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Contingent focus model of Decision Framing under Risk

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Abstract

Decision problems which are identical in form may give rise to different decisions due to subjective decision framing, in which the decision-making process can be altered depending on how the situation is described. This is called the *framing effect*. We applied the Contingent focus model (Takemura, 1994a) to an explanation of the framing effect. The model hypothesizes that a risk attitude depends on the extent to which a subject focuses on possible outcomes and probabilities, that is the *focusing hypothesis*, and focusing on possible outcomes and probabilities are, in turn, contingent on contextual factors including positive/negative frame condition, that is the *contingent focus hypothesis*. In order to test these hypotheses, we implemented two experiments (n = 180 for both experiments), which manipulated size of letters describing outcomes and probabilities. The results were compatible with predictions derived from the hypotheses, that is, the subjects more frequently selected risky options when outcomes were emphasized. We also applied the model to a psychometric meta-analysis of subjects' responses in experiments of Asian disease problem (Tversky & Kahaneman, 1981; Takemura, 1994b) and one of the experiments of this study (4 experiments; n = 831). The results were also compatible with predictions derived from the hypotheses.

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Introduction

Decision problems which are identical in form may give rise to different decisions due to subjective decision framing, in which the decision-making process can be altered depending on how the situation is described. This is called the *framing effect* (Tversky & Kahneman, 1981). For instance, when a decision needs to be made concerning whether or not one agrees to undergo an operation, the decision arrived at may be different when a doctor tells one that there is a 95% probability of living, compared to that when a doctor advises that there is 5% probability of dying. The existence of this effect violates description invariance in which different representations of the same choice problem should yield the same preference (Tversky & Kahneman, 1986).

Tversky and Kahneman (1981) posed a question under the following two frame conditions, which is a typical yet famous example called the Asian disease problem which gives rise to the framing effect, and let subjects make a choice under each condition.

[Problem 1]

Positive frame condition:

> Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of programs are as follows. Which of the two programs would you favor?
>
> If program A is adopted, 200 people will be saved.
>
> If program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved. (p.193.)"

Negative frame condition:

> The question is the same except for the description of programs , which were changed as below:
>
> If program C is adopted, 400 people will die.
>
> If program D is adopted, there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die. (p.193)"

Here, although the ways of describing the programs are different, it is clear that programs A and C, and programs B and D are the same in extensively confirmed meaning, respectively. Namely, "be saved" equals "not die", and "not be saved" equals "die". Tversky and Kahneman (1981) reported that in the case that a profitable side was emphasized in the description of a positive frame condition most subjects chose risk aversive programs, i.e. program A. On the other hand, in the case that a losing side was emphasized in the description of a negative frame condition most subjects chose the risk taking program, i.e., program D.

Tversky and Kahneman (1981, 1986) reported that the framing effect in decision making is a robust phenomenon. They suggested that, similarly to a visual illusion phenomenon in sensation, the framing effect leads to a paradoxical judgment in its process, even though the paradox may be recognized afterwards. Framing effects have been reported to occur in relation to medical judgments made by doctors (McNeil, Pauker, Sox, & Tversky, 1982), in managerial decision making (Qualls & Puto, 1989) and in many other decision making situations (see Kühberger, 1998).

Prospect theory

Tversky and Kahneman (1979) proposed *Prospect theory* as a theoretical explanation for

framing effects. They highlighted a difference between subjective values for gains and losses associated with choice behavior. As shown in Figure 1, the (hypothetical?) value function in prospect theory is concave in the gain area and is convex in the loss area, which implies that a decision maker is risk averse in the gain area and takes risks in the loss area. In addition, the slope of the value function is steeper in the loss area than in the gain area.

