Communication Analysis on Innovators Market Game

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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 whether they invest money to the ideas or not. In the game, the innovators do not only propose ideas, but also improve the ideas reflecting utterances from investors that represent negative impression to the ideas. Although it has been considered that ideas invested much money might be related to negative utterances from investors, the relation has not been validated. We analyzed the communications in the IMG. We have found features of communication in which ideas were invested much money. After a proposal of 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 much money to them.

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 the 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 relationships between innovators and investors [Ohsawa 08]. 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 whether they invest money to them or not. The purpose of the game is to train a player's ability of combinatorial thinking. It is considered that new ideas are just combinations of existing products, and an ability of finding new combinations strongly depends on an ability of finding relationships between existing products [Young 88]. We considered that the best way to train the ability is to make people think such combinations many times. Therefore, we have developed IMG just as a game that gave people funs in thinking ideas.

The innovators in the game are requested to think up new ideas required for a real society. In the game, the innovators do not only propose ideas, but also improve the ideas reflecting comments from the investors. The communications between the players help the innovators in improving their ideas. The innovators can develop their ideas that are required by the investors as members of the real society and invested much money. Though the communications are made for all ideas, some of the ideas are invested much money, and the others are not. It is considered that both of the communications are different from each other. If a communication in which a new idea invested much money is obtained is found, new ideas required for the real society are frequently obtained. The reveal of the communication improves the game.

We analyzed the communications between the players in the game in order to find features of communication in which ideas invested much money were obtained. We focused on the communication as an analysis target because it was considered that the amount of investment was strongly related to the communication.

2. Related Works
This section introduces IMG at first. Then, we explain the differences between IMG and the previous works related to creativity support. After that, we introduce the previous works related to communication analysis in order to clear features of our analysis.

2.1. Innovators Market Game
IMG is one of the table games. There are several kinds of players, innovators, investors and dealers. A role of the innovator is to propose new ideas. A role of the investor is to criticize the ideas and invest money to them. A role of the dealer is to control a game process. They play the game for about two hours. An innovator and an investor who have the highest incomes are the winners.

To play the game, the players need some items, knowledge cards, a game board, and billets 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 a one game. The innovators buy a card for one dollar to propose new ideas by combining information described in the cards. The innovators can use the proposed ideas to propose another new ideas. The game board is a graph that visualizes relationships of the knowledge cards. The knowledge cards are described as nodes, and the relationships are described as edges in the graph. The relationships are evaluated by a data crystallization method proposed by Maeno et. al [Maeno 07]. The method evaluates co-occurrences of keyword written in two cards. If many keywords are occurred in both of the cards, the cards are connected with an edge.

2.2. Creativity support

Brain Storming is one of the traditional methods for supporting human creativity [Osborn 53]. Brain Storming aims to obtain good ideas by adding comments from many people to ideas while they propose ideas without any constraints. IMG and Brain Storming are similar to each other in point of adding comments from many people to ideas. However, they are different from each other in point of allowing negative comments. The purpose of IMG is to obtain ideas required for the real society. It is necessary for obtaining such ideas to criticize defections of the proposed ideas with negative comments. That is why negative comments are allowed in IMG. On the other hand, negative comments may prevent the innovators from creative thinking. To avoid the prevention, we adopted a game style to IMG in which the players think up and improve ideas without any constraints.

This paper focuses on combinatorial thinking for idea creation that is one of the creativity support methods. One of the famous methods is KJ method proposed by Kawakita [Kawakita 82] that supports users for thinking ideas by discovering relationships between data. The players in IMG do not only propose ideas, but also choose ideas considering the relationships of the knowledge cards.

The previous works have proposed prediction methods of keyword combinations that would exist as commercial items and research themes in the future with high probability [Nishihara 07, Trumbach 07 , Kurz 02]. Though these methods can reduce the time to find such combinations, people have to think how the combinations are used for the real society. If how to use the idea is not thought up, the combination may be put away. The players in IMG also think up how ideas are used for the real society. Therefore, ideas required for the real society are never put away.

2.3. Communication analysis

Many researches have been conducted on communication analysis in order to improve human communications [Watts 07, London 97, Connolly 90]. Yamashita et. al have revealed features of successful negotiation using a general method of conversation analysis [Yamashita 05]. Though we also analyze communications in IMG, we focus on revealing features of communication in which an idea invested much money is obtained. The features will be useful for improving communications in IMG.

