PSEUDO-HAPTIC FEEDBACK FOR PROMOTING NARRATIVE COMPREHENSION

Kazuaki Umetsu and Akihiro Kashihara

Graduate School of Informatics and Engineering, The University of Electro-Communications
1-5-1, Chofugaoka, Chofu, Tokyo, 182-8585, Japan

ABSTRACT

Skill in reading comprehension requires reading sentences to understand an intention embedded between the lines. In the case of narrative, it is particularly necessary to read a narrative and find essential concepts such as emotions of the characters embedded between the lines for comprehending an intention of the narrative. In this work, we focus on reading between the lines and to require learners to compose a narrative map including a concept (called interlinear concept) between the lines, which is related to the narrative intention. We also demonstrate a tablet tool, which allows learners to compose a narrative map including interlinear concept from narrative. This tool presents pseudo-haptic feedback when learners operate the nodes and links representing the interlinear concept and narrative intention on the map. The results of a case study suggest that the pseudo-haptic feedback could enhance awareness of the interlinear concept and narrative intention.

1. INTRODUCTION

OECD (Organization for Economic Co-operation and Development)'s PISA survey pointed out the decline of Japanese reading comprehension (Ministry of education 2005). In particular, it showed that Japanese children were weak in reading sentences to understand an intention embedded between the lines. In particular, they seem to have difficulties in finding essentials embedded in sentences, which allow them to understand it. In the case of explanatory text, such essentials are clearly described in the text. But, these are embedded in the case of narrative. It is accordingly necessary to read narrative and find essential concepts such as background and emotions of the characters embedded between the lines for comprehending an intention of the narrative.

The main issue addressed here is how to help learners find essential concepts embedded in narrative to understand an intention of the narrative. Our approach to this issue is to focus on reading between the lines and to require learners to compose a concept map including the essential concepts. In concept map composition, learners are expected to make links among nodes indicating the concepts represented in the narrative. It accordingly allows them to make clear the relationships between the concepts and to promote understanding the narrative.

We have developed a tablet tool that scaffolds composing a concept map from a narrative. In this tool, learners are expected to read the narrative sentences to link the nodes prepared in advance according to the contents of the narrative. If the composed map is not correct, they are also expected to re-read the sentences to re-compose the map until the correct map is obtained.

Although such concept map composition is useful for understanding the contents of narrative, an essential concept embedded between the lines is often missing on the map. Our approach to this is to propose a narrative map including a concept (called interlinear concept) between the lines, which is related to the narrative intention. In addition, the intention of narrative varies with viewpoints of the readers. In this work, the tablet tool provides learners with a viewpoint before composing a narrative map so that the intention of the narrative can be uniquely decided. The tablet tool also presents an interlinear concept for the narrative map composition, which serves as a clue for comprehending the intention of the narrative.

In composing such a narrative map, in addition, it is not so easy particularly for learners with lower reading comprehension skill to become aware of the interlinear concept and the intention of narrative. We accordingly propose a method for presenting pseudo-haptic feedback when learners operate nodes/links representing the interlinear concept and the narrative intention. In this paper, we demonstrate the tablet tool with pseudo-haptic feedback. We also report a case study whose results suggest it could enhance awareness of the interlinear concept and narrative intention.

2. NARRATIVE UNDERSTANDING

In understanding a narrative, it is important to draw out the narrative intention as learning of linguistic culture (Ministry of education 2009). It is also necessary to infer the emotions of the characters and the atmosphere embedded between the lines. However, it requires a deeper understanding of the narrative including the intention of the author and the interlinear concept. Even though learners could grasp the contents of the story, it is not easy to obtain such deeper understanding. In this work, we focus on how to help learners read between the lines in narrative, which is essential in narrative comprehension.

3. NARRATIVE MAP

In order to promote understanding narrative, we introduce a concept map representing concepts appearing in the narrative and their relationships. The concept map visually represents the structure of the sentences with nodes as concepts and links as the relationships between the concepts. Composing such a map makes it possible to clarify the relationships and to promote understanding of the sentences. In the narrative comprehension, however, it is important to comprehend the intention of narrative embedded in the sentences. In general, information such as emotion and background embedded between the lines is not represented in the map.

