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Communication Analysis Focusing on Negative Utterances in Combinatorial Thinking Games

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Abstract. We have developed a table game named Innovators Market Game (IMG) that supports users in thinking up ideas by combining existing products. There are two kinds of players in the game, innovators and investors. While the innovators think up ideas and propose them, the investors criticize the ideas and make decisions as to whether or not they will invest their money in the ideas. In the game, the innovators not only propose ideas, but also improve on ideas that reflect utterances from investors that represent negative impressions. Although ideas that have much money invested in them might be related to negative utterances from investors, the relation has not been previously validated. We have analyzed the communications in the IMG and have found features of communication in which ideas were invested with much money. After a proposal of an idea by an innovator, investors give negative utterances to the innovator. The innovator accepts the negative utterances with positive utterances and improves their ideas. Finally, the investors satisfy the idea with positive utterances and invest highly in the idea.

Keywords: Innovators Market Game, Communication analysis, Negative utterance, Combinatorial thinking

1 Introduction

In the late 1990s, role sharing between innovators and investors helped many entrepreneurial ventures to be established in Silicon Valley. The culture of this role sharing has spread into Japan and other countries.

We have developed a table game named Innovators Market Game (IMG) that was invented based on the relationships between innovators and investors [1]. The game supports users in thinking up ideas by combining existing products. There are two kinds of players: innovators and investors. While the innovators think up ideas and propose them, the investors criticize the ideas and make decisions as to whether or not they will invest their money in the ideas. The purpose of the game is to train a player's ability in combinatorial thinking. A new product idea is a combination of existing products, and the ability of finding new combinations strongly depends on the ability of finding relationships between existing products [2]. We assume that the best way to train the players in the ability of combinatorial thinking is to make the players think through such combinations many times. Therefore, we have developed IMG as a fun game that lends itself to people making up new ideas. The innovators in the game are requested to think up new ideas for products required in a real, or actual society. In the game, the innovators do not only propose ideas, but also improve on ideas reflecting comments from the investors. The communications between the players help the innovators in improving their ideas. The innovators can develop their ideas as required by the investors who represent members of actual society who have invested much money. Though the communications are made for all ideas, some of the ideas receive large investments, while other ideas do not. Each communication is different from each other. If a communication in which a new idea invested with much money is obtained, new ideas required for actual society are frequently also obtained. This type of communication improves the ideas.

We analyzed the communications between the players in the game to find features of communications in which the ideas invested with much money were obtained. We focused on the communication itself as an analysis target because the amount of investment was strongly related to the communication. In IMG, players often use negative opinions to criticize defects of the ideas. Since most of the previous methods relating to creativity support have not allowed users to use negative opinions in their communications, the influence of negative opinion has not been previously revealed. By revealing such an influence, we can understand the features of IMG as an innovation generation methods.

2 Related works

In this section we first introduce the outline of IMG. Next, we explain the differences between IMG and previous works related to creativity support. Finally, we introduce the previous works related to communication analysis the features of our analysis.

2.1 Innovators Market Game

IMG is a face-to-face table game. There are two main kinds of players: innovators and investors. The role of the innovator is to propose new ideas. The role of the investor is to criticize the ideas and then invest money in the previously criticized ideas. The players play the game for about two hours. The innovator and the investor who have the highest incomes are the winners.

To play the game, the players need the following items: knowledge cards, a game board, and notes of virtual money. The knowledge cards are used to propose new ideas. Existing techniques are described in each card. About 40 cards are needed for one game. The innovators buy cards to propose new ideas by combining information described on the cards. The innovators can use the proposed ideas to propose other new ideas. A graph is drawn on a game board that visualizes the relationships of the knowledge cards (shown in Figure 1). The knowledge cards are described as nodes, and the relationships are described as edges on a graph. The relationships are evaluated by a data crystallization method proposed by Maeno and Ohsawa [3]. The method evaluates the co-occurrences of keywords written on two cards. If many keywords occur on both of the cards, the cards are connected by an edge.

