愛媛大学教育学部紀要　第60巻　47 ～ 57　2013

Knowledge Reconstruction Process through Conversation in Everyday Problem Solving

TOMIDA Eiji（EHIME University）

（平成２５年７月２４日受理）

Introduction

In our everyday lives, we sometimes have discussions when we are confronted with problems. When a problem is particularly critical for us, we are more likely to exchange opinions to examine our decisions or ideas. Through discussion, we revise or reject our prior decisions or ideas if we find weaknesses in then. What is an essential discourse process, which makes everyday discussion more effective in the sense that the discussants are facilitated to reconstruct their knowledge? Various fields of research have so far made efforts to understand the processes relevant to this question.

Cognitive psychologists have found that collaboration with other(s) facilitates problem solving in specific conditions (Okada & Simon, 1997; Teasley, 1995). However, these studies have not taken the knowledge reconstruction process as their research objects. In addition, experimental problem solving tasks which are typically employed in cognitive studies usually have a correct answer in advance. Since in most part of our everyday lives we do not have any answers which are established before we tackle a problem, the findings from cognitive studies would not be applicable to everyday problem solving discussion.

Another line of research is about attitude change through discussion. McCoy Nunez, & Dammeyer (1999) examined whether participants' verdict choices and their justifications change through a mock jury. Although they found that jury process improves the participant's justification quality and moderate their verdict choice, they neglected the discourse process of the jury. Although similar findings were obtained in similar experimental settings in other studies (Bernas & Stein, 2001; Kuhn, Shaw, & Felton, 1997), these investigations did not examine the discourse process, either.

Researchers in informal reasoning have examined the discourse process in problem solving. However, most of them have not gone beyond descriptive analysis of the discussion process. So they have not offered convergent findings to show factors or processes which facilitate knowledge reconstruction (Resnick, Salmon, Zeitz, Wathen, & Holowchak, 1993; Rips, 1998; 2002; Rips, Brem, & Bailenson, 1999). One exceptional case (Leitao, 2000) shows that engagement in conversational conflict leads the discussants to revise their beliefs slightly. She analyzed transcripts which were collected from several settings in our everyday conversation, e.g. faculty meetings at a university, informal discussions in a community program, and arguments on a political agenda. This finding, however, does not tell us whether the participants in the conversations actually revised their opinion through conversational conflict, because she did not directly assess to what extent their beliefs were changed.

On the other hand, developmental researchers have been interested in the developmental process through social interaction and have offered more reliable findings than Leitao's work. At an early stage of this line of work, they were interested in whether discussions facilitate the development of the participant's belief system on moral decision making (e.g. Doise & Mugny, 1979; Berkowitz & Gibbs, 1983).

After they established empirical findings that peer interaction helps children and adults to reach higher-order cognition on moral decision making, their interest turned to the process by which the cognitive change comes about. There were two major arguments

which are seemingly exclusive of each other. Following Piaget's theory (1965), constructivists argued that contradiction between subjects' opinions is crucial for cognitive change (Berkowitz & Gibbs, 1983; Berkowitz, Gibbs, & Broughton, 1980; Doise & Mugny, 1979; Roy & Howe, 1990). On the contrary, social constructivists argued that conflicting interaction has no positive effect on cognitive development and coordination is crucial for cognitive change through discussion (Damon & Killen, 1982; Silverman & Geiringer, 1973). Kruger (1993) has settled the controversy. Kruger offered evidence that, in order to reconstruct the participants' views, they have to perceive some disagreements among their opinions, as well as to coordinate those different opinions.

Following Kruger(1993)'s findings, Tomida and Maruno (2004) hypothesized that experiencing coordinated transaction followed by conflicting utterance is positively related to the degree of change in the participant's folk explanation. To examine this hypothesis, they prepared a discussion setting which had no single clear answer. Ten temporary groups which consisted of 4-5 Japanese college students were asked to collaborate to construct a hypothetical causal path model on a whiteboard explaining the possible causes of Japanese teenager's impulsive aggression. The task is called "social explanatory discussion task." In analysis, they examined the relationships between the degree of change in the explanation and the frequencies of emerged utterances during discussion, for example, "counter-arguing, "interpretation" and "explanation" etc. As a result, they found that the only frequency of being interpreted by other participant(s) was positively correlated with the degree of change. That is, contrary to their expectations, conflict did not affect the belief change through discussion. This finding contradicts other findings obtained with the moral discussion paradigm.

