Explain *with*, rather than explain *to*

How explainees shape their own learning

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Research about explanation processes is gaining relevance because of the increased popularity of artificial systems required to explain their function or outcome. Following an interactive approach, not only explainers, but also explainees contribute to successful interactions. However, little is known about how explainees actively guide explanation processes and how their involvement relates to learning. We explored the occurrence and type of explainees' questions in 20 adult — adult explanation dialogues about unknown present and absent objects. Crucially, we related the question types to the explainees' subsequent recall of the unknown object labels. We found that explainees asked different types of questions, especially about the object's label and facts. Questions about the object's function were asked more when objects were present. In addition, requests for labelling were linked to better recall. The results contribute to designing explainable AI that aims to provide relevant and adaptive explanations and to further experimental approaches to study explanations.

Keywords: explanations, explainee, interactive learning, types of questions, presence of referents

Introduction

Whereas research on explanations has traditionally focused on how a cause of an event can be revealed, recently, the focus has shifted toward explanations of everyday situations. These studies are motivated by the fact that technology surrounding us requires explanations to be accessible, adjustable, and thus useful. To make technology accessible is the goal of Explainable Artificial Intelligence (XAI) that develops models capable of explaining their functions. Scholars within the field increasingly recognize that not only is it important to develop contents to

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explain (the *what*), but because the goal of explaining is to create understanding in an explainee, *how* to explain is also critical. Surprisingly, it seems difficult to achieve a good understanding in an explainee, because people differ in what they are interested in and thus require diverse solutions. In XAI, it is argued that the answer to "what" is not as important as information about "how" (Besold & Uckelman, 2018) as it takes the users' needs, interests, and experiences into account when formulating a successful explanation. Miller (2019) claims therefore to recognize explanations as a social process to better understand how the required information emerges in the social interaction. Following this line of research, current approaches allow the user to steer the explanations by asking questions (Sokol & Flach, 2020), thus, allowing personalization of the interaction. However, although novel approaches in XAI build on the users' ability to ask questions (Sokol & Flach, 2020) and thus allow for a user's contribution in the explanation process, they currently lack an empirical basis to allow an interactive and thereby adaptive explanation. Previous studies on voice assistance systems revealed that users' familiarity with them influences their question-asking behavior (Le Bigot et al., 2008). However, the familiarity effect does not inform about how explainees might give cues and prompts to their needs in understanding.

In fact, little is known about explainees' question-asking behavior. When people are asked to explain spontaneously, they often provide long and monological statements which contribute only a little to learning (Chi et al., 2008). In contrast, the active involvement of both participants contributed considerably to deep learning effects (see Chi, 2009 for a summary). Question asking is used as a means to retrieve specific information (Rugerri & Lombrozo, 2015). Drawing from tutoring research, it is important to understand the type of questions that explainees ask (as a measure of their active involvement) and how these questions can foster their knowledge acquisition to provide a better empirical basis for the design of XAI.

The present study addresses this gap by analyzing the verbal interaction in dyads conversing about objects (provided by the experimenters). However, the experimental design is limiting explainers' behaviors to providing labels, functions, and facts of novel objects. Thus, one objection is that information that is typical in explanations (relations, causes) is not elicited in our setting. According to Klein (2009), however, contents such as labels, functions, and facts are essential and occur in more complex explanations as well. Thus, even though limited, the design of this study is providing ground for future experiments on interactive explanations and the enhancement of the design of adaptive systems.

For the analysis of question types, we took inspiration from work carried out on caregiver – child interactions, by Tare and colleagues (2011) that investigated how parents support children's learning at an exhibit. Because little is known

about questions during explanations, we aimed to explore what types of questions will be raised.

In addition, in this study, two conditions were included: one in which the object explained was present during the interaction, and one in which it was absent. Reasoning that the presence of an object is a resource for communication, and non-present referents may elicit different forms of verbal and nonverbal behavior (e.g., Stukenbrock, 2014; Vigliocco et al., 2019), we hypothesized that the two conditions will give rise to different question types.

The question types observed were then used to relate performance by the explainee in a recognition task.

Method

ECOLANG Corpus

The audio data used in the analyses is taken from the dyadic adult-adult interactions of the ECOLANG Corpus[1] (Gu et al., in press). This is a corpus of dyadic interaction between two adults, or an adult and a child.

Participants

Participants in the dyadic explanation dialogues were 40 native English speakers (mean age of 25 years). 20 dyads were considered (5 female-female, 4 male-male, 11 female-male).

