Changes in Partner Models – Effects of Adaptivity in the Course of Explanations

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Abstract

The process of adaptation to the partner in the course of an interaction is still not well understood. In the case of explanatory dialogues, to provide satisfying explanations, explainers have to consider the needs of the explainees. This requires mental representations of the explainees, i.e., "partner models". Little is known about whether and how modifications of partner models during an explanation take place. We assumed that they get informed by the interactive behaviour of the explainee and investigated partner models in relation to explainees' verbal moves. A total of 59 dyadic explanations were investigated in an observation study. The comparison of the partner models before and after the explanation showed changes regarding, e.g., knowledge, interest in the explanation, cooperation, and mood. Moves such as questions as well as summarising and paraphrasing information given by the explainees were associated with the partner model dimensions interest in the explanation and co-construction.

Keywords: explanation; partner model; cognitive adaptivity; verbal behaviour; speaker moves

Introduction

It seems natural that speakers consider "the needs" of their interlocutors and adapt to them (Brennan & Hanna, 2009). However, anecdotal experience as well as research shows that this is not always the case. Adaptation seems to be especially important in the case of everyday explanations, which are the topic of this paper. To provide satisfying explanations, explainers (EXs, persons who explain) must consider prior knowledge, abilities, interests, etc. of the explainees (EEs, persons who receive explanations). The adaptation process requires mental representations of the EEs, which are summarised here as "partner models" (Brennan, Galati & Kuhlen, 2010). In the course of an explanation, the interaction with an EE can change the partner model (Brennan, Galati & Kuhlen, 2010; Dillenbourg, Lemaignan, Sangin, Nova & Molinari, 2016). These changes of EXs' partner models are in focus of this paper: We reasoned that the partner model of the EX adapts to the interactive behaviour of the EE in the course of the interaction. Thus, assuming an interplay of cognitive representations and interactive behaviours as the driving force of the adaptation, for the first time, we investigated whether and how partner models get modified in the course of an explanation in association with EEs' interactive behaviour.

Adapting to the Partner in Explanations

The concept of audience design speaks to the observation that speakers tailor their utterances to the needs of addressees (e.g., Brennan, Galati & Kuhlen, 2010; Brown-Schmidt, Yoon & Ryskin, 2015; Horton & Gerrig, 2005) and establish a common ground of knowledge, emotions etc. shared with others (Clark, 1996; Vasil, Badcock, Constant, Friston & Ramstead, 2020). There are at least two approaches to account for why speakers' verbal behaviours are adaptive to their partners. A cognitive approach is based on the speakers' mental representations of a topic, the situation, the interlocutor, the course of the conversation, etc. (s. summary in Fischer, 2016). The more or less proper mental representation of the partner – the so called "partner model" (e.g., Dillenbourg et al., 2016) – has been considered as a relevant precondition to adapt to the (needs of the) partner (Nickerson, 1999). Accordingly, depending on the retrieved partner model, the verbal actions of the speaker will vary (s. summary in Fischer, 2016). An interactive approach is based on the addressees' behaviours. In support of it, many studies have shown that speakers are responsive to the verbal behaviour of their partners (s. summary in Fusaroli, Rączaszek-Leonardi & Tylén, 2014), and also to the modalities in which these behaviours are performed (Fischer et al., 2014). Thus, both interlocutors have a mutual influence on each other and organise the interaction jointly. In the following, we aim to bring the two approaches together to investigate the possibility of adaptation being based on both cognitive and interactive processes.

