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A Support System to Accumulate Interpretations of Multiple Story Timelines

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Abstract

The story base interpretation is subjectively summarised and segmented from the first-person viewpoint. However, we often need to objectively represent an entire image by integrated knowledge. Yet, this is a difficult task. We proposed a novel approach, named the synthetic evidential study (SES), for understanding and augmenting collective thought processes through substantiated thought by interactive media. In this study, we investigated the kind of data that can be obtained through the SES sessions as interpretation archives and whether the database is useful to understand multiple story timelines. For the purpose, we designed a machine-readable interpretation data format and developed support systems to create and provide data that are easy to understand. We conducted an experiment using the simulation of the projection phase in SES sessions. From the results, we suggested that a "meta comment" which was deepened interpretation comment by the others in the interpretation archives to have been posted when it was necessary to consider other participants' interpretation to broaden their horizons before posting the comment. In addition, the construction of networks to represent the relationships between the interpretation comments enabled us to suggest the important comments by using the degree centrality.

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1. Introduction

We usually interpret a series of events in our daily life as an episode and refer to a kind of long-term memory as "episodic memory". Episodic memory is the memory of autobiographical events including times, places, associated emotions, and other contextual knowledge. It is the collection of past subjective experiences. The story base interpretation is subjectively summarised and segmented from the first-person viewpoint. However, we often need to objectively represent an entire image by integrated knowledge and experiences from different perspectives. In this case, we have to take what is good, leave what is bad, and merge what is appropriate among the diverse pieces of story scenes. Yet, this is a difficult task (we refer to this as the "problem of parallel story interpretations") because each subjective experience is gained based on incomplete information, which is complemented by different viewpoints.

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A subjective experience is a kind of tacit knowledge. As we say "seeing is believing"; i.e. one of the most general ways to understand subjective experiences is to have an experience that is much the same. When it is difficult to have the same experience, a role-playing method in which participants simulate a similar experience is an alternative. In fact, dramatic role playing has been used in various contexts of education[4]. Meanwhile, Cavazza et al.[6] demonstrated that immersive interactive story telling is useful in gaining the first-person understanding of the story in the area of intelligent virtual agents. Although the role-playing method is useful to understand the experience from a particular viewpoint, it does not provide the entire image objectively by integrating knowledge and experiences from diverse perspectives. In addition, the role-playing method cannot repeat the same interaction among the participants.

Some of the problems associated with the role-playing method might be solved if it is presented in the form of interactive story telling[8,1]. For example, interactive story telling was more useful to improve participants' awareness of the issues surrounding some social problems, such as the smoking habit and bullying[9,10,2,3]. The design and development of interactive stories, multiple story timelines, and their dependencies on transitions would have to be manually put together based on interaction with the users and the characters that are controlled by the interactive story telling system. However, it would be very costly to build the stories from diverse viewpoints.

We proposed a novel approach, named the synthetic evidential study (SES), for understanding and augmenting collective thought processes through substantiated thought by interactive media[11,12]. SES combines dramatic role play and group discussion to help people create stories by bringing together partial thoughts and evidence. The SES framework consists of SES sessions and interpretation archives.

In each SES session, participants repeat a cycle consisting of dramatic role play, observation of projection into an annotated agent play, and a group discussion. An SES workshop involves the execution of one or more successive SES sessions until participants come to an initial agreement. In our previous work[12], we conducted a feasibility study with a partially implemented SES Support System. The major findings included participants' behaviour in role playing, deepened understanding by playing, deepened understanding based on contrasting third-person and first-person views, deepened understanding based on first-person view transfer, and implicit opinion expression by acting.

The interpretation archives consist of a database in which interpretations for events relating to the story are annotated and in which the relationships between the multiple story timelines and the transitions are described as networks. The SES sessions enable participants to accumulate their interpretations for a particular story and to compare their own perspectives with those of others. We expect the interpretation archives to be useful for understanding participants' subjective views of the stories and for building the interactive stories.

The purpose of this study is to investigate the kind of data that can be obtained through the SES sessions as interpretation archives and whether the database is useful to construct multiple story timelines for interactive stories. Therefore, we designed the data structure for the interpretation archives by developing support systems to interpret the archived data. In addition, we conducted an experiment to obtain an interpretation of the data. After the experiment, we analysed the obtained data and the results obtained by way of questionnaires.