There are two kinds of the player role in IMG. The previous works about communication analysis focusing on people roles have revealed relationships between utterances and people involvements [Wrede 03], and relationships between communication topics and communication leaders [Walker 90]. This paper also reveals relationships between player roles and utterances in communications. The obtained findings will be given to the players as guidelines of communication.

One of the communication features in IMG is an allowance of negative utterance. In communication analysis focusing on utterance types, utterance labels that represent utterance types was proposed and used [Allen 97, Jurafsky 97]. If we use the utterance labels for analyzing the communications in IMG, it is difficult to obtain the efficiency of negative utterance because the number of the 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 of communications in IMG.

3.1. Procedures

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

3.2. Utterance labels that represent utterance impressions

We proposed four kinds of the labels for utterances reflecting player's impressions: positive label (P), neutral label (I), negative label (N), and laughing label (L). The positive label was annotated to an utterance that showed a positive impression to 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 to questions what the idea was used for, what the knowledge cards were used, and so on, we annotated the I labels for such utterances. The N label was annotated to an utterance that showed a negative impression to the previous utterance. We particularly defined four labels for the N label. These negative labels were the features of communication in IMG.

N1: It denotes a negative impression to an idea. An investor does not understand what an idea is.
N2: It denotes that an investor cannot accept an idea because he/she does not understand what an idea is.
N3: It denotes a negative question.
N4: It denotes an indication pointing out defections of an idea.

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

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 the same labels by the three people, two annotators and one of the authors, for the analysis. Table 2 shows the rates of annotation coincidence evaluated with Eq. (1).

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

Eq. (1) evaluates the averaged rate of the number of label coincidences to the number of annotated labels.

There was no utterance that was not annotated any negative labels though the annotators judged the utterance was the negative one. This indicates that negative utterances obtained in IMG could be annotated with the negative labels. The rates of annotation coincidence were in 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.

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 for using the huge quantity of energy?
N4	Innovator	Though the idea has some difficulties, I propose this for you.
	Investor	Your idea about small computer 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

Table 3. Analyzed data of IMG

Game	# of innovators	# of investors	# of total	# of much invested
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

Table 5. Averages and variances of utterances in communications

	Much invested	Not much invested
Average of utterances	42.8	23.5
Variance of utterances	12.9	16.9

3.3. Definition of an idea invested much money
We defined an idea invested 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.

3.4. Analyzed data and analyzed items
We used five data sets obtained in IMG for the analysis (as shown in Table 3). Table 4 shows the averages and the standard deviations of the amount of investments.

The analyzed items were the follows: (1) a relationship between a much invested idea and the number of utterances in an idea proposal, (2) a 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 features of communication in which an idea invested much money is obtained.

4.1 Relationship between much invested idea and number of utterances
Table 5 shows the averages and the variances of utterances in communications. The average for ideas invested much money was bigger than the average for ideas not invested much money (t=4.2, P=0.00087<0.1). Though 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 if innovators and investors communicate with each other for a long time, ideas invested much money are obtained frequently.

4.2 Relationship between much invested ideas and utterance tags
Figure 1 shows label rates in idea proposals. The rate of the positive utterances for ideas invested much money was bigger than the rate for ideas not invested 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 if innovators and investors utter positively, ideas invested much money are obtained frequently.

The rate of negative utterances for ideas not invested much money was bigger than the rate for ideas invested 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 if investors utter negatively, ideas invested much money are not obtained frequently.

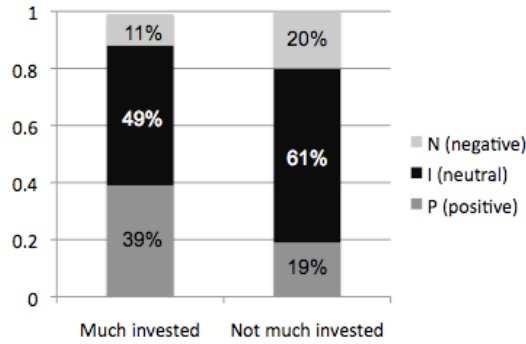**Figure 1.** Rates of each label in idea proposals. Percentages were the averages for all ideas
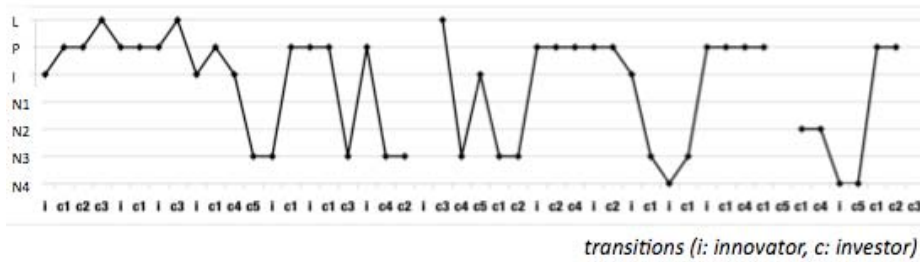

