Annotation of Group Behaviour: a Proposal for a Coding Scheme

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Abstract. In this paper, we introduce a coding scheme aimed at annotating group behaviour. The scheme is inspired by the Bales' Interaction Process Analysis and consists in 10 labels organized in 2 dimensions. After the description the categories some preliminary results concerning its reliability are presented.

1 Introduction

Meetings are more and more important in structuring daily work in organizations. Executives on average spend 40%-50% of their working hours in meetings (Doyle & and Straus, 1993) and automatic tools to support group interaction in face to face meetings is becoming a hot topic. Recently a number of research projects have been funded to investigate ways of employing multimodal technologies in supporting group's interaction; as a consequence, the need for annotation schemes that serve both for exploratory research aiming at understanding relevant social phenomena and to provide databases that can be used to train systems has risen.

Most of the recent research in multimodality focuses on analyzing the verbal communicative behaviour of the participants in group activities. For example, Cohen et al. (2002) study how the meeting scenario changes the way subjects integrate deictics and language references driving interesting guidelines for the design of multimodal system to support collaboration. Robinson et al., (2004) analyses the patterns of exchanges in multi-party dialogues using a widely used coding scheme for annotation of dialogues (i.e. the *HCRC dialogue structure coding*).

Laskowsky and Burger (2005) propose a new annotation scheme for emotionally relevant behaviour. Finally, Carletta, J.C. and Kilgour (2004) discuss a tool to annotate topic segmentation in the ICSI Meeeting Corpus. They mention the objective of exploiting Bales's Interaction Process Analysis (Bales, 1970) for social interaction, but they do not provide an annotation scheme.

In the context of the CHIL project (Waibel et al., 2004), we are investigating the use multimodal information to monitor the group behaviour in face-to-face meetings in order to provide meta-level services that can impact on group dynamics (Zancanaro & Pianesi, 2004).

This paper describes a coding scheme aimed at identifying suitable observable behavioural sequences. Suitability refers both to the relevance of the behavioural sequences to implement useful meta-services, and to their definition in terms of low-level (audio and video) events that a multimodal system can detect.
In section 2, we discuss the motivations and the background of our coding scheme, which is inspired by the Bales' Interaction Process Analysis (Bales, 1970). In section 3, we introduce in details the coding scheme while in section 4 we present some preliminary results concerning its reliability.

2 Observing Group Behaviour

A coding scheme for group behaviour should, in the first place, be usable by human annotators. This is needed both for exploratory research aiming at understanding relevant social phenomena and to provide data bases that can be used to train systems. Hence, the categories of coding scheme must be capable of mapping onto constellations of low-level patterns that can be detected through vision and speech technologies.
In our search for suitable categories for the coding scheme, the goal of presenting individual profiles to participants suggested carefully considering those approaches to social dynamics that focus on the (functional) roles members play inside the group.

Among the available notions of group members' roles, the work of Salazar (Salazar, 1996) defining them in terms of behaviour enacted in a particular context is of particular interest to us. Indeed, it moves away from a strictly organizational perspective whereby roles are defined by the social positions within the group, and it differs from other approaches defining roles according to the social expectation associated with a given position (for example Katz and Kahn, 1978). This perspective on function (or situation, following Salazar, 1996) as opposed to social expectation allows exploiting information about what actually happens in the course of an interaction while reducing the necessity for knowledge about the group' structure, history, position in the organization, etc.
Benne and Sheats (1948) provided such a list of "functional roles" recognizable in working groups. Three dimensions are considered task-oriented, maintenance-oriented or individual-oriented. The first two dimensions are directed toward the group's need: task-oriented roles provide facilitation and coordination while maintenance roles contribute to structure and preserve interpersonal relations in order to reduce tensions and maintain smooth group functioning. The third type of roles, the "individual roles", comprises those roles that aim at reaching individual's rather than group's goals. Importantly, during the interaction, each person can enact more than one role. Finally, though not providing definitive answers to the quest for optimal group structure, Benne and Sheats emphasise the threat due to a strong presence of individual roles, and the importance of achieving the task and maintaining the relationship between members.