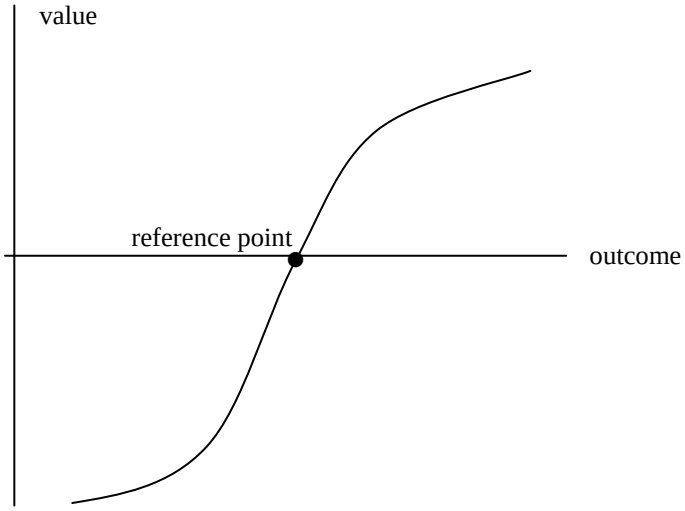


Figure 1. Value function assumed in Prospect theory

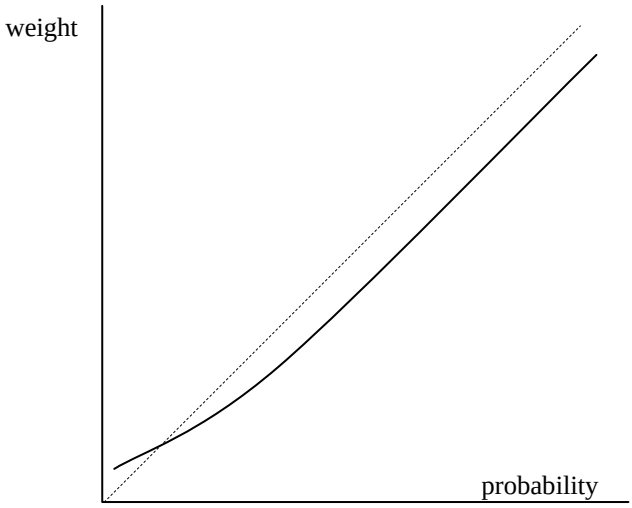


Figure 2. Probability weighting function assumed in Cumulative Prospect theory

Tversky and Kahneman (1992) extended Prospect theory by formulating a value function using a Choquet integral and labeled it *Cumulative prospect theory*. With respect to mathematical descriptions of a value function, Cumulative prospect theory can be categorized as a nonlinear utility theory (Fishburn, 1988), which is an extended version of subjective expected utility theory (Von Neumann and Morgenstern, 1944; Savage, 1954). However, Prospect theory is substantially different from the utility theory because the latter assumes that original points of utility functions never shift, whereas the former assumes that original points of the value functions, i.e. *reference points*, shift depending on the description of a decision problem. Prospect theory explains framing effects by a shift of the reference point.

When a reference point is greater than an outcome, the outcome is interpreted as a gain. However, if the reference point shifts to be less than the outcome, it then comes to be regarded as a loss. Since Prospect theory assumes that subjects avoid risks when outcomes are framed as gains (i.e. positive frame), and that subjects take risks when outcomes are framed as losses (i.e. negative frame), Prospect theory predicts that risk attitudes change depending on the frame condition. Another cause of framing effects indicated by Tversky and Kahneman (1981) is that, as shown in Figure 2, the weighting function of probabilities is nonlinear. This implies that framing effects become more prominent as the value of gain or loss for a certain alternative becomes larger.

Reference Point

For Prospect theory, a reference point is a key concept necessary to explain decision making under risk, because risk attitude, which determines a decision, depends on the relation between a reference point and an outcome. This implies that it is indispensable to be able to predict the position of a reference point and its shift due to contextual factors, including positive/negative frame conditions, for a theoretical understanding and prediction of decision making under risk in the actual environment in which numerous contextual factors are embedded.

Does Prospect theory, then, provide a theoretical and quantitative explanation as to the shift of a reference point *per se*? With respect to this question, Tversky and Kahneman (1981) stated the following:

> "The frame that a decision maker adopts is controlled partly by the formulation of the problem and partly by the norms, habits, and personal characteristics of the decision maker" (p. 453)

In line with this conjecture, Fischhoff (1983) reported the experiment that investigated reference point positions while postulating the validity of Prospect theory. However, he found that it was difficult, or even impossible, to identify a reference point position from external observations, i.e. actual choices. In addition, he found an inconsistency between a reference point that is derived from actual choice based on Prospect theory, and a self-reported reference point. To the present time, a methodology to identify reference point position does not seem to have been proposed.

While Prospect theory postulates one reference point, a decision maker may, however, have multiple reference points. For instance, Takemura (in press.) proposed the Mental ruler theory that postulates two reference points to explain numerical judgements. He confirmed that the theory provides a better fit to judgmental data than other theories. In addition, Maule (1989) collected verbal protocol data of decisions involving the Asian disease problem and found that 5 subjects out of 12 made their decisions while adopting two different reference points.

Contingent focus model

Basic idea

A reference point is a useful concept used to explain the framing effect. However, as is argued above, it is difficult to define a reference point, to theoretically predict its position and its shift. Furthermore, Prospect theory can not explain decision making when a decision maker has multiple reference points. For these reasons, one of the authors of the present study proposed the *Contingent focus model*, while abandoning the concept of reference point to explain the framing effect (Takemura, 1994a).

The basic assumption of the Contingent focus model is that framing effects emerge, not when a reference point shifts, but when a decision maker changes focus on possible outcomes and probabilities depending on frame conditions of decision problems. As shown in Figure 3, under positive frame conditions, a decision maker is assumed to pay more attention to probabilities than to possible outcomes, which results in the decision maker being risk averse. On the other hand, under negative frame conditions, a decision maker is assumed to pay more attention to possible outcomes than to probabilities, which results in risk taking. In other words, a decision maker is assumed to attend to negative outcomes (i.e. loss) more intensely than to positive outcomes (i.e. gain).

This hypothesis is in line with the *loss sensitivity principle* (Gärling, et al., 1997; Romanus & Gärling, 1999) which presumes that a decision maker is more sensitive to a negatively-framed outcome (i.e. loss) than to a positively-framed outcome (i.e. gain). Prospect theory hypothesizes that the value function of outcomes is steeper for losses than for gain, which is also in line with the hypothesis, since curvature of the value function implies the decision maker's sensitivity to outcome. Furthermore, Kahaneman & Tversky (1984) directly argued that "losses loom larger than gains (p. 348)". These arguments imply that a decision maker pays more attention to outcomes under negative frame conditions than under positive frame conditions, as is assumed in the Contingent focus model.