We accordingly propose a narrative map, which includes the interlinear concept in addition to the concepts clearly described in the narrative. The interlinear concept affords a clue to grasp the narrative intention. In composing such narrative map in concurrent with reading the narrative, learners are expected to become aware of the interlinear concept and the narrative intention. Since the intention of narrative could be interpreted differently depending on viewpoints of the readers, in addition, we give learners one viewpoint so that an intention can be given.

Let us demonstrate narrative map composition with Figure 1. Figure 1 (A) shows a part of narrative sentences, which corresponds to a paragraph on *"Ozbel and the Elephant"* (Kenji Miyazawa,1989). Figure1 (B) shows a narrative map to be composed from Figure 1 (A) with 9 nodes and 11 links. Links are expressed with labels such as "action", "casual", "object" and "state".

In this narrative, *white elephants laughed with lonesome*. However, the reason why *white elephant laughed with lonesome* isn't described, which is an important interlinear concept in this narrative. We accordingly give learners a viewpoint of the narrative such as "consider why *white elephant laughed with lonesome*?" before starting map composition. This viewpoint could allow learners to become aware that a feeling of guilty that is caused by "*crushing the master Ozbel*". The feeling of guilty is viewed as an interlinear concept.

In Figure 1 (B), this is represented with the relationships among the nodes "*white elephant*", "*feel guilty*", and " *laugh with lonesome*", and the causal relationship between the nodes "*crush*" and "*feel guilty*". The node "*feel guilty*" represents the interlinear concept. An intention of the narrative can be interpreted as "killing the master produces feel guilty", which is expressed as a partial of the narrative map shown in Figure 1 (B).

In this work, we prepare and present some concepts according to the sentences and an interlinear concept as nodes in advance, then require learners to compose a narrative map in concurrent with reading the sentences. However, all nodes have no visual differences.

Although learners with high reading comprehension skill are expected to correctly understand the intention of narrative while linking the interlinear concept and other concepts, it is not so easy particularly for learners with low skill to become aware of the interlinear concept node and the partial structure representing

the narrative intention. In order to address this issue, we introduce pseudo-haptic feedback into the narrative map composition process. Pseudo-haptic feedback could promote such cognitive awareness to bring about understanding of the narrative intention (Kashihara and Shiota 2014).

.
.
.
Ozbel was already crushed while holding the case of the gun.
As soon as the gate opens, the elephant pours. "Where is the prison?"
Everyone rushes into the cabin. The logs were folded like a match, that white elephant ran out of the hut badly. "Well, I'm glad, did not you?"
Everyone quietly removed the chain and copper. "Oh, thank you, I was saved." White elephant laughed with lonesome.

(A) A Paragraph on *"Ozbel and the Elephant"* (Kenji Miyazawa,1989)"
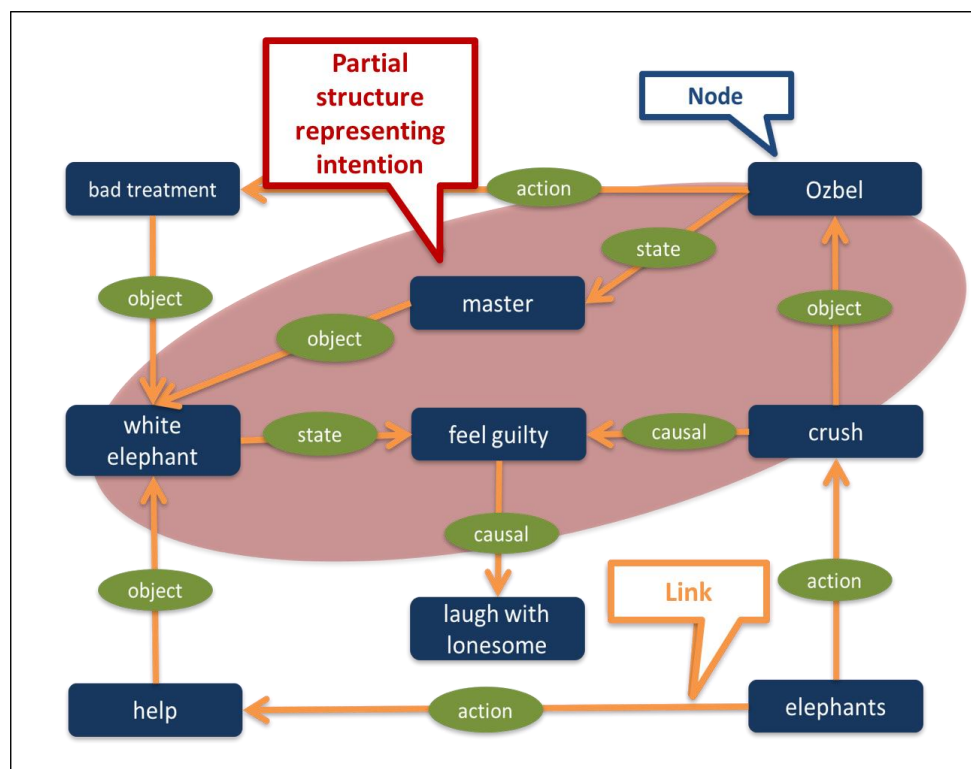
(B)