What brought about this difference between the findings in Tomida & Maruno (2004) and others'? One of the possible explanations is the difference of the task structure. In the moral development research, a discussion situation is arranged so that the participant can easily recognize the disagreement among the participants. In a typical moral discussion paradigm, participants are asked to read some short stories in which the protagonists have to make a choice in critical situations. In the decision making, the protagonists have two alternatives both of which inevitably lead to immoral conduct (e.g. robbery or murder). After reading, participants are asked to choose which alternative is better and to explain why they think so. Prior to the discussion sessions, dyads are composed of two persons possessing mutually exclusive opinions. Each dyad is then asked to discuss the topic in order to reach an agreement on the choices and to supply their justifications. In this task structure, because they have only two alternatives which are mutually exclusive, the participants spontaneously discover disagreement in their lines of thought from the very outset of discussion. In addition, since they are explicitly instructed to reach an agreement through discussion, they have to explore the belief system behind their choices in moral dilemma and come to a common belief which will be the foundation for the construction of joint explanations. In short, the task structure typically employed in moral developmental research is created so that it can easily induce the participants to reexamine their belief systems through discussion, as Kruger (1993)pointed out.

On the other hand, the social explanatory discussion task in Tomida & Maruno (2004) has no such a facilitative structure. When people are asked to explain why a social phenomenon occurs, they almost always propose a variety of causes. Usually, these causes are not mutually exclusive. For example, someone might suggest "the inability to tolerate frustration" and another person might assert that "stress has built up to an extreme." These two causes appear to be able to exist compatibly at the same time as parts of explanation system for teenager's impulsive violence, even though there might be some latent contradictions between them. Therefore, argumentations might not induce the participants to reexamine their belief systems in the task in which participants jointly construct an explanatory model for social phenomenon.

Consequently, the ineffectiveness of conversational conflict is attributable to the difference between these task structures. In other words, conversational conflicts do not always induce cognitive conflicts in the social explanatory discussion tasks. What is a necessary process to induce cognitive conflicts even in that kind of task? As shown above, it is difficult for participants to show others that the different opinions possibly incompatible in a consistent explanation system in the social explanatory discussion task. To clarify this possible contradiction, participants have to actively analyze the difference between belief systems which can

be inferred from their utterances. The present study calls this kind of verbal action as "the management strategy".

In the social explanatory discussion task, it is presumed that the management strategies are necessary so that conversational conflicts lead to cognitive conflicts. However, to my best knowledge, no studies have ever formulated this kind of verbal strategy. Most verbal categories employed in previous investigations are formulated in terms of functions of the utterance which operate on a certain foregoing utterance. For example, "paraphrase" (Berkowitz and Gibbs, 1983) is a coding category for the utterance which expresses other's previous uttered idea with different words, "concession" (Resnick, et al., 1993) . All these kinds of verbal units are called "the moves" (Coulthard, 1985). Then, to explore the effective verbal activities in everyday discussion, we have to develop an adequate coding scheme for the management strategies.

In the present study, the author proposes a preliminary version of coding scheme which includes coding categories for the management strategy in addition to coding categories for the moves. As the coding scheme is constituted of categories for the moves and categories for the management strategies, this scheme is named "the Dual Coding Scheme for Discussion".

The Dual Coding Scheme for Discussion (DCSD)

Table 1 shows coding categories that constitute the DCSD. The DCSD is consisted of two subordinate systems. One of the two is the move system, which is placed in the upper part of Table 1. The move system has further subordinate sets of categories: conflict-related categories (which include counterargument, doubting, and pointing out problems), coordination-related categories (which include completion, interpretation, elaboration, and rephrasing), and question-related categories (which include information request, opinion request, continuation request, clarification request, and confirmation). All these categories correspond to the traditional coding categories employed in most previous studies in which a wide variety of categories have been proposed to date. Considering the relevance to the research interests of the present study, the author employed only a small portion of the categories from these existing ones as the move system of the DCSD. According to the review on cognitive developmental research introduced above, conflict and cooperation have been regarded as the principal processes for knowledge reconstruction through discussion. Further, generating questions are believed and verified to have a positive effect on knowledge construction (e.g. Palincsar & Brown, 1984). However, in addition to the categories shown in Table 1, we employ several categories (e.g. "explanation", "suggestion"). Although these categories are not relevant to the present study, they were served to help coders understand the threads of the arguments during the actual coding process.

Another subordinate system of the DCSD is the management system, which is placed in the lower part of Table 1. The management system has utterance categories for verbal strategies that operate on the developmental process of discussion with an explicit manner. The management system also has further subordinate sets of categories: divergent strategies (which include collecting opinions, exploring exceptions, and broadening the scope) and convergent strategies (which include organizing, narrowing the scope, summarizing, critical analysis, conflicting exploring, and cooperative exploring). The divergent strategies are supposed to have the function of making participants explore the problem more extensively. In contrast, the convergent strategies are supposed to have the function of making participants explore the problem more intensively. Further, the convergent strategies can be divided into prospective strategies and retrospective ones. The prospective strategies are utilized to propose the participants to set a discussion for a certain direction. On the other hand, the retrospective strategies are utilized to examine the lines of discussion up to that time. The management system is originally conceptualized and developed in the present study.