Starting from the model proposed by Benne & Sheats' model, Bales (1970) proposes the Interaction Process Analysis (IPA): a framework to study small group interaction, by classifying functions in face-to-face interaction in a two-dimensional space based only on the Task and the Socio-Emotional dimensions. In this perspective, twelve functions needed for the internal group equilibrium are introduced, e.g. the *Show Solidariety* function in the Social-Emotional Area is performed by raises other status, giving help and rewarding. The occurrence of a function is estimated in terms of the frequency of performance of the smallest verbal and non verbal acts.
Other attempts to classify functional roles can be found in literature, even if, as Hare (2003) points out, "for a comparison of the various lists of roles described in the literature, each of the roles can be typed according to their position along the dimensions identified by Bales ".

3 The Coding Scheme

In order to build a reliable coding scheme and, in perspective, to build a multimodal system that automatically recognize group behaviour, both the Benne and Sheats' and the Bales approach are too complex in terms of the numbers of functions/roles they introduced.
We decided to employ the Bales' categories because of the wide acceptance of the Interaction Process Analysis while interpreting the functions as (functional) roles in terms of Benne and Sheats' approach. Since, it can be expected that the behaviour of each participant will not change too often during the meeting (even if the changes of roles would be the most interesting to observe for a multimodal system that aims at supporting the group), the static concept of "role" is more reliable than the dynamic concept of "function".
The coding scheme consists of five labels for the Task Area and six labels for the Socio-Emotional Area. The Task Area includes functional roles related to facilitation and coordination tasks as well as to the technical experience of members while the Socio-Emotional Area involves functional roles oriented toward the functioning of the group as a group. Following (Salazar, 1996) in this area we also included some behaviour types that Benne & Sheats define individual roles.

3.1 Task Area Roles

The *Orienteer* is the person orienting the group. S/He introduces the items on the agenda, defining the position of the group relative to the goals and helps keeping the group focused and on track. S/He summarizes the main ideas of the group, recording the most important arguments in the discussion, the minutes, and the group decisions. S/He spells out suggestions in terms of examples or develops meanings, offers a rationale for suggestions previously made and tries to deduce how an idea would work out if adopted by the group.
From a behavioural point of view, s/he is often the first person to speak, proposes the topics to discuss, defines the situation, summarizes the results, and uses the Agenda. The *orienteer* tends to look at all the audience, rather than at one specific person (as opposed to the *giver* who focuses on the interlocutor); s/he has a major role in structuring the discussion ("ok, let's move on"), and in planning the future works. S/he often uses the first person plural ("we" instead of "I"), or impersonal pronouns.

The *Giver* (of information, opinions, suggestions, etc.) is concerned with providing information. S/he often has expertise on a given topic. She tends to state his/her beliefs and attitudes about the ideas, expresses personal

values as well as factual information, and shows or clarifies the relationship or linkage among various ideas and suggestions.
From a behavioural point of view, the *giver* tends to adopt a first personal, singular perspective (using "I" rather than "we"), and his/her focus of attention is directed towards the given interlocutor; finally, she/he often acts reactively, upon prompt by another person.

The *Seeker* (of information, opinions or suggestions, etc.) requests information, usually doing so to promote group decisions. S/He can also ask for clarification of values and opinions expressed by other members of the group. This role can be mistaken with the Orienteer; however, whereas the latter's questions are mostly meant to help the group reaching the objectives (for example, "what about moving to the next agenda item?"), the Seeker's ones are related to the task under discussion (e.g. "what's the status of project?", "what do you think about adding a new functionality to the system?").

The *Procedural Technician* is the participant who does something for the group: s/he uses the resources available to the group and manages them for the sake of the group. The most apparent manifestation (and useful) function of this role consists of keeping tracks of the discussions and the decision for the group, this is, what Benne & Sheats called "the recorder". In this respect, it should not be mistaken with the Follower (see below) who takes notes only for his/her own sake.

Finally, the *Follower* listens and follows the group interaction, possibly takes notes for personal use, but does not participate actively.

3.2 Socio-Emotional Area Roles

The Socio-Emotional Area in our coding scheme comprises five roles: *Attacker*, *Gate-Keeper*, *Protagonist*, *Supporter* and *Neutral*. Each participant of the meeting should enact one and only one role in the socio-emotional area at a given time. We emphasise that although we keep to Bales' terminology by calling this area 'socio-emotional', we are nor focusing on emotional states (like for example in Laskowsky and Burger, 2005), but only on the social aspects.

