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Rationality, emotions and reference dependent

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Abstract. This study provides the results of induced estimation of reference dependence based on the original model that included empathy and expectation, personal anger and jealousy, and anger over social justice in the utility function, and clarified the relationship between emotion and reference dependence. The conclusions obtained are the following seven points. First, that the relationship between expectation and reality influences decision making even in economic experiments. Second, the results of examining whether the emotions of the players who changed their behavior between the first and second time were shame or guilt, showed that it was a shame. Third, empathy influences decision making. Fourth, the expectations of others (anticipation) serve as a model of reference dependence. Fifth, that personal anger/jealousy influences decision-making by expectations (anticipation) of others. Sixth, when expectations of others influence decision-making, the emotions are based on personal anger and jealousy. Seventh, the degree of anger toward the free-rider is related to the degree of sanction.
Keywords. Reference dependence; Rationality; Emotion; Decision-making.
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1. Introduction

Emotion is a mechanism that aids in decision-making. They have been created, adapted, and developed during evolution to increase our chances of survival. Without the emotion of fear, we might die by engaging in risky behavior, and even if we are lucky enough to survive, we might repeat the risky behavior over and over again and eventually die if we cannot feel regret. Likewise, without the ability to feel anger towards others, we will be preyed upon by those around us and our ability to fight for scarce resources will be weakened. On the other hand, in addition to emotions, humans have the ability to perform rational analysis as a mechanism to assist in decision-making. When we are in danger of taking a risky action, deliberation based on rational analysis may reduce the probability of survival. In such a situation, the quick reaction by the emotional mechanism is more efficient than slow deliberation by the rational mechanism.

While emotions such as fear, sadness, and regret can be defined as autonomous emotions, emotions such as anger, envy, hatred, and empathy are social emotions. Social emotions are based on relationships with others. We feel anger and empathy towards others but regret our actions and situations. Autonomous emotions influence one's own decisions, while

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social emotions influence both one's own decisions and the decisions of others (Winters, 2014).

Based on social emotions, commitment (promise) to others is a function of emotions. Commitment often exists through the medium of shame. Commitment arises from the notion that one party has an advantage if it can convince the other that it will pursue a certain outcome (even at its loss), and if the seller can convince the buyer that he is not going to discount, the seller can negotiate to an advantage. If the buyer believes that the seller will lose more money by not closing the deal than by making concessions and offering discounts, the seller will also have an advantage. The person making the commitment must convey a readiness to make the necessary sacrifices or it will not be perceived as a credible declaration. Humans have the ability to recognize the emotional states of others, and without this ability, our ability to engage with society is greatly impaired. The ability to recognize emotions in other people's faces belongs to the deepest and oldest region of the human brain, where the amygdala plays a role. In studies of subjects with damage to the amygdala, the subjects were able to recognize faces, but could not distinguish facial expressions or judge emotions.

In the first part of this study, we summarize previous research on emotions and trust in neurophysiology, management, psychology, and experimental economics. In the second part, we present a reference dependence model that includes emotions such as anger, expectation, and empathy, and show that the model is consistent with reality through a looting game.

2. Psychology and emotions

There is controversy in the definition of emotions in the field of psychology; I will explain the difference between the psychological constructivism of emotions by (Barrett & Russell, 2014) and the basic emotion theory.

Basic Emotional Theory believes that the emotions of anger and fear themselves exist and have a biological basis. Psychological constructivism states that they are moving within some basic dimensions (Oohira, Kenta, Mariko, & Ken, 2017). Taking perception as an example, when we look at something, we do not see a certain object reflected on our retina and receive it as it is, but we think that we create an image and look at that image even though we receive some input from the outside world. In other words, even if we perceive something as black, whether it is black or not is another matter. Barrett explains that he was influenced by Kant's "thing itself. Kant's constructivism is divided into psychological constructivism and sociological constructivism in the field of psychology, with psychological constructivism going back to Piaget and sociological constructivism emphasizing the shared culture of a group or society, especially language, and going back to Wittgenstein.