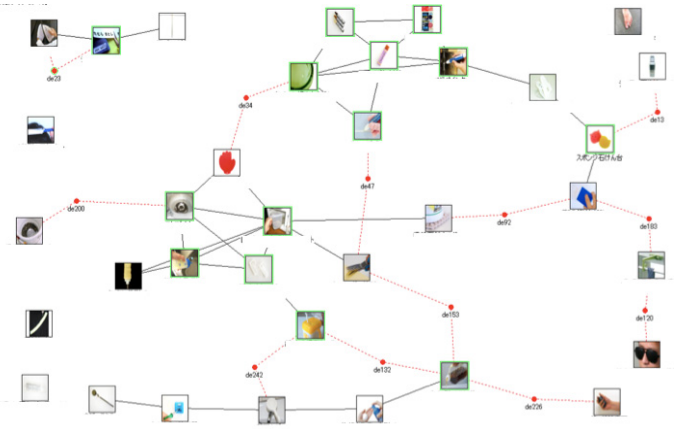

Figure 1. Example of a game board

2.2 Creativity support

Brainstorming is a traditional method used for sparking human creativity [4]. Brainstorming allows several to many people to work together to propose ideas without any constraints. IMG and brainstorming are similar to each other because both allow ideas to evolve from several to many people. However, they are different from each other because only IMG allows negative comments. The purpose of IMG is to obtain ideas required for an actual society. To obtain such ideas it is necessary to criticize the proposed ideas with negative comments. On the other hand, negative comments may prevent the innovators from creative thinking. To avoid this prevention, we adopted an IMG game style in which the players think up and improve ideas without any constraints.

This paper focuses on combinatorial thinking for idea creation as a creativity support method. A well-known and somewhat similar method is the K-J Method proposed by Kawakita Jiro (K-J) [5] that supports users in thinking up ideas by discovering relationships between data. The players in IMG do not only propose ideas, but also choose ideas by considering the relationships of the knowledge cards.

Previous work has proposed prediction methods of keyword combinations such as commercial items and research themes that could exist in the future with a high probability [6]-[8]. Though these methods can reduce the time needed to find such combinations, people still have to imagine how the combinations can be used in actual society. If how to use the idea is not thought up, the combination may be discarded. The players in IMG also think up how ideas can be used for actual society, and in this case, the ideas are never discarded.

2.3 Communication analysis

Much research has been conducted on communication analysis to improve human communications [9]-[11]. Yamashita and Ishida have revealed features of successful negotiation using a general method of conversation analysis [12]. Though we also analyze communications in IMG, we focus on revealing features of communication in which an idea invested with much money is obtained. We intend for the players in IMG to understand the features needed to make good communications for obtaining ideas that will have much money invested in them.

There are two kinds of player roles in IMG. Previous works on communication analysis that focused on people's roles have revealed relationships between utterances in terms of people's involvement in the utterance [13], and relationships between communication topics and communication leaders [14]. This paper also reveals

relationships between player roles and utterances in communications. In addition, the obtained findings will be given to the players as guidelines of communication.

One of the communication features in IMG is the allowance of negative utterances. In communication analysis focusing on utterance types, utterance labels that represent utterance types have been proposed and used [15], [16]. If we use the utterance labels for analyzing the communications in IMG, obtaining the efficiency of negative utterances is difficult because the number of labels for negative utterances is small. Therefore, we propose new utterance labels for the analysis instead of the previous labels.

3 Analysis method

This section explains an analysis method for communication in IMG.

3.1 Procedures

We analyzed all communications manually. We transcribed recorded voice data of communications to text data. First, we cut the text data into several text data in which an idea proposal was included. The starting point of the proposal was the beginning of a presentation by an innovator, and the end point was the beginning of an investment by investors. Secondly, we annotated labels that reflect the impressions of each utterance. Thirdly, we visualized label transitions as temporal sequences for an idea proposal. Finally, we obtained features of communication in which an idea was invested with much money.

3.1.1 Utterance labels that represent utterance impressions

We proposed four kinds of the labels for utterances reflecting a player's impressions: a positive label (P), a neutral label (I), a negative label (N), and a laughing label (L). The positive label was annotated to an utterance that showed a positive impression of the previous utterance in a communication. When players answered yes for a question, we annotated the P label for such an utterance. The neutral label was annotated to an utterance that showed a topic change that was not related to the previous utterance. When players answered questions about what the idea was used for, what knowledge cards were used, and so on, we annotated the I labels for such utterances. The laughing label L was annotated to an utterance of laughing.