Interested in adaptation occurring in everyday explanations, we draw on research regarding instructional explanations and tutoring in learning settings. Explanations are more effective if they are adaptive and consider the learners' prior knowledge, skills, or cognitive abilities (Wittwer & Renkl, 2008). When tutors got explicit information regarding tutees prior knowledge, they adapted their explanation to this information. This reduced tutees' misunderstanding and supported their knowledge acquisition (Nückles, Wittwer, & Renkl, 2005). However, as research on tutoring also shows, the needs of the partner are often neglected. Especially, tutors with less tutoring-experience are weak in monitoring the specific individual understanding of

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.*

the tutee (Chi, Siler & Jeong, 2004). They overestimated their knowledge and neglected false alternative beliefs. In consequence, they did not reveal knowledge deficits, e.g., by giving direct feedback or scaffolding. Wittwer, Nückles and Renkl (2010) analysed three reasons regarding instructional explanations why they are not learner-tailored: EXs have an egocentric bias and assume their own knowledge from others (Buhl, 2001; Horton & Keysar, 1996; Nickerson, 1999). Additionally, they do not engage in seeking information on EEs' understanding. Finally, the instruction demands a high amount of cognitive resources, thus, there is no further cognitive capacity to consider the knowledge and motivation of the learner. Interestingly, whereas many reasons were discussed for EXs adapting – or not adapting – to the EEs, little is known about the impact of EEs' verbal behaviour. Yet verbal behaviour of the EEs' can be informative and steer the ongoing interaction to be more or less adaptive. Some support for this can be drawn from the area of language and discourse development. There, different forms of 'moves' could be identified as EEs' behaviour that was informative for the tutors / EXs about what the EEs knew, so they could offer more scaffolding episodes (Chi et al., 2001; Chi, Roy & Hausmann., 2008; Graesser, Person & Magliano, 1995). Questions were identified as such moves that had the potential to influence the nature of the dialogue and learning (Roscoe & Chi, 2007, 2008; Fisher, Rohlfing et al., 2023). However, so far little is known about the role of the EE in explanations and especially on the partner model of the EXs.

Partner Model: Dimensions and Changes

Research on communication in general (e.g., Brennan et al., 2010; p. 304; Vasil et al., 2020) and instructional explanations in particular (e.g., Wittwer et al., 2010) points to important dimensions of partner models, namely partners' needs, interests, knowledge, abilities or expertise. With a deeper look into motivational theories, it is useful to differentiate between intrinsic and extrinsic motivation (cf., Eccles & Wigfield, 2002): Someone may follow an explanation because they enjoy the object of the explanation or because the explanation seems useful to pursue instrumental goals, e.g., to be better than others. Additionally, the explanation itself can be interesting.

An actual research strand investigating partner models stems from communication and cooperation with digital resources like computer supported collaborative learning (Dillenbourg et al., 2016) and speech interfaces (Doyle, Clark & Cowan, 2021). As a precondition of collaborative learning, Dillenbourg et al. (2016, p. 230) differentiate between dispositional and situational aspects of partner models. Whereas disposition aspects refer to "long-term knowledge, skills or traits", situational aspects refer to "knowledge, behaviour or intentions activated in the situation in which A and B are collaborating" with a temporal limited validity. They mention further aspects of partner models, like beliefs, emotions, history, status, etc. In the following study, we differentiated between seven dimensions of partner models: knowledge, intrinsic motivation and extrinsic motivation connected with the object of an explanation, interest in the explanation, emotional states, co-construction and cooperation (see Table 1).

Further, our study is based on the idea that to come to an appropriate partner model, the interlocutors infer the partners' mental states (partner modelling, Dillenbourg et al., 2016.). At the beginning of an explanation, EXs have global partner models which result from stereotypes, e.g., regarding their gender, age, profession, and physical appearance, and previous experiences with this or other EEs (cf. Brennan et al., 2010; Dillenbourg et al., 2016). In the course of an interaction, the partner models are modified and refined. We assume that this is a consequence of the verbal and non-verbal interactive interactions. In the case of an explanation, this might be signs of (the construction of) understanding or non-understanding. This results in a local partner model. However, little is known about whether and under which influence the partner models get modified in the course of the interaction. It is reasonable to assume that as the interaction unfolds, the verbal behaviours of the explainees will inform the partner modelling leading to some modifications.