Figure 2. Label transition in which an idea invested much money was obtained. The vertical axis denotes an utterance label. The horizontal axis denotes each player. This transition corresponds to a transition (6) in Table 6
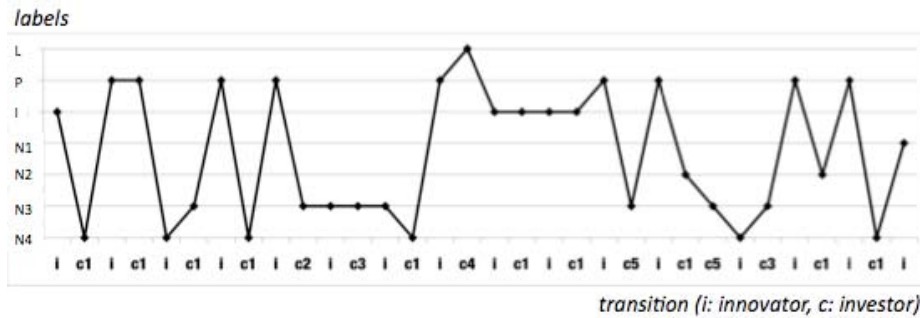

Figure 3. Label transition in which an idea not invested much money was obtained. This transition corresponds to a transition (1) in Table 6
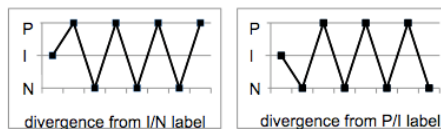

Figure 4. Examples of a divergence from the bottom and a divergence from the top in transitions of labels

4.3 Relationship between a much invested idea and a label transition

Figure 2 shows an example of label transition in a communication in which an idea was invested much money. On the other hand, Figure 3 shows an example of label transition in a communication in which an idea was not invested 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 2, and the communication ended with a positive utterance. On the other hand, rounds between positive utterances and negative utterances were appeared in Figure 3, and the communication did not end with a positive utterance.

Figure 2 and Figure 3 indicate that the transitions for ideas invested/not invested much money were different from each other. For checking the difference, we defined 11 patterns of transition shown in left side of Table 6, and counted the number of ideas whose transitions were corresponded to each pattern. For defining 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 in left side of Figure 4). The other is a label

sequence whose first label is a neutral/positive label and the second label is a negative one (shown in right side of Figure 4).

A transition in which an idea was invested much money was the transition (6) as shown in Table 6. Table 7 shows an example of communication in which the transition (6) was appeared. Investors gave negative utterances about the risk of 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 were appeared in this communication. Sicne the investors finally accepted the idea and gave positive utterances, the communication ended with positive utterances that corresponded to #6 through #9 utterance. In communications in which the transitions (6) were appeared, innovators improved the defections pointed by investors, and most of investors accepted the proposed ideas. This indicates that negative utterances helped innovators to improve their ideas. Therefore, when the transition (6) was appeared in a communication, an idea invested much money was obtained.

However, when the transitions (6) were appeared in communications, ideas not invested much money were also obtained. We calculated the rates of each negative label in communications that included transitions (6) in order to analyze the differences between ideas invested/not invested much money. The rates are shown in Figure 5. The rate of the N2 label for ideas invested much money was bigger than that for ideas not invested much money. On the other hand, the rate of the N4 labels for ideas not invested much money was bigger than that for ideas invested 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 for ideas, the ideas proposed by the innovator was invested 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 much money because of the first bad impressions. These results indicate that when the transition (6) is appeared in a communication, the high rate of N2 tags leads to obtain ideas invested much money, and the high rate of N4 tags leads to obtain ideas not invested much money.

