A closer look at moral dilemmas: latent structure of morality and the difference between the trolley and footbridge dilemmas

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Abstract

Although moral dilemmas such as the trolley and footbridge dilemmas (Thomson, 1986) have been widely employed to investigate the nature of moral reasoning, but their psychometric properties remain a mystery. In this study, 219 participants completed 62 moral dilemma tasks used in Greene et al. (2001), and the correlation structure among the dilemmas was analyzed through factor analysis and structural equation modeling. The results show the following two points. First, the moral-personal dilemma tasks studied are composed of one factor, indicating that the assumption in Greene et al. (2001) was supported. Second, the trolley and footbridge problems fall into the same factor category; therefore, the difference between the two problems cannot be attributed to emotional involvement. In addition, results of the structural equation modeling suggest that they differ in engagement of the rational processing. Some theoretical suggestions were discussed.

Keywords: moral dilemma; trolley problem; footbridge problem; factor analysis; structural equation modeling

Introduction

Is it permissible to sacrifice a few lives in order to save many others? This is a central question in the debate between utilitarianism and deontology. Utilitarians (e.g., Bentham, 1789; 1948) argue that it is permissible to do so because saving more lives results in greater utility for society than saving only one, whereas deontologists (e.g., Kant, 1965) argue that it is not permissible because life is an ultimate right that should not be violated, irrespective of the amount of benefit yielded by its sacrifice. This debate has drawn the attention of various researchers, who have proposed many answers to the issue (see e.g., Singer, 1979; Thomson, 1986; Greene & Haidt, 2002; Mikhail, 2009).

This conundrum is complicated by the fact that the permissibility of sacrificing the few lives depends on the context of the question, even when the numbers of people sacrificed and saved remain the same. The trolley and footbridge dilemmas (Thomson, 1985) are the most prominent examples of this context dependency. The trolley dilemma supposes that a runaway trolley is headed for five people who will be killed if it proceeds on its present course. The only way to save these people is to hit a switch that will turn the trolley onto an alternate set of tracks, where it will kill one person instead of five. Should you turn the trolley in order to save five people at the expense of one? This problem, known as the trolley dilemma, most people answer yes to this dilemma (Greene et al, 2001). Then consider the footbridge dilemma, in which (as before) a trolley threatens to kill five people. You are standing next to a large stranger on a footbridge that spans the tracks, in between the oncoming trolley and the five people. In this scenario, the only way to save the five people is to push this stranger off the bridge and onto the tracks below. He will die if you do this, but his body will stop the trolley from reaching the others. Should you save them by pushing this stranger to his death? Most people answer no to this problem. The discrepancy between the answers to the two problems clearly demonstrates the context dependency described above, and challenges both philosophers and psychologists who are interested in people's criteria for moralistic action.

One prominent solution to this discrepancy is provided by Greene et al. (2001). They hypothesize that the footbridge dilemma engages the emotions while the trolley dilemma does not. This is because pushing someone to his or her death is more emotionally salient than hitting a switch that will cause a trolley to produce similar consequences, resulting in different treatment of the two cases. To test this hypothesis, they performed brain-imaging studies in which participants were required to solve a number of moral dilemmas, including some that were similar to the trolley and footbridge dilemmas. Greene et al. (2001) hypothesized that brain areas associated with emotions would be more active during contemplation of dilemmas such as the footbridge dilemma than they would be during contemplation of dilemmas such as the trolley dilemma. Their results consistently supported their predictions. Brain areas that are considered to reflect emotional processing, such as the medial portions of Brodmann's Areas (BA) 9 and 10 (the medial frontal gyrus), BA 31 (the posterior cingulated gyrus), and BA 39 (the angular gyrus, bilateral) were significantly more active when solving moral dilemmas similar to the footbridge dilemma than when solving moral dilemmas similar to the trolley dilemma.