Explainees' Verbal Behaviour

EEs' verbal behaviour has received little attention in the literature. This is surprising, facing research revealing adaptation of partners to each other (see summary in, e.g., Fusaroli et al., 2014) in interactions that were symmetrical in terms of knowledge. In interactions in which there is a knowledge asymmetry (one partner knowing more than the other), tutoring dialogues have been investigated for clarifying whether tutees contribute to the process of knowledge construction. In this research line, tutees' behaviours were found to be informative and resulted in some changes of the tutoring behavior: Tutors offered more scaffolding episodes that, in turn, improved tutees' understanding (Roscoe & Chi, 2007, 2008; Graesser et al., 1995). Moreover, when tutees were actively involved in the construction of knowledge, their learning was more effective (Chi et al., 2001; 2004; 2008). This was especially the case when tutees asked questions, which functions as "metacognitive prompts for tutors" (Roscoe & Chi, 2008, p. 342). Addressing tutees' questions, tutors provided more scaffolding episodes thus constructing further knowledge that is tailored to the tutees. The focus of the tutoring research, however, was on "identifying the repertoire of tactics or moves available to tutors [...] such as explanations, giving feedback, and scaffolding" (Chi et al., 2001, p. 474). To describe such verbal tactics in conversations, Chi et al. (2008, p. 323) introduce the term "speaker move" which is classified as a statement including a single idea by a speaker within a turn.

Beyond tutoring, Fisher, Rohlfing and colleagues (2023) investigated explanatory dialogues finding support for some EE's questions benefiting their understanding. However, to our knowledge, no study has investigated the effect that questions of the EEs as metacognitive prompts can have on the EXs' partner model. In this study, we reasoned that verbal

behaviours of the EEs are helpful to the EXs in recognizing their "needs" in understanding and resulting in changes of the partner model. In this vein, EEs' moves such as raising questions or summarizing information might be particularly effective, because they monitor the EEs' level of understanding.

Research Questions

There is a broad consensus in cognitive science that the adaptation of interlocutors to each other is a prerequisite for successful communication. In our study, we bring cognitive and interacting processes together assuming that EEs' verbal behaviours are influential resulting in changes of the partner models in the EXs. The research questions are:

1) Does the EX partner model of the EE change during the explanation?

We assumed changes in dispositional as well as situational dimensions because the EXs did not know the EEs prior to the explanation. However, because we cannot anticipate whether the explanations are a successful and positive experience for the EXs, we did not hypothesise directions of changes.

2) How are the partner models associated with the interactive behaviours of the EEs?

We assumed that the partner model assessed after the explanation is associated with the moves of the EE. We hypothesised that EEs

a) who asked factual questions and paraphrased partner utterances are perceived to have more knowledge.
b) who asked questions, summarised and paraphrased the information given by the explainer and gave additional information are perceived with a higher degree of co-construction, and cooperation.
c) who asked questions are perceived as more interested in the explanation as well as intrinsically and extrinsically motivated regarding the subject of the explanation.

Because of the novel character of the investigation, we were also interested in the further associations and tested them exploratively.

Methods

To answer these questions, dyadic explanations of board games were investigated in an observation study. Before and after the explanation, the EXs were asked about their partner model of the EE. The interactive behaviour of the EEs was coded regarding their moves during the explanation.

Design, Sample and Procedure

The study was conducted at the campus of a medium-sized German university and was approved by the local ethical committee. A total of 118 people (101 students from 29 different programs, 3 trainees, 1 pupil and 13 others) participated (age M = 25 years, SD = 8.76, Range =18–68, 72 reported to be female, 42 male, and 4 diverse). They received between 20€ and 30€ (a total of 2,435€ was paid) or between 2 and 2.5 hours as required as part of the study program. Informed consent was obtained from all subjects involved in the study.

After they agreed to participate in the investigation, the participants were randomly assigned to the role of EX or EE. Prior to the study, the EXs got the task to familiarise themselves with the board game Quarto. Participants were allowed to make use of any resources for preparation, with exemplary sources provided and access to the physical game. Quarto is a strategic board game featuring game figures possessing four distinct characteristics. The goal for each player is to arrange four figures in a line, sharing a common characteristic.

Figure 1: Study design.