With the current development of neurophysiology, we know that emotions are related to the reward system of the brain's insular cortex,

amygdala, orbitofrontal cortex, and striatum. However, in the past, it was thought that specific neural circuits existed for specific emotions such as anger and fear, but since the amygdala and insula respond to various emotional changes, it is more likely that emotions are a mixture of responses from various regions. In other words, since we cannot identify emotions biologically, we cannot look at psychological responses for each site response, and since it is difficult to capture emotions objectively, the measurement of emotions depends on individual subjectivity. Since different individuals may have different emotions when placed in different situations, and since it is difficult to completely control them in experimental situations, research on the antecedent state (Affect) before the emotional change is brought about, rather than the emotion, is progressing.

Seth (2012) argues that people can regulate emotional ups and downs, and treat an individual's mental prior state like Bayesian prior knowledge, where events occur and become definite emotions through the accumulation of emotional experiences. Seth & Friston (2016) presents a model of emotion formation. In this study, based on the viewpoint that Affect is important for emotion measurement, in order to make the individual's prior state the same, the initial holding amount is determined by drawing a lottery (the player does not know the probability) that must be won regarding the determination of the initial holding amount in the experiment. This allows all players to participate in the experiment under positive conditions.

3. Consumer behavior and brain processing

This section provides an overview of neuroscience research on emotions that can be applied to marketing.

The executive functions of the brain, which are involved in the control of human thought and behavior and are required to accomplish a series of actions to achieve a goal, mainly involve inhibition of behavior, updating of information such as reading nutritional information, and switching of responses in response to changes in the situation (Miyake *et al.*, 2000). The anterior cingulate gyrus and ventral lateral prefrontal cortex are involved in behavioral inhibition, the dorsolateral prefrontal cortex in working memory with information updating, and the ventral lateral prefrontal cortex in rule switching (Sakai, 2008). For example, a marketing strategy may stimulate different parts of the brain to form an image of a person or a product, which may weaken the effect of the strategy.

Different brain processing takes place during the recognition and judgment of a person and that of an object, and these differences are being utilized in the field of marketing. In the field of brand personality, which considers brands as people and classifies personalities for each brand, Yoon, Gutchess, Feinberg, & Polk (2006) used fMRI to show that the brain regions that are active when considering the personalities of people and brands are different. This suggests that brand personality, the brand image, is not perceived by consumers in the same way as it is by humans. Regarding price premiums, which people evaluate as more favorable for products with

higher prices, Plassmann, O'doherty, Shiv, & Rangel (2008) found that consumers respond favorably to price premiums because they make rational choices based on the inference that higher price means better quality. Karmarkar, Shiv, & Knutson (2015) examined the price-precedence effect, where the price is shown before the product is shown. That showing the price first makes it easier for people to act on purchases based on monetary value. Functional goods (purchased primarily based on usefulness or utility).

Different brain processing takes place during the recognition and judgment of a person and that of an object, and these differences are being utilized in the field of marketing. Recently, it has been reported that fMRI can be used to predict the behavior of individuals and the market as a whole from brain activity and that the prediction accuracy can be improved by using brain activity data, which is difficult to achieve with subjective indicators (Berns & Moore, 2012). Brain activity related to value judgments and rewards includes product preferences that consumers cannot verbalize, suggesting that brain activity data (especially in areas related to rewards and value judgments) has explanatory power that cannot be captured by subjective indicators from questionnaires. Research on the many purchasing behaviors that take place on the Internet and word-of-mouth through social media has also progressed; Genevsky & Knutson (2015) studied microfinance (small loans to the poor). Genevsky & Knutson (2015) studied microfinance (small loans to the poor). They found that in Kiva, a microfinance institution where the profiles of poor people (names, photos, businesses, etc.) are introduced online, people with profiles that have higher ventral striatal activity when shown the profiles of poor people give more loans. In the area of predicting the effectiveness of Internet marketing, Falk., Berkman, Whalen, & Lieberman (2011) partnered with a public agency to test the effectiveness of an anti-smoking campaign via e-mail. They found that high activity in the ventral medial prefrontal cortex was useful in predicting the effectiveness of smoking cessation campaigns (limited to those that evoked negative emotions). Using multivoxel pattern analysis, which provides highly accurate prediction, Tusche, Bode, & Haynes (2010) predicted later purchase behavior from brain activity patterns in the ventral medial prefrontal cortex and insular cortex while passively looking at a product. As an application to the field of political science and sociology, Anderson (1983) called the state an imagined community. The state, a large group that includes individuals who have never met, is a community born from people's imagination, and yet it can cause strong feelings toward the state. Takeuchi *et al.*, (2016) confirmed the difference between patriotism and nationalism by using fMRI to activate different brain regions.