Greene et al. (2001) use the brain-imaging method to shed light on the importance of emotional processing in the formation of moral judgments. Traditional theories of moral psychology emphasize the role of reasoning and higher cognition in the making of such judgments (Kohlberg, 1969; Greene et al., 2004). For example, Kohlberg and his colleagues (Kohlberg, 1969) explore moral reasoning by presenting participants with dilemmas in which moral and non-moral claims exist within both alternatives, and then observing their methods of resolving the conflicts. The social intuitionist approach (Nucci & Turiel, 1978; Turiel, 1983; Turiel, Killen, & Helwig, 1987) adopts the methodology of interviewing children about rule violations. This approach requires children to think about moral rule and provide justifications for their conclusions. Both

Kohlberg's approach and the social intuitionist approach employ rationalist methods because they mainly focus on the role of the conscious reasoning process in resolving moral dilemmas. They also fail to study the neural correlates of moral judgment. In contrast to these approaches, Greene et al.'s (2001) work stands out because it considers and explores the role of emotion using brain-imaging methods. In fact, most subsequent studies have centered on the role and neural basis of emotional processing in moral reasoning (see e.g., Greene et al., 2004; Moll et al., 2005; Harenski & Hamann, 2006).

In this study, we pay attention to how the emotional and rational processing affects the moral judgment. However, we also point out that methodology adopted by the previous studies is insufficient to explore our research interests. In what follows, we argue methodological problems of the previous studies and explain our approach to address these concerns.

Defining emotions and moral dilemmas

The term "emotion" must be defined before we can investigate its place in the formation of moral judgment. However, the definition of the relationship between emotional processing and moral reasoning depends upon the interpretation of the moral dilemmas used. Thus, researchers must specify a feature of the moral dilemmas that clearly engages the emotions. To do this, we first look at the definition of emotion in previous studies.

Greene et al. (2001; see also Greene & Haidt, 2002) distinguish between moral-personal and moral-impersonal situations. They categorize a moral violation as personal if it is (i) likely to cause serious bodily harm, (ii) to a particular person, (iii) in such a way that the harm does not result from the deflection of an existing threat onto a different party. They derive these three criteria from Thomson (1986) in a provisional attempt to capture what is considered a natural distinction of moral psychology (Greene et al., 2004). They then requested two independent coders to evaluate a selection of moral dilemmas using these criteria. Consequently, 19 and 25 dilemmas were classified into the moral-impersonal and moral-personal categories, respectively. Greene et al. also used 20 non-moral dilemmas in their study; therefore, they showed participants 64 types of the moral dilemmas. They then specified the neural correlates of moral reasoning by comparing the average brain activity of the participants during contemplation of these dilemmas (Greene et al., 2001). This methodology is also adopted in subsequent studies exploring the neural correlates of moral reasoning (Greene et al., 2004; Moll et al., 2005; Harenski & Hamann, 2008).

However, this method of defining emotional processing contains the three following problems. First, Greene et al.'s (2001) three criteria yield an imperfect distinction between the moral-personal and the moral-impersonal. A dilemma is moral-personal if it satisfies all three criteria, and moral-impersonal if it does not. Consequently, a moral-impersonal dilemma may differ from a moral-personal dilemma for many reasons; a dilemma-causing action might be considered moral-impersonal because it *cannot* reasonably be expected to lead to serious bodily harm, because it does *not* cause serious bodily harm to a particular person or a member or members of a particular group of people, or because the harm it causes *is* the result of deflecting an existing threat onto a different party. That is, Greene et al. (2001) define the distinction between the two dilemmas in terms of combinations among the three criteria. Accordingly, a dilemma may be categorized as moral-impersonal for many reasons. Thus, the criteria do not clearly define the differences between the moral-personal and the moral-impersonal, and the meaning of emotional processing remains unclear.

Second, data analysis in Greene et al. (2001) was based on brain activity averages for the three types of dilemmas (moral-personal, moral-impersonal, and non-moral). While Greene et al. referred to the difference between the footbridge and trolley dilemmas, their findings were not based on comparison of data for the trolley and footbridge dilemmas but on comparison of data for the moral-personal and moral-impersonal dilemmas. That is, they compared average brain activation for the two moral categories. Thus, they discovered only the average difference in activated brain areas between the moral-personal and moral-impersonal dilemmas, but not how *each* dilemma activated the brain areas associated with emotion.

