Collaborative Mediation of the Setting of Activity

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Abstract

Various aspects of task settings, including the actors and the physical environment, interact in complex ways in the construction and selection of action. In this paper, we examine the process of collaborative mediation, that is, how collaborators facilitate activity by making aspects of the setting available or accessible to the principal actor. We investigate collaborative mediation in three activities: verbal descriptions of strongly structured objects, such as one's house; cooperative computer use; and parent-child cooking. In each of these cases, the collaborator's role with respect to the principal actor and the rest of the setting differs, but they are all of similar kind. The collaborator makes available different aspects of the setting (physical setting, goals, tests of success, etc.) as needed at appropriate moments, thus helping to operationalize goals via physical guidance, advice, indication of aspects of the setting to make them accessible or relevant, or the taking of initiative which moves the activity forward more directly. Our analysis elaborates the methods by which agents can mediate one another's construction of the settings in which they find themselves, and so facilitate successful activity. We thus extend and generalize similar analyses and approach a general theory.

Introduction

In this paper we investigate the role of collaboration in activity. Activity is embedded in a setting that includes actors, their goals, the physical environment, and perhaps other aspects. These aspects interact in complex ways in the construction and selection of action. Collaboration is one form of this interaction. Consider the case of a linguist trying to find information about a particular method of linguistic analysis via a computerized database. If the linguist is not an expert user of the database, she will probably be assisted by a research librarian. The librarian's skills contribute significantly to the activity of looking up information. For example, since the librarian knows the structure of the database and what sorts of queries are appropriate (or have worked well in the past), he can guide the linguist's use of the system in a number of ways that are crucial to the success of the whole enterprise.

For purposes of analysis, we shall distinguish a *principle actor* who is taking particular actions at particular moments. In addition to the principal actor, we define three further parts of the setting: the domain of discourse; the task setting; and the collaborator set. The *domain of discourse* is approximately the subject of activity (e.g., the topic being discussed, the global goals of the activity). The *task setting* includes the physical and historical aspects relevant to the activity (e.g., the tools at one's disposal, things that have already been said). The *collaborator set* includes other intentional actors that participate in the task. When this set contains a single member, we will refer simply to the *collaborator*. In the above example, from one point of view, our hypothetical linguist is the principal actor; the databases system and its interface constitute the task setting; the domain of linguistic analysis and the linguist's local requirements constitute a likely domain of discourse; and the research librarian is the collaborator. It is important to note that this set of analytic categorizations will vary over the course of activity, and with different points of view. So, for instance, if the participants have a conversation about the database interface itself, then the domain of discourse is no longer linguistic analysis, but perhaps the windows on the screen and their functions. Similarly, we could reanalyze the setting, taking the research librarian as principal actor and the linguist as collaborator.

It is clear that the aspects of the setting are not entirely separate; indeed, it is central to the present project that these do not have separate existences, but rather that they co-construct one another. In

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a previous study, Agre and Shrager (1990) examined the fine tuning of the complementarity of the principal actor and the domain of discourse and task setting, involving an office worker and a copier. Aspects of the worker's physical and (presumably) mental activity evolved with respect to the rhythms of the copier to produce efficient joint activity. In this paper, we are particularly concerned with the way in which the collaborator set "mediates" the task setting; that is, how collaborators make aspects of the setting available or accessible to the principal actor. We shall use the term *collaborative mediation* for this process.

We have investigated collaborative mediation in three activities: verbal descriptions of strongly structured objects, such as one's house (Sibun, 1991; Sibun, 1992); cooperative computer use, such as that described in the above example; and parent-child cooking (as studied by Shrager & Callanan, 1991).

Three Cases of Collaborative Mediation

The three cases in which we shall examine collaborative mediation lie along a dimension of the role of collaboration in activity: from the relatively passive role of interlocutor in a description activity, through the more active role of assistant in an information access activity, through the very proactive role of parent in a parent-child cooking activity. In each of these very different situations we will identify ways in which collaborators make aspects of the setting available to the principal actor, or make them relevant to the moment.

Description Production

Consider describing your home to another person. The particulars of your home, especially the physical layout, are clearly relevant to what you will say, but what the listener knows, how he or she interacts with you, and other aspects of your shared knowledge are also relevant to the structure of the description. The general form of such descriptions involves the principal actor constructing for an audience text that reflects the structure of the house. The domain of discourse is the house and the collaborator is the person requesting the description. In this case, the task setting is largely irrelevant for the present analysis; its most interesting feature is a tape recorder. We chose this relatively non-interactive version of conversation instead of, say, task-oriented dialogue (e.g., Grosz & Sidner, 1986) because the latter is evidently co-constructed. While the interlocutor of a description is a relatively passive collaborator, all of the examples of house description that we have collected show evidence of participation by the collaborator, even when he or she is trying not to take part in a dialogue.