The activity of a certain brain region obtained by using fMRI does not necessarily reflect a specific psychological process, and many psychological processes are inherent in a single brain region. Even if different brain regions can be identified by multiple theories, it is difficult to deepen the theory of consumer behavior if we do not know what psychological processes were active in those brain regions (Motoki & Sugiura, 2017).

4. Methods and overview of economic experiments (Ultimatum game, dictator game, trust game, public goods game)

In the ultimatum game, both players are given a certain amount of money at the beginning. For example, the two players receive 10,000 yen together. Player 1 (the proposer) proposes to Player 2 (the respondent) how much of the 10,000 yen to divide, and if the respondent accepts the proposal, the 10,000 yen is divided as proposed. If the respondent accepts the proposal, the 10,000 yen is distributed as proposed. If the proposal is rejected, the experimenter forfeits the 10,000 yen, and neither player gets a dime. The respondent has no choice but to accept or reject the proposer's proposal. If both players are selfish and rational, they will agree on a split of 9,999 yen for the proposer and 1 yen for the respondent. Since the game will be played only once, the respondent will accept it because it is beneficial to him, as long as his share is not zero. The theoretical equilibrium is that the proposer, knowing the situation of the respondent, proposes the lowest amount of 1 yen.

However, in many studies, including (Güth, Schmittberger, & Schwarze, 1982), money is split 50-50, and if the proposal is less than 35% of the full amount, the majority of respondents reject it. Since we do not know whether the proposer makes a 50-50 proposal out of fairness and courtesy or out of fear that the respondents will reject the proposal if the share is too small, we can confirm the reason for the 50-50 proposal by playing the dictator game together.

In a dictator game, the respondent must always accept the proposer's proposal. They cannot retaliate even if the proposal is for a small amount. If a proposer proposes a 50-50 split in the ultimatum game and makes the same proposal in the dictatorship game, we can assume that his main motive is to be fair. Güth *et al.*, (1982) argued that players in ultimatum games should be able to anticipate their opponents' reactions and avoid inviting their opponents' rejection. Roth, Prasnikar, Okuno-Fijiwara, & Zamir (1991) made a multinational comparison and found that the Japanese would accept a relatively small proposal, while many Americans would reject it. It can be presumed that the U.S. takes a proposal of the same amount as stingy. The amount of money that can be spent without causing the other person's rejection differs depending on cultural differences, and the amount of money that is considered fair can be estimated when the proposer and the respondent both live in the same country. However, when the above game is played repeatedly, the respondent initially rejects a small proposal, but then accepts the amount. The respondent wants to increase the amount of the next proposal by continuing to reject it but accepts it after repeated attempts. This means that the respondent compromises with the proposer. Originally, the proposer and the respondent know approximately the appropriate amount that they can agree on, but as the game is repeated, a compromise other than the original appropriate amount is formed. Winter

& Zamir (2005) confirm that in a stable and homogeneous society, the criterion of fairness is stable, but in a society with high immigration, the criterion of fairness is repeatedly learned and applied, and the equilibrium is unstable.

Using fMRI to measure the brains of respondents when they were offered small amounts of money, brain regions associated with nausea and vomiting reflexes were activated. Respondents' rejection of small proposals is thought to be an evolutionary mechanism to avoid being preyed upon when repeatedly interacting with others as humans (Winters, 2014).

In a trust game, the proposer initially receives a certain amount of money, say 10,000 yen. He can either keep it all to himself or offer to share some of it with the recipient. Once the proposer shares the money with the recipient, the experimenter gives twice that amount to the recipient. For example, if the proposer shares 2,000 yen from the first 10,000 yen with the recipient, the recipient will get 2,000 yen from the proposer and 4,000 yen from the experimenter, for a total of 6,000 yen, three times the 2,000 yen. The recipient can refund some of the money to the proposer. How much is returned depends on the level of trust the recipient has in him. If you choose to keep the first amount given to you all to yourself, you will get 10,000 yen and the recipient will receive three times that amount. If the recipient gives back half of it, they both get more money; if the full 10,000 yen is given, the recipient gets 30,000 yen. If the recipient gives back half of the money, they both get 30,000 yen, and if the recipient gives back half of the money, they both get 15,000 yen. However, the recipient has no incentive to return the money, except in response to goodwill, generosity of spirit, or ungrateful behavior. In other words, if both players are selfish and rational, the game theoretic expectation is that the proposer will not share a penny of the initial money given to the recipient.