Figure 3. Basic idea of Contingent focus model (Takemura, 1994a)

Numerical Representation

Similarly to Prospect theory (Kahneman & Tversky, 1979) and the subjective expected utility theory (Von Neumann and Morgenstern, 1944; Savage, 1954), the Contingent focus model also describes decision making under risk. In the Contingent focus model, it is hypothesized that a decision maker chooses an alternative whose subjective decisional value is maximum from among possible alternatives. The value is formulated as follows.

$$U(X, P) = F(X)^{a} G(P)^{(1-a)} \quad (1)$$

where, X denotes possible outcome, P denotes the probability that a decision maker gets X, $U(X, P)$ denotes a subjective decisional value of an alternative of X and P, $F(X)$ denotes the subjective value of a possible outcome X ($F(X) > 0$), $G(P)$ denotes the subjective value of P ($G(P) > 0$), and a denotes a parameter ($0 \leq a \leq 1$) indicating the degree of focus on outcome X. We label this parameter as the *focal parameter*. As the focal parameter, a approaches 1 from 0, for a decision maker making riskier decisions. When a equals 1, only outcomes influence the decision making and a decision maker is extremely risky. On the other hand, as a approaches 0 from 1, a decision maker becomes risk averse. When a equals 0, only probabilities influence the decision making, and a decision maker is extremely risk averse. This hypothesis, which

shows how focusing on possible outcomes and probabilities determines a risk attitude, is labeled as the *focusing hypothesis*.

The focal parameter a can be hypothesized to change depending on contextual factors, including frame condition. This hypothesis is labeled as the *contingent focus hypothesis*. Thus, in the Contingent focus model, framing effects are ascribed to changes of the focal parameter a, and not to a shift of reference point. This contingency of the focal parameter is formulated as follows:

$$a = \Psi(\theta) \tag{2}$$

where, θ denotes a vector of contextual factors and $\Psi(\ )$ denotes a function indicating the contingency of the focal parameter a on θ. Contextual factors (θ) include positive/negative frame conditions. A basic idea of the Contingent focus model to explain a framing effect, that is, a decision maker attends to negative outcomes more intensely than positive outcomes, indicates that the focal parameter a is supposed to be larger under negative frame conditions than under positive frame conditions.

Elaboration condition, which refers to how well a decision is elaborated, is a possible contextual factor included in θ. When a decision is elaborated by virtue of a long decision time or a self-justification of a decision, a decision maker may frequently discover covert aspects of a decision problem which are not explicitly described compared to when the decision problem is not elaborated. For example, when decision making is elaborated, a decision maker might discover the fact that 200 survivals implies 400 deaths although 400 deaths were not explicitly described under the positive frame condition in the Asian disease problem. Accordingly, the Contingent focus model predicts that differences in the value of the focal parameter a for positive and negative frame conditions are less when decision making is elaborated than when it is not elaborated. This decrease in the difference of the focal parameters for positive and negative frame conditions is, in turn, conjectured to eliminate the framing effect. A series of experiments by one of the authors of the present study, whereupon the extent of the elaboration was manipulated, confirmed this prediction; that is, framing effects were not observed when decisions were elaborated (Takemura, 1992, 1993, 1994b). These results cannot be adequately explained by Prospect theory.

Empirical Tests

The focusing hypothesis, which states that the extent of focusing on possible outcomes and probabilities determines risk attitudes, is a key to explaining framing effects by Contingent focus. However, this hypothesis has not been sufficiently tested by experimental data. In order to confirm whether risk attitudes change in line with the prediction of the focusing hypothesis, we implemented two experiments in which the relative sizes of letters of possible outcomes and probabilities were manipulated compared to the other letters in described decision problems.

Experiment 1

The first experiment was a 3 (control-emphasis condition, outcome-emphasis condition, and probability-emphasis condition) by 2 (positive/negative frame conditions) factorial experiment. The subjects for this experiment were 180 students and staff members at Kyoto University, Japan. They were randomly assigned to one of the 6 conditions, with 30 subjects in each condition.

For the positive frame condition, the following decision problems were used. Decision problems for negative frame conditions were identical with those under positive conditions except that the word "loss" was used in stead of "gain".

(control-emphasis condition)

Which do you choose?

A: certainly gain 20,000 yen

B: a lottery with a 50 % chance to gain 40,000 yen and a 50 % chance for no gain.

(outcome-emphasis condition)

Which do you choose?

A: certainly gain **20,000 yen**

B: a lottery with a 50 % chance to gain **40,000 yen** and a 50 % chance for no gain.

(probability-emphasis condition)

Which do you choose?

A: **certainly** gain 20,000 yen

B: a lottery with a **50 % chance** to gain 40,000 yen and a 50 % chance for no gain.

As described above, under the outcome-emphasis condition, possible outcomes were emphasized by larger bold fonts than the other letters. Emphasized letters were described by size 18 fonts, while the other letters were described by fonts of size 10.5. In contrast, for the probability-emphasis condition, probabilities were emphasized in the same way.

Due to the experimental manipulation of size of letters, it was supposed that subjects would focus on possible outcomes more strongly under the outcome-emphasis condition than under the probability-emphasis condition. Accordingly, the focusing hypothesis predicts that subjects take risks more frequently under the outcome-emphasis condition than under the probability-emphasis condition, regardless of the positive/negative frame conditions.