The study consisted of three phases which are of interest for this article (see Figure 1). Phases 1 and 3 involved distinct questionnaires incorporating standardised items. Phase 1 prior questioning: The EX was asked about their partner model of the EE. In Phase 2, participants engaged in explaining the game without its physical presence. The EX had the task to spontaneously explain the board game 'in a manner that the EE could win it'. Thus, the goal was to develop a deep conceptual and procedural knowledge of the game. The EE received the instruction 'to actively take part in the explanation'. The board game was not present, to prevent the use of the material in the explanations. There were no time restrictions for this phase, resulting in diverse explanations due to the subjects' freedom in game preparation and speech. It lasted on average 5.5 minutes (Range: 2.3–12.3 minutes). Phase 3 post questioning: The EX was asked about the partner model resulting from the interaction. Likewise, the EEs were asked about their partner model of the EX. The study had three further phases in which an explanation session with the game took place and two subsequent questionnaire phases. These phases are not considered in our analyses. In total, the study lasted 1.8 hours.

Instruments

Partner Model of the EXs: Questionnaire

The partner model was assessed in a standardised manner. The questionnaire was developed on the basis of previous qualitative interviews with explainers. We used a seven-point Likert scale (scale 1 = strongly disagree to 7 = strongly agree), regarding seven dimensions of the partner model at both measurement points with one item per dimension (cf. Table 1). They were only moderately correlated for a few dimensions: In the prior questioning there were correlations between the partner models' dimensions between r = .02 (joy and extrinsic motivation) and r = .50 (joy and interest in

explanation). In the post questioning, the correlations were between r = .00 (co-construction and extrinsic motivation) and r = .54 (knowledge and intrinsic motivation). Two further initial assessed dimensions (items "He/she adapts his/her utterances to the explanation." and "… is helpful") were excluded from the analyses because they were close to cooperation in terms of content and correlated highly r > .50.

Table 1: Partner model-dimensions (Descriptives: Means and standard deviation, comparison prior and post).

Dimension	**Item** He/she…	**Prior** ***M* (*SD*)**	**Post** ***M* (*SD*)**	***t***
knowledge	is a real game expert.	3.38 (1.30)	4.34 (1.28)	2.32 *
intrinsic motivation	likes playing games.	5.61 (0.89)	5.71 (1.12)	0.63
extrinsic motivation	plays to be better than others.	3.78 (1.54)	3.42 (1.50)	-1.45
interest in explanation	finds the explanation very interesting.	4.86 (1.14)	5.27 (1.34)	2.12 *
emotion: joy	is in a good mood.	5.63 (1.03)	5.92 (1.12)	1.96 +
co-construction	can contribute proficiently to explanations.	5.46 (1.02)	6.14 (1.01)	4.07 **
cooperation	is cooperative.	5.92 (0.93)	6.39 (0.74)	3.90 ***

Note. English version of the original German items. *t*-Test two-tailored testing + p < .10, * p < .05, ** p < .01, *** p < .001.

Interactive Behaviour of the EEs: Coding

The interactions were video-recorded, transcribed, and analysed using the program ELAN (Wittenburg et al., 2006). The interactive behaviour of the explainees was coded regarding the content of their speaker moves. It resulted in a Cohen's kappa of k = 0.68. Thus, revealed substantial coding-agreement. To enable the semantic analysis of the single ideas, Fisher, Robrecht et al. (2023) developed explanation nodes as a basis for the speaker move analysis. With an extended coding schema, the interactive behaviour of the EE was coded as different kinds of moves. For the definition of the speaker moves, see Table 2. In the statistical analyses, we considered the total frequencies of these moves. The moves were weakly to moderately associated. The highest correlation (r = .49) was between the moves paraphrasing partner and paraphrasing both. Some moves (example, repeating self, repeating partner, focus monitoring, labelling questions) were not considered in the analysis because they occurred in less than 10% of the explanations.

Table 2: EEs' moves (Frequencies).