The looting game developed by Bosman & Van Winden (2002) is a simple experiment to understand the interaction between emotions and economic behavior. It shows how emotions work better than other experiments. Player A is the proposer and Player B is the responder, both of whom have initial holdings of income. The proposer can propose to distribute the initial income held by the respondent between the two players. The respondent can discard his or her income at a rate of 0% to 100%. In other words, if the respondent is dissatisfied with the proposer's proposal for whatever reason, he can punish or retaliate against the proposer by giving up (some or all) of his initial income (or not giving up at all). Both parties have equal initial holdings of income, but only the responder's income is subject to distribution. Thus, the respondent can expect that his income will be plundered or exploited by the powerful proposer, and the respondent will experience feelings of anger, guilt, and shame over the proposal. In addition, the respondent can destroy his or her income, making the trade-off between punishment and income feasible.

The public goods game is tackled by many members. Each member is given an initial holding of income, and each member decides how much to

contribute to the public good from his or her initial holding. The amount contributed to the public good is aggregated among all members, and alpha times the amount contributed is distributed equally to each member. Theoretically, each member will contribute zero to the public good due to free-riders.

Emotions that help form one's optimal environment are called rational emotions. Based on normal rationality, the respondent in the ultimatum game should not have chosen to reject even a single game, but he perceived his opponent's behavior as rude and his self-preserving mechanism (rational emotion) kicked in. Behavior based on rational emotions and intuitive rules is called rule rationality, which is useful in making quick decisions but leads to overgeneralization. On the other hand, behavior that requires a high level of cognition and attention and is suitable for a specific interaction is called behavioral rationality. People form trust based on rule rationality, but once trust is formed, it is a characteristic that cannot be easily modified even if it is later discovered that the person is not the one to be trusted.

5. An economic experiment on emotions and social preference

People pay attention not only to their interests but also to the interests of others, and the preferences that influence their utility and determine their behavior are called "others-conscious preferences. There are three main types of models of othering preferences (Fehr..., Ernst. & Schmidt., 2003).

The first is called "social preference," which is a preference that includes not only one's gain but also the gain of others in the utility function. It includes the altruism model, the relative income and jealousy model, and the inequality avoidance model. The second is "interdependent preferences," in which people are divided into selfish and (conditionally) altruistic types, and altruistic people show altruistic preferences when they are involved with an altruistic partner, but they also act selfishly when the other person is selfish. The third is the "intention-based reciprocity" model. People pay a great deal of attention to the intentions of others and assume that if they view the other person as having bad intentions toward them, they will act in a way that is detrimental to the other person, and if the intentions are good, they will act in a way that benefits the other person. In many cases, the role of emotions is unclear or not given any role at all in the preference model of consideration for others. For example, in a final proposal game, it was shown that responders had different emotional responses when the proposer was a computer and when the proposer was a human, even if the amount of the proposal was the same (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). not imply irrationality, but suggest that people are rational in the sense that they incorporate emotions into the utility function and maximize the utility function. Maximizing a utility function that takes into account all goods and emotions that arise in all cases would require an enormous amount of computation, but it is thought that people focus only on immediate events

and seek short-term results and that limiting the scope of consideration is done by heuristics, which is consistent with the idea of limited rationality. (Tomono, 2005; Tomono., 2006). Emotions are deeply involved in heuristics. Straub & Murnighan (1995) suggest that the respondent's anger is the cause of the respondent's rejection of the lower offer in the final proposal game, but they do not directly measure emotion. Pillutla & Murnighan (1996) conducted an open-ended questionnaire in which respondents were asked, "How did you feel?" after the proposer's offer was presented in the final proposal game. Pillutla & Murnighan (1996) asked respondents in a final proposal game how they felt after the proposer's offer was presented. Ketelaar & Tung Au (2003) conducted multiple experiments of a prisoner's dilemma game and a final proposal game and found a strong positive correlation between the degree of anger and the rejection of the proposal. Ketelaar & Tung Au (2003) conducted multiple experiments of prisoner's dilemma games and final suggestion games and found that controlling subjects' moods and emotions between games changed their behavior in later games. They played the final suggestion game once so that the subjects would feel guilty because of their own choices, and then played the final suggestion game again one week later with the same opponent in the same setting. As a result, they found that the change from selfish behavior to generous behavior occurred in those who felt guilty after the first game.