Finally, the moral dilemmas were only classified by two coders. It is thus possible that although the data supported the hypothesis, the study's definitions of the moral-personal and moral-impersonal dilemmas are shaped by these two coders, and that their classifications of the dilemmas are not universally correct. To eliminate this possibility, the moral dilemmas should be explored using procedures of greater objectivity, such as quantitative analysis of their statistical properties.

The above problems strongly suggest a necessity of quantitative analysis of the moral dilemmas. Although the distinction between the moral personal and moral-impersonal is widely accepted, its validity has not been fully examined. What dimensions are needed to measure moral reasoning performances? How do the moral dilemmas compare with each other in those dimensions? We must answer these questions in order to classify the moral dilemmas and consider their relationship to emotional processing. However, the latent structure of moral reasoning has not been explored in previous studies.

Thus, the present study aims to examine the empirical validity of Greene et al.'s (2001) three criteria. For this purpose, we instructed participants to solve the dilemmas used in Greene et al. (2001), and explored correlation structure among the dilemmas via multivariate analysis methods such as factor analysis and structural equation modeling. These methods are appropriate for this study because they provide quantitative expressions of the relationships or similarities among variables. Our experiment will show that Greene et al.'s (2001) three

criteria for distinguishing between the two types of moral dilemmas are almost valid, but also reveal that emotional processing does not differ substantially between the trolley and footbridge dilemmas. Rather, the dilemmas differ mainly in terms of rational processing.

Methods

Participants

Two hundreds and nineteen undergraduates participated in this study in order to obtain credits for their courses. The data of nineteen participants was excluded because they did not answer all the problems.

Materials and procedure

The participants completed 62 dilemma tasks that had been chosen from Greene et al. (2001). Like the trolley and footbridge dilemmas, these dilemmas presented three types of problems for which participants had to choose between two options that were incompatible with each other. We excluded two of Greene et al.'s (2001) dilemmas because they involved issues we deemed too sensitive to pose to undergraduates. One is an "infanticide" problem that requires participants to decide whether it is acceptable for a girl to kill her baby. The other is a "hired rapist" problem that asks them to determine whether it is defensible to hire a man to rape one's wife so that she will be grateful to her husband for comforting her. These two problems were moral-personal dilemmas; therefore, our experimental tasks consisted of 20 non-moral dilemmas, 19 moral-impersonal dilemmas, and 23 moral-personal dilemmas.

We prepared six types of booklets containing the 62 dilemmas in randomly determined order, with six dilemmas on each page. Including instruction, the booklets comprised 12 pages. The instruction page used an example dilemma to demonstrate how to answer the questionnaire, and the 62 dilemmas began from the second page. Participants were randomly provided with one of the six types of booklets and asked to make choices in various situations that did not have correct answers. All participants finished answering the 62 dilemmas within 40 minutes. Data collection was performed in the classroom.

Results

Item responses

The data of nineteen participants was deleted because it contained missing values. Table 1 shows the percentages of participants who thought the behaviors described in the corresponding dilemmas acceptable. Greene et al. (2001; see also Greene et al., 2004) do not report precise values for the percentages of acceptable behaviors in their study, so we cannot tell whether the general pattern of responses in our study replicates that in theirs. However, we compared our results with the percentages of acceptable behaviors reported in other articles (see e.g., Greene & Haidt, 2002; Mikhail, 2009) and found that our results duplicate trends observed in those articles. For example, the percentage of acceptability in our study is higher for the trolley dilemma (0.69) than it is for the footbridge dilemma (0.38), and the difference between them is statistically significant (p-value [p] < 0.01). This pattern accords with Greene and Haidt's (2002) findings. Additionally, the percentage of acceptability for the five-to-seven trolley dilemma, which asks participants whether it is acceptable to hit a switch to save five workmen instead of seven people in the trolley situation, is significantly lower than the percentage of unacceptability in both our study and that of Mikhail's (2009, p34). Despite limitations on our ability to compare the results of our study with those of previous studies, these correspondences show that our study reproduces the general pattern of responses to the moral dilemmas tested in previous studies.