The N label was annotated to an utterance that showed a negative impression of the previous utterance. We further defined four labels for the N label. These negative labels represented the features of communication in IMG.

N1: Denotes a negative impression of an idea. An investor does not understand what the idea is; therefore, he/she shows their impression with an emotional interjection.

N2: Denotes that an investor cannot accept an idea because he/she does not understand what the idea is; therefore, he/she shows their impression with a sentence.

N3: Denotes a negative question.

N4: Denotes an indication that an idea has deficiencies.

Table 1 shows utterance examples corresponding to the negative labels, N1, N2, N3, and N4. There were two types of negative labels. One of them was used to represent the player who does not understand the efficiency of idea, and the other was used to disallow understanding of the idea's efficiency. In case of the latter, if the player did not seem to have the possibility of understanding, we annotated using the N2 labels. If not, we annotated the N1 labels. In the case of the former, if the efficiency of an idea was disallowed, we assigned the N4 labels. If an innovator seemed to have the possibility of changing impressions by improving the idea's deficiencies, we annotated the N3 labels. Since the N1 labels and the N2 labels did not represent disallowances of an idea's efficiency, the possibility of improving the idea was expected. However, utterances annotated with the N1 labels did not give any information for the improvement of ideas. Therefore, the ideas criticized by utterances annotated by the N1 labels probably would not be improved. On the other hand, the N3 labels and the N4 labels represented disallowances of the idea's efficiency. However, which label was better for improving ideas was not clear. The purpose of the analysis was to verify the efficiency of the utterances annotated with the N2 labels for improving ideas, and to compare the efficiency of utterances annotated with the N3 labels and the N4 labels. Therefore, we defined the four labels for negative utterances, and we analyzed the relationships between negative utterances and the amount of the investments given to ideas.

Table 1. Examples of negative utterances obtained from communications in IMG

Label	Player	Utterance
N1	Innovator	It is expected in education.
	Investor	Hmm.
N2	Innovator	I propose … idea.
	Investor	I can not understand your idea because it is too innovative.
N3	Innovator	We can use all of the energy until the earth dies.
	Investor	What is the purpose of using huge quantities of energy?
N4	Innovator	Though the idea has some difficulties, I propose this idea for you.
	Investor	Your idea about small computers does not consider the security of data. I am afraid of using such a computer.

Table 2. Rates of annotation coincidence for each label

Label	P	I	N1	N2	N3	N4	L	Average
Rate	0.86	0.83	0.64	0.76	0.69	0.83	1.00	0.80

Two annotators judged these labels independently. In annotations, the annotators watched videos of communication to check non-verbal information. One of the authors checked the annotated labels. We used utterances annotated with the same labels by three people, two annotators and one of the authors, for the analysis. Table 2 shows the rates of annotation coincidence evaluated with equation (1).

$$\text{Rate}(\text{label}) = \text{E}(\#\text{ of label coincidences} / \#\text{ of annotated labels}) \quad (1)$$

Equation (1) evaluates the average rate of the number of label coincidences to the number of annotated labels.

There were no utterances that were not annotated without any negative labels although the annotators judged which utterances were the negative ones. This indicates that negative utterances obtained in IMG could be annotated with the negative labels. The rates of annotation coincidence were from 0.64 to 0.83. When labels are annotated randomly, the degree is about 0.14. Since the obtained degrees were bigger than 0.14, the negative labels were valid for the analysis.

3.1.2 Definition of an idea that has much money invested in it

We defined an idea invested with much money as an idea whose amount of investments was bigger than the sum of the average and the standard deviation of the investment in one game.

3.2 Analyzed data and analyzed items

We used five data sets obtained in IMG for the analysis (as shown in Table 3). Each set of players was different from each other. Each set of knowledge cards was also different from each other. Some of the players played IMG for the first time, while

Table 3. Analyzed data of IMG

Game	Number of innovators	Number of investors	Number of total ideas obtained	Number of ideas invested with much money
1	3	3	16	1
2	4	3	20	3
3	4	8	13	2
4	4	8	13	2
5	3	6	17	3

Table 4. Averages and standard deviations of the amount of investments

Game	Average	Standard deviation	Average + standard deviation
1	1.2	2.6	3.7
2	4.3	4.1	8.4
3	3.5	2.3	5.8
4	5.1	4.4	9.5
5	8.6	7.9	16.6

some of the others have played IMG more than ten times. Table 4 shows the averages and the standard deviations of the amount of investments.