In public goods games, the possibility of punishment plays an important role, and cooperation is maintained when there is punishment (Fehr.. & Gächter, 2002). Cooperation is also maintained by introducing third-party punishments (Carpenter & Matthews, 2010; Fehr & Fischbacher, 2004). The smaller the contribution, the more likely it is to be punished and the harsher the punishment. When punishment is introduced in repeated games, the amount of contribution increases significantly (Fehr, Ernst. & Simon, 2000a; Fehr. & Simon, 2000b). Fehr.. & Gächter (2002) show that anger and discomfort toward free-riders are consistent with punitive behavior after a public goods game experiment with punishment. Hopfensitz & Ernesto (2005) found that social emotions such as shame and guilt are important for cooperative norms to be effective. Feeling angry at being punished may lead to retaliation against the punisher. Since anger alone can lead to repeated punishment and retaliation, leading to a waste of resources, he showed that for punishment to be effective, it is important for the person being punished to have a moral responsibility, that is, for the punished to cooperate and refrain from retaliation. It is prosocial emotions such as shame and guilt that discourage retaliation Bowles & Herbert (2006).

Sanfey *et al.*, (2003) used fMRI to measure brain images of subjects in a final proposal game and observed that responders to unfair and unequal proposals of 10-20% of the initial amount specifically activated the dorsolateral prefrontal cortex (DLPFC), anterior cingulate cortex (ACC), and insula. The insula is the region that is activated when experiencing unpleasant emotions such as pain, disgust, hunger, and thirst; the ACC is the brain region responsible for administrative control abilities, coordinating

signals from various other regions of the brain; and the DLPFC, which requires distribution, is the region that is activated when experiencing unpleasant emotions such as pain, disgust, hunger, and thirst. We can speculate that the ACC regulated the conflict between the DLPFC, which demands distribution, and the insula, which is uncomfortable with inequity. In particular, subjects whose insula was strongly activated tended to reject the proposal (correlation coefficient 0.45); when the insula was activated relative to the DLPFC, the proposal was rejected, and when the DLPFC was activated more than the insula, subjects tended to accept the proposal even if it was unfair. Rilling *et al.,* (2002) conducted repeated prisoner dilemma experiments and found that the striatum, ACC, and orbitofrontal cortex (OFC) were activated when the other person chose to cooperate when the other person also chose to cooperate. Reward, conflict regulation (ACC), and emotion (OFC) all function. In particular, the reward-related areas of the brain (the dopamine system in the limbic system, including the striatum and preorbital cortex) are activated, indicating that reciprocal cooperative behavior is rewarding (pleasant). In addition, the degree of activation is stronger in the case of a human partner than in the case of a computer partner, even though the amount of reward is the same. If the brain feels pleasure from financial gain, it should not matter whether the opponent is a human or a computer, and if the fairness of the outcome is important, it should not matter who the opponent is. De Quervain, Urs Fischbacher, Melanie Schellhaer, Alfred, & Ernst (2004) used PET imaging to examine brain activity related to punishment in trust games. (2004) used PET imaging to examine brain activity related to punishment in a trust game. The caudate nucleus is known to be activated when making decisions and taking actions in anticipation of rewards, but subjects with more activation in the caudate nucleus were punished more heavily. This suggests that punishing those who violate morals and norms can be pleasurable in itself.

The previous studies mentioned above suggest the positive role of emotions. Emotions support cooperation through a variety of routes: cooperative behavior and following norms bring pleasure, anger leads to cooperation through punishment, and shame and guilt lead to cooperative behavior through regret and remorse. In addition, in social dilemma situations, an important function of emotions is that they are the driving force that causes people to choose cooperation, which is successful in the long run, instead of betrayal, which is a rational strategy in the short run. Reuben & Frans (2005) asked emotional questions in a looting game and found that fairness was established from shame. Reuben & Frans (2005) asked about emotions in a looting game and showed that fairness is established from shame.