Factor pattern

Using Mplus Version 6 (Muthen & Muthen, 2007), we performed factor analysis on the tetrachoric correlation matrix of the 62 dilemmas, and employed the promax rotation method by maximum likelihood estimation. Eigenvalues for the first five factors were 12.36, 8.20, 3.08, 3.06, and 2.77, respectively. Decreases in the eigenvalues were very small after the third factor, but we chose a four-factor solution because it exhibits a factor pattern with a very simple structure (see Table 1). This solution reveals that most of the problems used in this study are strongly loaded by one factor, indicating that they can be clearly classified into one of four categories. We then considered the substance of the problems in order to identify the four factors.

The first factor mainly affects the non-moral dilemmas. Perusal of dilemmas that are strongly loaded by this factor shows that it reflects a tendency to think over matters in a rational way. Thus, we named this factor the rationality factor.

The second factor mainly affects the moral-personal dilemmas, such as the footbridge dilemma. However, this factor also strongly affects the trolley dilemma, which is a moral-impersonal dilemma. Careful consideration of the dilemmas that are strongly loaded by this factor shows that most of them involve a situation in which a few people may be sacrificed to save many lives. In addition, most of the dilemmas involving such a situation are affected by this factor, which we thus call the life dilemma factor.

The third and fourth factors affect most of the impersonal moral dilemmas. We examined these dilemmas and found that these factors represent risk- or cost-avoiding tendencies. That is, the third factor mainly affects dilemmas that require choosing between the lower probability of a larger benefit and the higher probability of a smaller benefit, and the fourth factor reflects a preference for saving on a cost in order to pursue a plan. Thus, we call the third and fourth factors the risk-averse factor and the efficiency factor, respectively.