Speaker Move	**Definition**	**Total**
providing info	Introduction of topic. Node is mentioned for the first time.	21
providing personal info	Includes individual preferences and experiences of the EX and EE.	28
summarising info	Previous information is summarised. At least two nodes need to be addressed.	37
additional info	New information on the already mentioned node. The subnode might be mentioned for the first time.	97
mentalising	Formulating a wish, goal or emotional state. Can also include agreement or an update within the knowledge state.	228
repeating partner	Information is repeated in the same manner as previously mentioned by their conversational partner.	52
paraphrasing self partner both	Information is put into different words than previously mentioned by the speaker themselves, their conversational partner or both. It has to be connected to a previous part of the conversation.	11 100 22
	Question Type	
factual	Seek information of a node. Include general demands for more information and examples.	352
reassurance	Make sure the conversational partner is serious, a sign of disbelief, surprise, or auditory difficulties.	14
personal	Includes individual preferences and experiences of the EX and EE.	20
procedure	Is an off-topic remark. Also includes information on the pre-session of the EX.	9

Results

RQ 1: Does the EX Partner Model of the EE Change during the Explanation?

Table 1 shows descriptives and prior–post comparison for the seven partner model dimensions. With the exception of extrinsic and intrinsic motivation regarding the game, all scores were higher in the post questioning than in the prior questioning.

RQ 2: How are the Partner Models Associated with the Interactive Behaviours of the EEs?

Table 3 shows the correlation between the frequency of EEs' moves and the scores of the partner model-dimensions of the EX. In general, the associations were quite small. Against the assumption, there was no correlation between the partner model-dimension knowledge and questions or paraphrasing partner. Remarkably, there were no correlations at all between the partner model dimension of knowledge and the moves of the EE. As assumed, EEs who summarised as well as paraphrased the information of the partner were perceived as more co-constructive. In addition, EEs who asked questions were perceived as more co-constructive. While the partner model dimensions of motivation in dealing with the game were not associated with moves, EXs experienced EEs who paraphrased their utterances and asked reassurance questions as more interested in their explanation. The associations with the partner model dimension joy were inspected exploratively and were correlated with the frequency of summarising info. The question remains what influence the before explanation partner model has on the partner model after the explanation. In order to confirm the effect of the EE moves on the post-partner model, regression analyses were calculated for the variables of interest. This controlled for the pre-explanation partner model. As Table 4 illustrates, the moves of the EEs have an own or even higher contribution to the explained variance. The only exception is the partner model dimension joy (that the partner is in a good mood). The pre-partner model weight is considerably higher than the weight of the move. However, both betas impress a significant contribution.

Table 3: Spearman Correlation between partner model-dimensions (post-questionnaire) and EEs' moves.

	Knowledge	Intrinsic mot.	Extrinsic mot.	Interest in expl.	Joy	Co-conc.	Coop.
Providing info	.02	.13	-.07	.13	.14	.18	.05
Providing personal info	-.09	.01	.07	.17	.02	.09	.04
Summarising info	.22	.24	-.03	.23	.29*	.32*	.03
Additional info	.02	.08	-.15	.08	.05	.20	-.16
Mentalising	-.05	.06	-.23	.03	.17	.15	.11
Repeating partner	.09	.01	.16	.12	.08	.14	-.09
Paraphrasing self	-.09	.07	-.11	.07	.13	.03	-.20
Paraphrasing partner	.02	.22	.02	.26*	.20	.27*	.07
Paraphrasing both	-.05	-.03	.14	-.12	-.12	.14	-.06
Factual question	-.03	.12	.17	.24	.15	.31*	.05
Reassurance question	.00	-.04	-.02	.26*	-.04	.13	.06
Personal question	-.05	-.15	.21	.16	-.17	.19	.01
Procedure question	.03	.06	-.24	-.07	-.10	.01	-.07

Note. mot. = motivation, expl. = explanation, co-con. = co-construction, coop = cooperation. * $p < .05$.

Table 4: Regression coefficients of partner model before the explanation (prior) and moves on partner model after the explanation (post).