The paper is organised as follows. Section 2 briefly introduces the conceptual framework of SES, the data format of the interpretation archives and support systems. Section 3 describes an experiment to obtain the interpretation archives and the results. Section 4 discusses the achievements and future work. We present conclusions in Section 5.

2. Related works

As mentioned above, dramatic role playing is one of the effective methods to simulate a similar experience. There are some researches using role playing. Hawkins et al. proposed Dramatic Problem Solving (DPS) which was a systematic approach to conflict transformation through a series of simultaneously fun and serious exercises[5,4]. They carried out a participatory action research in Costa Rica. The results demonstrated that direct action through facilitated community performance could result in both community and personal empowerment, development and conflict transformation. Miettinen et al.[10] proposed a laboratory concept consisting of an environment and set of tools suitable for service prototyping and interaction design. In this, role-playing was a powerful method for observing and discovering aspects and elements in the service prototype. In our study, we focused on not only the effects of own role-play experiences but also the effects of sharing the others'. To share the role-play and the interpretations, we designed the data structure for the interpretation archives by developing support systems.

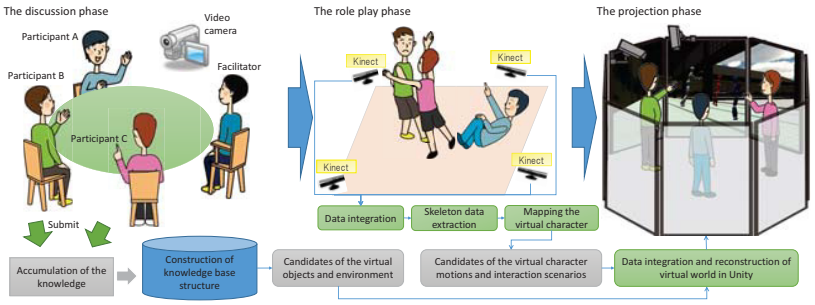

Fig. 1. A typical sequence of procedures during an SES session.

To provide multiple story timelines, researchers proposed interactive story telling systems. Mateas et al.[1] showed Façade which was a real-time 3D interactive drama. Cavazza et al.[6] presented a small-scale integration of a real-time immersive interactive storytelling system. The quality of these interactive story telling systems are high, but a lot of time and cost are taken for making them. To reduce the time and cost, it has proposed the Hierarchical Task Network (HTN) planning and Heuristic Search Planning (HSP) (e.g.[7]). These methods are useful for constructed stories in advance. In our concept of SES, the stories are updated and refined through discussions and role-play.

3. Concept and Support Systems

The SES framework consists of SES sessions and interpretation archives. In the SES sessions, the participants freely interpret and discuss the target story. As the raw data that are obtained from an SES session are very complex, it is difficult to convert to machine-readable data and to provide data users would find easy to understand. Therefore, we designed a machine-readable interpretation data format and developed support systems to create and provide data that are easy to understand. In this section, we briefly explain the conceptual framework of SES, the data format of the interpretation archives, and the support systems.

3.1. SES sessions

Each SES session comprises participants repeating a cycle consisting of dramatic role play (role-play phase), observing projection into an annotated agent play (projection phase), and participating in a group discussion (discussion phase). In the role-play phase, participants play respective roles to demonstrate their first-person interpretation. This allows them to interpret the given subject from the viewpoint of an assigned role. In the projection phase, an annotated agent play is produced on a game engine from the dramatic role play in the previous phase. We use this play for refinement and extension in the later SES sessions or even adapt it for reuse in a new context. In the discussion phase, the participants or audience members share annotated interpretation data from the previous phases for criticism. The understanding of the given theme will be progressively deepened by repeatedly looking at embodied interpretation from the first- and third-person points of view. Figure 1 shows a typical sequence of procedures during an SES session.

In all of the phases, the participants freely discuss the interpretation of the target story. They try to agree on a conclusion for one or a few of the stories by deciding which conclusions are appropriate in each phase. A conclusion is considered to be a concrete story timeline that is possible in a real situation from a particular perspective (role-play phase), an integrated story timeline that is interpreted from diverse perspectives (projection phase), and an interpreted story summarised from an objective perspective (discussion phase). As the cycle is repeated, participants are able to deepen their understanding of the story based on implicit opinion expression by acting, subjective view transfer, and the summarised process for creating an objective perspective[12].