To develop the DCSD, in the beginning, we conceptually divided two discursive systems, the move system and the management system, as we described above. A trial version of the move system was constructed based on existing coding categories such as Berkowitz and Gibbs (1983), Damon and Killen (1982), and Resnick et al. (1993) and a trial version of the management system was developed by authors. Then we repeatedly applied the trial version of HSCD to available transcripts of discussion and gradually revised the category systems to the present status.

The coding scheme introduced here is not a category

Table 1 Coding Categories of the Dual Coding Scheme for Discussion Category

Category	Description
Move system	
Question-related category	
Information request	Asking other(s) to offer information or ideas related to the topic.
Opinion request	Asking other(s) to express their opinions or attitudes.
Continuation request	Asking other(s) to continue their talk.
Clarification request	Asking other(s) to explain about unclear points in what they said.
Confirmation	Questioning a speaker about what s/he wanted to mean with his/her previous utterance.
Conflict-related category	
Counterargument	Providing one's own ideas in opposition to other(s)' ideas.
Doubting	Doubting certainty of other(s)' ideas or knowledge shared with the members.
Pointing out problems	Pointing out the problems in other's previous utterance.
Cooperation-related category	
Completion	Compensating other's utterance to complete it before s/he finish to speak.
Interpretation	Explaining what other want to say following her/his utterance in anticipation.
Elaboration	Adding extended explanaiton or another point of view to other's utterance.
Rephrasing	Putting other's utterace differently.
Management strategy system	
Divergent Strategy	
Collecting opinions	Asking all members to offer their opinions or ideas.
Exploring exceptions	Proposing to try to find any exceptional cases which cannot be explained with proposed causes.
Broadening the scope	Proposing to try to explore other knowledge domains which have not been examind.
Convergent Strategy: Prospective	
Organizing	Proposing to summarize lines of discussion.
Narrowing the scope	Proposing to limit the scope to examine.
Convergent Strategy: Retrospective	
Summarizing	Summarize the lines of discussion up to that time.
Critical analysis	Pointing out the problems in shared beliefs through considering the lines of discussion up to that time.
Conflicting exploration	Clarifying differences among discussants' beliefs or ideas.
Cooperative exploration	Clarifying common grounds among discussants' beliefs or ideas.

system which aims to cover all kinds of utterance observed in everyday discussion, nor a complete version. The DCSD is open for elaboration and extension through further application to a variety of discussions.

Research aim and hypotheses

The present study aims to examine whether the management strategies promote the reconstruction of participants' knowledge in the social explanatory discussion tasks with a preliminary version of the DCSD. Considering the structural characteristics of the social explanatory discussion task that participants do not have mutually exclusive opinion about a task, we hypothesized that the conflicting exploration of the management strategy system would promote knowledge reconstruction, but the counterargument of the move system would not.

To examine the hypothesis, we compared two transcripts obtained from two small group discussions in which undergraduates participated. These two groups were constructed in an experimental setting so that the participants of one group would have relatively higher discussion skills in terms of discussion management than the participants of the other. We employed self-rating scores on discussion management skills of the Maruno Kato Discussion Inventory (MKDI, Kato & Maruno, 2000) to compose a high-skilled group and a low-skilled group. If this manipulation were to be effective, the people in the high-skilled group would be more likely to use the conflicting exploration strategy than those in low-skilled group and this difference in discourse process would result in a more radical change in the high-skilled group's explanation than in the low-skilled group's. Conversely, use of the counterargument would be found to have no relationship with the change in explanation.

Method

Participants

Fifty-one undergraduate Japanese students (19

males and 32 females, M = 22.2 yrs old, Range = 19-27) enrolled in a psychology course at a university in Japan were asked to participate in the sessions as a part of their course assignment. They received research participant credit for their introductory psychology course. In those, 6 students, 3 of who belong to the high-skilled group and 3 belonging to the low-skilled group, were subject to examination in this study. The high-skilled group includes Keiko (female), Naomi (female), and Fumi (female). The low-skilled group includes Eita (male), Masa (male), and Aki (female). These names are pseudonyms given by the author.

Procedure

Experimental sessions were held over two days. On the first day, the participants completed the MKDI for which the data obtained were utilized for grouping them. They were asked to rate the MKDI items on a 7-point scale regarding how descriptive the statements were of themselves. Based upon their self-rating scores, participants were assigned into one of 17 groups (each including three participants). Among these groups, the high-skilled group was formed with the top three participants while the low-skilled group was made with those getting the lowest MKDI score. The analysis was focused only on the two groups. On the second day, a week after the pretest session, discussion sessions were held. In these sessions, to assess the changes in their beliefs about the discussion topic, the participants were asked to write down possible causes for an impulsive violent behavior in individually delivered questionnaires. The assessments were conducted before and after the discussion sessions a total of 4 times.