Figure 1. A narrative map of *"Ozbel and the Elephant" (Kenji Miyazawa,1989)*

4. PSEUDO-HAPTIC

Pseudo-haptic is illusion about tactile sense caused by uncomfortable feeling between physical manipulation of an object and its visual movement. While moving an object on a tablet with finger, for example, learners can get a feeling that the object is heavy as the movement of the object slows down (Lecuyer 2009). We have already ascertained that pseudo-haptic feedback for manipulating a concept map representing knowledge learned from an instructional text could promote an awareness of important concepts or important relationships embedded in the text (Kashihara and Shiota 2015).

In this paper, we introduce pseudo-haptics into the narrative map composition. Learners are provided with pseudo-haptic feedback as shown in Table 1. Let us consider the first feedback shown in Table 1 with Figure 2. When a learner touch-operates a node representing interlinear concept such as *feel guilty*, it moves with a delay in comparison with the touch operation. The visual movement represents heaviness of the node as the pseudo-haptic feedback. It expects learners to explore into the text the reason why the pseudo-haptic feedback occurs. Such exploration brings about cognitive awareness that the node represents an interlinear concept.

In addition, let us also consider the second feedback shown in Table 1 with Figure 3. When a learner moves a node linking another node, the link usually lengthens or shortens according to the positions of the nodes. When the learner moves a node belonging to the partial structure representing the narrative intention, all the nodes and links included in the partial structure move accordingly without shortening/lengthening the links. In other words, all the nodes representing the intention move together. This visual movement represents hardness of the links as the pseudo-haptic feedback. It also expects learners to explore the reason in the text to become aware that the partial structure represents the narrative intention.

Table 1. Pseudo-haptic feedback from operation

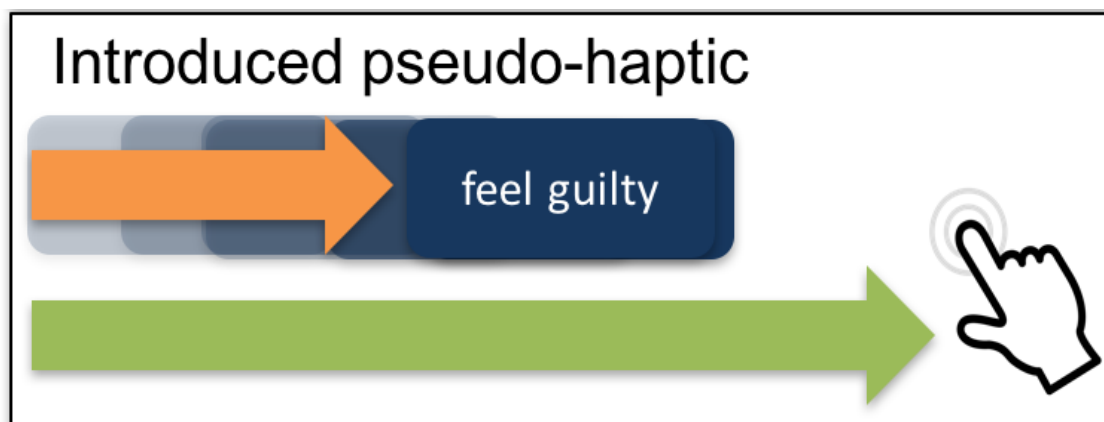| Operation on narrative map	Pseudo-haptic feedback	Cognitive awareness
Interlinear node operation	Node heaviness	Interlinear concept
Operating nodes belonging to the partial structure representing the narrative intention	Link hardness	Intention of narrative