The *Protagonist* is the participant that takes the floor and drives the conversation. S/he assumes a personal perspective asserting his/her authority or superiority because of her/his status or because of the particular task she/he is performing.

The *Attacker* may work in many ways – deflating the status of others; expressing disapproval of the values, acts or feelings of others; attacking the group or the problem it is working on; joking aggressively and so on. S/He consistently reacts negatively to other's ideas: makes very critical comments, uses humor and so on.
The behavioural indicators that signal this role are, among others, an aggressive tone of voice, looking elsewhere, making noise, moving nervously.

The *Supporter* shows a cooperative attitude indicating understanding, attention and acceptance as well as providing technical and relational support to other members of the group. S/He also keeps a collaborative atmosphere sharing the common objects and trying to make them available to each member.

The *Gate-keeper* is the moderator within the group. S/he mediates the communicative relations and attempts to keep communication channels open by encouraging and facilitating the participation. S/He mediates the differences between other members, attempts to reconcile disagreements, and relieves tension in conflict situations.

Finally, the *Neutral* goes along with the group passively accepting the idea of the others and serving as an audience in group discussion.

4 Studies on the Reliability of the Coding Scheme

The object of our research is supporting small group interactions in ecological setting. Therefore, all our observations were conducted on spontaneous interactions of ITC-irst researchers not involved in the CHIL project.

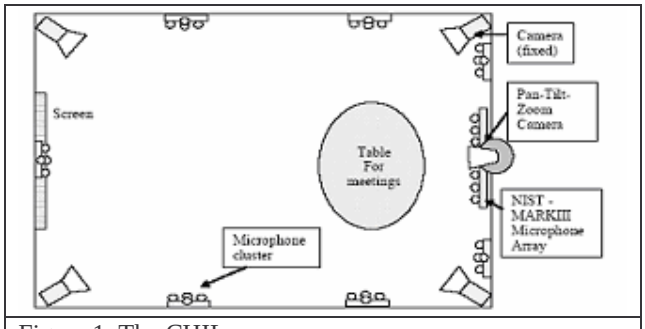

Figure 1. The CHIL room

All the interactions took place in a special room equipped with two cameras and table microphones. The group work took place around a circular table, with the possibility of

using a tabletop device for co-located interaction (Falcon et al., 2004). Most of the groups talked in Italian and a few in English (non-native speakers). A small number of group interactions were recorded using six cameras, closed-talk microphones and a microphone array according to the specifications for data collection of the CHIL project (see figure 1).
For each interaction, participants were annotated separately using an event based procedure, marking the start time and the end time of each role occurrence. MultiVideoNote, a tool developed at ITC-irst for annotation of multiple-streams videos, was used for this task. This tool is designed for ethnographic-style annotations of multimedia data, it is available as Open Source from http://tcc.itc.it/research/i3p/mvn/. The new version that will be release in Fall 2005 will offer a better support for behavioral analysis.

Figure 2. shows an example of an annotation of the behaviour of four subjects on the task and the socio-emotional areas. By visualizing the behaviour of the subjects on parallel lines, the group dynamics can be easily seen. For example, Subj1 enacts the role of the Orienteer on the task area while being Protagonist on the Socio-Emotional Area for most of the entire meeting. In a way, he emerges as a leader. Subjects 2 and 3 alternated in serving as Procedural Technicians and in contributing to the meeting interaction as Givers of information.

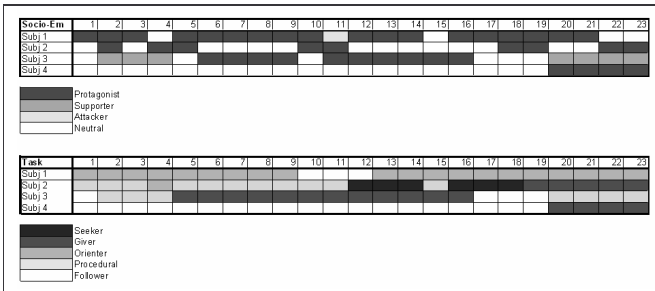

Figure 2. An example of a 23 minutes of annotation for 4 subjects.

