Aging and decision making: Differences in susceptibility to the risky-choice framing effect between elderly and non-elderly adults in Japan

加齢と意思決定：高齢者と若年者に対するフレーミング効果による影響の相違

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本研究は、高齢者と若年者におけるフレーミング効果による影響の相違について実験を行い検討を加えたものである。無作為抽出された調査対象者に対して、フレーミング課題についての解答を求め分析を行った。その際に、フレーミング効果の定義として、Wangの定義[25]を新たに採用し分析に用いた。その結果、若年者では先行研究で示されたとおり典型的なフレーミング効果が観察されたが、高齢者についてはフレーミング効果は観察されなかった。これは、ネガティブ・フレームでリスク回避選択を行った高齢者が多かったためである。この現象を説明するために、高齢者ではプロスペクト理論[9]の価値関数の形を損失領域でも上に凸の関数を考えることを提案する。さらに、高齢者における価値関数の変化が、社会情動的選択性理論と意思決定モードによって説明できることを示す。

The number of elderly adults (over 65 years of age) in Japanese society has been increasing exceptionally fast. This growth rate is unprecedented both in Japanese history and throughout the world, and is expected to continue; in fact, Japan currently has the largest proportion of elderly adults worldwide (22.1%), with the country's own health department predicting an increase to 30% by the year 2025[8]. It is widely known that there are differences in psychological characteristics, such as a memory capacity and intelligence, between non-elderly and elderly adults[18]. However, differences in decision making process between the two groups are relatively unexplored. Understanding the differences in decision making processes between the two age groups can help improve the quality of life for all Japanese adults[22].

It is impossible to deal with all aspects of decision making processes in this paper, therefore specifically the risky-choice framing effect is being studied with respect to differences between elderly and non-elderly adults. Only small numbers of studies on risky-choice framing effect have been focused on the elderly population. We have extended the results of studies conducted with undergraduate and graduate level students to elderly participants, despite the suggestion that it may not be appropriate[5]. While a large number of studies have focused on the effect of aging in the field of memory and intelligence, the effect of aging in decision making processes has often been overlooked[16]. Masataka[15] insisted that in

order to adjust ourselves to a rapidly aging society, we must redefine "elderly" based on fundamental studies that uncover the mind's decision-making mechanism. This work seeks to uncover the effects of aging in decision making processes involving risk.

In order to collect real world data from elderly adults, this study relied on the ex post facto design using a social survey, instead of an experimental design typically used in studying the framing effect[1]. Participants were randomly selected from a voter list. Participants later self-reported age in the demographic section of the anonymous surveys. When large numbers of elderly persons are involved in a psychological study, information regarding their cognitive ability is typically collected. However, the ex post facto design of this study prevented the collection of information regarding participants' cognitive ability. The elderly participants' cognitive ability was not considered for two reasons: questionnaires were returned voluntarily with all items complete and few inconsistent or illogical responses (proportionally distributed between age groups), and factor structures on the scales used in this study - a quality of life scale and leisure satisfaction scale - did not show meaningful differences between elderly and non-elderly groups.

1. The risky-choice framing effect

Framing effects refer to the effect that the framing, presentation of a problem, has on the outcome of our decisions. It suggests that if a question is expressed differently, we may make different decisions, even when the content of the decision problem is logically equivalent. Kühberger[13] conducted a meta-analysis based on 136 empirical studies and concluded that framing effect is a reliable phenomenon, although he reported that profound differences existed in research designs among the studies. Levin, Schneider, and Gaeth[14] published a literature review of framing effects in which they classified framing effects into three categories, risky-choice, attribute and goal framing. The three types of framing effects seem to occur based on somewhat different psychological mechanisms, despite being classified under the general term "framing effect". The risky-choice framing effect is a specific type of framing effect caused by varying the problem description to reflect different perspectives of risk. A typical risky-choice framing effect is presented when a decision problem is described positively, a majority of participants choose a low risk option, but if the same decision problem is described negatively (without changing the logical content of the problem), the participants' preferences are reversed. A pair of positive and negative items, conveying the same content logically, can be compared to response frequencies for a risk-seeking choice versus risk-aversive choice[12),13),14)].

2. Mechanism of the risky-choice framing effect

Expected utility theory has long been used for explaining decision making behaviors, although it is known that phenomena such as risky-choice framing effect may not follow expected utility theory predictions. In order to provide an explanation for the risky-choice framing effect, Kahneman and Tversky[9] proposed prospect theory in which the decision making process has two distinctive phases, editing and evaluation. A decision frame for a given problem is constructed during the editing phase, and a decision will be made through the evaluation of that problem within the constructed frame. Prospect theory indicates that the shape of value functions differs on opposite sides of the reference point separating gain and loss regions. The theory assumes that the location of the reference point is determined by the way a respondent interprets the context presented in a problem. Indeed, the reference point may shift toward or away from the gain or loss region depending on how a respondent constructs the decision frame during the editing phase. Prospect theory is cited as the most prominent theory for explaining the mechanism of the risky-choice framing effect, although there are some unclear issues. Fujii and Takemura[4] pointed out that how the shift of a reference point occurs is not completely clear in prospect theory. Takemura[23] also indicated the possibility of the existence of multiple reference points. Fujii and Takemura[4] also published some promising results using the contingent focus model to address issues concerning the

reference point, and provided better predictions for decision behavior under the risky-choice framing context.