Manipulation of the positive/negative frame conditions in this experiment has been used to show the reflection effect (Kahneman & Tversky, 1979), which denotes a decisional phenomenon whereby a subject takes risks when a choice is between losses, whereas he avoids risk when a choice is between gains. This effect can be predicted by Prospect theory, since the theory assumes that a value function for gains is concave while that for losses is convex. The effect can also be predicted by the Contingent focus model, since the model hypothesizes that a decision maker pays more attention to outcomes presented under negative conditions than if they were presented under positive conditions. The net effect is for the subject to take greater risks risk for negative frame conditions than for positive frame conditions.

Table 1 shows results of these experiments, which indicate that subjects preferred risky options more frequently under negative frame conditions than under positive frame conditions for the respective emphasis conditions. Table 2 presents the results of a hierarchical log-linear analysis. The hierarchical log-linear analysis yielded a significant main effect of a positive/negative frame conditions on risk attitudes (reject risk vs. accept risk), that is P * R. This result may be similar to the reflection effect. However, the finding indicates that subjects

were *relatively* more risky under negative frame conditions than under frame positive conditions. As can be seen in Table 1, under the probability emphasis condition, subjects were not risk takers at all, even under the negative frame condition. For the control-emphasis condition, there is no clear tendency that subjects were risk takers under the negative frame condition. Since the reflection effect denotes that a subject takes risks under negative frame conditions and avoids, on the other hand, risk taking under positive frame conditions, the results were not compatible with reflection effects. In contrast, for the Contingent focus model, which hypothesizes that positive/negative frame conditions determine the extent of relative attention towards outcomes which in turn determines risk attitude, the model predicts that subjects were *relatively* riskier under negative frame conditions than those under positive frame conditions. Accordingly, the results presented here do not support Prospect theory, but do support the Contingent focus model. The results may imply that the reflection effect is a special case which is brought about by a difference of attentions towards outcomes between positive and negative frame conditions.

Table 1 Outcome/uncertainty Emphasis Effect and Reflection Effect

	positive frame		negative frame	
Emphasis condition	Reject risk % (*N*)	Accept risk % (*N*)	Reject risk % (*N*)	Accept risk % (*N*)
Probability	90.0 (27)	10.0 (3)	50.0 (15)	50.0 (15)
Control	83.3 (25)	16.7 (5)	56.7 (17)	43.3 (13)
Outcome	63.3 (19)	36.7 (11)	30.0 (9)	70.0 (21)

Table 2 Results of Log-Linear Analysis

Model	χ^2	*df*	*p*
(1) F*E*R, F*E, E*R, F*R, F, E, R	.0	0	
(2) F*E, E*R, F*R, F, E, R	0.85	2	
Δ1-2: F*E*R	0.85	2	*n.s.*
(3) F*E, F*R, F, E, R	11.85	4	
Δ2-3: E*R	11.00	2	$p < 0.005$
(4) F*E, E*R, F, E, R	26.66	3	
Δ2-4: F*R	25.81	1	$p < 0.001$

F, frame condition (positive/negative); E, emphasis condition (uncertainty/outcome/control); R, risk attitude (reject risk/accept risk)

Table 1 shows that more subjects selected risky options under the outcome-emphasis condition than for the probability-emphasis condition, regardless of the positive/negative frame conditions. The hierarchical log-linear analysis reported in Table 2 yielded a significant main effect of emphasis condition (control-emphasis condition, outcome-emphasis condition, and probability-emphasis condition) on risk attitudes (reject risk vs. accept risk), that is E * R. This result is in line predictions derived from the focusing hypothesis and the contingent focus hypothesis in the Contingent focus model.

Table 3 Outcome/uncertainty Emphasis Effect and Framing Effect

	positive frame		negative frame	
Emphasis Effect	Reject risk % (*N*)	Accept risk % (*N*)	Reject risk % (*N*)	Accept risk % (*N*)
Probability	70.0 (21)	30.0 (9)	40.0 (12)	60.0 (18)
Control	60.0 (18)	40.0 (12)	56.7 (17)	43.3 (13)
Outcome	43.3 (13)	56.7 (17)	20.0 (6)	80.0 (24)

Table 4 Results of Log-Linear Analysis

Model	χ^2	df	*p*
(1) F*E*R, F*E, E*R, F*R, F, E, R	.0	0	
(2) F*E, E*R, F*R, F, E, R	2.59	2	
Δ1-2: F*E*R	2.59	2	*n.s.*
(3) F*E, F*R, F, E, R	10.73	4	
Δ2-3: E*R	8.14	2	$p < .05$
(4) F*E, E*R, F, E, R	6.87	3	
Δ2-4: F*R	4.28	1	$p < .05$

F, framing condition (positive/negative); E, emphasis (uncertainty/outcome/control); R, risk attitude (reject risk/accept risk)

Experiment 2

The second experiment performed was a 3 (control-emphasis condition, outcome-emphasis condition, and probability-emphasis condition) by 2 (positive frame condition and negative frame condition) factorial experiment. In the experiment the Asian disease problem was used. Under the outcome-emphasis condition and the probability-emphasis condition, a possible outcome and a probability were emphasized in the same way as that described in the first experiment, respectively. The subjects for this experiment were 180 students and staff members, different from those used in Experiment 1, from Kyoto University, Japan. Table 3 presents results from this experiment and Table 4 shows the results of a hierarchical log-linear analysis.