	Prior	Post Int E	Prior	Post Int E	Prior	Post Joy	Prior	Post Co	Prior	Post Co	Prior	Post Co
β	Int E	.29*	Int E	.31*	Joy	.43*	Co	.19	Co	.15	Co	.15
β	Para	.27*	Reas	.26*	Sum	.24*	Sum	.23	Para	.21	Qu	.25
R^2		.16		.15		.26		.10		.08		.10
R^2adj		.13		.12		.23		.06		.05		.07

Note. Int E = Interest in explanation, Co = Co-construction, Para = Paraphrasing partner, Reas = Reassurance questions, Sum = Summarising info, Qu = Factual Questions; * $p < .05$.

Discussion

It is widely assumed that partner models change in the course of an interaction (cf. Brennan et al., 2010). Following specific interest in everyday explanations, our first research question was how partner models changed, regarding seven dimensions, assessed before and after the explanation of a strategic board game. For our purpose, we conducted a complex study, in which self-report questionnaires of the EXs' partner model were combined with a subset of the EEs' observed verbal behaviours (questions of the EEs) and analysis of them. To account for EXs' partner models, in a standardised manner, dimensions which were reported as relevant from the literature (e.g., Fischer, 2016; Wittwer & Renk, 2008) were adapted and applied to explanations: knowledge, intrinsic motivation, and extrinsic motivation connected with the object of an explanation, interest in the explanation, emotional states, co-construction and cooperation. We found that most of the dimensions changed significantly: On average, after the explanation, the EXs perceived higher degrees of knowledge, more interest in the explanation, more co-constructive capabilities, more cooperation, and slightly more positive emotions. Thus, the changes affected dispositional as well as situational aspects of the partner models (Dillenbourg et al., 2016). In a nutshell, the EEs explainees were perceived to be more knowledgeable and co-operative than the EXs expected before the explanatory dialogue.

The second research question concerned a possible cause of the partner model change. As far as we know, the specific association between the verbal behaviour of the EE and the partner model was not investigated so far. Our novel point is that the adaptation of the partner model is a means to tailor the explanation to the EE. Thus, we raised the question of how partner models of EXs were associated with the interactive behaviours of the EE. Drawing from research showing that questions as specific moves of the EE are associated with EXs' understanding (Fisher, Rohlfing et al., 2023) and elicit particular helpful scaffolding behaviour from tutors (Roscoe & Chi, 2007, 2008), we assumed associations with the perception of the EEs' knowledge, motivation, co-construction and cooperation. In support of the findings from literature, more factual questions went along with the perception of the partners' co-constructive capabilities, which were also correlated with moves such as summarising and paraphrasing information of the partner. Regarding the motivational dimensions of the partner model, only the perception of the interest in the explanation was significant and was associated with paraphrasing information given by the partner as well as reassurance questions. Finally, EEs who summarised information were perceived as being in a good mood. With subsequent regression analyses, we controlled effects of the partner model before the explanation. We could confirm that the EEs' moves predicted the partner model - in some cases in addition to the partner model before the explanation. Further longitudinal analyses should provide causal insights into the mechanisms of the interplay between EEs' moves and the partner model.

In critically reflecting our results, it should be highlighted that the correlations between partner model and moves were quite small and only a few of the hypothesized associations could be observed. In order to evaluate this result, some limitations have to be taken into account. The explanations were short and the interlocutors had only a first impression of each other. Starting with a global partner model the EXs had only scarce information to come to a local partner model. Additionally, the task of explaining a game without its physical presence is quite cognitive demanding (cf., Wittwer et al, 2010). There might have been not enough time and cognitive resources for adapting the partner model to the verbal behaviour. Taking this into account in future research, longer and multiple interactions of the same interlocutors might be interesting to investigate. In addition, the aggregated data provides a superficial picture. Although the partner model "improves" in the majority of interactions (more knowledge, interest, co-construction), the values also decrease in some interactions. A more detailed analysis will follow here.