Questionnaire.

The MKDI (275 items in total) was employed for grouping. The MKDI is an inventory which has 7-point self-rating scales for the measurement of discussion skill. It contains 28 scales over four domains (i.e. discussion skill, value for discussion, anxiety for discussion, and attitudes for discussion) which are assumed to determine discussion performance. For grouping, the mean scores on the scales for the practical/management scales were utilized. The sample items are below: "To make people aware of the crucial issue here, I intentionally pose opposite opinions/ideas", "When the discussion misses the point, I try to talk about what our original goal is", and "I can point out what is the difference between my opinion and other's opinion" (The original items were printed in Japanese). Average scores were 5.59 in the high-skilled group, 3.41 in the low-skilled group, and 4.44 (SD = .55) in all 51 samples.

Discussion sessions.

As the social explanatory discussion task, the author instructed participants before the discussion session began as follows: "Nowadays, in Japan, news programs sometimes report some violent crimes committed by calm persons who at least are thought to be calm by those around them. We are going to think about this kind of social problem. What factors do you think make calm persons become violent? This is a question we are going to discuss in each group for the duration of 45 minutes in total." In these discussions, 15 minutes sessions were repeated three times with 2 ten minutes intervals. Before and after these discussion sessions and during the intervals, participants were asked to write down possible causes for the violent behavior in an open question style, independent from the collective decisions in their group discussions. All discussion sessions were recorded with tape recorders set on each groups' table and transcribed.

Coding of transcripts.

The analysis unit for coding was basically the conversational turn. However, when the coders judged that one turn had two or more functions, they gave two or more categories to that particular turn. Each turn was identified as one of the categories in the coding system. Since the move system and the management system are conceptually independent, these systems can give their own coding category for an identical conversational turn. All transcripts were independently coded by the first author and an additional coder who did not know the research aim. He was received 8 hours training in the DCSD coding. When the judged categories were not congruent between the coders, the decision was made through discussion. In case of the move system, the obtained degree of agreement was sufficiently high, Cohen's kappa = .82. In case of the management system, because cases corresponding to them were rare, Cohen's kappa was not calculated. However, there was only one case that the coding judgments were incongruent between the coders.

Results and Discussion

The two groups' characteristics in discourse were initially compared to ascertain whether the grouping operation had made a significant difference between the two groups. The comparison was held in terms of (A) frequencies of utterance coded by the DCSD and (B) discussion processes. This was followed by an analysis of the change in the participants' causal explanation of the discussion topic. Finally, the author examines how the identified differences in discourse between the two groups had led the resulting change in participants' explanations.

Group comparison A: Frequencies of utterance

Table 2 shows the frequencies of utterances observed in the high skill group and the low skill group in each session. As the DCSD has many categories, the present study focused on conflict-related categories in the move system and on convergent retrospective strategies in the management system, which was directly related to the present research interest.

In the move system, the conflict-related categories were observed over all sessions in both groups. The total frequencies of the conflict-related categories were nine in both groups. On the other hand, in the management system, the conflicting exploration category was only observed in the session 1 in the high-skilled group, but not in the low one. These results mean there is evidence that grouping manipulation with the MKDI scores was effective.

Group comparison B: Discussion processes

Here the analysis is exclusively focused on session 1, since distinctive features in discourse were observed there in session 1 as shown in the last section. In the end of each utterance, coded categories are indicated in parentheses. In order to make the transcripts easier to understand, chiming in (which is defined as an unexpected short agreeable reply to the speaker, such as "yeah", "hmm", or "aha") was deleted and punctuation marks and parentheses were added by the author. All transcripts were translated into English from Japanese.

At the beginning, both groups showed the same development pattern in which each participant suggested his/her causal explanations for the topic in turn.

Table 2 Frequencies of Utterances Observed in the High-skilled Group and the Low-skilled Group

	High-skilled				Low-skilled			
	S1	S2	S3	Total	S1	S2	S3	Total
Move system								
Information request	1	0	1	2	2	0	3	5
Opinion request	1	0	0	1	3	3	0	6
Continuation request	0	0	0	0	0	0	0	0
Clarification request	0	1	0	1	2	5	0	7
Confirmation	1	0	1	2	4	7	3	14
Counterargument	3	5	1	9	2	3	1	6
Doubting	0	0	0	0	2	0	1	3
Pointing out problems	0	0	0	0	0	0	0	0
Completion	2	3	1	6	1	0	0	1
Interpretation	0	3	4	7	2	2	0	4
Elaboration	12	21	13	46	8	11	10	29
Rephrasing	5	3	5	13	0	4	4	8
Management strategy system								
Collecting opinions	0	0	0	0	0	0	0	0
Exploring exceptions	0	0	0	0	0	0	0	0
Broadening the scope	0	0	0	0	0	0	0	0
Organizing	0	0	0	0	0	0	1	1
Narrowing the scope	0	0	0	0	0	1	1	2
Summarizing	1	1	1	3	1	2	1	4
Critical analysis	0	1	0	1	0	0	1	1
Conflicting exploration	2	0	0	2	0	0	0	0
Cooperative exploration	2	0	0	2	0	0	0	0

Note. S1, S2, and S3 in column heads mean session 1, session 2, and session 3 respectively.