Table 1: Factor analysis results

	Dilemmas	Factor 1	2	3	4		
1	Grandson	**-0.78**	-0.23	0.34	**-0.53**	10.4	**
2	New job	**-0.73**	0.17	-0.01	-0.10	10.9	**
3	Reversed turnips	**-0.72**	0.02	-0.12	0.02	18.8	**
4	Broken VCR	**-0.69**	0.07	0.01	-0.03	18.8	**
5	Investment offer	**-0.68**	0.04	0.21	-0.24	15.3	**
6	Three-for-seven fume	**-0.66**	-0.04	0.07	-0.12	19.3	**
7	Food prep	**-0.59**	-0.02	-0.11	0.26	28.2	**
8	Jogging	**-0.54**	0.09	0.16	0.05	48.5	
9	Choosing classes	**-0.49**	0.13	-0.02	0.24	43.6	
10	Shower	**-0.49**	0.07	-0.19	0.17	25.2	
11	Coupons	**0.48**	0.00	0.19	0.20	85.1	**
12	Raffle	**-0.46**	0.05	0.01	-0.03	25.2	**
13	Transplant	**-0.45**	-0.33	0.22	-0.19	21.3	**
14	Computer	**0.44**	0.02	0.31	0.34	89.1	**
15	Country road	**-0.43**	-0.24	-0.18	-0.11	8.9	**
16	Plant transport	**0.41**	-0.13	0.06	0.42	83.2	**
17	Illegal lunch	-0.31	-0.22	0.16	-0.13	27.2	**
18	Modified safari	-0.02	**-0.73**	0.17	-0.04	60.9	**
19	Submarine	0.32	**-0.68**	0.11	0.21	67.3	**
20	Standard trolley	**-0.21**	**-0.67**	**0.16**	**0.29**	69.3	**
21	Modified lifeboat	0.18	**-0.66**	0.02	0.13	49.5	
22	Footbridge	**0.00**	**-0.64**	**-0.22**	**0.13**	37.6	**
23	Modified bomb	-0.02	**-0.63**	-0.11	0.09	60.4	**
24	Vaccine test	0.17	**-0.62**	0.11	0.13	64.4	**
25	Euthanasia	0.33	**-0.60**	-0.19	0.25	68.8	**
26	Sacrifice	0.02	**-0.59**	0.06	-0.32	24.8	**
27	Preventing the spread	-0.07	**-0.59**	-0.03	0.10	46.5	
28	Vitamins	-0.21	**-0.57**	0.20	-0.26	29.2	**
29	Lifeboat	0.09	**-0.56**	0.08	0.11	41.1	**
30	Safari	-0.05	**-0.55**	-0.28	-0.18	32.2	**
31	Crying baby	0.30	**-0.53**	-0.14	0.09	44.6	
32	Architect	-0.30	**-0.52**	-0.19	-0.23	14.4	**
33	Plane crash	-0.15	**-0.52**	0.09	-0.11	25.2	**
34	Standard fumes	-0.12	**-0.51**	0.13	0.18	58.9	**
35	Sophie's choice	0.07	**-0.49**	0.10	-0.13	48.5	
36	Eyes	-0.30	**-0.46**	-0.07	-0.37	20.8	**
37	Smother for dollars	-0.30	**-0.42**	-0.07	-0.18	12.9	**
38	Hard times	-0.32	-0.33	0.13	-0.30	17.3	**
39	Lawrence of Arabia	0.33	-0.34	0.09	0.29	71.8	**
40	Taxes	-0.20	-0.32	-0.09	-0.11	25.7	**
41	Resume	-0.09	-0.35	-0.15	0.07	42.6	**
42	Stock tip	-0.16	-0.34	-0.01	-0.05	29.7	**
43	Environmental policy A2	-0.18	-0.24	**0.84**	-0.13	75.2	**
44	Environmental policy A1	-0.20	0.07	**0.61**	0.21	71.3	**
45	Five-for-seven trolley	-0.37	-0.24	**-0.51**	0.16	19.8	**
46	Environmental policy B1	-0.23	-0.17	**-0.48**	0.07	26.7	**
47	Scenic route	0.06	0.04	**0.46**	0.21	81.2	**
48	Environmental policy B2	-0.26	-0.08	**-0.43**	0.17	20.8	**
49	Generic brand	0.11	-0.16	0.36	0.13	77.2	**
50	Brownies	0.02	0.18	0.33	0.39	84.2	**
51	Speedboat	-0.03	-0.17	-0.12	**0.77**	70.3	**
52	Guarded speedboat	-0.17	-0.18	0.24	**0.55**	78.7	**
53	Sculpture	0.11	0.03	0.03	**0.53**	83.2	**
54	Scheduling	0.13	-0.09	0.15	**0.52**	85.1	**
55	Modified preventing the spread	0.12	-0.28	0.16	**0.42**	78.2	**
56	Standard turnips	0.29	0.09	0.05	0.39	85.1	**
57	Errands	-0.17	0.05	-0.13	0.39	55.0	
58	Train or bus	0.28	-0.05	0.07	0.33	81.7	**
59	Survey	0.23	-0.17	0.18	0.16	82.2	**
60	Donation	0.08	-0.20	-0.13	-0.05	49.0	
61	Vaccine policy	-0.07	-0.10	0.26	0.03	61.4	**
62	Lost wallet	-0.25	-0.22	-0.14	-0.02	23.8	**

Factor correlations	1	2	3	4
1	1.00			
2	0.20	1.00		
3	0.37	0.05	1.00	
4	0.28	0.01	0.26	1.00

1)The rightmost column shows the percentages of participants who considered the behavior described in the corresponding dilemma acceptable.

2)The black, blue, and red fonts indicate non-moral, moral-impersonal, and moral-personal dilemmas, respectively.

3)**:p <.01.

Correlations among the first, third, and fourth factors are relatively high as compared to those among the second and other factors (see Table 1). Given the character of the factors, this factor correlation pattern is very natural because the first, third, and fourth factors indicate rational processing, whereas the second factor relates to emotional processing. In other words, this result supports the dual processing model of moral judgment proposed by Greene et al. (2004; see also Greene & Haidt, 2004).

The factor patterns demonstrate the two following points. First, the factor pattern of the four-factor solution generally supports Greene et al.'s (2001) dilemma classification scheme. The correlation structure of the dilemmas corroborates Greene et al.'s (2001) methods of distinguishing among the three categories of dilemmas, especially the criteria for differentiating between the moral-personal and the non-moral dilemmas. While the moral-impersonal dilemmas may be affected by either one of two factors, they are distinguished from the moral-personal and non-moral dilemmas.