4.1 Corpus collection and preparation

We collected a corpus consisting in the video and audio recordings of 9 spontaneous group meetings, for a total of 12.5 hours. For all the interactions, the behaviour of the most active participants was manually annotated, yielding a total of 10.5 hours for the Task Area and 14 hours for the Socio-Emotional Area annotated data (see Table 1).

meeting code	total time of group interaction	number of participants	number of participants annotated	Task-Area annotation	Socio-Em annotation
A	1h 15'	5	1	30'	30'
B	2h	3	2	2h	2h
C	45'	4	3	2h	2h
D	1h 15'	2	1	30'	15'
E	1h	3	2		2
F	30'	3	3		1h 45'
G	2h	4	2	1h 45'	1h 45'
H	1h 45'	4	1	2h	2h
I	1h 45'	4	1	1h 45'	1h 45'

Table 1. Summary of the meeting collected and annotated.

4.2 Method

The reliability of the scheme was assessed on subset of the corpus consisting of 130 minutes for the Socio-Emotional Area and 126 minutes for the Task Area (from 3 group interactions). Five participants were coded on the Socio-Emotional Area and 5 in the Task Area. Two judges separately annotated each selected subject of each interaction. The annotations were then sampled every 10 seconds to get a *timed sequence of events* (Gottman & Roy, 1989) which is more suitable for data analysis. Figure 3 shows a portion of an annotated interaction in the two formats. On this data, the Cohen's K (Cohen, 1960) was computed.

Start	End	Role
...	...	...
259,62	522,30	r
522,30	602,98	n
602,98	648,58	r
...	...	...

Time	Role
...	...
510	r
520	r
530	n
540	n
...	...

Figure 3. Event based (left) and time-based (right) annotation.

Eventually, part of the corpus will then be re-annotated in a reconciliation phase to obtain a golden standard.

4. 3 Results

On the Task Area roles, the inter-annotator agreement was computed on 5 subjects for a total of 126 minutes using the Cohen's Kappa statistics reaching an agreement of $\kappa = 0.70$ (N=758, SE=0.020, $p<.0001$). Table 2 shows the confusion matrix (the table shows the occurrences of the different roles at sampling of 10 seconds).

JUDGE1 * JUDGE2 Crosstabulation

Count

		JUDGE2					Total
		g	n	o	r	s	
JUDGE1	g	115	55	13	3	0	186
	n	3	140	15	18	1	177
	o	2	18	231	0	16	267
	r	1	7	0	81	0	89
	s	0	8	3	0	28	39
Total		121	228	262	102	45	758

Table 2. Confusion matrix for the roles in the Task Area (758*10 secs = 126 minutes): g = Giver; n= Follower; o= Orienteer; r = Procedural Technician; s= Seeker

Figure 4. shows the relative percentage of the different roles as they occur in our corpus. The Orienteer is the most common role reflecting the nature of the interactions observed that were mostly project meetings were teams had to report to their project managers about the status of the work.

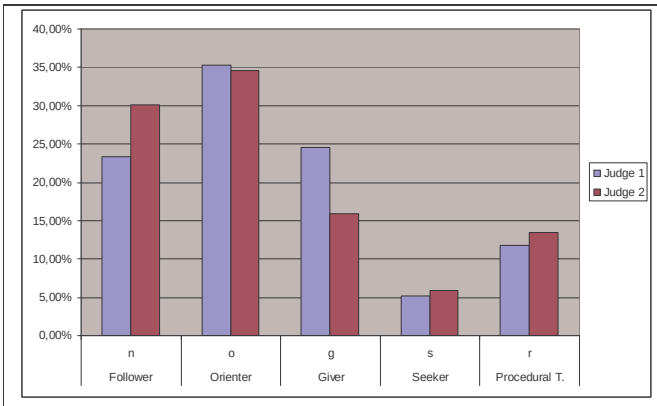

Figure 4. Percentage of the different roles in the Task Area.

Regarding the Socio-Emotional Area, the inter-annotator agreement was computed on 5 subjects for a total of 130 minutes using the Cohen's Kappa statistics reaching an agreement of $\kappa = 0.60$ (N=783, SE=0.023, p<.0001).

JUDGE1 * JUDGE2 Crosstabulation

Count

		JUDGE2				Total
		a	n	p	s	
JUDGE1	a	26	1	5	0	32
	n	3	241	29	105	378
	p	0	32	233	12	277
	s	0	14	7	75	96
Total		29	288	274	192	783

Table 3. Confusion matrix for the roles of the Socio-Emotional area (783*10 secs = 130 minutes): a = Attacker; n= Neutral; p= Protagonist; s = Supporter; g= Gate-Keeper (not present)

Table 3. shows the confusion matrix (the table shows the occurrences of the different roles at sampling of 10 seconds).