The analyzed items were the follows: (1) the relationship between an idea with a large investment and the number of utterances in an idea proposal, (2) the relationship between a much invested idea and utterance labels, and (3) a relationship between a much invested idea and a label transition.

4 Results and discussion

This section discusses the features of communication in which an idea invested with much money is obtained.

4.1 Relationship between ideas invested with much money and the number of utterances

Table 5 shows the averages and the variances of utterances in communications. The average for ideas invested with much money was bigger than the average for ideas not invested with much money ($t=4.2$, $P=0.00087<0.1$). Although the average from innovators was 22.2, the average from investors was 20.8. There was no significant difference between them ($t=1.3$, $P=0.19>0.1$). These results indicate that if innovators and investors communicate with each other for a long time, ideas invested with much money are obtained more frequently than if there is less communication.

Table 5. Averages and variances of utterances in communications

	High investment	Low investment
Average of utterances	42.8	23.5
Variance of utterances	12.9	16.9

4.2 Relationship between ideas invested with much money and utterance tags

Figure 2 shows label rates in idea proposals. The rate of the positive utterances for ideas invested with much money was higher than the rate for ideas not invested with much money (Chi-squared = 85.4, P=2.2e-16<0.1, r=9.00). On the other hand, the rate of positive utterances from innovators was 0.4, and the rate from investors was 0.38. There was no significant difference between them (t=0.27, P=0.78>0.1). These results indicate that if innovators and investors make positive utterances, ideas invested with much money are obtained frequently.

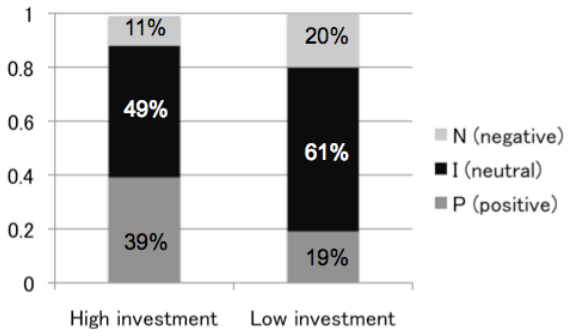

Figure 2. Rates of each label in the idea proposals percentages were the averages for all ideas

The rate of negative utterances for ideas not invested with much money was higher than the rate for ideas invested with much money (Chi-squared = 85.4, P=2.2e-16 <0.1, r=4.37). Though the rate of negative utterances from innovators was 0.16, the rate of negative utterances from investors was 0.31. There was a significant difference between them (t=5.05, P=0.000014<0.1). These results indicate that if investors make negative utterances, ideas not invested with much money are obtained frequently.

4.3 Relationship between an idea invested with much money and a label transition

Figure 3 shows an example of a label transition in a communication in which an idea was invested with much money. On the other hand, Figure 4 shows an example of a label transition in a communication in which an idea was not invested with much money. The vertical axis denotes an utterance label, and the horizontal axis denotes an uttered player in a temporal sequence. The number of positive utterances was big in Figure 3, and the communication ended with a positive utterance. On the other hand, rounds between positive utterances and negative utterances appeared in Figure 4, and the communication did not end with a positive utterance.

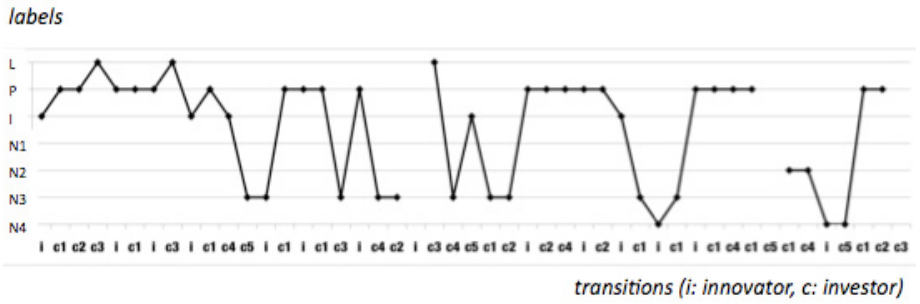

Figure 3. Label transition in which an idea invested with much money was obtained. The vertical axis denotes an utterance label. The horizontal axis denotes each player. This transition corresponds to a transition (6) in Table 6.