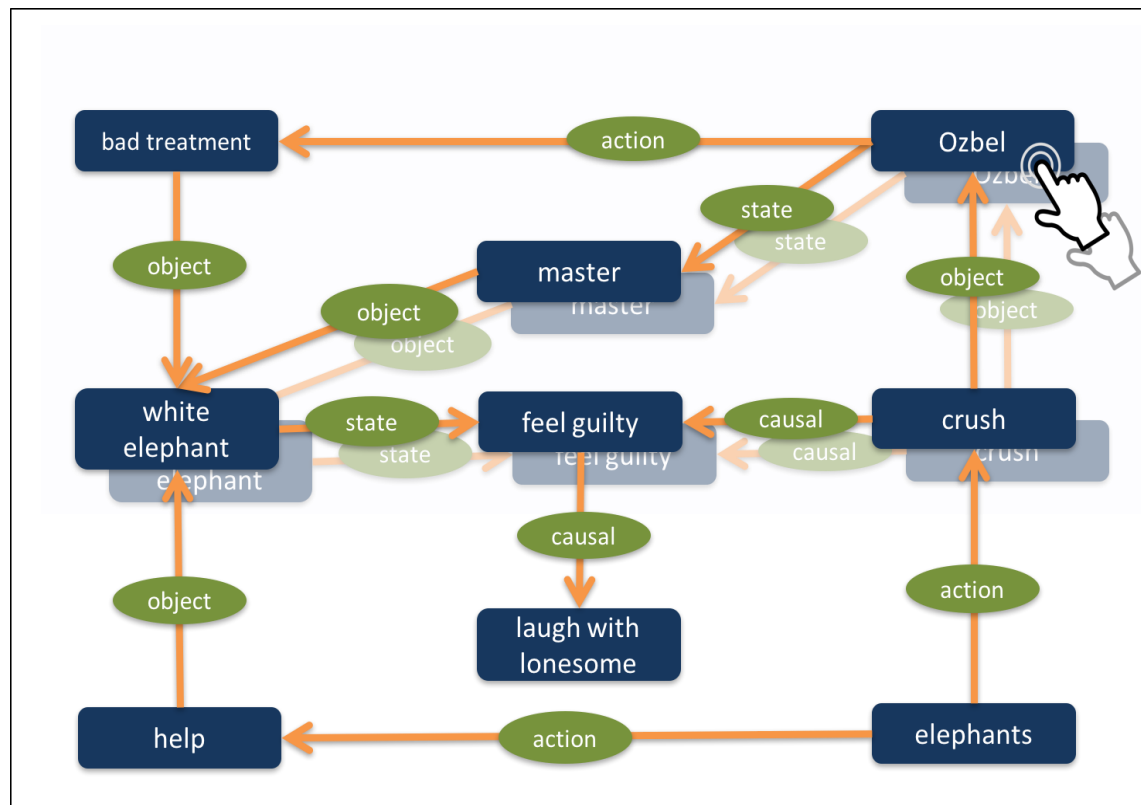Figure 2. Example of pseudo-haptics for "node heaviness"

Figure 3. Example of pseudo-haptics for "link hardness"

5. TABLET TOOL

We have developed a tablet tool on iPad, which provides learners with pseudo-haptic feedback according to Table 1. Figure 4 shows the user interface of the tool. Let us here describe the framework of the tool, the narrative map composition on the tool, and the learning process expected.

5.1 Framework

This tool prepares a narrative text and the corresponding correct narrative map including an interlinear concept and the intention embedded in the text. On the left pane of the interface, the tool displays the text. On the right pane, the tool provides a space for narrative map composition. As the initial setting, the tool put the nodes on this pane, which represent the interlinear concept and the concepts used in the narrative text.