In addition, the nature and factor loadings of the dilemmas by the four factors confirm Greene et al.'s (2001) hypothesis that the moral-personal dilemmas engage the emotional process more than the moral-impersonal or non-moral dilemmas do. The inherent qualities of the dilemmas that are heavily loaded by the second factor strongly suggest that it concerns the emotional process because the decision to sacrifice a few people to save many others is surely based on an emotional response. For these reasons, our analysis validates Greene et al.'s (2001) interpretation of the moral-personal dilemmas.

Second, the factor pattern does not distinguish clearly between the trolley and footbridge dilemmas, although it categorizes the moral-personal dilemmas in the same way as Greene et al. (2001) do. For these two problems, factor loadings by the second factor are almost identical (-0.67 for the trolley dilemma and -0.64 for the footbridge dilemma). If, as we argue, the second factor represents engagement of the emotional process, then the trolley and footbridge problems are almost equivalent in their reliance on this process. This contradicts Greene et al.'s (2001) hypothesis, which posits that these problems belong to different dilemma types. It is plausible that the near-equivalence of the factor loadings for the two problems mainly reflects the similarity of the contexts in which they are framed. Both problems address a situation in which a runaway trolley will kill five persons, regardless of whether the respondent is on a railroad or a footbridge. Thus, the trolley and the footbridge dilemmas may have similar factor loadings solely because they present the same situation.

However, the factor pattern for the disproportional death dilemma controverts this possibility. Factor loading by the second factor for this problem is low (-0.24), whereas factor loadings by the first and third factors are relatively high (-0.37 and -0.51, respectively; see Table 1). This indicates that this type of trolley problem is different from the standard trolley and footbridge problems, which are strongly

loaded by the second factor, and suggests that the similarity in factor loading between the trolley and footbridge dilemmas is not solely due to context.

The results of the factor analysis can be summarized as follows. The factor pattern of the four-factor solution generally supports Greene et al.'s (2001) dilemma classification scheme. In particular, the correlation structure of the data corroborates Greene et al.'s (2001) categorization of most of the dilemmas. However, the analysis does not verify their interpretation of the dilemmas' contents. Greene et al. insist that the difference between the trolley and footbridge dilemmas lies in the engagement of the emotional process, but our results indicate that they differ in the involvement of the rational reasoning process.

Structural equation modeling

To further explore the difference between the trolley and the footbridge dilemmas, we performed structural equation modeling (see Figure 1). Our model aims to investigate the differences between the two dilemmas in terms of the pattern of effects created by the four factors. The four factors are each defined by the dilemma whose factor loading for that factor exceeds 0.40 in absolute value, and both dilemmas are assumed to be affected by only one of the four factors (see Figure 1). The Root Mean Square Error of Approximation (RMSEA) value of this model is below 0.065, indicating that the model accounts for more than 90% of the data variances. In addition, the value of the Comparative Fit Index (CFI) is 0.837; this shows that the model is a better fit for the data than the independent model is. (The latter assumes that the sixty-odd dependent variables under examination are mutually unrelated.) Thus, the model shown in Figure 1 is a good approximation of the data.

Structural equation modeling shows that the path coefficients for the life dilemma factor do not differ substantially between the trolley and footbridge dilemmas (0.94 and 0.80, respectively; $p < 0.01$). However, the dilemmas differ in respect of the patterns created by the effects of the other three factors. Whereas the footbridge dilemma is significantly affected by the risk-averse factor (path coefficient = -0.48; $p < 0.01$), the trolley dilemma is affected by the efficiency and rationality factors (path coefficients = -0.54 and -0.25, respectively; $p < 0.01$).

Of course, this still leaves room to discuss the validity of correspondences among the four factors and emotional and rational processing. However, this study provides another scheme for describing the difference between the trolley and the footbridge dilemmas. If the life dilemma factor reflects emotional processing whereas the other three factors reflect rational processing, then our results suggest that the difference between the trolley and footbridge dilemmas mainly lies not in their engagement of the emotional process, but in the extent to which rational processing affects judgment of these dilemmas.