High-skilled group (Turn 1-4):

1. Naomi : First of all, I thought of two situations. First, when a calm person uses violence, he probably has a reason to do so. And second, he either has no reason to do it or he is just a bad person. In the first case, he might be hitting back or threatened by somebody. In an extreme, he might hit someone in self-defense or to protect children from violence.
2. Fumi : That's a case where people could understand his reason, isn't it? (Elaboration, Confirmation)
3. Naomi : Right, right. [Abbreviated] How about you? (Information request)
4. Keiko : What I imagined was the kind of person who behaves wildly or suddenly loses it and causes trouble, [Abbreviated]. I imagined that sort of thing. Maybe he has a grudge against society and vents his long-pent up frustration out. He wants to be accepted by others but can't so this grudge builds up over time and he resorts to violence.

Low-skilled group (Turn 1-3):

1. Aki : I think that calm people resort to violence when their pent-up stress explodes. Their feelings gush out because they can't put up with it any more.
2. Eita : My opinion is that they were the victims of violence themselves or that they are unable to endure or keep themselves from behaving violently. That's what I thought.
3. Masa : I don't know how to say... The only thing I can come up with is stress or something similar to your opinions.

Immediately after that, each group developed differently. After each participant in the high-skilled group stated his/her causal explanations, Fumi pointed out an essential difference among the explanations in turn 6 (Conflicting exploration). Following this, Naomi articulated in 9th turn that it seems as if both Keiko and Fumi were assuming "snapped" person (that is, the person who lost presence of mind when they became violent) as the calm person to be discussed here (Conflicting exploration).

High-skilled group (Turn 6-9):

6. Fumi : You know, now we are considering causes of a sudden violence, ideas we had about the problem are very dif... (Conflicting exploration)
7. Naomi : Different. (Completion)
8. Fumi : Yes I think so.
9. Naomi : Snap, to snap is what Fumi and Keiko thought, you know. They are quiet persons who suddenly blow his top. People usually say they just snapped don't they? (Rephrasing / Conflicting exploration])

Further, as shown below, Fumi elaborated on Naomi's comment in turn 11 and 13 that the causal explanations proposed by Naomi seem to suggest that a person who behaves violently always has an understandable reason for doing so.

High-skilled group (Turn 11-13):

11. Fumi : I feel that Naomi may have a positive image of calm people first of all. (Elaboration)
12. Naomi : Um... Positive image.
13. Fumi : Yes, you have a positive image. When he is protecting children, he is being bullied or trying to protect himself, um, what do I want to say... I'm confused... Then that kind of calm person would have something of a reason.

On the contrary, participants in the low-skilled group did not explore the differences among their opinions. Instead, as indicated explicitly in turn 10, they explored other causal explanations. Moreover, as noted above, they totally lacked the management strategies in the discussion.

Low-skilled group (Turn 4-10):

4. Aki : Another thing, when something they can't tolerate happens, um, there's no way they can just let it go, even though they are usually calm and don't get angry.
5. Masa : Ah, it's difficult.
6. Aki : Well... A calm person behaves violently all of a sudden.
7. Eita : And they are always the calm types, aren't they. Why, why?
8. Masa : I wonder if they are the type of people who get stressed out easily.
9. Aki : They are the kind of people who normally cannot explain their ideas.
10. Eita : Are there any reason for them to act violently? (Information request)