Stimuli

For each dyad, 24 stimuli objects (12 unknown, 12 known) out of a total of 37 objects were chosen. These objects belonged to four categories: tools, musical instruments, food, and animals (see Figure 1).

1. Detailed information on the ECOLANG Corpus: https://ucl.primo.exlibrisgroup.com/discovery/collectionDiscovery?vid=44UCL_INST:UCL_VU2&collectionId=81414722010004761

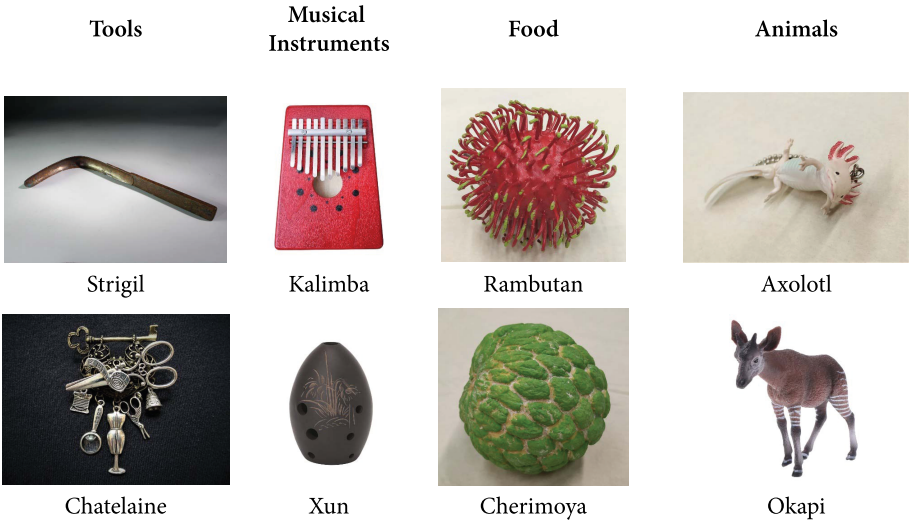

Figure 1. Four object categories as a pool

Procedure

The study was conducted in three stages: training session, explanation session, and recall task. Only the explanation session was recorded. For each dyad, one of the participants (explainer) was more knowledgeable than the other (explainee). Each of them was taking part in two sessions.

The online training session took place one or two days before the explanation session. In this session the explainer received materials informing them about different objects. They were presented with videos of 12 unknown objects which contained information about the labels, functions, and facts of these objects. For the 12 known objects, bulletin summaries of the object characteristics listed next to a photo were provided to the explainer. Additionally, in this session the explainer was instructed to talk about the objects in the explanation session. Right before the explanation session, the explainer went over a PowerPoint presentation listing all the objects including their pronunciation. Before the session, the explainee was informed about the subsequent recall task, in which labels were asked. In the explanation session, the dialogical partners were asked to engage about objects provided by experimenters, while they were audio- and video-recorded. The explainer spontaneously provided the explainee with knowledge about the unknown and known objects. The possible 12 unknown objects were each consecutively presented in two conditions: present and absent. When the first presentation was absent, the second was present.

If the objects were not present initially, the experimenter informed the explainee that the explainer was already aware of what the items were, and the explainer would provide information about the items while the experimenter retrieved them.

The order was counterbalanced, and half of the dyads started with the object-present condition and the other half of dyads with the object-absent condition. They were given four to five minutes to discuss the objects in each condition.

The recall task was administered directly after the explanation session and only with the explainee. During the task, explainees were tested on remembering the labels of the unknown objects in a forced choice test: The participants had to decide whether a presented picture and sound of a label matched.

Afterwards, explainees were asked to fill in a questionnaire in which they had to indicate their prior knowledge of the unknown objects to check whether these were unknown to them before the explanation.[2]

Coding

The question type analysis focuses on the unknown objects. For this, the explainee's questions were coded into six categories and transcribed using ELAN (2021). The categories are based on the work by Tare and colleagues (2011) with some modifications that concern the category of labelling and procedure questions (see Table 1). In the coding scheme by Tare and colleagues (2011), labelling questions were counted as factual questions. However, we decided to further differentiate them to examine more closely which particular types of questions lead to higher word recognition scores. With procedure questions, speakers in our data aimed to negotiate with what object to proceed in their conversation. In the work of Tare et al. (2011) this category was used with reference to space because the parents and children talked about where to go next within the exhibition. Based on observations in the data set, the category of reassurance was added. For the definition and examples of the question types, see Table 1.