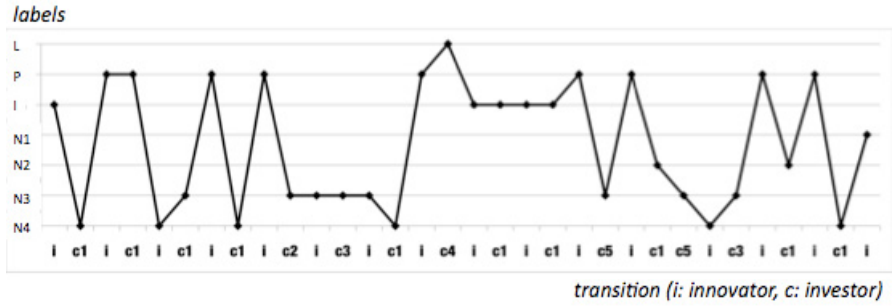

Figure 4. Label transition in which an idea not invested with much money was obtained. This transition corresponds to a transition (1) in Table 6.

Figures 3 and 4 indicate that the transitions for ideas invested/not invested with much money were different from each other. To check the difference, we defined 11 patterns of transition shown on the left side of Table 6, and counted the number of ideas with transitions that corresponded to each pattern. To define the patterns, we defined two shapes of label transition: a divergence and a convergence. The divergence is a round in which different labels appear more than four times. The convergence is a sequence in which the same labels appear more than four times. There are two types of divergence. One of them is a label sequence whose first label is a negative/neutral label and the second label is a positive one (shown on the left side of Figure 5). The other is a label sequence where the first label is a neutral/positive label and the second label is a negative one (shown on the right side of Figure 5). The obtained results are shown in Table 6.

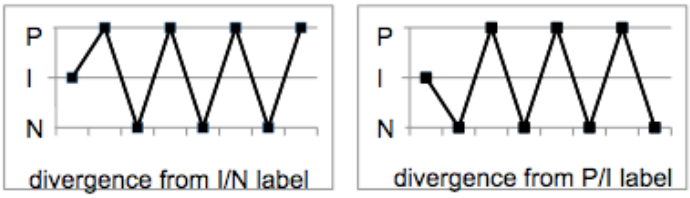

Figure 5. Examples of a divergence from the bottom and a divergence from the top in the transitions of labels

Table 6. Label transitions, number of ideas invested with much money, and the number of ideas not invested much money. D denotes a divergence. C denotes a convergence.

Transition	High investment	Low investment
(1) Start with D from the top. End with the D.	1	18
(2) Start with D from the bottom. End with the D	0	14
(3) Start without D. End with C to P labels.	0	17
(4) Start without D. End with C to I labels.	0	3
(5) Start without D. End with C to N labels.	1	1
(6) Start with D from the top. End with C to P labels.	10	8
(7) Start with D from the top. End with C to I labels.	0	0
(8) Start with D from the top. End with C to N labels	0	0
(9) Start with D from the bottom. End with C to P labels.	1	3
(10) Start with D from the bottom. End with C to I labels.	0	0
(11) Start with D from the bottom. End with C to N labels.	0	2

4.3.1 Discussion about a transition (6) in Table 6

An example of a transition in which an idea was invested with much money is the transition (6) as shown in Table 6. Table 7 shows an example of communication in which the transition (6) appeared. Investors gave negative utterances about the risk of the ozone by #2 and #4 utterances. Then an innovator gave an utterance about the consideration of ozone risk by #5 utterance. Rounds between positive/negative utterances appeared in this communication. Since the investors finally accepted the idea and gave positive utterances, the communication ended with positive utterances that corresponded to #6 through #9 utterances. In communications in which the transitions (6) appeared, innovators improved the deficiencies pointed out by investors, and most of investors accepted the proposed ideas. This acceptance indicates that negative utterances helped innovators improve their ideas. Therefore, when transition (6) appeared in a communication, an idea invested with much money was obtained.