Table 3 Causal explanations generated by each participant and their change

	Causal explanation	B1	A1	A2	A3	Change Type
	High-skilled group					
Keiko	1. Having a grudge against society.	1	1	1	1	Not changed
	2. Pent up stress cannot be vented.	1	1	0	0	Not changed
	3. Irritation arising from being ignored.	1	1	1	1	Not changed
	4. They would like to attract the attention of society.	1	1	0	1	Not changed
	5. Self-defense.	0	1	0	0	Employed temp
	6. To change the image that s/he is a calm person.	0	0	1	0	Employed temp
	7. To find meanings in one's existence.	0	0	0	1	Version of 4
Naomi	1. Self-defense.	1	0	0	0	Rejected
	2. Revenge.	1	0	0	0	Rejected
	3. To protect somebody.	1	0	0	0	Rejected
	4. Frustrated from not being able to express him/herself in words.	1	1	0	0	Replaced by 13
	5. Desire to show one's physical power.	1	0	0	0	Rejected
	6. Irresistible urge.	1	0	0	0	Replaced by 9
	7. Stress from other people.	0	1	1	1	Employed
	8. Grudge.	0	1	1	1	Employed
	9. Impatience and anger at being ignored.	0	1	1	1	Replaced by 6
	10. Weakness of mind.	0	1	0	0	Employed temp
	11. Being labeled as a calm person.	0	0	1	1	Employed
	12. Passive character.	0	0	1	1	Employed
	13. Poor at asserting oneself.	0	0	1	1	Replaced of 4
	14. Having no support by those around.	0	0	0	1	Employed
Fumi	1. Venting bottled up frustration.	1	0	1	0	Replaced by 7
	2. Stress builds up	1	0	0	0	Replaced by 7
	3. Come to heel many times.	1	0	0	0	Rejected
	4. Attending to someone's needs.	1	0	0	0	Rejected
	5. Being rejected one's assertion.	1	0	0	0	Rejected
	6. Being rejected one's assertion many times.	1	0	0	0	Rejected
	7. Stress builds up to the breaking point.	0	1	0	1	Version of 1, 2
	8. Not being able to express him/herself well.	0	1	1	1	Employed
	9. To affirm one's existence with violence.	0	1	0	0	Employed temp
	10. Not being able to control him/herself.	0	1	1	1	Employed
	11. To express what has been repressed.	0	0	1	0	Employed temp
	12. Last way to express one's repressed oneself.	0	0	0	1	Employed
	Low-skilled group					
Aki	1. Venting frustration that's bottled up.	1	1	1	1	Not changed
	2. Something makes one blow up.	1	1	1	1	Not changed
	3. Mental disease.	0	1	1	1	Employed
	4. Drug-induced hallucinations.	0	1	1	1	Employed
	5. To protect oneself.	0	1	1	1	Employed
	6. Problems to be solved exceed one's ability.	0	0	0	1	Employed
Eita	1. Being attacked by others.	1	1	0	1	Not changed
	2. Stress.	1	1	1	1	Not changed
	3. Being too week to control oneself.	1	0	0	1	Not changed
	4. Being tainted by drugs.	1	1	1	1	Not changed
	5. Mental disease.	1	1	1	1	Not changed
	6. Bad life environment.	1	1	0	0	Rejected
	7. Inherited factor.	0	1	1	0	Employed temp
	8. Being poor at venting one's stress.	0	0	1	1	Employed
	9. Stress exceeds one's ability to control.	0	0	0	1	Version of 2
	10. Being considered calm restricts one's possibilities.	0	0	0	1	Employed
	11. Not able to feel self-efficacy.	0	0	0	1	Employed
Masa	1. Stress.	1	1	1	1	Not changed
	2. Irritating happenings.	1	1	0	0	Rejected
	3. Life environment.	1	1	1	1	Not changed
	4. Bullying.	0	1	1	1	Employed
	5. Mental Disease.	0	1	1	1	Employed
	6. Drugs.	0	1	1	1	Employed
	7. Inherited characteristics.	0	0	1	1	Employed
	8. Not knowing how to vent stress.	0	0	1	1	Employed
	9. Perception gap of oneself between oneself and other people.	0	0	0	1	Employed
	10. Violence from others.	0	0	0	1	Employed

Note. B1, A1, A2, and A3 in column heads mean Before session 1, After session 1, After session 2, and After session 3 respectively. The numbers 0 or 1 plotted on the right side of each explanation indicate the presence of the corresponding explanation: 0 for absent and 1 for present.

Change in causal explanation

In the previous sections, it was showed that the conflicting exploration strategy was used only in the high-skilled group and how the two groups differently developed their discourse. Therefore, according to the hypothesis, participants in the high-skilled group would exhibit greater change in causal explanations than the low-skilled group.

Table 3 shows a list of causal explanations assessed before discussion, after session 1, session 2, and session 3. The right most column of Table 3 shows types of change occurred in each explanation. "Not changed" means an original explanation which remained when session 3 finished. "Version of x" means an explanation which was newly employed through discussion, but is considered to be a variation of explanation x. "Replaced by x" means an explanation which was no more employed in its original expression, but remained as a similar explanation x. "Replaced of x" means a newly employed explanation which corresponds to a prior explanation x. "Employed" means a newly employed explanation which remained until session 3 finished. "Employed Temp" means a newly employed explanation which disappeared when session 3 finished. Finally, "Rejected" means an explanation which was rejected and never appeared again.

In the high-skilled group, although Keiko only showed minor changes, the explanations of Naomi and Fumi were largely changed. Naomi rejected her explanation 1, 2, 3, and 5 after session 1 as well as employed new explanations. The rejected explanations were not replaced by other explanations. Fumi's explanations changed as much as Naomi's. Although explanations 1 and 2, which pertain to stress, were replaced by explanation 7, explanations 3, 4, 5, and 6, which pertain to situational factors of violence, were rejected after session 1. After session 1 and the following session, explanations 8 to 12 were newly employed.