6. Model

6.1. Emotional model that includes anger, jealousy, empathy, and expectations of the other person

The following model is based on Falk & Fischbacher's (2006) model, which states that kind behavior affects the gains of others and the self, and includes reference-dependency perspective by Kőszegi & Rabin (2006) and emotion.

$$U_i = \pi_i + \rho_i \sum_{j \neq i} \sigma_{ij} \left[\pi_i(s_i, b_{ij}) - \pi_i(b_{ij}, b_{iji})\right] \lambda_{iji} \left[\Gamma_i(\gamma_i)\pi_i(b_{ij}, b_{iji}) - \pi_j(b_{ij}, b_{iji})\right] \eta_{ij} \left[\Psi_i \pi_i(b_{ij}, b_{iji})\right] \zeta_{ij} \left[\phi_{ij} \pi_j(b_{ij}, b_{iji})\right] \nu(\pi_i, \pi_j)$$

The first bracket shows the difference in gain between different strategies for the same individual, while the second bracket shows the difference in gain when individual i and individual j choose the same strategy. The model is based on Falk & Fischbacher (2006) including anger and jealousy (γ), empathy (Ψ), and expectation of the other person (ϕ) as emotional parameters. Anger and jealousy γ reflect the player's positive and negative emotions, similar to soft games often used in the field of psychology. In the case of negative emotions, they take a negative value. For variables other than the above, see Falk & Fischbacher (2006).

An increase in γ has a bias that makes the presence of a particular strategy less visible or misleads the estimation of its own gain. For example, if γ exceeds a threshold value, strategy s_i becomes unrecognizable to individual i. Even a specific range below the threshold will mislead the recognition of the expected gain. Individuals i and j change their expected gains through their respective feelings of anger and jealousy. λ_{iji} represents the sense of unfairness due to the disparity (inequality) between the interests of others and the based on their own assumed sense of fairness and justice. An increase in λ_{iji} decreases utility U_i.A rise in λ_{iji} lowers utility U_i. Ψ indicates empathy. An increase in Ψ increases utility U_i. The higher the value of Ψ, the higher the amount of money one is willing to pay for the product and the more the gain changes. The higher the value of ϕ, the greater the confidence in one's own abilities and attitudes toward others. The higher the value of ϕ, the greater the trust in one's own abilities and attitudes toward others,or the stronger the belief that others like one and will act favorably toward one. The parameter γ of personal anger and jealousy takes values of $-\infty \leq \gamma \leq \infty$. If $-\infty < \gamma < \bar{\gamma} < \infty, \gamma$ distorts the gain, $\Gamma = \gamma$. If $\bar{\gamma} < \gamma, \gamma$ hides the strategy, $\Gamma = 0$. The empathy Ψ takes the value of $0 \leq \Psi \leq 1$, and the parameter of expectation of others ϕ takes the value of $0 \leq \phi \leq 1$.

7. Estimation of results

In order to clarify the relationship between emotion and reference dependence, we conducted an economic experiment with 242 university students.

The looting game was repeated twice. The looting game was repeated twice, and the emotions of the proposers who changed their behavior between the first and second times were checked. Furthermore, by asking questions about the expected looting rate, fair looting rate, and emotions, we examined how to reference dependence works based on emotions by clarifying the relationship between the fair looting rate and the actual looting rate, which represents the social justice assumed by the players, and the relationship between the expected looting rate and the actual looting rate. After the looting game, we conducted a public goods experiment and asked the participants how they felt about the existence of free riders.

To ascertain the emotions experienced by responders with a discard rate of 0.6 or higher (0.6 requires 80% of income) after the outcome of the first looting game, all responders rated the anger they felt (reported in many previous studies to produce feelings of anger, frustration, and contempt) on a 5-point scale.

From Table 1, it was confirmed that anger and discard were strongly positively correlated.