Table 7. Example of a communication that corresponds to a transition (6)

#	Player	Utterance
1	Innovator (I)	I propose an idea to reduce grime in pipes by combining plastic pipes and fat splitting in the ozone.
2	Investor 1 (N4)	It may be risky to use the ozone if people are near the system.
3	Innovator (P)	I think so.
4	Investor 1 (N3)	How do you consider the reduction of risks?
5	Innovator (P)	Even if people breathe in the ozone, they do not get ill soon. Though the pipes in my idea are placed on the ground and set in the underground, the ozone system is set only underground. So, if any accidents happen, no people will die.
6	Investor 2 (P)	Do you think that it is safe because the ozone system is set far from people?
7	Innovator (P)	Yes, I do.
8	Investor 1 (P)	OK. I accept your idea.
9	Investor 2 (P)	I see.

However, when the transition (6) appeared in the communications, ideas not invested with much money were also obtained. We calculated the rates of each negative label in communications that included transitions (6) to analyze the differences between ideas invested/not invested with much money. The rates are shown in Figure 6. The rate of the N2 label for ideas invested with much money was higher than that for ideas not invested with much money. On the other hand, the rate of the N4 labels for ideas not invested with much money was higher than that for ideas invested with much money (Chi-squared = 16.4, P=0.009 < 0.1, r (N2) =3.41, r (N4) = 3.35). The high rate of the N2 labels indicated that it was difficult for investors to understand what an innovator proposed. Since innovators could obtain acceptances from investors by adding explanations to their original ideas, the ideas proposed by the innovator were invested with much money. On the other hand, the high rate of the N4 labels indicated that many defections were included in ideas proposed by innovators. Though the innovators tried to improve the defections, the ideas were not invested with much money because of the initial bad impressions. These results

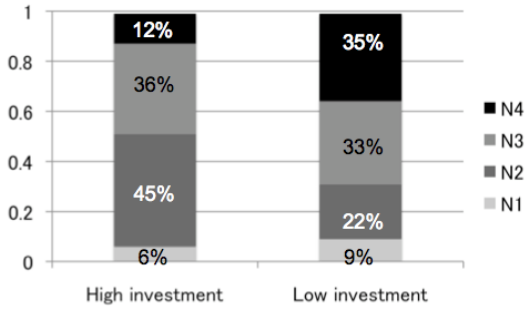

Figure 6. Rates of each negative utterance in a transition (6)

indicate that when the transition (6) appeared in a communication, the high rate of N2 tags leads to obtaining ideas invested with much money, and the high rate of N4 tags leads to obtaining ideas not invested with much money.

4.3.2 Discussion about transitions (1) and (2) in Table 6

Transitions in which ideas were not invested with much money were the transitions (1), (2), and (3) as shown in Table 6. In the transitions (1) and (2), rounds between positive/negative utterances are shown and the communications end with divergences. Table 8 shows an example of communication that corresponds to the transition (1). An idea about a bath that put a bath agent into the communication automatically was proposed. The #1 utterance corresponded to an idea proposal. For this idea, investors criticized the idea of putting the bath agent into a communication automatically and thought it was nonsense in #2, #5, and #7 utterances. The innovator could not defeat the negative utterances using the #8 utterance, and she/he could not obtain acceptance from the investors. That was why the idea was not invested with much money.

Table 8. Example of a communication that corresponds to a transition (1)

#	Player	Utterance
1	Innovator (I)	I propose an idea about putting in an automatic system for putting bath salt into a bath by combining a pump with safety valves and a bath.
2	Investor 1 (N3)	I would like to put the bath salt in by myself and not automatically.
3	Investor 2 (P)	Yes, me too!
4	Innovator (N2)	This system can take a solid bath salt, not a liquid one.
5	Investor 1 (N3)	I would like to watch the spreading of the bath salt by adding it myself to a bath.
6	Innovator (P)	You would like to watch it, wouldn't you?
7	Investor 3 (N2)	It is fun to watch adding bath salt as I like.
8	Innovator (N2)	I am not sure all of you think so.

4.3.3 Discussion about transition (3) in Table 6

In transition (3), no round appeared, and the communication ends with a positive utterance. Table 9 shows an example of a communication that corresponds to the transition (3). In Table 9, an innovator in the #1 utterance proposed an idea about a dance service with robots after a haircut. Though investors gave positive utterances in the #2 and #4 utterances, they did not invest much money in the idea. This result indicates that investors tend to give positive utterances even though they do not accept the ideas.