We show two examples in which collaborative mediation takes place. The text fragments are drawn from descriptions given by people who had spent significant time in a particular house. Each was answering the question: "Can you describe for me the layout of [this] house?" (See Sibun, 1991, for more details and complete transcripts.) In the italicized portions of the fragment in Figure 1, the principal actor explicitly indicates that the form of his description has been affected by his knowledge that the collaborator lives in the house, and presumably is familiar with it. In the fragment in Figure 2, the principal actor not only expects, but insists on input from the collaborator in accomplishing the task.

In these examples, what is being mediated by the collaborator is the principal actor's access to aspects of the domain of discourse, or his interpretation of the relevance of these aspects. That is, in these cases, the seemingly passive listener is actually highly relevant to the speaker, and is particularly relevant in helping the speaker decide, in the first example, what information to give, and in the second example, how to envision the house.

Human-Assisted Information Access

As part of a project to provide computational assistance in information access (approximately, database search), we studied human-assisted information access. Xerox PARC researchers were solicited for help in the study. The first author was familiar with the database system and acted as an assistant. Researchers produced their own goals for the search task. For the present analysis, the searcher will be considered the principal actor, and the assistant will be considered the collaborator. The task setting includes the structure and the content of the databases, the layout of the interface (e.g., where the windows are located on the screen, when buttons are available and what actions they would invoke), and, peripherally, the physical setting (an office) in which the searcher and assistant work.

The clearest examples of mediation in this domain arise from the differential skill and knowledge of the principal actor and collaborator. In the fragment in Figure 3, the assistant helps the searcher translate his search desires into actions in the database interface. The researcher is interested in querying a database of Xerox information to find out how many researchers there are at PARC. The assistant, because she knows both the content of the database and the types of queries

....then there's—there's kind of a big central....room-thing
I mean like when you come in
....this seems very strange telling you this Penni
[...]
....and there's an outside entrance to the—to the basement
....and I guess that's how I would describe the layout of your house
although if I were probably describing it to anyone else
I might have given a little more size information

Figure 1: A description fragment in which the speaker explicitly indicates that the form of his description has been affected by his knowledge that the collaborator lives in the house.

Claire:	my room is....a little longer than wider
	but it looks pretty square
	it has two windows....sort of at this one corner
	that is pretty much diagonally opposed to the door
	which goes outside to the little hallroom before the bathroom and Ann's room
	the bathroom is fairly uh....not square
	I don't know, does this—the bathroom stick out?
Penni:	*no!*
Claire:	*it doesn't?*
Penni:	*I don't think you're supposed—*
Claire:	*it doesn't?*
Penni:	*—to ask me though!*
Claire:	*well, I don't—ok—anyway*
	so there's the bathroom that has one adjacent wall to mine....

Figure 2: A description fragment in which the principal actor insists on input from the collaborator.

that would be successful, points out that this query is unlikely to be usefully answered, and suggests instead a query that would search for documents that mention a particular topic. They settle on [linguistics].[1] Notice that in this case the assistant helped the searcher structure his expectations of the search facility by indicating certain capacities that it does not have. Although the searcher had some initial idea of what he was interested in, the goals of the search are jointly developed by virtue of the assistant knowing for what sorts of questions the database is relevant, and how the system will respond to different sorts of queries.

In the fragment in Figure 3 the domain of discourse is initially the domain of research at PARC, but shifts to focus on the searcher's goals and questions and how they related to the contents of the database, as the assistant and searcher negotiate what precisely should be done. The shifting around of the domain of discourse is a common feature of collaborative mediation. The domain of discourse often shifts to the system and the interface, since the searcher is unfamiliar with both, and requires explanations from the assistant.

The fragment in Figure 4 exemplifies this sort of mediation. The searcher enters into this portion of the task wishing to find out "which laboratories (at PARC) do research on [linguistics]"(Figure 4). We enter this fragment after searcher and assistant have discovered one document that seems particularly relevant, and then want to search through that document for the section on research on [linguistics]. Unfortunately, the facility for searching within a document looks in the selected document for *any* of the terms from the original query (including "on" and "do"), thus leading to an enormous amount of useless search. More importantly, in the context of a document that is already relevant to the query, searching once more for the query terms is not usually helpful in locating interesting parts of the document (unless the selected document is very heterogeneous).