Figure 5 shows the relative percentage of the different roles in the Socio-Emotional area as occur in our corpus.

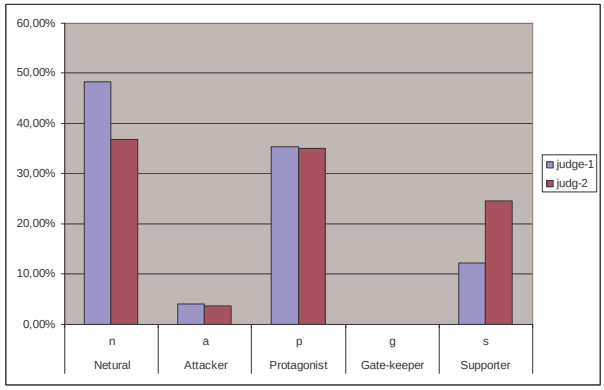

Figure 5. Percentage of the different roles in the Socio-Emotional Area.

It can be noted that the *Gate-Keeper* role has never been observed in our corpus, this being probably due to the absence of a (either professional or *de facto*) facilitator in our meetings.
The *Attacker* too is not a well represented role. Again, this reflects the nature of our meetings which prevents strong contrasts among participants from arising.

4.4 Discussion

Following Landis and Koch (1977), the agreement on the roles of the Task Area is good ($0.6 < \kappa < 0.8$) while the agreement on the roles of Socio-Emotional Area is on the borderline between being good and moderate ($0.4 < \kappa < 0.6$).

The class-wise analysis of the κ's for the Task Area show that the most reliable classes are the *Orienteer* and the *Procedural Technician* (see also the values of the z-scores in Table 5). The least reliable class is the *Seeker*, mostly because of its high standard error. The *Giver* and the *Follower* fall in between. Considering the absolute values of the κ's and the lower bounds of the confidence intervals, the classes that deserve consideration in view of improvements are the *Seeker* and the *Follower*.

	κ	SE	z-score	Conf. interval Up. bound	Conf. interval Low. bound
g	0,69	0,032	21,53	0,75	0,63
f	0,58	0,033	17,61	0,65	0,52
o	0,81	0,023	35	0,85	0,76
r	0,83	0,031	26,65	0,89	0,77
s	0,65	0,062	10,44	0,77	0,53

Table 4. Class-wise κ values for the Task area - g = Giver; f= Follower; o= Orienteer; r = Procedural Technician; s= Seeker

The use of standardised residuals computed with respect to the independence model, enable us to pin point the disagreements that more closely follow a uniform pattern, hence those on which the judges diverge most. This is the case when the standardized residual is close to zero.

Judge1 \ Judge2	g	F	o	r	s
g	19.7	**-0.2**	-9.1	-5.4	-3.9
f	-5.9	16.2	-8.3	-1.5	-3.5
o	-8.4	-10.3	22.2	-8.0	**0**
r	-4.1	-4.9	-7.3	22.8	-2.5
s	-2.8	-1.3	-3.6	-2.5	17.9

Table 5. Standardized residual for the roles in the Task Area. Model: independence.

The data from Table 5 confirm the results based on the κ statistics, in that almost all off-diagonal residuals are strongly negative, and often below the value of -3 that can be taken as a cut-off threshold for significance. The most interesting disagreements between the two judges concern two cases: in the first, judge1 classifies a role as *Giver* and judge2 classifies it as Follower; in the second, judge1 sees a *Procedural Technician* role whereas judge2 classifies it as a *Seeker*. Putting together these results with the discussion of Table 4, it can be concluded that in order to improve inter-annotators agreement in the task area, we must address, in the first place, the *Seeker* and the *Follower*, in particular reducing the '*giver-follower*' and the '*orienteer-seeker*' disagreement

Judge1 \ Judge2	a	N	P	s	Total
a	26	1	5	0	32
n	3	241	29	105	378
p	0	32	233	12	277
s	0	14	7	75	96
Total	29	288	274	192	783

Table 6. Confusion matrix for the Socio-Emotional area - a = Attacker; n= Neutral; p= Protagonist; s = Supporter

Turning to the Socio-Emotional Area, the class-wise analysis of the κ's, in Table 7, confirms that the social area is slightly less reliable than the task one (see also Table 8). The most reliable class is the *Protagonist*, and the by far less reliable one is the *Supporter*; the *Attacker*, despite its high κ value, needs some consideration, given its high standard error.

