

The feeling of what happens in a game

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Abstract—Isolation can result in such extreme states of mind as suicidal ideation, which are sometimes experienced by patients of psychiatric disorder (e.g. depression). We investigated when or why we feel a sense of isolation in the physical proximity of others, using a money game without any aspect of interest payments. 3 subjects of the same sex took part in a “lend and pay back money game.” One of them, designated by the experimenter, was “betrayed” by other subjects. Under the condition in which the subjects represented their trust in others when they lent money, they felt loneliness (but not sadness) when they were betrayed. Thus, we could replicate the feeling of loneliness through this procedure. This result may suggest that the sense of loneliness is associated with trust in and from others. This study showed the importance of interaction with others and its effects on both mental and physical well-beings. These results suggest a possible correlation with and a model system of psychiatric disorder symptoms.

Keywords—loneliness; sadness; trust

I. INTRODUCTION

Interactions with other people, including family, friends, peers and partners, play an important role in life. The human beings are highly social, and it is a natural tendency to rely on others and form affectional bonds with them in life. However we may feel a sense of isolation, even in the physical presence of others, e.g., when we are talking with our friends. Why do we experience a sense of isolation in such cases?

Some reports have shown that loneliness is associated with schizophrenia and depression in adolescents and adulthood [1]. Indeed, it has been suggested that a potentially problematic situation, in which many patients have a suicidal ideation, comes from a sense of isolation that they often feel [2].

Additionally, some studies examined how treatments involving social isolation had behavioral and anatomical effects. Social isolation in juvenile mice elicits impediments of spatial learning and memory [3]. In rats, the volume of medial prefrontal cortex was decreased by social isolation (while there was no change in the number of neurons), the same phenomena being found for patients with schizophrenia in humans [4]. It can be inferred that these anatomical

defects lead in turn to cognitive deficits. Moreover, other studies have reported that there were relationships between loneliness and eating disorders, obesity, anorexia [1]. These evidences suggest that the sense of isolation can lead to impairments of general health conditions.

Recent studies have focused on the significance of social interaction and communication. Eisenberger NI., et al. showed that the anterior cingulate cortex (ACC), which is associated with physical pain, is activated by social exclusion. In their study involving a virtual ball-tossing game, a subject was excluded from the tossing of the ball. It was found that the subjects were distressed by this social exclusion [5]. Recently, it has also been reported that social support of one's partner could reduce a physical pain in women [6]. The physical pain could be reduced not only when having the hands held by their romantic partner but also simply by viewing a photograph of them. In the context of social communication, it was reported that good reputation from others activated the striatum in a manner similar to the monetary reward [7].

These evidences suggest that the interaction with others have drastic effects on one's well-being.

Anecdotal evidences suggest that when we communicate with others, we often feel a sense of isolation that is different from what one feels under a condition of physical isolation. In this study, we hypothesized that one may feel a sense of loneliness (and also sadness) in the absence of trust. We examined how negative feelings (loneliness and sadness) would be induced when the subject lost trust in others due to betrayal. In a previous study, Kruger F., et al. examined how trust in others was constructed using money game [8]. We used money game in this study, without any aspect of interest payments. We examined whether the lack of trust in a gaming condition would affect the subject's mental condition when they were betrayed, in the physical presence of others.

II. METHODS

A. General method

Subjects: The subjects were 9 healthy people (6 males and 3 females) who were members in the same laboratory. Mean age and SD was 31.0 ± 2.25 years. They were all right-handed by self-report, and had a normal or

corrected-to-normal vision. The subjects were explained about the general conditions of the experiment and gave written informed consent.

Procedure: 3 subjects of the same sex (named A, B and C here) sat around a round low table (1 meter across) and played a "lend and pay back money game." The room temperature was 25°C. The table was separated into three compartments that were provided to subjects as their territories. The height of the partition was about 0.25 meter, so subjects could not observe others' behaviors. "Self-money space" (where subjects put their own money) and a place to put money when lending or paying back were provided and designated by pieces of cloth in each subject's territory. The subjects rated their physical and emotional conditions (hotness, hunger, happiness, tiredness, sadness, sleepiness, loneliness, contentment (satisfaction), thirstiness, pleasantness, trust in others) on a 7-point scale (1-low, 7-high) with a written questionnaire before and after each session, completed within one minute. The questions and ratings were given in the subjects' native language of Japanese. Previous studies have suggested that eye gaze activates the striatum associated with reward prediction [9] and social touch may have a certain influence on social interaction [10]. Accordingly, subjects were prohibited from talking, turning one's gaze on the others, laughing, and touching other's hand as they interacted with each other in the task.