We see a progression through domains of discourse; moving from discussion of the topic of

[1] This is not the actual topic. It has been changed for reasons of privacy and clarity. In the protocol fragments we have noted this change by enclosing the modified text in [brackets].

Assistant:	why don't you ask another question [...] another PARC-related question [...]
Searcher:	another PARC-related question
Assistant:	ahhm something that— now that you've seen a little bit— if it's a more general question I think we'll have better luck
Searcher:	okay I okay I got one [...] "how many researchers at PARC?"
Assistant:	know what? I bet that's gonna be— have a similar thing that it's going to mostly hit on "PARC"— I guess it'll hit on "PARC" and "researchers" it may or may not come up with....a number
Searcher:	okay so you want you think—therefore I should try something else?
Assistant:	yeahhh.... [...] if you ask about um like [linguistics] at PARC or....um....
Searcher:	mmhm by content rather than structure
Assistant:	yeah more more content than particular facts
Searcher:	okay....um....okay...."which laboratories do research [in linguistics]"
Assistant:	okay

Figure 3: An assistance fragment in which the assistant helps the searcher translate his search desires into action in the database interface.

	[The searcher and assistant have located a number of documents relevant to the query: "which laboratories do research [in linguistics]?"]
Searcher:	I would guess that "Research Overview" is probably gonna contain something [They select the Research Overview document for detailed examination.]
Assistant:	okay well hit on "Find Key" and see which key it's looking for... [The Find Key button looks for any of the query keywords in the selected document and highlights them in turn.]
Assistant:	"research"....well that's that's good you can now—
Searcher:	where did you see that....oh I see
Assistant:	it lights it up
Searcher:	okay
Assistant:	um so I think if you hit "Find Key" again it will [The searcher continues to press the Find Key button.]
Assistant:	....yes....keep going through with "research" so that....
Searcher:	"research centers"...."Palo Alto Research Center" [...] well here we finally found "[linguistics]" in the title [...] *once I got into this thing probably I'd want to search for the word "[linguistics]"* *I wouldn't want to search for "research"* *or I mean—once we know the context of this document is "research"*
Assistant:	right
Searcher:	and then and I wanna narrow on—narrow in on "[linguistics]"

Figure 4: An assistance fragment exemplifying shifts the in domain of discourse.

desired information, through how to implement the search, discussion of the resulting documents, methods of searching through chosen documents for relevant parts, and finally to discussion of problems with the method (italicized portion). This progression is facilitated by, and in part driven by, the collaborator (the assistant).

Parent-Child Cooking

Child development has long been understood as collaborative. Indeed, it is the origin of at least one central thread of research on activity theory (cf. Vygotsky, 1978; Wertsch, Minick, & Arns, 1984). More recently Rogoff (1990) has characterized the interactionist approach to child development by way of an apprenticeship metaphor. Apprenticeship is inherently collaborative. It is therefore particularly interesting to see how collabora-

tive mediation is deployed in a developmental setting. One version of mediation in development has been advanced by Bruner (1983) and by Wood (1980). They describe the processes of "scaffolding" in which an adult (the collaborator) gives over portions of a task that are doable by the child (the principal actor in this analysis), and structures the setting so that the child can accomplish those aspects and move on to more complete skill. This is similar to the way in which the database search assistant guides the researcher in using the database interface. We shall see that there are other more subtle mediating processes at work in the parent-child setting.

Shrager and Callanan (1991) studied parent-child dyads engaged in baking raisin bran muffins in the family kitchen. Significant changes in the collaborative structure of the activity were observed, and the naturally-occurring "active language" taking place in the setting was examined to identify the various roles that are played by language in such settings of activity. Five functions of active language were identified: object and action labeling; sequencing of expectations (procedure organization); task structuring articulations; explication of non-obvious aspects (e.g., goals and causes) and focusing on relevant aspects; and interaction facilitating articulations. For the purposes of the present paper we are concerned mainly with the function identified as "focusing on relevant aspects" (of the activity).