Table 3 shows that the framing effect emerged under both the probability-emphasis condition and the outcome-emphasis condition; namely, a majority of subjects avoided risk under the positive frame condition, whereas a majority of subjects tended to be risk taking under the negative frame condition. As can be seen in Table 4, risk attitudes were significantly dependent on frame condition. These results were in line not only with Prospect theory but also with the Contingent focus model. However, under the control-emphasis condition, the framing effect did not emerge. Nevertheless, more subjects tended to be risk taking under the negative frame condition than under the positive frame condition. This result supports the Contingent focus model rather than Prospect theory.

As can be seen in Table 3, more subjects were risk taking for the outcome-emphasis condition than for the probability-emphasis condition. Table 4 indicates that risk attitudes were significantly dependent on the emphasis condition. These results cannot be predicted by Prospect theory but are consistent with the basic idea of the Contingent focus model, which

shows how focusing on possible outcomes and probabilities determines risk attitude.

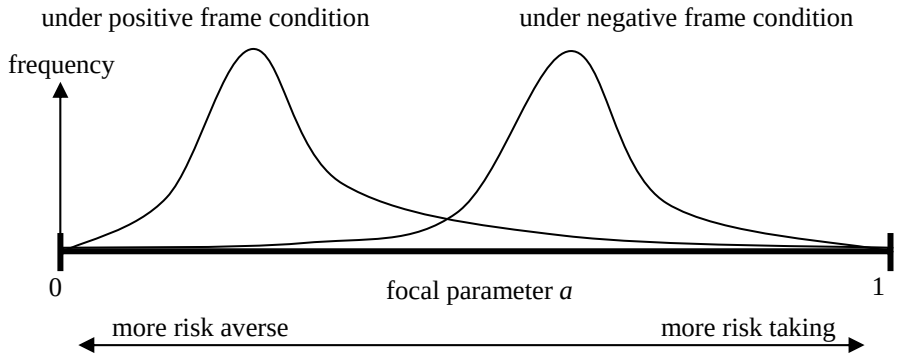


Figure 4. Distributions of the focal parameter *a* under positive/negative frame conditions

A Meta-Analysis of Asian Disease Problem

Heterogeneity in risk attitudes across decision makers can be always observed in any experiments of decision making under risk. In the Asian disease problem, for example, opposite responses to the prediction by Prospect theory, i.e. risk seeking under the positive frame condition and risk aversion under the negative frame condition, have been always observed, even if they were in the minority.

The Contingent focus model explains this heterogeneity by using a distribution of the focal parameter *a*; that is, the heterogeneity in how subjects focus on possible outcomes and probabilities is assumed to cause heterogeneity in risk attitudes. For example, in the Asian disease problem, as shown in Figure 4, the expected range of distribution of the focal parameters is expected to be larger under the negative frame condition than under the positive frame condition.

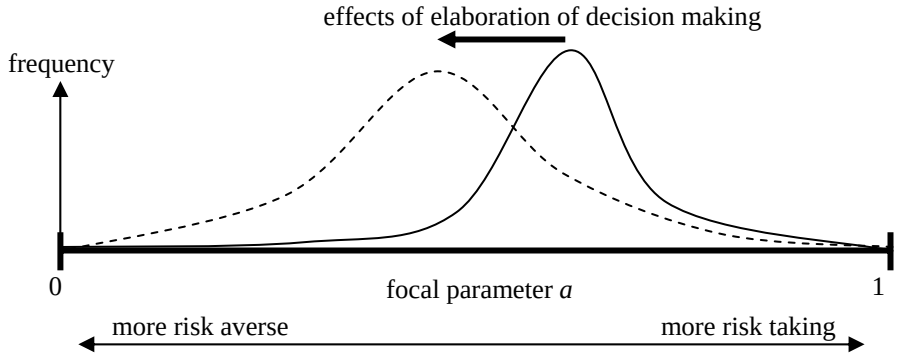
If we accept parametric assumptions with respect to the distribution of the focal parameters, the Contingent focus model can psychometrically analyze the decision framing under risk (see **Appendix**). We applied the Contingent focus model to a meta-analysis of the Asian disease problem, in order to disentangle contextual factors associated with decision frames.

Contextual Factors Influencing the Focal Parameter

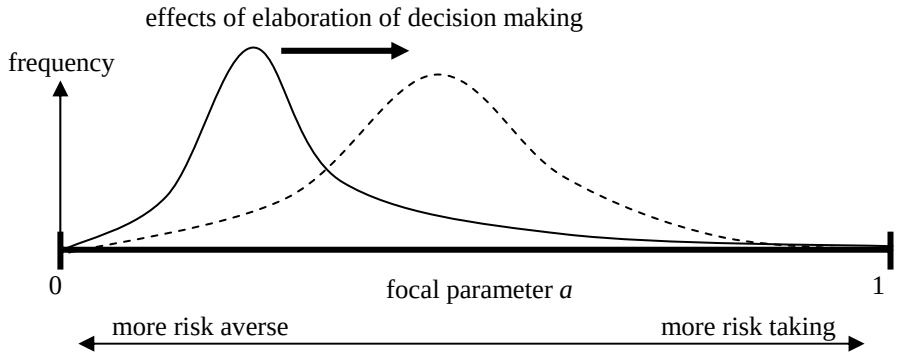
There are several possible contextual factors which may influence the focal parameter, which in turn is assumed to determine risk attitudes. Such factors include positive/negative frame conditions and emphasis conditions, as has been shown in the two experiments of the present study. The difference between the expected value of distribution of the focal parameters under positive frame and negative frame conditions is conjectured to cause the Asian-disease-problem-type's framing effect. Moreover, the effect of outcome emphasis on the focal parameter is conjectured to bring about the result that more subjects are risk takers under the outcome-emphasis condition than for the other conditions. On the other hand, the effect of probability-emphasis is postulated to result in more subjects being risk averse under the probability-emphasis condition than for the other conditions.