Of special interest is that the moves of the EEs were associated with the interest in the explanation, good mood, and the capability to co-construct the explanation. In contrast, the most frequently mentioned aspects of the partner models, knowledge and interest in the object of the explanation (Brennan et al., 2010; Dillenbourg et al., 2016; Wittwer et al., 2010) were not associated with the moves of the EEs. Therefore, we have to reflect the partner model questionnaire. Knowledge and motivation were roughly assessed asking primarily for dispositional aspects: "He/she is a real game expert." and "He/she likes playing games." Further investigations could concentrate on more concrete pieces of knowledge that are acquired in the situation.

We can conclude that our investigation shows first evidence for changes of partner model dimensions during an explanation in relation to the verbal behaviours of the partner. This gives insights into the co-construction of everyday explanations where the partner model adapts to the verbal behaviour of the interlocutor. The results have practical implications for the design of explaining (systems) such as XAI (Explainable Artificial Intelligence), with the claim to make these systems more social (e.g., Miller, 2019; Rohlfing et al., 2021). They highlight the relevance of EE utterances for developing an adequate partner model. Considering the partner model during an explanation can be trained.

First promising solution to how the interplay between the EEs' moves and the partner model of the EX can be transferred to XAI with the goal to generate tailored explanations are already available (Robrecht & Kopp, 2023). For future research, it is worth to consider further functions of questions (e.g., of the EXs) as specific subset of verbal behaviours as well as other contributions of both partners that may steer the interaction in a substantive way resulting in changes of partner models.

Acknowledgments

The work in this paper was funded by the Deutsche Forschungsgemeinschaft (DFG): TRR 318/1 2021–438445824, project A01. We thank Erick K. Ronoh, Viviane Gladow, Marie Weise, and Celina Nitschke for supporting the data collection.

References

Brennan, S. E., Galati, A., & Kuhlen, A. K. (2010). Two minds, one dialog: Coordinating speaking and understanding. *Psychology of Learning and Motivation, 53*, 301–344.

Brennan, S. E., & Hanna, J. E. (2009). Partner-specific adaptation in dialog. *Topics in Cognitive Science, 1*(2), 274–291.

Brown-Schmidt, S., Yoon, S. O., & Ryskin, R. A. (2015). People as contexts in conversation. *Psychology of Learning and Motivation, 62*, 59–99.

Buhl, H. M. (2001). Partner orientation and speaker's knowledge as conflicting parameters in language production. *Journal of Psycholinguistic Research, 30*(6), 549–567.

Chi, M. T., Roy, M., & Hausmann, R. G. (2008). Observing tutorial dialogues collaboratively: Insights about human tutoring effectiveness from vicarious learning. *Cognitive Science, 32*(2), 301–341.

Chi, M. T., Siler, S. A., & Jeong, H. (2004). Can tutors monitor students' understanding accurately?. *Cognition and Instruction, 22*(3), 363–387.

Chi, M. T., Siler, S. A., Jeong, H., Yamauchi, T., & Hausmann, R. G. (2001). *Learning from human tutoring. Cognitive Science, 25*(4), 471–533.

Clark, H. H. (1996). *Using Language*. Cambridge: Cambridge University Press.

Dillenbourg, P., Lemaignan, S., Sangin, M., Nova, N., & Molinari, G. (2016). The symmetry of partner modelling. *International Journal of Computer-Supported Collaborative Learning, 11*, 227–253. https://doi.org/10.1007/s11412-016-9235-5

Doyle, P. R., Clark, L., & Cowan, B. R. (2021, May). What do we see in them? identifying dimensions of partner models for speech interfaces using a psycholexical approach. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1–14). New York, NY: Association for Computing Machinery.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153

ELAN (Version 6.7) [Computer software]. (2023). Nijmegen: Max Planck Institute for Psycholinguistics, The Language Archive. Retrieved from https://archive.mpi.nl/tla/elan

Fischer, K. (2016). Designing speech for a recipient: The roles of partner modeling, alignment and feedback in so-called 'simplified registers'. *Pragmatics & Beyond New Series, 270*. Amsterdam, NL: Benjamins.

Fischer, K., Foth, K., Rohlfing, K. J., & Wrede, B. (2011). Mindful tutors: Linguistic choice and action demonstration in speech to infants and robots. *Interaction Studies, 12*(1), 134–161.