Table 1. *Coefficient of probit estimation for Discard variable as dependent variable.*

Disappointment	0.431**
Thanks	-0.335*
Despise	0.326*
Anger	0.249*
Confused	0.212*
Amusement	-0.360*
Jealousy	0.499*
Honor	-0.04
Sorrow	0.096
Shame	0.401
Pride	0.152
Consciousness of guilt	0.078
Regret	0.033
Surprise	-0.022

Note: ** denotes significance at the 1% level; * at the 5% level

We also examined the relationship between the expected value and the degree of anger and the rate of destruction, and Table 2 shows that anger and destruction are negatively correlated with the expected looting rate. It is not surprising that they are positively correlated with the actual looting rate, and if inequality-avoidance and intentions are important to responders, then it is the actual looting rate that is important, not the expected looting rate. It is thought that strong emotions are aroused when the unexpected occurs. Table 3 shows that when the actual looting rate is less than the expected looting rate, the discard rate is small, and when the sign is reversed, the discard rate is large. In other words, the reference point effect works with the forecast as the reference point. The estimation based on the inductive system model is shown in Table 7.

Table 2. *Correlation coefficient between expected, actual and fair looting rate.*

	Expected looting rate	Actual looting rate	Fair looting rate
Anger	-0.622*	0.473*	0.143
Jealousy	0.103	0.31	0.256
Shame	0.218*	-0.261	0.423
Guilt	-0.042	0.192	0.332
Regret	-0.033	0.2	0.29
Discard	-0.462*	0.232*	0.104

Notes: ** denotes significance at the 1% level; * at the 5% level.

Table 3. *Average discard rate by relationship between actual and expected looting rate.*

Actual looting rate<Expected looting rate	0.13
Actual looting rate≥Expected looting rate	0.72

We also asked the proposer and the respondent what they thought about a fair looting rate, and the results are shown in Table 4. In the group where the difference between the actual and expected looting rate is above average, the expected looting rate is 60.3 and the actual looting rate is 37.3, which means the expected looting rate > the actual looting rate. The relationship is reversed when grouped around the average. On the other hand, when the difference between the fair looting rate and the actual looting rate was compared between above-average and below-average groups, there was no reversal of the relationship. It seems that the relationship between the fair looting rate and the actual looting rate is not reference-dependent.

Table 4. *Average and below about fair, actual and expected looting rate.*

	Fair looting rate	Actual looting rate	Expected looting rate
Difference between Fair rate and Actual rate is above average	9.54	70.2	45.4
Difference between Fair rate and Actual rate is less than average	42.4	70.1	30.2
Difference between Actual rate and Expected rate is above average	25.1	37.3	60.3
Difference between Actual rate and Expected rate is less than average	39.9	90.5	21.4

In Table 5, we show the average sentiment of the proposers who were discarded the first time and changed their behavior the second time. We see the mean of the emotions for each difference in the relationship between the actual and fair looting rates; the emotions of the proposers who decreased their looting rate the second time were high for shame and guilt, and especially high for proposers with actual looting rate > fair looting rate. Respondents confirmed that their assumed fair looting rate was not the cause of their anger and discard, and the results in Table 3 suggest that only the actual and expected looting rates are important. That is, the proposer feels strong shame if the loot rate chosen by the proposer is higher than the loot rate he considers fair, but is discarded by the respondent. The proposer's feeling is partly guilt, but a large percentage is a shame. The respondent's discarding implies blame, which can be said to make the respondent feel shame. Fairness plays an important role in the proposer's decision, but it is supported by the emotion of shame.

Table 5. *Average emotional value of the proposer who changed his behavior the 2nd after being abandoned the 1st (5 levels from 1-5).*

	Decrease(2nd looting rate)		Unchange(2nd looting rate)		Rise(2nd looting rate)	
	Actual looting rate ≥Fair looting rate	Actual looting rate <Fair looting rate	Actual looting rate ≥Fair looting rate	Actual looting rate <Fair looting rate	Actual looting rate ≥Fair looting rate	Actual looting rate <Fair looting rate
Anger	2.4	1.4	2.1	1.8	3.1	2.5
Jealousy	1.4	2.5	1.4	1.5	1.6	1.5
Shame	4.5	3.1	2.5	2.9	2.1	2.5
Guilt	3.9	2.8	2.4	2.1	2.6	2.1
Regret	1.3	1.5	2.1	2.5	2.7	2.1

After the looting game, a public goods experiment was conducted and the participants who were free-ridered were surveyed, and Table 6 shows that they felt angry. As a result, the Pair-wise correlation coefficient was -0.66, which is high with a minus sign and significant at the 5% level, suggesting that the punitive action against free-riders reduced their contribution.