3.2. Interpretation archives

In the discussion phase, participants try to form an objective viewpoint by summarising their experiences and other materials which are useful to understand the target story, such as documents, videos made by others, and archived

data from other SES sessions. We expected the other SES session data to be very useful because the experiences they document are similar to the archived data. However, we did not use the data in our previous study because the raw data of SES sessions were complex and not machine readable. We tried to improve the reusability of the SES session data by accumulating machine-readable interpretation data from SES sessions.

Ideally, we would have to accumulate all of the data in SES sessions, such as role-play motion data, natural language conversation and the history of each participant's interpretations, and reconstruct the relationships between them. However, it would be hard to develop a system to convert the raw data. As a first step, we developed a prototype system to accumulate interpretation data in the projection phase. The prototype system includes Dramatic Role-Play Reconstruction (DRPR) and Interpretation Comment Annotation (ICA) subsystems. The system provides multiple story timelines that are captured or virtually reconstructed in the form of dramatic play. Users can annotate the story timelines by adding their own interpretations as comments. The system records the time, viewpoints of the replay, the target object of the comment, and the category of the comment. After adding their annotations, users can link the comments to create networks. If the system contains archived interpretation data produced by other users, the current user could combine this data with their own to create integrated networks. The pairing of these annotated networks with projected dramatic play data is defined as "interpretation archives" in this study.

The user annotates the interpretation comments with an interpretation category and the network connections between the comments. The category is selected from a predefined list which includes "clarification", "empathy", "confirmation", "suspicion", "conjecture", "question", and "surprise". The interpretation category was defined by conducting an analysis based on two preliminary experiments. The category shows part of the reasons why the participant focused on the situation. The network connections show a kind of appropriate transition of the multiple story timelines. The analyses of the distribution of the interpretation categories and the relationships between the contents of the interpretation comments enable us to discover possible multiple story timelines.

3.3. Interpretation Archive Support System

We developed a prototype system to accumulate interpretation data. The prototype system includes Dramatic Role-Play Reconstruction (DRPR) and Interpretation Comment Annotation (ICA) subsystems.

3.3.1. Dramatic Role-Play Reconstruction System

The DRPR system is an improved system of Dramatic Group Play Capture (DGPC) system which was proposed in our previous work[12]. The DRPR system can capture 3D surface model data and skeleton model data of multiple persons without markers and can convert the data for use in the Unity3D environment in a short time. This system includes a projection subsystem. The projection subsystem is capable of converting the captured skeleton data into character motion data in the Unity3D virtual environment and can play the motion data using the character. After the data has been converted, users can easily change the projection. For example, the same data can be displayed on both a large flat screen display and a 360-degree immersive display. In addition, users can change the positions of virtual cameras to achieve the desired effect when displaying the data on a screen. They can select a third-person view to present an overview of an entire role play scene using a flat display in the discussion and one of the role player's subjective positions to experience the player's situation using an immersive display. The perception by the person who was playing the role of the spectator is also different from the third-person view. These indicate that different perspectives provide useful clues to investigate principles of human behaviour in SES sessions.

The improved points are two: 1) DRPR system can capture multiple user interactions including up to six persons. 2) DRPR system can complement skeleton model data based on the point cloud data. By this improvements, we come to be able to capture more complex interaction. Figure 2 shows the outline of the DRPR system.

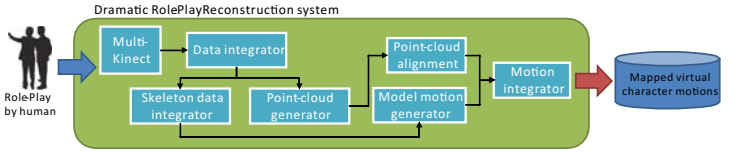

Fig. 2. Outline of the DRPR system.

