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Visualizing Conversational Structure: Effects of Conversation-Analytical Knowledge and Social Media Experience

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Abstract. This paper explores how people understand and visualize externally a synchronous multi-threaded four-party conversation that was audio-recorded, and investigates whether conversation-analytical knowledge and/or digital skills with social media tools have an effect on the nature and complexity of the conversational structure depicted in the representation constructed. An experiment has been performed, in which 60 participants took part. Their task was to listen to a conversation, and to display it on a magnetic whiteboard in their own way. Predesigned conversation's utterances and pictures of participants were provided, as well as markers of different colors. Both visualization process and product were coded. Coding of process included production time and relistening behavior. The product was analyzed with respect to the ordering of utterances. We used four characterizations of ordering: by chronology, by reply-to relationships, by topic, and by conversational participant. Production time and relistening behavior turn out to have varying effects on products. Results of the representations' analysis suggest that conversation-analytical knowledge or experience with a variety of social media influence the type and the number of ordering principles used.

Keywords: External representation · Conversational structure
Conversation analysis · Digital skills

1 Introduction

In visual communication, application domains are linked to graphical domains. An interpretational link maps application domain entities to graphical ones. Application domain entities are inherently visible or not. Visibility may influence the graphical marks chosen by people to construct external representations [4]. Especially in the invisible, abstract case it is interesting to see how people conceptualize the abstract information in the application domain and represent it externally. As pointed out by [1], self-constructed external representations are affected by individual differences, e.g. prior knowledge. [3] shows that abstract

knowledge is involved in the application of diagrams visualizing different informational structures. Both the visualization of something in the world that is not inherently visible, and the influence of more or less abstract domain knowledge, will be addressed in this paper. The abstract entity involved is a multi-party, multi-threaded conversation, and in particular the underlying structures it can be associated with. Different groups are targeted in this study. On the one hand we distinguish people with and without some prior knowledge regarding abstract conversational notions, such as turn-taking, mentioning and topic shift. On the other hand we focus on differences in computer-mediated communication experience with a variety of social media tools, such as Facebook, Reddit and text chat. The outcomes of this paper will give insight in (i) external representations of conversational structure, and (ii) effects, on these representations, of prior knowledge, either of abstract conversational notions or of a broad repertoire of different online discussion representations. This study is part of a larger research where we investigate visualizations of conversations, not only from a production, but also from a comprehension perspective. Results may provide clues for optimizing user interfaces of applications representing group discussions.

This study focuses on conversational structure. A conversation is defined as a collection of related utterances, also referred to as messages. The utterances are bound by various relationships, based on different aspects involved in conversations. One such aspect is chronology, which corresponds to a sequential ordering of utterances by time. Interactional coherence is another aspect, which is based on reply-to relationships between utterances. If emphasis is put, not on chronology, but on coherence, conversations can be viewed as having a tree structure. Much more ordering approaches are imaginable [2].

Fig. 1. Message orderings according to the sequential (left) and tree (right) model.

One branch of research interested in the analysis of computer-mediated conversations concerns the effective and efficient visualization of online discussions. As pointed out in [5], implicit in online conversational designs are two models of conversation, the sequential and the tree model. Figure 1 shows schematic representations of these models. A visualization supporting the sequential model allows to answer questions about the chronological order of utterances (e.g. ‘which of these two messages was sent first?’) at a glance, that is, with direct simple visual inspection. Text chat interfaces are often based on this model. A visualization based on the tree model allows to answer questions about reply-to relationships between utterances (e.g. ‘Does this message have any replies?’) at a glance. Reddit’s interface supports the tree model. Facebook and many online discussion sites use a mixed model, in which, however, the tree model is generally

not applied in a consistent way; comments are presented as responses to an original post, but are not ordered with respect to reply relations among one another. We have added two other ordering criteria of utterances to the ones discussed above, which we will refer to as the topic and the participation model. Topic clusters utterances based on the subject discussed. Participation aggregates messages according to their contributor. Visualizations supporting the topic model allow to answer questions such as ‘Which topic does this message address?’ at a glance, ones based on participation facilitate answering questions such as ‘Who contributes to the discussion with this message?’.

2 Method

This study aims to address the following research questions: RQ1: Which model types (sequential, tree, topic, or participation) and which model tuples (combinations of model types) is/are supported by the visualizations individuals produce of the conversational structure, implied in a multi-party and multi-threaded conversation? RQ2: Does more or less abstract knowledge of conversation have an effect on the model type and tuple used in the visualizations produced? An empirical experiment has been conducted in order to answer RQ1 and RQ2.