Game task procedure: The experiment consisted of 7 sessions. Sessions 1, 3, 5, and 7 were the control conditions and sessions 2, 4 and 6 were the "betrayed" conditions. Each session consisted of 12 trials (6 for the interaction with one's neighbor on the right, and 6 for the left). The lending and paying back were conducted within 25 s (5 minutes per session for 12 trials.).

In the betrayed condition, there was one betrayed person (A in session 2, B in 4, C in 6) and two contrivers in the designated order. Two contrivers behaved independently, and did not explicitly conspire.

Analysis procedure: The differences in the feelings of subjects between conditions were evaluated using two-tailed T-test. The correlations between measures of subjects' feelings by correlation analysis were calculated.

B. Experiment1

Procedure for providing money: All subjects were provided with 33,336 yen from the experimenter before the experiment. All paper currencies used in this study were folded and clipped in a way that they would be as large as coins.

Game task procedure: In the control condition, subjects lent 10,000, 1,000 or 100 yen to one's neighbor (on the right in the odd-numbered trials, and on the left in the even-numbered trials). Subsequently, they paid back the same amount to the payer (on the left in the odd-numbered trials, and on the right in the even-numbered trials).

In the "betrayed" condition, subjects conducted the process of lending and paying back in the same way as in the control condition. Two contrivers lent 10,000, 1,000 or 100 yen and paid back the same amount to each other. On the

other hand, they were instructed to lend 100, 10 or 1 yen to the betrayed person, paying back less than the amount bestowed. In addition, two contrivers could pay back less than 100 yen to the betrayed person. The betrayed person took actions in the same way as in the control condition.

C. Experiment2

Procedure for providing money: Except for the following points, the procedure was the same as in Experiment 1. All subjects were provided with 3,336 yen from the experimenter before the experiment. The experimental money was given in exchange to the subject's own money.

Game task procedure: Except for the following points, the procedure was the same as in Experiment 1.

In the control condition, subjects lent 1,000, 100 or 10 or 1 yen to one's neighbor. Subsequently, they paid back the same amount to the lender.

In the betrayed condition, two contrivers lent 1,000 or 100 yen and paid back the same amount to the payer between them. On the other hand, the contrivers were instructed to lend 10 or 1 yen to the betrayed person and to start betraying from a self-determined point with the constraint that they had to start to betray at least after the 4th trial of paying back to the betrayed person. The contrivers could not give more than 10 yen to the betrayed person.

D. Experiment3

Procedure for providing money: Money was provided for all subjects in the same way as in Experiment 2.

Game task procedure: The experiment was constructed in a similar way as in Experiment 2.

However, in both the control and the betrayed conditions, the subjects were instructed to lend an amount of money as much as they could give away, representing their trust in the borrower.

Moreover, in the betrayed condition, two contrivers were instructed to start betraying from the 1st trial for the betrayed person in the same way as in Experiment 1.

III. RESULTS

A. Experiment1

The senses of isolation of the subjects were not replicated in Experiment 1. There were not significant differences in the rating levels of one's condition between the average rating level of the control condition and that of the betrayed condition (all two tail $P > 0.05$). However, only that of tiredness was higher in the betrayed condition than in the control condition immediately after the betrayed condition ($t_7 = 2.828$, $P = 0.022$, data not shown).

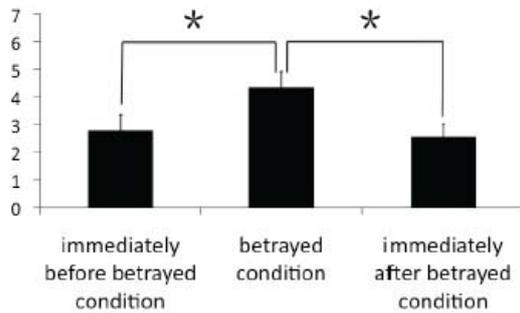


Figure 1. The change in the sense of sadness between conditions in Experiment 2. The error bars indicate standard deviations. The level of sadness in the betrayed condition was significantly higher than that in the control condition immediately before and after the betrayed condition. X-axis indicates the rating level of sadness, and Y-axis indicates the conditions.

The rating level of the trust in others was also lower in the betrayed condition than in the control condition immediately after the betrayed condition ($t_7 = 2.344$, $P = 0.047$). Although there were no significant differences, compared with the average rating level of all control conditions, the rating level of trust was lower in the betrayed condition ($t_7 = 2.226$, $P = 0.057$).

There were significant correlations between some measures of feelings. Interestingly, there were significant positive correlations between sleepiness and sadness ($r = 0.779$, $P = 0.013$), and loneliness ($r = 0.787$, $P = 0.012$), and loneliness and thirstiness ($r = 0.670$, $P = 0.048$).