3.3.2. Interpretation Comment Annotation System

The Interpretation Comment Annotation (ICA) system has the purpose of supporting the annotation of the interpretation comments to the story timelines. The system records the time, viewpoints of the replay, the target object of the comment, and the category of the comment. This system functions as an extension tool of the projection subsystem in the DRPR system. Outline of ICA system is shown in Figure 3

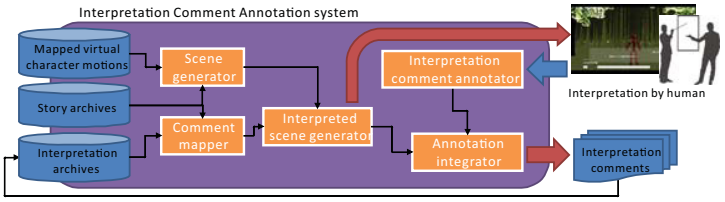

Fig. 3. Outline of the ICA system.

The extended projection subsystem can play multiple story timelines that have been captured during the role-play phase in other SES sessions. The story timeline is divided into some scenes of which there are two types: a slide-show type that contains selected still images and narrations displayed as text and a motion-play type that contains time-series motion data of the virtual agents and temporally synchronised narration texts. A slide-show type scene is usually used to either explain the background story or to present a scene in which motion is not important. A motion-play type scene is used to describe the climax scenes or the scenes portraying interaction between the characters, which are played by virtual agents. In both types of scene, users are able to view the comments that were added to facilitate interpretation and which have been annotated during past SES sessions.

Users are able to control the rate of transition of the story timeline using a slider bar and play/stop button, with the speed of the play being controlled by the speed control slider. Users can also stop the play to use the interface to add an interpretation comment in the form of an annotation via one of the textboxes. The addition of an annotation requires the user to select an interpretation category. As it is not time consuming to add a comment, this does not interfere with the interpretation of the story timeline. The present version of this system requires explicit annotation using the graphical user interface, but we plan to improve the system such that the future version accepts voice input.

4. Experiment

We conducted an experiment to investigate the kind of interpretation archives that could be obtained through the projection phase in SES sessions and whether the interpretation archives were useful to construct multiple story timelines. The experiment contained two sessions: a comment post session in which participants conducted the projection phase, and a network construction session in which participants constructed networks between their own annotated comments and the archived interpretation comments of other participants. The data that were obtained from both of these two sessions enabled us to construct interpretation archives. We investigated the effects of the quality of the interpretation archives by forming three groups of participants: a no-comment group, a first-comment group, and a meta-comment group. The groups were distinguished from one another by whether they were permitted to refer to prior interpretations by other groups. We expected that participants would deepen their interpretation by referring to other participants' interpretations because the others provided different perspectives about the same story timeline. We tried to investigate the extent to which participants' deepened interpretations influenced the other participants by comparing the interpretation comments of the three sessions.

4.1. Task and Settings

In this study, we used the Immersive Collaborative Interaction Environment (ICIE) [13] to experience the story created by the ICA system from different viewpoints. ICIE uses a 360-degree immersive display that is composed of eight portrait orientation monitors with a 65-inch screen size in an octagonal shape. This environment allows participants to effortlessly look around the virtual space with a low cognitive load as in the real world.

4.1.1. Target story for the SES

The SES workshop is a joint activity open to any group of people interested in jointly unravelling the interpretation of a given theme by bringing together prior interpretations of participants. We adopted the story "In a Grove" ("Yabu no Naka" in Japanese) as the theme of this experiment.

"In a Grove" is a short story by the author Ryunosuke Akutagawa. It presents three varying accounts of the murder of a samurai whose corpse was found in a bamboo forest near Kyoto. Each section simultaneously clarifies and obfuscates what the reader knows about the murder, eventually creating a complex and contradictory vision of events that brings into question humanity's ability or willingness to perceive and transmit the objective truth.

In the story, multiple story timelines are presented as three varying accounts of the murder. We regarded the story as one of the results of the SES workshop in which the theme was the criminal investigation of the murder. This story has been analysed by many researchers, but there is no commonly accepted notion. Therefore, we expected participants to provide their own interpretations with the expectation that these interpretations would sometimes differ from those of others. This is an appropriate theme for our investigations. The experimenter asked participants to read the story and consider their own interpretations including the inner states of the main three characters before the experiment.