2.1 Participants: Recruitment and Description

Sixty persons, aged between 22 and 50 years, were recruited for participation in this experiment. We have made a distinction between two types of prior knowledge, conversation-analytical knowledge, and knowledge based on experience with computer-mediated conversations via a variety of interfaces. The first one implies abstract conversational concepts, rules and patterns, either acquired as communication specialists or as graphical designers of online conversations. The second type is based on concrete examples and is acquired by reading and/or participating in online conversations in various applications, viz. Facebook, WhatsApp, Reddit, text chat, and online discussion boards. Thirty participants (14 women and 16 men) with conversation-analytical knowledge were recruited. The other half (15 women and 15 men) was selected as not having prior abstract knowledge. A questionnaire at the end of the experiment was used to get information about the experience of the participants with online conversations. Analysis of the questionnaire answers shows that all 60 participants use Facebook and WhatsApp regularly. Remarkably, participants who indicated to use Reddit, turn out to participate more in chat conversations and online discussions. We decided to consider this group (N=27) as the participants with a broad experience with

Fig. 2. Distribution of participants (N=60) with respect to conversation-analytical knowledge and/or experience with social media tools.

different social media tools. As shown in Fig. 2, the majority of the preselected knowledgeable participants (yes/no and yes/yes segments) turns out to be experienced (yes/yes). We think that this relation, which is significant ($\chi^2(1, N = 60) = 19.46$), is not causal, but just a coincidence. A few non-knowledgeable participants are experienced (no/yes segment). What does not seem to be fortuitous is the predominance of males in the group of experienced participants (8 women versus 19 men).

2.2 Design and Procedure

The experiment has a between-group factorial design. All participants were individually exposed to the same experimental conditions. They got the task 1) to listen to two conversations, a simple and a more complex one, between four conversational participants (the same for both conversations: two women and two men, with distinguishable voices), and 2) to visualize them on a whiteboard. The simple conversation (of 14 s) consisted of five utterances continuing the same topic, and served as a means to get the participants acquainted to the type of experiment. The second, more complex, conversation (of 49 s), which is the focus of this study, consisted of 24 utterances, and involved two main different topics, each containing subtopics; the four conversational participants discussed the buying of a present for a mutual friend (topic 1), and the cooking of a meal (topic 2). Discussion of one (sub)topic was disrupted by discussion of other (sub)topics. Relistening was allowed. We chose to expose the participants to an audio-recording of these conversations and to allow relistening in order to reduce the cognitive load. The exact wording of the task was (translated from Dutch): ‘Please represent the conversation you hear on the whiteboard in your own way. There is no time limit. You may relisten the conversation, or parts of it. You are allowed but not obliged to use the materials provided.’ With this succinct wording, we hoped to elicit as spontaneous productions as possible within the boundaries of the experiment (see materials below). The wording has been kept constant for each participant. Several aspects of the visualization process were recorded. Photographs were taken of all visualization products.

2.3 Materials and Coding

The experimental materials consisted of a magnetic whiteboard, small white rectangular magnets corresponding to the conversation’s utterances (five for the first and 24 for the second conversation). The utterance text (in black) preceded by name of utterer (different color for each of the four utterers) were printed on the magnet. Four circular magnets with photo and name of each conversational participant were available, as well as markers of different colors, and a wiper. We have chosen to provide these aids in order to relieve the participants and to steer toward listening carefully to and laying out the whole conversation.

The construction process was coded with respect to construction time and number of times that (part of) the conversation was relistened. Coding of the final visualization product was performed by two coders and based on the four

Table 1. Frequencies of model types supported by the visualizations constructed (N = 104).

Model Type				Total
C (%)	R (%)	T (%)	P (%)	
51 (49)	9 (9)	27 (26)	17 (16)	104 (100%)

model types introduced in the introduction. Different series of questions were answered in order to decide which model type(s) is/are supported by the representation laid out on the whiteboard. The following labels were used to characterize the conversational structure visualized: C (chronology) , R (reply-to), T (topic), and P (participation), for the sequential, tree, topic and participation model respectively. Theoretically, each ordering criterion (C, R, T, P) and its combination with other criteria (e.g. CR, CT, CTR, CRTP) could end up as a visualization label. There was a high degree of agreement (96%) about the final labels for each product.

3 Results

3.1 Visualization Process and Products

Every participant was able to depict the conversation on the whiteboard properly, that is, design a visualization corresponding correctly to aspects of the conversation overheard. In most representations (93%), all 24 utterances are used. Only 25 participants (42%) decided to use all discussants' profile pictures, and more than half (58%) chose to augment their representations with their own graphical marks (mostly lines or arrows), using the color markers. There is quite some variation in the time spent for relistening and construction. The mean time is 8.1 min (SD = 4.3; mode and median = 7; range = [3–25]).

Three (5%) participants did not relisten (parts of) the conversation, 18 (30%) did only once, and 38 (63%) (one missing value) more than once. Relistening the conversation more than once tends to take more time to produce the visualization than relistening zero times or only once. The relation approaches significance ($t(57) = 1.9547$, $p = 0.0556$).

Tables 1 and 2 show the results of the visualizations produced.

Table 2. Frequencies of (combinations of) models supported by the visualizations constructed (N = 60).

Single				Double				Triple				Quadruple	Total	
C	R	T	P	CR	CT	CP	RT	RP	TP	CRT	CRP	CTP	RTP	CRTP
16	0	4	4	1	15	11	1	0	0	6	1	1	0	0
24 (40%)				28 (47%)				8 (13%)				0 (0%)		60

Fig. 3. Illustrations of the visualizations supporting the C, CT, CP and CRT models.