	κ	SE	z-score	Conf. interval Up. bound	Conf. interval Low. bound
a	0,85	0,05	16,92	0,94	0,75
n	0,53	0,03	17,53	0,59	0,47
p	0,76	0,024	31,75	0,81	0,72
s	0,43	0,039	10,95	0,50	0,35

Table 7. Class-wise values for the Social area - a = Attacker; n= Neutral; p= Protagonist; s = Supporter

The analysis of standardized residuals (computed with respect to the independence model) shows the importance of the disagreement on *Neutral* and *Supporter* between judge1 and judge2, see Table 7.

Judge1 \ Judge2	a	n	p	s
a	23.7	-4.0	-2.3	-3.3
n	-4.2	15.1	-15.5	**2**
p	-4.1	-10.8	21.3	-9.7
s	-2.1	-4.8	-6.1	13

Table 8. Standardized residual for the Social Area. Model: independence - a = Attacker; n= Neutral; p= Protagonist; s = Supporter

In conclusion, the weakest class in the social area is the *Supporter*, which is involved in a strong disagreement with the *Neutral*.

Finally, an important feature of coding schemes is the symmetry of their confusion matrices. In a perfectly symmetric confusion matrix, for labels *a* and *b*, any *a* vs. *b* disagreements between judge1 and judge2 correspond to a *b* vs. *a* disagreements between judge2 and judge1. Symmetry can be assessed through the Bowker test (Agresti, 2002), which yields a statistics that has asymptotic χ^2 distribution. In our case, the value of the Bowker statistics is 75.14 and 69.59 for the task and the social area, respectively, with 10 and 6 degree of freedom. In both cases, the null hypothesis that the matrices are symmetric can be rejected with p<.0001. Table 9 and table 10 report the standardized residuals under the symmetry hypothesis.

	g	f	o	r	s
g	0	**6,83**	2,84	1	0
f	-**6,83**	0	-0,52	2,2	-2,33
o	-2,84	0,52	0	0	**2,98**
r	-1	-2,2		0	0
s	0	2,33	**-2,98**	0	0

Table 8. Standardized residual for the Task Area. Model: symmetry. g = Giver; f= Follower; o= Orienteer; r = Procedural Technician; s= Seeker

The analysis of residual under the symmetry hypothesis shows that the offending cases are the same as those analysed above in connection with the independence hypothesis. In detail, the '*giver – follower*' and the '*orienteer – seeker*' disagreements are the main responsible for the lack of symmetry in the task area, whereas the '*neutral – supporter'* disagreement is the main responsible for the lack of symmetry in the social area.

	a	n	p	s
a	0	-1	2,24	0
n	1	0	-0,38	**8,34**
p	-2,24	0,38	0	1,15
s	0	**-8,34**	-1,15	0

Table 9. Standardized residual for the Social Area. Model: symmetry - a = Attacker; n= Neutral; p= Protagonist; s = Supporter

To improve agreement, therefore, future efforts must be focused on the *giver-follower* and the *procedural technician* disagreements in the Task Area, with the goal of improving the κ values for the *follower* and the *seeker* respectively, and the balance/symmetry of the annotation schema. In the Socio-Emotional Area, the validity of the annotation schema can be ameliorated by reducing the *neutral-supporter* disagreements, which is expected to improve the κ value of *supporter* and the overall schema balance.

5. Conclusions

In this paper, we discussed the background and the motivation for a coding scheme inspired by the Bales' Interaction Process Analysis. We discussed the 12 labels and the two dimensions of the coding scheme as well as the procedures for the data collection and the annotation. We then presented some initial results concerning its reliability. The inter-annotator agreement was computed using the Cohen's Kappa statistics and resulted in a good agreement on one dimensions and moderate on the other.
Finally, a discussion about the reasons for the disagreements and the way to improve the coding rules to achieve a better agreement was discussed.
In the future, we plan to investigate these issues and refining the coding scheme with new annotation exercises. We also plan to enlarge the multimedia corpus of recordings by using groups from other domains and possibly to control the task of groups in order to make some roles more likely to happen.

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