Fisher, J. B., Robrecht, A. S., Kopp, S., & Rohlfing, K. J. (2023, August). Exploring the semantic dialogue patterns of explanations—a case study of game explanations. *Proceedings of the 27th Workshop on the Semantics and Pragmatics of Dialogue* (pp. 35–46). Maribor: MariLogue.

Fisher, J. B., Rohlfing, K. J., Donnellan, E., Grimminger, A., Gu, Y., & Vigliocco, G. (2023). Explain with, rather than explain to: How explainees shape their own learning. *Interaction Studies*. [Manuscript submitted for publication]

Fusaroli, R., Rączaszek-Leonardi, J., & Tylén, K. (2014). Dialog as interpersonal synergy. *New Ideas in Psychology, 32*, 147–157.

Graesser, A. C., Person, N. K., & Magliano, J. P. (1995). Collaborative dialogue patterns in naturalistic one-to-one tutoring. *Applied Cognitive Psychology, 9*(6), 495–522.

Horton, W. S., & Gerrig, R. J. (2005). The impact of memory demands on audience design during language production. *Cognition, 96*(2), 127–142.

Horton, W. S., & Keysar, B. (1996). When do speakers take into account common ground? *Cognition, 59*(1), 91–117.

Miller, T. (2019). Explanation in artificial intelligence: Insights from the social sciences. *Artificial Intelligence, 267*, 1-38.

Nickerson, R. S. (1999). How we know - and sometimes ariemisjudge - what others know: Imputing one's own knowledge to others. *Psychological Bulletin, 125*(6), 737–759.

Nückles, M., Wittwer, J., & Renkl, A. (2005). Information about a layperson's knowledge supports experts in giving effective and efficient online advice to laypersons. *Journal of Experimental Psychology: Applied, 11*(4), 219–236.

Robrecht, A. & Kopp, S. (2023). SNAPE: A sequential non-stationary decision process model for adaptive explanation generation. *Proceedings of the 15th International Conference on Agents and Artificial Intelligence, 1*, 48-58. https:// doi.org/10.5220/0011671300003393

Rohlfing, K. J., Cimiano, P., Scharlau, I., Matzner, T., Buhl, H. M., Buschmeier, H., Esposito, E., Grimminger, A., Hammer, B., Häb-Umbach, R., Horwath, I., Hüllermeier, E., Kern, F., Kopp, S., Thommes, K., Ngonga Ngomo, A. C., Schulte, C., Wachsmuth, H., Wagner, P., & Wrede, B. (2021). Explanation as a social practice: Toward a conceptual framework for the social design of AI systems. *IEEE Transactions on Cognitive and Developmental Systems, 13*(3), 717–728.

Roscoe, R. D., & Chi, M. T. (2007). Understanding tutor learning: Knowledge-building and knowledge-telling in peer tutors' explanations and questions. *Review of Educational Research, 77*(4), 534–574.

Roscoe, R. D., & Chi, M. T. H. (2008). Tutor learning: The role of explaining and responding to questions. *Instructional Science, 36*(4), 321–350.

Vasil, J., Badcock, P. B., Constant, A., Friston, K., & Ramstead, M. J. (2020). A world unto itself: human communication as active inference. *Frontiers in Psychology*, *11*, 417.

Wittenburg, P., Brugman, H., Russel, A., Klassmann, A., & Sloetjes, H. (2006). ELAN: A professional framework for multimodality research. *5th international conference on language resources and evaluation (LREC 2006)* (pp. 1556–1559). Genoa: ELRA.

Wittwer, J., Nückles, M., & Renkl, A. (2010). Using a diagnosis-based approach to individualize instructional explanations in computer-mediated communication. *Educational Psychology Review*, *22*(1), 9–23.

Wittwer, J. & Renkl, A. (2008). Why instructional explanations often do not work: A framework for understanding the effectiveness of instructional explanations. *Educational Psychologist*, *43*(1), 49–64.