On average, each participant bases his/her visualization of the conversation on 1.73 models. All models are used, but in different proportions. The sequential model prevails, the tree model is applied the least, and the topic model is used more frequently than the participation model (see Table 1). The difference in proportion is significant at the 0.01 level ($\chi^2(3, N = 104) = 38.4$).

Table 2 shows visualizations supporting the quadruple don't occur, while single and double models occur more often than triple models. When we oppose single models (40%) to mixed (double and triple) ones (60%), the difference in proportions is not significant ($\chi^2(1, N = 60) = 2.4$), but it is when we oppose single and double models to triple ones ($\chi^2(2, N = 60) = 9.8$). There is no relation between relistening behavior and complexity of visualization, that is, the tuple based on, nor between relistening and type of model used to layout the conversation's utterances.

In general, we see clear patterns in the diversity of the external representations participants produce. The models most frequently supported are the C-, CT-, CP-, and CRT-model (see Table 2). Each picture in Fig. 3 illustrates visualizations of each of these models.

Table 3. Frequencies of model types supported by the visualizations constructed (N = 104), per knowledge group.

Type of prior knowledge	Model Type				Total
	C (%)	R (%)	T (%)	P (%)	
yes - yes (N = 22)	18 (35)	5 (56)	17 (63)	4 (23)	44 (42%)
yes - no (N = 8)	8 (16)	2 (22)	3 (11)	1 (6)	14 (13%)
no - yes (N = 5)	5 (10)	0 (0)	2 (7)	3 (18)	10 (10%)
no - no (N = 25)	20 (39)	2 (22)	5 (19)	9 (53)	36 (34%)
	51 (49)	9 (9)	27 (26)	17 (16)	104 (100%)

3.2 RQ2: Effects of Prior Knowledge on Model Type and Tuple

Conversation-analytical knowledge has an influence on the model type(s) chosen for the construction of the conversational structure. While use of the sequential model is equally distributed among participants, the topic model shows up more often in the visualizations of the knowledgeable group, and the participation model occurs more in those of the non-knowledgeable group (see Table 3). The proportional differences between topic and participation is significant ($\chi^2(1, N = 44) = 8.6$). The distributional frequencies between the two groups of participants differentiated by experience demonstrate a similar pattern, but without significant differences ($\chi^2(1, N = 44) = 3.57$). In general the tree model is applied sparsely, but more frequently by the knowledgeable group than by the non-knowledgeable one. Remarkably, there is no clear preference for the tree model by experienced participants, who are acquainted with Reddit’s tree design of discussions.

Figure 4 shows the use of simple and more complex models by the different groups of participants. Participants with conversation-analytical knowledge base their constructions significantly more often on a mixed (double or triple) model than on a single one ($\chi^2(1, N = 60) = 6.94$). And so do experienced participants ($\chi^2(1, N = 60) = 9.44$).

Although the experienced group contained more men than women, no gender effect has been observed; neither type nor complexity outcomes are influenced by gender.

For all groups, the relation between the model complexity and the production times follows the same pattern. Applying more complexity takes more time. An exception is the group with no conversation-analytical knowledge, but with experience. This may be due to the small numbers involved (no-yes: N = 5). No significant relations are observed between knowledge/experience groups and relistening behavior.

Fig. 4. Frequencies of model tuples, per group.

4 Discussion

The sequential model is supported by almost all visualizations constructed. This does not come as a surprise, given the stimulus, which is a synchronous discussion, in which participants apply turn-taking rules properly. The poor use of the tree model, even by Reddit users, may be explained by the effort it takes to detect reply-to relations in the conversation overheard. Conversation-analytically knowledgeable participants base their constructions more on the topic model, while the participant model is predominant in those of the group without abstract knowledge. The availability of participants' pictures in combination with the relatively easy attribution of utterances to each conversational participant probably has steered the non-knowledgeable group to use the participation model rather than the topic model. Identifying different conversational topics and relating them to utterances requires more conversation-analytic knowledge than identifying conversation participants and cluster their utterances.

Both the conversation-analytical knowledgeable group and the group with social media experience create more complex visualizations of conversational structure, without taking more time or relistening more often, than the non-knowledgeable and the non-experienced group. We can conclude that knowledge, either of conversational abstract notions or of a broad repertoire of online discussion interfaces, allow people to recognize and identify more conversational aspects, and to give indications of how to represent them externally. Conversation-analytical knowledge, or experience, or both have an effect, and future research should give insight in the exact nature of prior knowledge.

The quadruple model was not supported by any visualization. This may have several reasons. It may be cognitively too demanding to remember more than three utterance-related aspects of conversations overheard, the depiction of four aspects risks to give rise to cluttered depictions, or participants just don't get the idea that this is an option as well. Existing interfaces of commonly used social media tools don't give any clues how to visualize more than three orderings. This finding also gives rise to future research.

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