In addition, elaboration condition is another contextual factor influencing the focal parameter (Takemura, 1992, 1993, 1994b). For the elaboration condition, decision making is elaborated upon by virtue of a long decision time or a need for decision justification. Under such a

condition, subjects may more frequently discover, as distinct from the no-elaboration condition, covert aspects of the decision problem which are not explicitly described. For example, under the positive frame condition in the Asian disease problem, an outcome in an option is expressed as "200 people will be saved". Nevertheless, subjects may frequently discover under the elaboration condition, as distinct from the no-elaboration condition, the fact that this sentence implies "400 people will die". Due to the discovery of covert decision aspects under the elaboration condition, the focal parameter would become smaller under negative frame conditions, as shown in Figure 5 (a). This is because the distribution of the focal parameters skews towards the value of 1 for negative frame conditions without elaboration of decision making. On the other hand, under positive frame conditions, due to the elaboration of decision making, the focal parameter would become larger (see Figure 5 (b)). This is because the distribution skews toward the value of 0 for positive frame conditions without elaboration of decision making. Accordingly, elaboration of decision making is assumed to have a positive effect on focal parameters under positive frame conditions, but to have a negative effect under negative frame conditions. To summarize, positive/negative frame conditions, emphasis conditions, and elaboration conditions are hypothesized to have the following effects on the focal parameter:



(a) under negative frame condition



(b) under positive frame condition

Figure 5. The effects of elaboration on the focal parameter, *a*

- under negative frame conditions the focal parameter is larger than that for positive frame conditions (this is the reason for the Asian-disease-problem-type's framing effect),
- outcome emphasis increases the value of the focal parameter,

- probability emphasis decreases the value of the focal parameter,
- elaboration of decision making increases the value of the focal parameter under positive frame conditions, and
- elaboration of decision making decreases the value of the focal parameter under negative frame conditions.

A Meta-Analysis

To test these hypotheses, we implemented a meta-analysis of subjects' responses in the Asian Disease problem, which manipulated positive/negative frame condition, elaboration condition, and emphasis condition, and we applied the Contingent focus model to this meta-analysis.

The meta-analysis included the results of the original experiment by Kahneman & Tversky (1981), and the experiments which manipulated the elaboration of decision making of the Asian disease problem (Takemura, 1994b). The results of Experiment 2 in this study, which manipulated emphasis conditions, were also included. The total number of subjects used was 831, out of which 413 (49.7%) selected a risky option, and the remainder (418, 50.3%) selected a riskless option.

In order to test the hypotheses associated with the focal parameters, let the function representing contingency of decision framing on contextual factors $\Phi(\theta)$ (see eq. (A3) in **Appendix**) be described as follows:

$$\begin{aligned}\Phi(\theta) = {} & \beta_0 + \beta_1 PositiveFrame \\ & + \beta_2 OutcomeEmphasis + \beta_3 ProbabilityEmphasis \\ & + \beta_4 Elaboration(Negative) + \beta_5\, Elaboration(Positive)\end{aligned} \tag{10}$$

where, β_0 - β_5 denote parameters to be estimated; *PositiveFrame* is 1 if frame condition is positive, otherwise 0; *OutcomeEmphasis* is 1 for outcome emphasis condition, otherwise 0; *ProabilityEmphasis* is 1 for probability emphasis condition, otherwise 0; *Elaboration(Negative)* is 1 for elaboration condition under negative frame condition, otherwise 0; and *Elaboration(Positive)* is 1 for elaboration condition under positive frame condition, otherwise 0.

The parameters were estimated by maximizing likelihood formulated on the basis on eqs. (A6) and (A7) in **Appendix**. Table 5 shows the results of the estimation. As can be seen in the table, *PositiveFrame* has a significantly negative coefficient, which indicates that the focal parameter *a* under positive frame conditions is significantly smaller than under negative frame conditions. This result is in line with our hypothesis with respect to the Asian-disease-problem-type's framing effect. The coefficient of *Elaboration(Negative)* was significantly negative and that of *Elaboration(Positive)* was significantly positive. These results indicate that the focal parameter becomes larger by elaboration of decision making under positive frame conditions, but becomes smaller upon elaboration under negative frame conditions. These results are also in line with our hypothesis with respect to elaboration condition. The coefficient of *OutcomeEmphasis* is significantly positive, which indicates that the focal parameter becomes larger with outcome emphasis, a finding which is also in line with our hypothesis. However, the coefficient of *ProbabilityEmphasis* was not significant, which is not in line with our hypothesis.