There was no significant sex difference, and all contrivers did not feel the senses of sadness and loneliness in the betrayed condition.

B. Experiment2

The level of sadness was significantly higher in the betrayed condition than in the control condition conducted immediately before and after the betrayed condition ($t_7 = 2.401$, $P = 0.043$, $t_7 = 2.490$, $P = 0.038$, Figure 1).

Although there was no significant difference, compared with the betrayed condition, the level of trust in others was higher in the control condition immediately after the betrayed condition ($t_7 = 1.064$, $P = 0.147$).

There were significant correlations between some measures for feelings. Interestingly, there were significant positive correlations between sleepiness and sadness ($r = 0.912$, $P = 0.001$, Figure 2a), as well as between sleepiness and loneliness ($r = 0.866$, $P = 0.003$, Figure 2b).

There was no significant sex difference, and all contrivers did not feel the senses of sadness and loneliness in the betrayed condition.

C. Experiment3

The level of loneliness was significantly higher in the betrayed condition than in the control condition conducted immediately before and after the betrayed condition ($t_7 = 2.393$, $P = 0.043$, $t_7 = 2.673$, $P = 0.028$, Figure 3). But, in

Experiment 3, the senses of sadness of the subjects were not significantly changed.

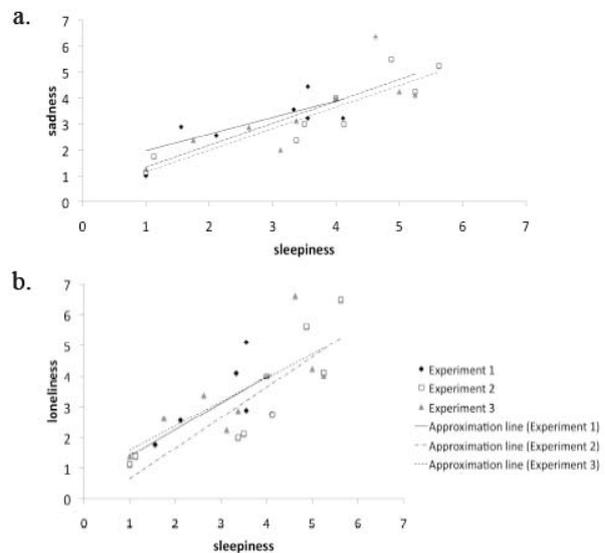


Figure 2. There were significant positive correlations between sleepiness and sadness, sleepiness and loneliness in all Experiments. X-axis indicates the rating level of sleepiness, and Y-axis indicates that of sadness (a), loneliness (b).

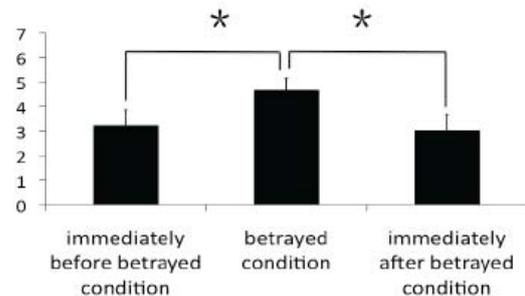


Figure 3. The change in the sense of loneliness between conditions in Experiment 3. The error bars indicate standard deviations. The level of sadness in the betrayed condition was significantly higher than that in the control condition immediately before and after the betrayed condition. X-axis indicates the rating level of loneliness, and Y-axis indicates the conditions.

Moreover, the level of tiredness was also higher in the betrayed condition than in the control condition conducted immediately before the betrayed condition ($t_7 = 2.490$, $P = 0.038$).

Although there was no significant differences, compared with the betrayed condition, the rate of trust in others was higher in the control condition immediately before and after the betrayed condition ($t_7 = 1.789$, $P = 0.111$).

There were significant correlations between some measures for feelings. Interestingly, there were significant positive correlations between sleepiness and sadness ($r = 0.811$, $P = 0.001$, Figure 2a), and sleepiness and loneliness ($r = 0.756$, $P = 0.003$, Figure 2b). Although there was no

significant correlation, the tiredness tended to correlate with the trust in others ($r = -0.641$, $P = 0.063$).

There was significant sex difference in hunger. In the average of the feeling rates in the control condition, males felt more hunger than females ($t_7 = 0.254$, $P = 0.018$). Although there was no significant difference, males tended to feel more happiness than females ($P = 0.075 > 0.05$). All contrivers did not feel the senses of sadness and loneliness in the betrayed condition.

IV. DISCUSSION

Through these studies, we could replicate the sense of isolation in Experiment 3 (Figure 3), while we could replicate the sense of sadness in Experiment 2 (Figure 1). These feelings might be induced in different ways.