Table 6. *Feelings for participants who repeatedly freeride in the 1st and 2nd public goods experiments.*

Anger	4.1
Jealousy	1.3
Shame	1.4
Guilt	1.4
Regret	1.8

Finally, in the second outcome of the looting game, the reference point is whether or not the reality exceeds the expectations of others. Table 7 show the results of the probit estimation. Tables 7 show that the respondent feels angry after the first game when the actual looting rate is higher than the expected looting rate. The relationship between the expected looting rate and the actual looting rate was significantly positive at the 1% level for the responders where the actual looting rate > expected looting rate. The actual looting rate > expected looting rate was discarded; since the actual looting rate for the first time was not significant, the reference-dependent model confirmed that people who had a higher actual looting rate for the first time discarded the second time when the looting rate was higher than expected, although no effect was found. We can see that the relationship between expectation and actual is the reference point. Also, the fair looting rate is not significant, confirming that the fair looting rate does not affect discarding, as in the results of Tables 1 and 2. Furthermore, empathy for the other party was negatively significant at the 1% level, indicating that empathy reduced the number of discards. From the above results, it was confirmed that the emotions of anger, an expectation of the other party, and empathy affected destruction.

Table 7. *The effect of the relationship between 1st Expected and 1st Actual rate on Discard in 2nd (Reference dependency).*

	Discard
1st:Actual looting rate >1st:Expected looting rate	0.440**
1st:Actual looting rate	0.698
Whether to discard	0.423*
Fair looting rate	0.362
Sex	0.412
Degree of Empathy	-0.023**
Num of Obs.	242

Note: ** denotes significance at the 1% level; * at the 5% level

This study aims to include emotions in the framework of economics. There are three contributions related to reference dependence in this study. The first is the introduction of a decision-making model based on reference dependence into game theory (looting games). The second is the development of an estimation model that includes emotions in Kőszegi & Rabin's (2006) model of reference dependence. The third is that we showed that emotion-mediated reference dependence exists as a human decision-making system. To explain the content of this study on reference dependence, it was confirmed that emotions are recalled depending on whether they exceed or fall short of one's own expectations, and that behavior changes according to the strength of the emotion, and that the strength of the emotion leads to stronger behavior as an attitude toward the other person. In addition, we showed that the difference between expectation and reality is important, and that general norms in society do not have a significant effect.

8. Conclusions

This study aims to include emotions in the framework of economics. The contributions of this study related to reference dependence are threefold. The first is the introduction of a decision-making model based on reference dependence into game theory (looting games). The second is the development of an estimation model that includes emotions in Kőszegi & Rabin's (2006) model of reference dependence. The third is that we showed that emotion-mediated reference dependence exists as a human decision-making system. The following is an explanation of what this study has shown regarding reference dependence. It was confirmed that emotions are recalled depending on whether they exceed or fall short of one's expectations, and that behavior changes depending on the strength of the emotion, and that the strength of the emotion leads to stronger behavior as an attitude toward the other person. We also showed that the difference between expectation and reality is important and that the general norms in society do not have a significant impact. In order to obtain the above results, we showed that the strength of emotion can be obtained through retrospective questionnaire surveys without collecting neural information.

This section details the results obtained through this study. Using the results of the economic experiment, we conducted an induced estimation of reference dependence based on the original model that included empathy and expectation, personal anger and jealousy, and anger over social justice in the utility function, and clarified the relationship between emotion and reference dependence.

The conclusions obtained are the following six points. First, that the relationship between expectation and reality influences decision-making even in economic experiments. Second, the fair looting rate assumed by the players does not affect the decision-making as much as the expectation. Third, the results of examining whether the emotions of the players who changed their behavior between the first and second time were shame or guilt, showed that it was shame. Fourth, empathy influences decision-making. Fifth, the expectations of others serve as a model of reference dependence. Sixth, when expectations of others influence decision-making, the emotions are based on personal anger and jealousy. Seventh, the degree of anger toward the free-rider is related to the degree of sanction.

The above results were obtained from economic experiments and questionnaires based on the original model of this study, and the relationship between emotions (expectation, empathy, and anger) and reference dependence was clarified. The results were obtained from economic experiments and questionnaires based on the original model.

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