Table 9. Example of a communication that corresponds to a transition (3)

#	Player	Utterance
1	Innovator (I)	I propose an idea about a dance service by combining dance robots, a partition system, and a 10-minute haircut service.
2	Investor 1 (P)	I see.
3	Innovator (I)	Would you invest in the idea?
4	Investor 2 (P)	Your idea is interesting.
5	Investor 3 (P)	Can we use only the haircut service if we like?
6	Innovator (P)	Yes, you can. In such a case, we would create a different system for the charges.

As a result, we found that a communication in which an idea was not invested with much money ended with rounds between positive/negative utterances, and ended with a convergence to a positive utterance.

4.4 Automatic evaluation of ideas invested with much money

In IMG, innovators and investors exchange notes of virtual money for investments to ideas. The exchanges stop the running of the game. Since we would like to cut the exchange processes, we reviewed the possibility of an automatic evaluation of ideas invested with much money by using three findings obtained from the analysis. The findings are as follows: many utterances in a communication (obtained in Section 4.1), a high rate of positive utterances in a communication (obtained in Section 4.2), and the transition (6) in a communication (obtained in Section 4.3). The threshold of the number of utterances was set to 42.8 because this was the average obtained in Section 4.1. The threshold of positive utterances was set to 0.39 because this was the average obtained in Section 4.2. We calculated precisions and recalls for evaluating ideas invested with much money by using equations (2) and (3):

$$precision = \frac{n(invested \wedge finding)}{n(finding)} \quad (2),$$

$$recall = \frac{n(invested \wedge finding)}{n(invested)} \quad (3),$$

where n denotes the number of ideas, *invested* denotes the ideas invested with much money, and *finding* denotes ideas satisfied with the findings. Figure 7 shows the precisions and the recalls. Though the highest precision was obtained by considering all findings, the highest recall was obtained only by considering a finding about the transition (6) in a communication. These results indicate that all findings are useful for narrowing downs ideas to the ones invested with much money, and the finding about the transition (6) is useful for obtaining as many ideas as possible that are invested with much money.

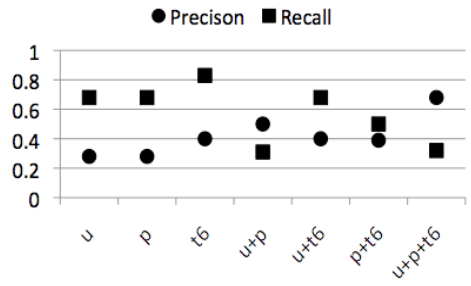

Figure 7. Precisions and recalls evaluating ideas invested with much money by using the findings obtained from the analysis. U denotes a finding about the number of utterances obtained in Section 4.1. P denotes a finding about the rate of positive utterances obtained in Section 4.2. T6 denotes a finding about the transition (6) obtained in Section 4.3.

5 Conclusion

In this paper, we analyzed features of communication in which a new idea invested with much money was obtained. We found the following features of communication:

(1) After a proposal of an idea by an innovator, investors give negative utterances to the innovator.

(2) The innovator accepts the negative utterances with positive utterances and improves their ideas.

(3) Finally, the investors satisfy the idea with positive utterances and invest much money in the ideas. However, if the rate of negative utterances pointing out the idea's deficiencies objectively is high, the idea is not invested with much money.

We ask the innovators to think up ideas with few defections, and recommend communication to all players in the game.

IMG can be applied to training courses in business companies. A manager of the training course in IMG divides new recruits into innovators and investors. The manager instructs the innovators to think up business ideas with few deficiencies. The manager also instructs the investors to look for defections of the proposed ideas, and criticizes them by using negative utterances. Both the innovators and the investors are instructed to communicate with each other to improve the proposed ideas with new ideas that have even fewer deficiencies. Through playing IMG, the new recruiters can learn communication in which positive ideas are obtained.

Currently, the game is played face to face. However, players who meet for the first time may find it difficult to make negative utterances in the early stages of the game.

We plan to improve the game so that such players can make negative utterances early on. The improvement is also useful for obtaining new ideas required for actual society.

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