4.1.2. Comment post session

In the comment posting session, participants freely posted their interpretation comments while watching the "In a Grove" story in ICIE. The story was reconstructed in advance by using the Dramatic Role-Play Reconstruction System. There were seven scenes including three slide-show type scenes and four motion-play type scenes; 1) The Woodcutter's Story, 2) The Traveling Monk's Story, 3) The Bounty Hunter's Story, 4) Tajomaru's Story, 5)Masago's Story - 1, 6) Masago's Story - 2 and 7) Takehiro's Story through a Medium. The participants were able to watch all of the scenes of the story from the viewpoint of each character and also from the third-person viewpoint. Participants in the no-comment group were not allowed to refer to interpretation comments posted by other participants. In contrast, participants in the first-comment group could refer to the interpretation comments posted by participants in the no-comment group, whereas those in the meta-comment group could refer to interpretation comments posted by both the no-comment and the first-comment group.

First, the participants watched the whole story from a third person's viewpoint. Then, they watched each scene from each character's viewpoint. After watching all of the scenes, they could play any of the scenes repeatedly if they wanted. While watching the scenes, they could post any number of interpretation comments at any time. They were not obliged to post comments when they did not consider a scene to be worthy of commenting. Participants could finish this session when they considered themselves to have posted all of their interpretation comments.

4.1.3. Network construction session

After the comment posting session, the participants constructed networks representing the relationships between interpretation comments. The participants in the no-comment group constructed networks using only their own comments. Participants in the first-comment group constructed networks based on their own comments and those provided by the no-comment group, whereas participants in the meta-comment group constructed networks using their own comments and those provided by the other two groups.

The experimenter asked the participants to create cause-and-effect connections or to indicate the order in which the provided comments were related. The networks constructed by the participants were directed graphs. First, participants linked their own comments to construct networks. Subsequently, the participants in the first-comment group merged their networks with those of the no-comment group, and the participants in the meta-comment group merged their networks with those created by the other two groups.

The experimenter instructed the participants to be consistent by creating complete networks. Participants who changed their interpretations while constructing the networks were allowed to change the relationships between the comments. In the networks, the different interpretation categories that were identified were indicated by using a different coloured box around the comments.

4.2. Procedure

After a brief explanation of the experiment, the participants answered two free description questions: Q1) Could you understand the story "In a Grove"? Q2) Please write down your brief interpretations of the murder. After answering the questions, participants started the comment posting session. Participants played the story and posted their comments repeatedly until they considered themselves to have posted all of their interpretation comments. After a short break, participants started the network construction session, following which the participants responded to three questionnaires.

The participants in this experiment were 29 Japanese university students aged between 19 and 25. Nine participants were assigned to the no-comment group, whereas the first-comment and meta-comment groups each received 10 participants. Participants were then allowed four hours to complete the experiment. Most of the participants spent four hours. The participants could take a rest freely, so they worked without distraction until the end of the experiment.

4.3. Analysis of responses to questionnaires

The purpose of this analysis was to investigate how the comments participants provided influenced their subjective impressions. At the end of the experiment, participants answered three questions using a seven-point scale. The scale was presented as seven ticks on a black line without numbers (scored from 1 to 7). The results are presented in Table 2. We performed a Kruskal Wallis test on the data obtained from the responses to the questionnaires; however, we could not find any significant differences between the responses received from the different groups.

Table 1. Average scores obtained for the responses to the questionnaires.

Questionnaires	no-comment	first-comment	meta-comment
1. How did you deepen the understanding from the third-person viewpoint through this experiment?	4.2	4.6	4.3
2. How did you deepen the understanding from the first-person viewpoint through this experiment?	4.2	4.2	4.4
3. How appropriately did you construct networks?	3.7	4.0	4.4

We asked two free description questions (Q1, Q2 described in Procedure section) before the experiment. Fifteen out of 29 participants answered Q1 as "not clear" or no answer. After the experiment, we repeatedly asked the same questions in the questionnaires. As a result, almost all participants (28 out of 29 participants) were able to write their own short interpretations. This means that the participants were able to deepen their understanding of the story because of using our support system.