General discussion

This study aims to explore the nature of moral dilemmas such as the trolley or footbridge dilemmas by analyzing the correlation structure of the 62 dilemma problems employed in Greene et al. (2001). Its results can be summarized as follows. First, the study supports Greene et al.'s (2001) distinctions between the moral-personal and moral-impersonal dilemmas. Second, factor patterns and structural equation modeling show that the difference between the trolley and footbridge problems is not due to the extent to which they engage the emotional process, as Greene et al. (2001) have hypothesized. Rather, judgment of the trolley and footbridge problems differs due to the varying involvement of the rational reasoning process.

To our knowledge, this study is the first to use statistical methods to test the three criteria proposed by Greene et al. (2001). Since the existing criteria for classifying moral dilemmas mainly depend on philosophical or intuitive principles, the study contributes to the field of moral reasoning by conducting empirical research that demonstrates that a meaningful classification method can be derived from the correlation structure of the data. Future research should use statistical analysis to more rigorously explore the latent structure of moral reasoning. Specifically, it should describe the quantitative features of *each* moral dilemma in order to promote a better understanding of the moral reasoning process.

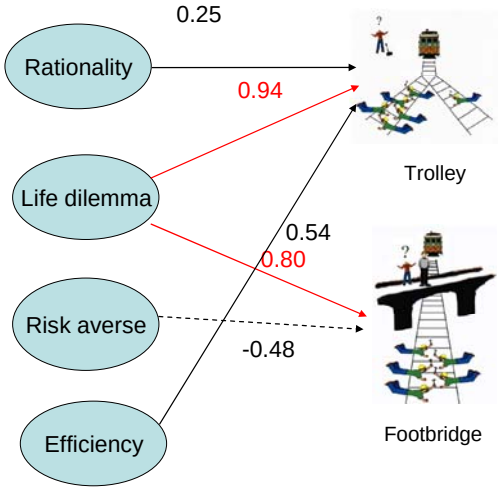

Figure 1: Structural equation modeling results

From a theoretical standpoint, this study suggests that it is important to investigate the role of rational processing in moral judgment. This is the perspective adopted in the traditional approach to this subject (Kohlberg, 1969; Nucci & Turiel, 1978; Turiel, 1983; 1998; Turiel, Killen, & Helwig, 1987). However, Greene et al.'s (2001) pioneering work has altered the focus of recent studies on moral reasoning, which use brain imaging to show how emotional processing functions when people solve moral dilemmas.

Our results indicate that moral dilemmas differ from each other not only in the engagement of the emotional process but also in the involvement of the rational process, which is triggered by mental activities such as considering the risk or efficiency of actions. Of course, this study does not deny the findings of brain imaging studies, including those of Greene et al. (2001). Rather, it suggests that the two approaches to moral reasoning (the traditional approach and the one developed by Greene et al. [2001; 2004]) are complementary. Both the emotional and rational processes contribute to moral reasoning, and their roles in the resolution of moral dilemmas must be understood if we are to uncover the processes of moral judgment.

It is noteworthy that the difference between the footbridge and trolley dilemmas lies in the engagement of the rational process rather than that of the emotional process. This finding disagrees with the prevailing view that the footbridge dilemma is more emotionally salient than the trolley dilemma is (Greene et al., 2001; 2004). However, this theory is derived from brain activation averages for the moral-personal and moral-impersonal dilemmas. This means that the effect of individual dilemmas on brain areas has not been fully explored, although the trolley and footbridge dilemmas have been analyzed as representations of the moral-personal and moral-impersonal dilemmas, respectively. In contrast to previous studies, this study has analyzed the correlation structure of each dilemma. Thus, it has examined Greene et al.'s hypothesis (2001) more directly than any preceding study has, and has demonstrated the importance of the rational process in forming moral judgments.

Finally, we argue that future research should provide precise definitions of the terms "emotional" and "rational." While this study has developed a new scheme for understanding the nature of moral judgment, it has not clarified the relationship between the emotional process and the life dilemma factor. Intuitively, this relationship is natural; however, we cannot explain why moral-personal dilemma enhances the emotional process. Greene et al. (2004) argue that the moral-personal dilemma and the emotional process are related from an evolutionary standpoint, but this argument depends solely on the importance of personal relationships in human life; consequently, the term "emotion" becomes merely a paraphrase of something crucial in moral judgment. We believe that a precise definition of this term is essential to a profound understanding of moral judgment.

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