In addition to the question types, we also coded the explainees' performance in the recall task: Each correct choice in the recall test was coded as 1 and each incorrect choice as 0. Their average performance was correlated to the question types.

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2. According to a post-experiment survey, if explainees knew the objects before the interaction, the items were excluded from the analysis. Therefore, the number of unknown objects varies for each explainee between eight and eleven objects (mean: 9.5).

Table 1. Coding scheme for the question types. All examples are taken from the recordings

Question type	Definition	Examples
labeling	Target the name of a stimulus in an oral or orthographic form.	*What is that?* *How do you spell that?* *What's it called okapi?*
function	Different functions of a music instrument, tool or body parts of an animal and what they do. How to eat a fruit.	*What does that do?* *And you eat it, like, with a spoon or something?*
factual	Seek information of a profile or product description. Include general demands for more information and examples.	*What's a gourd?* *Where do they live?* *When was it invented? And then?*
reassurance	Make sure the speaker is serious, a sign of disbelief or surprise or auditory difficulties.	*Really? Shells right? Is it?*
procedure	Is an off-topic remark on how to continue with the discussion. Also includes information on the pre-session of the explainer.	*Can I try?* *Did you watch videos?* *Well they not told you?*
personal	Includes individual preferences and experiences of the explainer and explainee.	*Have you played it before?* *Did you know that yourself?*

Results

All explainees engaged in asking questions. Overall, explainees asked 29 questions on average across the 12 unknown stimuli ($SD = 15.9$, range 9–73).

In the following, we will present the results concerning the questions types and their relation to the learning measure.

What type of questions do explainees ask?

For this analysis, we will consider the mean number of question types in the present and absent condition (see Figure 2).

As can be seen from Figure 2., all question types were present in both conditions, although there were only very few procedure questions overall. Factual and labelling questions were the most frequent ones in both conditions.

Thus, participants varied highly in their repertoire of questions, with the exception of factual questions.

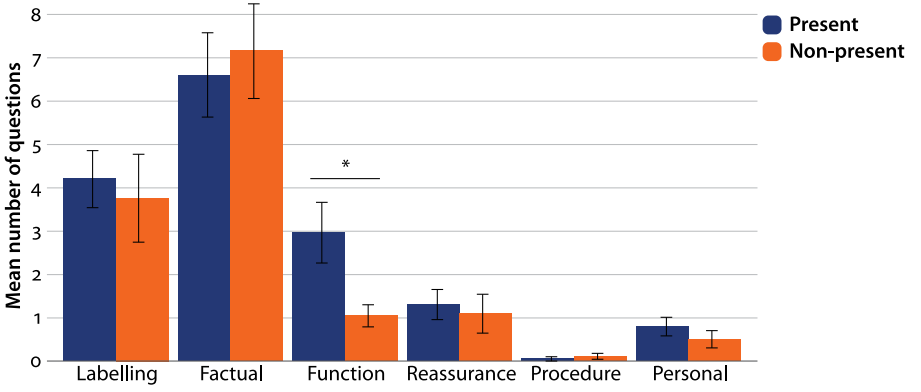

Figure 2. Mean number of question types

With respect to the present and absent condition, we found a significant difference in the occurrence of the function questions: According to a Wilcoxon test, the object-present condition ($M = 2.95$, $SD = 3.5$) elicited significantly more function questions than the absent condition ($M = 1.05$, $SD = 1.2$), ($Z = -2.46$, $p < .05$). This effect persisted also when we controlled for the overall number of questions that an explainee raised and considered percentages of the different question types.[3] However, this was the only significant difference. In contrast to our hypothesis, thus, our results suggest remarkable similarity between the conditions to a large extent.

Do questions relate to learning measures?

In the next step, we considered how the specific types of questions related to the recall score, and thus to the learning of the participants. On average, the participants scored .80 ($SD = .14$, Range .37–1.00) in the recall task. We performed a Spearman correlation analysis of the number of questions in the different question types and the recall score. The obtained *r*-values can be seen in Table 2. Bonferroni corrected results revealed that only the question type of labelling in the present condition correlated positively with the recall score ($r_s = .60$). Interestingly, although the occurrence of this question type did not differ between the condi-

3. In the study the number of questions were not put into proportion over total number of utterances of the speaker because they had a similar time limit.

tions, labelling questions in the absent condition were not significantly related to participants' learning.