4.4. Results of the analysis of posted interpretation comments

Figure 4 shows the frequency of the interpretation categories in the experiment. The result indicates that the frequency of "Clarification", "Empathy", and "Conjecture" largely increased in the meta-comment group. We performed non-repeated ANOVA by analysing the number of comments in each interpretation category for each of the groups. As a result, we found a marginally significant difference in the number of "Empathy" comments in the meta-comment group ($p=0.098$), whereas the number of "Conjecture" comments and the total number of comments posted by the meta-comment group was significantly larger than those from the other two groups ($p=0.043$, $p=0.048$). This means that the participants in the meta-comment group were able to interpret the story from different perspectives when they referred to the interpretation comments posted by other participants. On the other hand, participants in the first-comment group were unable to do so. We consider a "meta comment" to have been posted when it was necessary to consider other participants' interpretation to broaden their horizons before posting the comment. The participants in the no-comment group posted their comments based only on their own interpretations; however, those in the first-comment group posted their comments based on comments posted by the no-comment group. Some of the comments in the first-comment group are probably meta-comments.

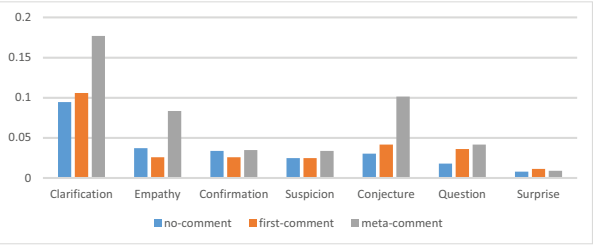

Fig. 4. Frequency of the interpretation categories.

4.4.1. Correlation between the interpretation category and depth of understanding from the third-person viewpoint

Based on the result of questionnaire No.1 in Table 1, we calculated the Spearman's rank correlation coefficient between the number of comments in each interpretation category and the depth of understanding from a third-person's viewpoint for each group. Table 3 shows the result. The "Clarification" and "Surprise" comments by the no-comment group and "Conjecture" by the first-comment group are significant at $p<0.05$.

Table 2. Correlation between the interpretation category and depth of understanding from a third-person viewpoint.

Category	no-comment	first-comment	meta-comment
Clarification	0.68 *	0.27	0.00
Empathy	-0.53	0.27	0.04
Confirmation	0.13	0.00	-0.07
Suspicion	0.21	-0.45	0.51
Conjecture	-0.54	-0.95 *	0.35
Question	0.31	-0.43	0.38
Surprise	-0.85 *	-0.58	0.02
Total	0.49	-0.55	0.27

There is a strong negative correlation between the number of "Surprise" comments by the no-comment group and the depth of understanding from the view of a third person. In general, the more participants deepened their understanding from the objective perspective, the less they were inclined not to encounter surprises.

There is a strong negative correlation between the number of Surprise comments in the no-comment group and the depth of understanding from third-person view. In general, participants more deepened an understanding from the objective perspective, the less they did not feel surprises.

There is a strong positive correlation between the number of "Conjecture" comments by the no-comment group and the depth of understanding from a third-person's view. In addition, there is a positive correlation between "Conjecture" comments by the first-comment group and the depth of understanding from a third-person's view. On the other hand, there is a weak negative correlation between that in the meta-comment group and the depth of understanding from a third-person's view. These results show that the interpretation of the story undergoes a qualitative change between the first-comment and meta-comment groups as mentioned before this subsection.

4.4.2. Correlation between the interpretation category and depth of understanding from the first-person viewpoint

Based on the result of questionnaire No.2 in Table 1, we calculated the Spearman's rank correlation coefficient between the number of comments in each interpretation category and the depth of understanding from a first-person's view for each group. Table 4 shows the result. The "Suspicious" category of the meta-comment group is significant at $p<0.05$. Because the "In a Grove" story presents three different subjective viewpoints of three characters and those are contradictory, it is hard for the participants to clearly understand the story.

There are negative correlations between the depth of understanding from the first-person view and the number of "Suspicious" comments in the no-comment and meta-comment groups. On the other hand, there is a positive correlation between the depth of understanding from the first-person's view and the number of "Suspicious" comments in the first-comment group, but there is a negative correlation between the depth of understanding from a third-person's

Table 3. Correlation between the interpretation category and depth of understanding from the first-person viewpoint.