Table 5. Estimation results of meta-analysis of the Asian disease problem

		parameter	std.	*p*
PositiveFrame	β_1	-1.72	0.172	.000
OutcomeEmphasis	β_2	0.919	0.314	.003
ProbabilityEmphasis	β_3	-0.23	0.299	.441
Elaboration(Negative)	β_4	-1.227	0.254	.000
Elaboration(Positive)	β_5	0.777	0.251	.002
constant	β_0	0.85	0.127	.000

General Discussion

Focusing Hypothesis and Contingent Focus Hypothesis

The Contingent focus model hypothesizes that attention to possible outcomes and probabilities determines decision making under risk. Based on this basic idea, we propose the focusing hypothesis and the contingent focus hypothesis. The focusing hypothesis states that a risk attitude for decision making under risk depends on the extent to which a subject focuses on possible outcomes and probabilities. The contingent focus hypothesis states that focusing on possible outcomes and probabilities, or attention to possible outcomes and probabilities, are contingent on decisional contexts. In order to test these hypotheses, we attempted in the experiments presented here to manipulate attention towards possible outcomes and probabilities by manipulating the relative sizes of letters describing possible outcomes or probabilities compared to the remaining letters in written alternatives.

The results of Experiment 1 (a decision problem highlighting the reflection effect) and Experiment 2 (Asian disease problem) indicated that subjects took risks more frequently under an outcome-emphasis condition than under a probability-emphasis condition, regardless of positive/negative frame conditions. This result seems to indicate that risk attitudes depend on how a subject focuses on possible outcomes and probabilities, or attention to outcome and probability, and is compatible with the focusing hypothesis and contingent focus hypothesis. This finding is well-known to advertising marketers, who often manipulate the salience of certain letters, e.g. letters dealing with price or special features of products, by manipulating their relative size or color. The current study may explain the theoretical influence of such manipulations on decision making, and why such practices are frequently adopted in the advertising industry.

Prospect theory predicts that subjects accept risk under negative frame conditions and reject risk under positive frame conditions, since the hypothetical value function, whose shape does not change depending on decisional contexts, is assumed to be convex for losses and concave for gains. However, for the probability-emphasis and control-emphasis conditions in Experiment 1, subjects under negative frame conditions did not show any significant difference in relation to preference for risky options compared to riskless options. With similar results found in Experiment 2, these findings were not compatible with Prospect theory. Nevertheless, subjects selected risky options more frequently under negative frame conditions than under positive frame conditions, regardless of the emphasis conditions. This result is compatible with the Contingent focus model, which hypothesizes that subjects pay more attention to negative outcomes than to positive outcomes.

A meta-analysis of the Asian disease problem using the Contingent focus model, which assumes a parametric distribution of the focal parameters, yielded results that were consistent with our hypothetical predictions. The analysis indicated that the focal parameter under negative frame conditions was larger than that found under positive frame conditions. This supports the basic hypotheses of the Contingent focus model. It was also indicated that emphasizing the possible outcome resulted in an increase in the focal parameter, which is also in line with the basic hypotheses of the Contingent focus model.

With respect to an effect of elaboration of decision making by asking subjects' justifications of their responses or by providing longer periods of time for decision making, we hypothesized that subjects would more frequently discover covert frames within the decision problems when decision makings were elaborated. As a result, the distribution of the focal parameters then becomes less skewed as shown in Figure 5, regardless of the positive/negative frame conditions. Accordingly, we predicted that the elaboration has a positive effect on the focal parameter under positive frame conditions, but a negative effect under negative frame conditions. The results of the meta-analysis were consistent with this prediction. These results provide a theoretical explanation of the empirical findings by Fagley & Miller (1987), Takemura (1992, 1993, 1994b) and Kühberger (1995) that elaboration of decision making eliminates the framing effect.

Although the effect of outcome emphasis on decision making was in line with our hypothesis, we did not find an effect of probability emphasis. This result may indicate that it is not the emphasis on probabilities, but the emphasis on the outcomes that has an impact on decision making. Furthermore, based on this result, one may propose an hypothesis that both decisional attentions towards a possible outcome and probability do not determine a risk attitude together, but decisional attention only on a possible outcome in fact determines a risk attitude. However, the data presented in this study is not sufficient to test this, and further experiments are required in order to elucidate this result.

Relations to the Other Theories

In terms of the mathematical formulations, the difference between Prospect theory and the Contingent focus model is the flexibility (or stability) of value functions of outcome. In Prospect theory, a value function of outcome and a weighting function of probability are assumed to be fixed across different conditions. From this viewpoint, Prospect theory has the same premise as have various utility theories. What is assumed to be changeable in Prospect theory is the reference point. In this regard, Prospect theory is different from utility theories. On the other hand, the Contingent focus model is similar to utility theories in terms of the definition of outcome because the definition of outcomes does not depend on reference point. However, the Contingent focus model is different from both utility theories and Prospect theory in terms of flexibility of value functions. Because the Contingent focus model has such flexibility in these functions, it can explain various types of framing effects, including those yielded by elaboration or emphasis on outcomes, which can not be explained by utility theories or Prospect theory.

Such flexibility of evaluation of functions describing decision making under risk is also hypothesized in Venture theory (Hogarth & Einhorn, 1990). In Venture theory, the weighting function of probability is assumed to be contingent on other factors, e.g., the size of outcome or ambiguity, whereas the value function of outcome is assumed to be fixed. Venture theory is similar to the Contingent focus model in terms of mathematical formulation, because the functions of outcome are contingent on decisional conditions in the two theories. However, a difference between these two theories lies in hypotheses used to explain such contingency of functions of outcome. In the Contingent focus model, the contingency of value functions is

hypothesized to be the result of the contingency of decisional attention to outcomes and probabilities.