Transitions in which ideas were invested much money were the transition (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 bath agent into automatically was proposed. The #1 utterance corresponded to an idea proposal. For the idea, investors criticized that putting bath agent into a bath automatically was nonsense by #2, #5, and #7 utterances. The innovator could not defeat the negative utterances by #8 utterance, and he could not obtain acceptances from the investors. That was why the idea was not invested much money. In the transition (3), no round is appeared, and the communication ends with a positive utterance. Table 9 shows an example of communication that corresponds to the transition (3). In Table 9, an idea about dance service with robots after hair cut was proposed by an innovator with #1 utterance. Though investors gave positive utterances by #2 and #4 utterances, they did not invest much money to the idea. This result indicates that investors tend to give positive utterances even though they do not accept ideas.

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

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

Transition	Much invested	Not much invested
(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

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

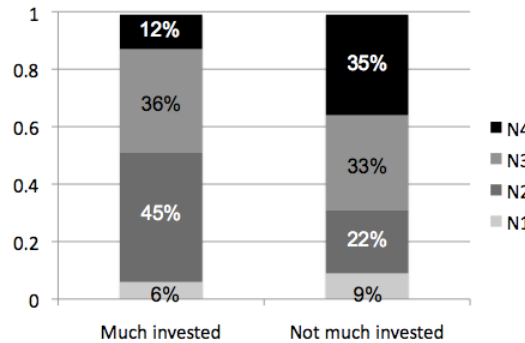| #	Player	Utterance
1	Innovator (I)	I propose an idea to reduce grimes in pipes by combining plastic pipes and fat splitting by ozone.
2	Investor 1 (N4)	It may be risky to use ozone if people are near the system.
3	Innovator (P)	I think so.
4	Investor 1 (N3)	How do you consider the reduction of risks?
5	Innovator (P)	Even if people breathe ozone, they do not get illness soon. Though the pipes of my idea are set to ground and underground, the ozone system is set in underground. So, if any accidents happen, it is considered that no people 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 you idea.
9	Investor 2 (P)	I see.

Figure 5. Rates of each negative utterance in a transition (6)

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

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

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

#	Player	Utterance
1	Innovator (I)	I propose an idea about dance service by combining dance robots, partition system, and hair cut service for 10 minutes.
2	Investor 1 (P)	I see.
3	Innovator (I)	Do you invest the idea?
4	Investor 2 (P)	Your idea is interesting.
5	Investor 3 (P)	We can use only hair cut service?
6	Innovator (P)	Yes, you can. In a such case, we prepare the other charge system.

4.4. Automatic evaluation of ideas invested much money

In IMG, innovators and investors exchange the billets 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 automatic evaluation of ideas invested much money by using three findings obtained from the analysis. The findings were as follows: many utterances in a communication (obtained in Section 4.1), 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 much money by using Eq. (2) and Eq. (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 ideas invested much money, finding denotes ideas satisfied with findings. Figure 6 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 is useful for narrowing downs ideas to ones invested much money, and a finding about the transition (6) is useful for obtaining ideas invested much money as many as possible.
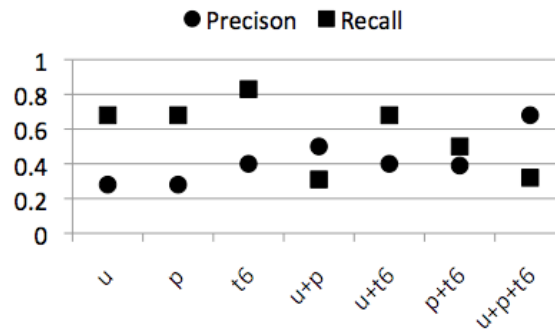

Figure 6. Precisions and recalls evaluating ideas invested much money by using findings obtained from the analysis. U denotes a finding about the number of utterances obtained in Section 4.1. P denotes a finding about the rate of positive utterances obtained in Section 4.2. T6 denotes a finding about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

5. Conclusion

In this paper, we analyzed features of communication in which a new idea invested much money is obtained. We found features of communication: after a proposal of 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 much money to them. However, if the rate of negative utterances pointing out idea's defections objectively is high, the idea is not invested much money. We ask innovators to think up ideas with few defections, and recommend the communication to all players in the game.

Now, the game is played by face to face. It may be difficult for players who meet at first time to utter negatively in the early stage of the game. We plan to improve the game in which such players can utter negatively. The improvement is also useful for obtaining new ideas required for the real society.

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