On the other hand, the explanations generated by participants in the low-skilled group were seldom rejected through discussion. Eita and Masa only rejected one originally generated explanation throughout the sessions. Aki did not reject any explanations. Despite the low incidence of rejection, all participants in the low-skilled group adopted many new explanations in their explanation system.

In short, the high-skilled group showed much greater change than the low-skilled group. Because the management strategy was observed only in session 1 and the major explanatory change in the high-skilled group was also observed immediately after the session, it is indicated that the greater change in the high-skilled group can be attributed to the use of the management strategies. Therefore, the hypothesis that the conflicting exploration strategy would promote knowledge reconstruction but the counterargument would not was supported.

Knowledge reconstruction process

Even though a relationship between the management strategy use and the relevant change in explanation was indicated, we do not know how the management strategies helped participants reconstruct explanations in process. Here, the author analyzed the discourse process of session 1 to clarify the definite way the explanatory changes came about.

In the high-skilled group as shown above, immediately after the all participants expressed their ideas, Naomi and Fumi started to jointly clarify the differences between their opinions using the conflicting explanation in turn 6. Actually the two not only had different opinions but also had some common opinions. As explained by Naomi in 1st and 15th turn, she supposed two cases: A calm person, who uses violence, has an understandable reason to do so and doesn't. Fumi, however, focused primarily on the first case. This biased interpretation of Naomi's utterance prepared a ground for Fumi to analyze Naomi's explanation critically. That is, focusing attention on the differences among opinions seems to be a necessary condition for using the conflicting exploration. The Fumi's analysis induced Naomi to use the conflicting exploration in turn 9.

Following the analysis by Fumi in 11th and 13th turn that Naomi's explanation largely pertains to understandable reasons for the violent behavior, Naomi remembered another line of explanation which she wrote before the discussion sessions (see Naomi's explanation 4 in Table 3) and started to explain how she can coordinate her opinion with others' in 14th turn.

14. Naomi: Ah! I guess you're thinking about violence from someone with a good reason. I've just remembered I supposed another situation. When I thought about the situation, I thought he is frustrated because he couldn't express his feelings in words. I took "being calm" to mean "being bad at expressing oneself". So he is not really a gloomy person, he's just bad at expressing

himself. He thinks "why don't they understand me?" So, I guess, in that regard, your idea and mine are similar. (Cooperative exploration)

In 14th turn, Naomi found that "feeling frustrated from not being able to express oneself in words" was part of her opinion which was relatively close to others'. In 16th turn, he then explicitly related "not being able to express oneself" with "stress" which two other participants had emphasized as a causal factor for violence.

16. Naomi : And that kind of person has more stress or more factors to irritate him than other people [Abbreviated].

It was the first time for Naomi to explicitly include a stress factor in her explanation system. That is, Naomi added new explanation of "stress" through exploration that she tried to explain others how poor self-expression ability can cause violence. This explanatory change shown in discourse was also confirmed by Table 3. Naomi's explanations associated with a stress (explanation 7, 8, and 9) were shown for the first time after session 1. At the same time, as indicated in Table 3, the explanations which pertain to understandable reasons to behave violently (explanation 1, 2, 3, & 5) were rejected after session 1. These rejections might be caused by a destabilization of her knowledge system which was brought by the clarification of disagreement among the participants.

Putting together these results, the use of the conflicting exploration strategy made a disagreement among participants clearer. This triggered Naomi to try to coordinate her explanation and others' explanations and, at the same time, brought about destabilization of her explanation system. These processes resulted in not only employing new explanations but also rejecting prior explanations.

Major changes in explanation were also observed in Fumi. She did not initially include "ability to express oneself" in her explanation system. However through exploring the way stress-related factors can cause violent behavior in 19th turn, she employed an expression "he cannot express himself" as a mediating causal process of stress-related factors and violent behavior.

19. Fumi : If his calmness is natural-born, it doesn't matter. But if his weak-willed aspect is connected to calmness, he would always have some kind of stress because he cannot express himself for his weakness, just like you two proposed earlier. As a result, he resorts to violence. [Abbreviated]

Also in case of Fumi, the explanatory change shown in discourse was also confirmed by Table 3. The explanation "not being able to express oneself well" appeared for the first time after session 1. At the same time, all explanations which pertain to situational factor (explanation 3 to 6) were rejected. It was indicated that Fumi's explanations also largely changed toward the explanation which was co-constructed through discussion. The co-construction was triggered by the use of the conflicting exploration in the first place.