Before the narrative map composition, the tool presents a viewpoint of the narrative at the top pane of the interface. The learners are then required to follow the viewpoint to read the text and compose a narrative map corresponding to the correct map. The correct relationships among the nodes are defined in the tool. When the learners move the nodes that embed the pseudo-haptic feedback, they are provided with the corresponding feedback according to Table 1. They are then expected to explore into the text the reason why the visual movement defined by the pseudo-haptic feedback occurs. Such exploration brings about cognitive awareness expected by the feedback. When learners complete the map, they can check the correctness by pushing the "Answer" button.

5.2 Map Operations

This tool provides learners with the touch operations: node movement, link generation/deletion, and attachment/change of link labels. The learners can touch and drag the node with fingers they want to move. Link generation is operated by tap and draw. The learners can tap a node to become the starting point of the link. They can then draw the link to another node. Change of link label is operated by tap. The learners can tap a label to change and select one of 4 types of labels "action", "casual", "object" and "state". Link deletion is operated by long tap. The learners can do long press on the links they want to delete.
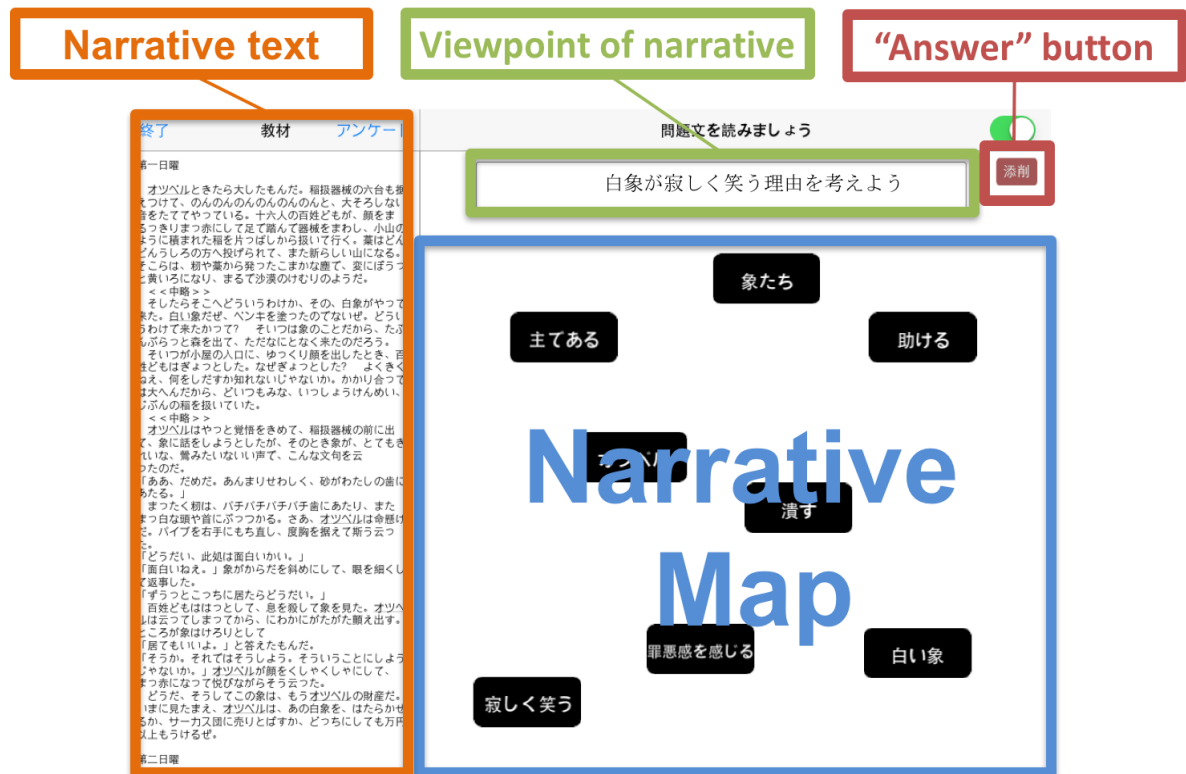

Figure 4. User interface

6. CASE STUDY

6.1 Purpose and Procedure

We have had a case study whose purpose was to ascertain whether the tablet tool could provide pseudo-haptic sense and cognitive awareness as shown in Table 1 compared to narrative map composition only with touch operation (without pseudo-haptic feedback). In order to allow the participants to compose a narrative map without pseudo-haptics, we prepared the control tool that removed the function of demonstrating the visual movements for the pseudo-haptics from the tablet tool. The participants were 6 graduate and undergraduate students in science and engineering. We set two conditions, which were (a) narrative map composition with the tablet tool (PseudoHaptic-group), and (b) narrative map composition with the control tool (Visual-group). We assigned 3 participants per condition.