Table 2. Spearman-Rho coefficients as results from the correlation analysis relating the question types to the recall score in the present and absent conditions (Bonferroni-corrected significance level, $p < .05$, indicated by *)

Question type	*r*-value in condition, $N = 20$	
	Present	Absent
Labeling	.60*	.35
Factual	.26	−.01
Function	.16	−.12
Reassurance	.27	.02
Procedure	.30	.22
Personal	−.04	.12

Discussion

In this study, we analyzed dialogues in which unknown objects were explained. Complementing current research focusing on the explainer, our analysis provides important insights into how an explanatory dialogue is shaped by an explainee: Instead of being only a passive receiver, the explainee asks various kinds of questions seeking specific information from the explainer. Following an approach created to describe child — caregiver interactions (Tare et al., 2011), we classified the questions asked by the explainee and found that questions concerning the label, facts, and functions were the most frequent. In addition, we investigated whether the type of questions asked differed depending upon whether the object was present or absent. Given that objects can be considered as resources for communication (e.g., Stukenbrock, 2014; Vigliocco et al., 2019), we hypothesized that they would elicit different question types. We found however, that the frequency of the questions occurring was similar in these two conditions. Only questions concerning the object's function were more common when the objects were present suggesting that the physical presence of the objects rendered their function-affording properties more saliently. For the other types of questions, the present study does not have evidence for the hypothesis that the two conditions result in different set of explainee's behavior. For the development of XAI, this might be of particular importance as XAI targets to explain the system's function. Thus, XAI research needs to consider that the presence of objects or referents might be crucial to elicit

questions about systems' functions. Further research is necessary to investigate technical contents in explanatory dialogues, how they are talked about, and how they result in a better understanding of the presented functions.

A crucial point of interest in our study was whether different questions were especially likely to relate to the mapping between the object and their label (as assessed in the recall task). In this task, the explainee had to decide whether the novel label and a picture of the object matched. Our results suggest that the more labelling questions the participants asked in the present condition the higher they scored in recalling the new labels and vice versa. One likely explanation for the correlation is that learning to map labels to objects is easier when the label is provided at the same time as the referent. The co-occurrence of label and referent is considered to be critical for early word learning in infants (Smith et al., 2002), our results indicate that this advantage exists in adulthood as well (see also Derks & Dunman, 1974). Without knowing the objects' appearance, participants' knowledge about the labels was little helpful in this task, as it was demonstrated by the lack of effectiveness of labelling questions in the absent condition. However, in our study, learning was limited to the mapping task. Future research needs to regard this limitation by creating comprehension or learning tasks that are assessing not only the mapping but also broader knowledge about the unknown object, its function, and facts. In this respect, Rohlfing and colleagues (2021) suggest different forms of comprehension that everyday explanations might yield ranging from remembering some facts to actual performance or ability to decide.

As our study was designed with a clear focus on explanation of novel objects' labels, facts, and their function, two critical points follow from it: Firstly, that the explainees were informed about the recall task prior to the explanation might have motivated them to ask comprehension questions that directly secured the acquired knowledge. We, thus, cannot rule out the possibility that our results about the engagement of the explainees are due to the prior announcement of the recall task. Secondly, in everyday settings, explanations extensively connect to emerging interests and various knowledge gaps requiring different forms of comprehension and follow-up actions. For this purpose, further studies have to take a rich behavior of the explainer into account in which different information is connected and combined.

Importantly, the results speak to a crucial involvement of the explainee, as all participants engaged in asking questions. Our results line up with the interactive learning account (Chi, 2009) proposing that episodes of tutoring that are initiated by the tutee foster their learning. Our results extend, however, this approach to explanatory dialogues showing that it is not only the sole initiative of the explainee that is crucial for recall of the labels. Even though they were as frequent as in the present condition, labelling questions in the absent condition were

not significantly related to the learning scores suggesting that the learning advantage cannot result from hearing the label more frequently and on own initiative. Instead, our results suggest that for the recall task, the visual information about the object was crucial. We see great potential to extend the analysis presented in this paper focusing on how the explainees' shape the dialogue to interaction-based measures relating the behaviors of the explainee and explainer. Such an extension would provide novel insights into how explainers react to the explainees' questions and whether there are patterns of responses.

For the development of XAI, the results of this study are informative as they show the necessity to involve the explainee as much as the explainer in the process of explaining: By raising quite a lot and a variety of different types of questions, the explainee is significantly steering the explanatory dialogue and, thus, contributing to the construction of the relevant information.

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