However the use of the conflicting exploration strategy does not guarantee knowledge reconstruction in all the discussants participated in a group. The fact that Keiko, who was not involved in the joint clarification by Naomi and Fumi, went through only minor explanatory change indicates that involvement in discussion is a necessary for positive effects of the conflicting explanation strategy.

Contrary to the high-skilled in which the participants tried to clarify the difference in opinion between them immediately after they all presented their own opinions, the low-skilled participants seem to be stuck for a while as shown in turn 5. Then, triggered by Eita's request for other opinions in turn 10, they tried to explore the other factors for a violent behavior. While they continued to exchange their ideas and opinions and elaborated on each other frequently, they did not analyze the differences among their ideas and opinions. Due to the characteristics of their discourse process, they did not have enough opportunity to review their ideas and opinions and deeply examine their own knowledge system on which their explanations were based.

Limitation and conclusion

Since the present study is a case study, whether the obtained findings can be generalized to discussions held in other situations and to discussants with different backgrounds and/or personal attributes is remained to be examined. Also remained is to directly examine how the management strategy works differently depending on the task structures.

However, the present study contributed to demonstrate some discourse processes through which discussants reconstruct their explanation systems in the social explanatory discussion task. Such processes have scarcely been examined so far. Even if the finding is

limited in external validity for the present, it is meaningful that this study developed the DCSD and demonstrated the conflicting exploration is one of the verbal strategies, which make everyday problem solving discussion effective.

Reference

Berkowitz, M. W. and Gibbs, J. C.: 1983, Measuring the developmental features of moral discussion. Merrill-Palmer Quarterly, 29, 399-410.

Berkowitz, M. W., Gibbs J. C. and Broughton, J. M.: 1980, The relation of moral judgment stage disparity to developmental effects of peer dialogues. Merrill-Palmer Quarterly, 26, 341-387.

Bernas, R. S. and Stein, N. L.: 2001, Changing stances on abortion during case-based reasoning tasks: Who changes and under what conditions. Discourse Processes, 32, 177-190.

Coulthard, M.: 1985, An introduction to discourse analysis (2nd ed.). Addison-Wesley Longman, London.

Damon, W. and Killen, M.: 1982, Peer interaction and the process of change in children's moral reasoning. Merrill-Palmer Quarterly, 28, 347-367.

Doise, W. and Mugny, G.: 1979, Individual and collective conflicts of centrations in cognitive development. European Journal of Psychology, 9, 105-108.

Fisher, B. A. and Hawes, L. C.: 1971, An interact system model: Generating a grounded theory of small groups. The Quarterly Journal of Speech, 57, 444-453.

Kato, K. and Maruno, S.: 2000, Development of Maruno-Kato Discussion Inventory. Poster presented at the 108th Annual Convention of the American Psychological Association, Washington, D. C.

Kruger, A. C.: 1993, Peer collaboration: conflict, cooperation, or both? Social Development, 2, 165-182.

Kuhn, D., Shaw, V. and Felton, M.: 1997, Effects of dyadic interaction on argumentive reasoning. Cognition and Instruction, 15, 287-315.

Leitao, S.: 2000, The potential of argument in knowledge building. Human Development, 43, 332-360.

McCoy, M. L., Nunez, N. and Dammeyer, M. M.: 1999, The effect of jury deliberations on juror's reasoning skills. Law and Human Behavior, 23, 557-575.

Okada, T. and Simon, H. A.: 1997, Collaborative discovery in a scientific domain. Cognitive Science, 21, 109-146.

Palincsar, A. S. and Brown, A. L.: 1984, Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. Learning and Instruction, 1, 117-175.

Piaget, J.: 1965, The moral judgment of the child. Free Press, New York.

Resnick, L. B., Salmon, M., Zeitz, C. M., Wathen, S. H. and Holowchak, M.: 1993, Reasoning in conversation. Cognition and Instruction, 11, 347-364.

Rips, L. J.: 1998, Reasoning and conversation. Psychological Review, 105, 411-441.

Rips, L. J.: 2002, Circular reasoning. Cognitive Science, 26, 767-795.

Rips, L. J., Brem, S. K. and Bailenson, J. N.: 1999, Reasoning dialogues. Current Directions in Psychological Science, 8, 172-177.

Roy, A. W. N. and Howe, C. J.: 1990, Effects of cognitive conflict, socio-cognitive conflict and imitation on children's socio-legal thinking. European Journal of Social Psychology, 20, 241-252.

Silverman, I. W. and Geiringer, E.: 1973, Dyadic interaction and conservation induction: A test of Piaget's equilibration model. Child Development, 44, 815-820.

Teasley, S. D.: 1995, The role of talk in children's peer collaborations. Developmental Psychology, 31, 207-220.

Tomida, E. and Maruno, S.: 2004, An exploratory study on thinking process in everyday problem solving discussion. Manuscript submitted for publication, Kyushu University in Japan.