Concluding Remarks

Herbert A. Simon states the following in his famous paper;

> *"Human rational behavior is shaped by a scissors whose two blades are the structure of task environments and the computational capabilities of the actor* (Simon, 1990, p. 7.)*"*

This argument indicates that human behavior should be understood not only as an outcome of *covert* cognitive decision making but also an *overt* response to environments. In a similar vein, the Contingent focus model describes the *covert* psychological contingency of decision making on contextual factors in the environment, as well as *overt* behavioral decision making under actual environmental conditions, by virtue of parametric assumptions of attention to outcome.

Of course, in order to demonstrate the hypotheses of the Contingent Focus model, including the focusing hypothesis and various hypotheses with respect to contingency of decisional attentions to outcome on contextual factors (e.g. positive/negative frame conditions or elaboration conditions), further empirical research is called for. Possible further experiments include utilizing an eye gaze recorder in order to observe more directly a relation between decision making and attention to outcomes and probabilities. Information board technique is another possibility. Although such further empirical research is necessary, we believe that the Contingent focus model could possibly serve as the "scissors" as stated by Simon (1990) in order to understand human behavioral decision making.

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Appendix: *Mathematical Formulation for Psychometric Analysis*

If function $F(\ )$ and $G(\ )$ in eq. (1) are assumed to be linear, the Contingent focus model, then, predicts that a decision maker chooses an alternative whose $U(X, P)$ formulated below is maximum:

$$U(X, P) = X^{a}P^{(1-a)} \tag{A1}$$

If only a non-zero possible outcome is attached to each alternative, as is the case of the Asian disease problem, orders of alternatives yielded by this $U(X, P)$ are identical with orders described by $U'(X, P)$ as follows:

$$U'(X, P) = X^{a/(1-a)}P \tag{A2}$$

This is because 1- a is positive. Equation (A2) indicates that a decision maker whose $a/(1-a)$ is larger than 1 is a risk taker, and one whose $a/(1-a)$ is less than 1 avoids risk (see Figure A).

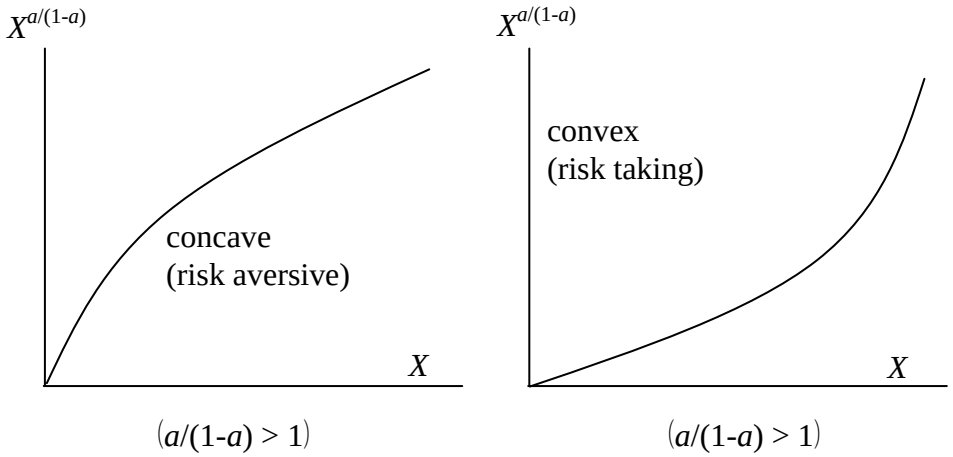

Figure A. Curvature of $X^{a(1-a)}$ depending on $a/(1-a)$

Since the focal parameter a is contingent on contextual factors as formulated in eq.(2), $a/(1-a)$ is also contingent on them. In addition, since the focal parameter is assumed to be distributed across all decision makers, $a/(1-a)$ is assumed also to be distributed. Now, let $a/(1-a)$ be formulated as follows:

$$a/(1-a) = \exp\{\Phi(\theta) + \varepsilon\} \tag{A3}$$

where ε is an error term giving rise to a range of distribution of $a/(1-a)$, and $\Phi(\theta)$ is a function representing contingency of decision framing on contextual factors θ.

Accordingly, the probability that a decision maker is a risk taker, i.e. P(take), and the probability that one avoids risk, i.e. P(averse), are;

$$\begin{aligned} P(\text{take}) &= \text{P}\,(a/(1-a) > 1) \\ &= \text{P}\,(\exp\{\Phi(\theta) + \varepsilon\} > 1) \\ &= \text{P}\,(\Phi(\theta) + \varepsilon > 0) \end{aligned} \tag{A4}$$

$$\begin{aligned} P(\text{averse}) &= \text{P}\,(a/(1-a) < 1) \\ &= \text{P}\,(\exp\{\Phi(\theta) + \varepsilon\} < 1) \\ &= \text{P}\,(\Phi(\theta) + \varepsilon < 0) \end{aligned} \tag{A5}$$

When an error term ε is assumed to have a logistic distribution, these probabilities can be described as follows (e.g. McFadden, 1973):

$$P(\text{take}) = \exp[\Phi(\theta)] / (\exp[\Phi(\theta)] + 1) \tag{A6}$$

$$P(\text{averse}) = 1 / (\exp[\Phi(\theta)] + 1) \tag{A7}$$

By maximizing the likelihood function derived from these probability functions, the effects of contextual factors on the distribution of the focal parameter or risk attitude can be estimated.

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