In this case study, all participants were required to read a narrative text *"Ozbel and the Elephant"* (Kenji Miyazawa,1926), and to compose a narrative map with the tool. After map composition, they were required to refer to their composed map and to answer the questionnaire about pseudo-haptic sense and cognitive awareness brought about by pseudo-haptic feedback.

In order to evaluate the effects of the table tool, we compared the results of the questionnaire. The questionnaire included the following four questions:

(1) Select the nodes that felt important from the composed map
(2) Select the nodes included the part that felt an intention of the narrative from the composed map
(3) Select the node that felt heavy from the composed map
(4) Select the links in which you felt hard from the composed map

We used the answers to these questions to analyze.

6.2 Results and Consideration

Table 2 shows the results of the questionnaire. Node importance shows whether the node corresponding to the interlinear concept "*feel guilty*" felt important. Partial structure representing the intention shows how many nodes included in it felt representative of the narrative intention. Node heaviness shows whether the node corresponding to the interlinear concept felt heavy. Link hardness also shows how many links in the partial structure felt hard.

The results suggest that both group obtained almost the same cognitive awareness about the interlinear concept and narrative intention. As for PseudoHaptic-group, on the other hand, the participants obtained less pseudo-haptic sense about node heaviness, although the participant B obtained cognitive awareness of the interlinear concept.

Table 2. Cognitive awareness brought by presentation of pseudo-haptic and Awareness of presentation of pseudo-haptic

		(1)Node importance	(2)Partial structure representing the intention	(3)Node heaviness	(4)Link hardness
PseudoHaptic-group	A	incorrect	3 correct nodes	incorrect	2 correct links
	B	correct	4 correct nodes	incorrect	3 correct links
	C	correct	4 correct nodes	correct	5 correct links
Visual-group	D	correct	5 correct nodes	n.a	n.a
	E	correct	4 correct nodes	n.a	n.a
	F	correct	4 correct nodes	n.a	n.a

7. CONCLUSION

This paper has described the narrative map composition with pseudo-haptic feedback, which promotes the understanding the narrative intention. We have also demonstrated a narrative map generation tool on iPad, which could produce pseudo-haptic feedback such as heaviness and hardness on touch operations. The results of the preliminary case study suggest the possibility that the tablet tool could provide cognitive awareness of interlinear concept and narrative intention. However, the results also suggest we need to modify the pseudo-haptic feedback so that learners can obtain the pseudo-haptic sense in addition to cognitive awareness.

In future, we need to reconsider the method of pseudo-haptic feedback, and must have case studies with more subjects to evaluate the possibility of pseudo-haptic feedback. In addition, we will check whether the tablet tool can promote narrative intention understanding.

ACKNOWLEDGEMENT

REFERENCES

Ministry of education(2005), "Reading Comprehension Program", available at: www.mext.go.jp/a_menu/shotou/gakuryoku/siryo/05122201/014/005.htm (accessed 3 Jane 2017).

Ministry of education(2009), "Course of guidance 'Living power'", available at: http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/chu/koku.htm (accessed 3 Jane 2017).

Kashihara, A., Shiota, G.: Knowledge Construction with Pseudo-Haptics, Proc of ITS2014, LNCS 8474, Springer, pp.61-68, Hawaii, U.S.A. (2014).

Kashihara, A., Shiota, G.: Knowledge Construction with Visual and Pseudo-Haptic Senses, IEICE transaction, Vol.J98-D, No1, pp.104-116, 2015.01, in Japanese.

Kenji, M. (1989), Ozbel and elephant.

Lecuyer, A.: Simulating Haptic Feedback Using Vision: a Survey of Research and Applica- tions of Pseudo-Haptic Feedback, Teleoperators and Virtual Environments, Vol.18, No.1, pp.39-53, MIT Press, 2009