In Experiment 3, all subjects handed 1,000 yen to each other in all trials in the control condition. But the level of the trust of the betrayed person in others was not changed between the conditions. They were instructed to lend the money with the amount representing the trust in others. Money can be a measure of trust in others [8]. The amount of money lent by the two contrivers was lower in the betrayed condition than in the control condition, revealing clues about the level of trust. Therefore, the betrayed person might feel that the trust of two contrivers in him or her was low. One may consequently feel a sense of isolation as a result of the realization that others do not trust in him or her.

This study method employed a combination of the ball toss game and money game, and has the advantage of investigating the sense of trust in following respects. In the ball toss game, a designated subject is eventually excluded from the activity after a few tosses and never receive the ball again [11]. There is no socially explicit trust associated with a tossing ball. In this study, money [8] was used in place of tossing ball to explicitly represent subject's trust in others. The result showed that the collapse of trust was induced even in the physical presence of counterparts. On the other hand, a game based solely on monetary exchange would not bring about social activity involving more than two persons. In this study, three mutual interactions successfully replicated a sense of loneliness and sadness through that social activity. Such feelings are pertinent to social feeling in the sense of Alfred Adler [12], which are never reproduced with money game alone (such as [8]).

There is a difference between Experiment 1 and 2 in regard to the timing of betraying. Two contrivers decided when to start betraying in Experiment 2, while they betrayed from the 1st trial in Experiment 1. The procedure conducted in Experiment 2 was very similar to a study of social exclusion conducted by Eisenberger NI., et al. [5]. In Experiment 2, the contrivers irregularly behaved on a voluntary basis. The common points between their study and this study are the unpredictability of other's behaviors and the sadness that subjects felt through the interaction with others. In light of this distinction, the unpredictability of others' behaviors (in this case, betraying) may induce the sense of sadness (Figure 1). Moreover, the subject might feel "exclusion" in the betrayed condition even if two contrivers followed the experimenter's instruction. By tossing money,

"exclusion" is more likely to be induced because one was more sensitive to a physical pain or the social exclusion when one's gain was low [13]. The result in this study is consistent with their report.

The present study was different from the study conducted by Eisenberger NI., et al. in the following respects. While the subject could see and understand other contrivers' behaviors in a social exclusion study of Eisenberger NI., et al., it was not possible to do so in this study. Although subjects might also feel "envy" in Eisenberger NI., et al., the present experiment should be able to cut off "envy," as subjects in this study had been let to think about only interactions between one and others. Hence, it is possible that the feelings invoked in the subjects, depended only on the interaction engaged oneself. As subjects could be the contrivers in turns and learn the instructions behind the contrivers' behaviors, the betrayed person could have some expectations about the interaction with the two contrivers. Debriefing sessions after the completion of the task suggested that the subjects were not always aware of the designated nature of the contrivers in the actual interaction.

Through all Experiments, there were significant correlations between some measures of subjects' feelings. There were positive correlations between happiness and contentment, tiredness and sleepiness, sadness and sleepiness, and loneliness, and sleepiness and loneliness. On the other hand, there were negative correlations between sadness and contentment, and pleasantness. It was the correlation between sleepiness and loneliness, and sadness that we were interested in especially (Figure 2). This result indicates a strong relationship between negative feelings (in this case, sadness and loneliness) and sleepiness. Some patients with conditions of depression report that they often feel weariness which was a condition intermingled sadness, loneliness, tiredness and sleepiness [2][14].

The level of tiredness was higher in the betrayed condition than in the control condition immediately after the betrayed condition in Experiment 1, and than in the control condition immediately before the betrayed condition in Experiment 3. This result may suggest the significance of the interaction with others. At the same time, the level of the trust in others was also lower, resulting in a significant difference in Experiment 1, but not in Experiment 3. From these results, we may conclude that there are correlations between physical health (in this case tiredness) and the trust in others. In passing, the tiredness seemed to be negatively correlated with the trust in others, although there was no significant difference. The level of trust in others was not significantly changed among the conditions, supporting the result mentioned above.

Males were more likely to feel happiness than females. Although it was different from this study in surveillance periods and scales, a study reported by Fowler et al. exhibited the same phenomenon [15]. The present result is consistent with their report. It has been reported that there is a sex difference in the brain region response to hunger [16]. Sex difference in the amount of feeling of hunger observed in this study may due to the differences between the neural systems involved.

We have reported here a study of the emotional elements invoked in a game involving reward exchange. The nature of the emotional elements reveal information about the neural circuits underlying decisions and choices in such a game, providing additional information about the nature of neural mechanisms. Studying the feelings of what happens in a game would thus provide important constraints towards a model of the cognitive process of interpersonal interactions.

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