Category	no-comment	first-comment	meta-comment
Clarification	0.22	-0.34	0.49
Empathy	-0.19	0.08	0.51
Confirmation	0.39	-0.07	-0.39
Suspicion	-0.37	0.50	-0.65 *
Conjecture	-0.29	0.07	0.57
Question	0.42	0.12	0.35
Surprise	-0.31	-0.18	0.23
Total	0.28	-0.06	0.47

view and the number of "Suspicious" comments in the first-comment group. This means that the participants in the no-comment and meta-comment groups posted the "Suspicious" comments about the interpretation from the first-person viewpoint, but the participants in the first-comment group posted those comments about the interpretation from a third-person's viewpoint. This also suggests a difference in interpretation between participants in the first-comment and meta-comment groups.

4.5. Results of the analysis of constructed networks

All of the constructed networks in the experiment were directed acyclic graphs. This shows that the graphs were appropriately constructed because the cause-and-effect or order relation did not circulate. Nodes that are connected to many other nodes are important for understanding the multiple story timelines. Therefore, we calculate the degree centrality and rank the important comments. The result is provided in Table 5.

Table 4. Result of the degree centrality and ranking of the important comments.

	Comment	Category	Scene	Viewpoint	Commentator	degree
1	Masago did not much love Takahiro. Masago might have wanted to kill her husband for some reason	Conjecture	Masago2	3rd person	G (first-comment)	15
2	Tajomaru had relationship with Masago	Confirmation	Takehiro	Takehiro	I (first-comment)	10
3	Masago was I panic	Conjecture	Masago2	Takehiro	B (no-comment)	9
4	Did Takehiro really said "Kill me"? Why was Masago able to kill her husband so quickly.	Question	Takehiro	Takehiro	I (first-comment)	9
5	Double shock caused by being made way with and being despised by husband	Empathy	Masago1	Masago	L (first-comment)	7

The degree centrality of rank 1 is 15. This is relatively high; thus, the comment is very important to deepen the interpretation. In fact, one participant wrote that the node with the highest centrality changed my opinion. In addition, dense connectivity exists among nodes with a high rank (1->3, 2->1, 2->3, 1->4, 1->5, 2->5, 3->5). It is suggested that critical comments can be identified based on the degree centrality. Moreover, four out of five comments were posted by the participants in the first-comment group. This also suggests that many important comments were posted by the first-comment group and that these comments were responsible for the qualitative change in the interpretation of the story by the meta-comment group.

5. Discussions

In this study, we conducted an experiment to obtain interpretation archives by the simulation of the projection phase in SES sessions. By using the interpretation archives, we investigated how referencing the interpretation archives influenced other participants' interpretation of the story. The construction of networks to represent the relationships between the interpretation comments enabled us to suggest the important comments by using the degree centrality.

The analyses suggest that the interpretation of the story underwent a qualitative change between the first-comment and meta-comment groups. The results also indicate that the posting of meta-comments based on other participants'

interpretation played an important role in achieving this qualitative change. However, we can raise an alternative possibility: the number of comments is important. This is reasonable because the probability of an important comment appearing increases when the number of comments increases. On the other hand, when the number of comments increases, it is more difficult to find the important comment. Even during the experiment, the participants in the meta-comment group had to refer to over 200 comments during their interpretation. Therefore, we consider extraction of meta-comments from the interpretation archives to be an important issue. In future, we plan to extract meta-comments by using the degree centrality or other network analysis techniques.

We were unable to capture some of the important aspects of SES in this study because we conducted an experiment to simulate the projection phase in SES sessions. This means that the participants did not conduct any role-play in the experiment. Especially, our contribution to "the problem of parallel story interpretations" was small. We intend improving the support system to use in actual SES workshops in future.

6. Conclusions

In our previous work, we proposed a novel approach, named the synthetic evidential study (SES), for understanding and augmenting collective thought processes through substantiated thought by interactive media. To support the SES, we designed a machine-readable interpretation data format and developed support systems to create and provide data that are easy to understand. We conducted an experimentusing the simulation of the projection phase in SES sessions. From the analyses, we suggested that a "meta comment" in the interpretation archives to have been posted when it was necessary to consider other participants' interpretation to broaden their horizons before posting the comment. In addition, the construction of networks to represent the relationships between the interpretation comments enabled us to suggest the important comments by using the degree centrality. We intend improving the support system to use in actual SES workshops in future.

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