pairs



- Graph shapes and verbal data were categorized as attribute pairs following Dale and Reiter's methodology.

UPDATING INFORMATION

- E: Is this the start point? - (type, start point)
 A: Yes, it is also the origin. - (type, origin)

INTRODUCING NEW INFORMATION

- E: no request.
 A: You are at the first curve; (type, curve), (relation, order, first)

- Positive correlation between the number of attribute update in the dialogue and higher sketching scores.
- The verbal assistants introduced more graph domain oriented concepts to dialogues, while haptic explorers tended to use simpler daily terms or even onomatopoeic words.

(see Alaçam et al., 2014a)

Perspective Alignment

Action perspective vs. Spatiotemporal Perspective

- Haptic explorers' first preference is to focus on basic spatial properties of the graphs relying on action-perspective, however when they realize that it may not be sufficient to explain graph domain changes or may conflict with graph reading, they switch to spatiotemporal-perspective.

Example for "Unusual" Description

Segment	Exploration Direction	Utterance
sp6 - sp7	left-to-right	Here, at the last part, there is a elevation.
sp6 - sp5	right-to-left	We have another one here
sp5 - sp4	right-to-left	A descent

(see Alaçam et al., 2014c)

Perspective switch w.r.t. communicational goal

- focusing on the graph to be explored, (i.e. navigational)

Instructional Assistance	Utterance
Loc1	E: Is this left-end?
Loc1	A: No, <i>go upwards to left</i>
Loc2	A: go downwards there
Loc3	A: Now, you are at the left-end

- focusing the content about a domain, e.g. 'bird population'.

Descriptive Assistance	Utterance
Loc1	E: Is here flat?
Loc1	A: Yes
Loc2	E: then <i>it increases</i>
Loc2	A: yes, it increases but before it increases, there is a slight fall.

CONCLUSION

- ❖ The contribution of the verbal assistant to the comprehension of haptic graphs seems important.
- ❖ Taking initiative for requesting help and having adequate verbal assistance in response seems a superb combination for a successful joint activity.
- ❖ Observing Assistant has to synchronize language production with Explorer's hand-movements. Some important aspects are
 - ❖ turn-taking during dialogue
 - ❖ aligning perspective between interlocutors
 - ❖ establishing appropriate referential and co-referential links.
- ❖ The shape is the basic element of verbal descriptions, and the geometric properties of shape segments seem to affect the way how the readers segment the graph.