A number of examples of such focusing can be seen in the collaborative cooking data. It is generally the case in these studies that the parent and child are jointly focussed on a particular object, say, the measuring spoons that are being used to add baking soda to the mixture. The parent has a number of methods by which he or she can obtain, check, and manipulate the child's focus, such as waving the spoons in front of the child to grab his or her attention, and taking the child's hand and touching it to the spoons.[2] These are often (though not always) accompanied by verbalizations that include explanations of what is being pointed out or accomplished. In these ways the parent (the collaborator in the present analysis) is emphasizing certain aspects of the physical setting (part of the task setting), and in so doing is facilitating the joint activity. (Some version of baking activity would go on without these interactional resources, but it might not be very easily understood as collaborative—the child most likely not being very closely engaged with baking.)

In this case, the parent and child are very closely engaged, and almost all aspects of the setting are made available to the child by way of mediating activities of the parent such as naming, explanation, and indication (making aspects of the setting accessible or relevant). (Examples of these are given in Shrager and Callanan, 1991.) The parent's proactive guidance is largely responsible for keeping the task on track, and for enabling it as a collaborative activity.

[2]Transcribed examples of these activities appear in Shrager and Callanan, 1991.

Discussion

We have examined collaborative mediation in three cases that lie along a dimension of the role of collaboration in co-activity, from the relatively passive role of interlocutor in the description activity, through the more active role of assistant, to the very proactive role of parent as assistant, guide, and tutor in baking. In each of these very different situations we are able to characterize ways in which a collaborator makes aspects of the task domain or setting available (or relevant to the moment) for the principal actor. The case of parent-child cooking is perhaps the most obvious; here it is necessary for the parent to do a great deal of explicit mediation of the setting by way of naming, explanation, indication, etc. The parent's proactive guidance is largely responsible for maintaining the directionality of the task, and for enabling it as a collaborative activity. In the case of human-assisted information access, the searcher's access to a significant part of the setting can only be accomplished through the assistant, and both participants act to take advantage of the mediating role of the assistant in this function. The assistant's role enabled the searcher to refine his desires into the specific operations both necessary and sufficient for implementation of the search activity.[3] The case of giving a description is in many ways the most subtle example of mediation. The collaborating person, even in playing the relatively passive role of audience, is still clearly a part of the setting, as evidenced by the appeals of the principal actor to the collaborator.

The collaborator's role with respect to the principal actor and the rest of the setting is similar from one activity to next: actions of the collaborator shape and enable actions of the principal actor, thus facilitating the overall activity. More specifically, the collaborator makes available different aspects of the setting (physical setting, goals, tests of success, etc.) as needed at appropriate moments. This mediation helps to operationalize the princi-

[3]Note once again that our analysis from the point of view of principle actor and collaborator(s) is merely an analytic stance; this analysis can be carried out from any chosen point of view, or from no individual point of view at all. It is rather more complicated to speak about it, though, in the case where there is no individual point of view.

pal actor's goals via physical guidance, advice, indication (making aspects of the setting accessible or relevant), or the taking of initiative to move the activity forward. Our analysis of the functions of collaboration in the construction of activities elaborates the methods by which agents can mediate one another's construction of settings. We thus extend and generalize similar analyses (e.g., Agre & Shrager, 1990; Vygotsky, 1978; Wertsch, Minick, & Arns, 1984) and approach a general theory.

There are many other, more subtle, cases of co-construction of these domains. The most interesting is, perhaps, the construction of which parts of the task setting (which might include people) shall be nominated as "collaborators" and thus, by our definition, become a part of the collaborator set. Thus nominated, a collaborator can take part in the processes of mediation that we have identified. It is interesting to ask what capacities an agent must have in order to be elected to collaborator status. Latour (1988) has analyzed the social role of a mechanical "door-closer"—the hydraulic and spring device that pulls a door closed after one has walked through it. This simple device is hardly a collaborator despite its social role. Rather than mediating the setting for an actor, the door-closer is simply changing the structure of the setting by absolving one of the requirement of pulling the door closed after oneself. Some computational systems exhibit collaboration in a simple sense. A number of systems that attempt to provide mixed-initiative advice to users of computer systems (e.g., Shrager & Finin, 1982), and so-called "learning apprentice" systems attempt to learn the common procedures used by users and then to propose operations in the form of advice when later similar contexts arise (e.g., Mitchell, Mabadevan, & Steinberg, 1990).

The present analysis sheds some light on additional capacities that may be required of such computational agents if they are to become fully-fledged collaborators. A crucial facility for such collaborative systems will be the negotiation of domains of discourse. Such negotiation seems to require the maintenance of joint attention, which may be maintained either by linguistic communications (as in the cases of description and human-assisted information access), or by a number of physical means (as in the case of parent-child cooking).

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