It is important to note that both expected utility theory and prospect theory emphasize that respondents are passive entities who respond rationally to a given context. This implies that the choices made by respondents are readily predictable based on how decision problems are presented. Tversky and Kahneman[24] stated that the construction of the decision frame can be affected by social norms adopted by a decision maker and expectations which correspond to a level of aspirations, which may or may not be realistic. Since respondents are asked to make risk-seeking or risk-aversive choices in a risky-choice framing problem, respondents with a high level of risk-seeking propensity may choose a risk-seeking option and respondents with a low level of risk-seeking propensity may choose a risk-aversive option, regardless the way the decision problem is presented. Reality reinforces this conclusion to a certain extent; problem presentation cannot generally be held accountable for rational adult human decisions. While it is widely known that factors beyond our control can affect our decisions, the way a problem is presented cannot make decisions for us. Thus, decisions made by respondents who are neutral in terms of the risk-seeking propensity may be strongly affected by the way the decision is framed, because it is known that risky-choice framing effect exists. Schneider[20] predicted the framing effect would not occur in the extreme regions of risk attitudes. The relationship between risk attitudes and risky-choice framing effects is key to understanding the mechanism of the framing effect. However, as space limits the scope of our discussion, this matter will be addressed in future work, and we will focus now the differences between the elderly and non-elderly adults in risky-choice framing effect.

3. Definition of the risky-choice framing effect

When ratios of a response frequency in the risk-aversive option to the positive and negative items are designated as p and q, respectively, the response ratios of risk-seeking options in the positive and negative items can be expressed as 1 - p and 1 - q, respectively. Tversky and Kahneman[24] defined risky-choice framing effect as $p > 1 - p$ and $q < 1 - q$, which translates into the numerical ratios of $p > 0.5$ and $q < 0.5$. Wang[25] categorized risky-choice framing effect into two fundamental categories, the bidirectional and unidirectional framing effect. The bidirectional framing effect is the same as the aforementioned definition adopted by Tversky and Kahneman[24]. The unidirectional framing effect does not always require p to be greater than 0.5. Wang[25] further classified the unidirectional framing effect into two subcategories, the risk-aversion augmenting and risk-seeking augmenting. Risk-aversion augmenting is defined as $p > 0.5$ and $q > 0.5$ and also $p > q$. Risk-seeking augmenting is defined as $p < 0.5$ and $q < 0.5$ and also $p > q$. Watanabe and Shibutani[27] pointed out that one of the problems of adopting the bidirectional definition is the empirical difficulty of achieving the criteria. If $1 - p > 0.5$, which frequently happens, the bidirectional definition automatically rejects the existence of the framing effect. The definition of unidirectional framing effect is adopted in this study to encompass a wider range of phenomena so that characteristics of the risky-choice framing effect might be revealed for analysis.

4. Purpose of the study

The rationale behind this study is to understand risky-choice framing effects on the following areas:

① Differences in the risky-choice framing effect between the elderly and non-elderly adults.

② Interdependency of the risky-choice framing effect and number of human lives at risk.

③ Effects of aging on the risky-choice framing effect

5. Method

Two versions of a questionnaire, positive and negative, were sent to 2000 participants drawn randomly from the voter lists in two cities in northern Japan. Of these, 829 participants completed four risky-choice framing items; 661 non-elderly adults (M=44.8 years old, SD=11.5) and 168 elderly (M=72.5 years old, SD=4.1). This study compared the two age groups in terms of the presence or absence of risky-choice framing

effect. There were four risky-choice framing items in the survey questionnaire. All four had the same format as the Asian disease question in Kahneman and Tversky[9], except there were four response options, instead of two options in the original item.

Scenario: 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 exact scientific estimates of the consequences of the programs are as follows.

Positive frame item: 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. Which of the two programs would you favor? Please circle the number of the option which is closest to your opinion.

1. Strongly agree with A
2. Agree with A
3. Agree with B
4. Strongly agree with B

Negative frame item: 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. Which of the two programs would you favor? Please circle the number of the option which is closest to your opinion.

1. Strongly agree with C
2. Agree with C
3. Agree with D
4. Strongly agree with D

All four items had the same content arena, human lives, and risk probability levels of 1/3 vs. 2/3, although different numbers of lives were at risk, 90, 600, 9 000, and 600 000. The content of the risky events were an avalanche, cancer, and terrorism, in addition to the Asian disease. Participants received only one set of four positive or negative items. The assignment of the frame type to the participants was done randomly so that the two framing groups, positive and negative, were randomly equivalent. Participants were asked to choose either a risk-seeking solution or a risk-aversive solution to each item. The format allowed participants to respond in a 4 alternative Likert-type scale in order to expand the binary nature of the original items used by Kahneman and Tversky[9]. The item format was revised for obtaining polytomous data so that the rating scale model based on item response theory (IRT) can be applied for a scale analysis, although the IRT analysis is not presented in this study. Options 1 and 2 were combined to form the risk-aversive option, and options 3 and 4 were combined to form the risk-seeking option.

The two groups were compared in terms of the response frequency in positively and negatively framed items. Then, the presence or absence of the framing effect was evaluated for each item in both age groups. Possible mechanisms that may have contributed to the observed response patterns are discussed.

6. Results

Results of frequency analyses for evaluating differences between elderly and non-elderly participants are presented in Table 1. Among the 829 participants who responded to item 1, which risks 90 human lives, 327 non-elderly adults responded to the positively framed version and 334 non-elderly adults answered negatively framed version, and 33.4% and 23.4% of the participants chose the risk-aversive option, respectively. These results were classified as a unidirectional framing effect based on Wang's definition[25]. The remaining 168 participants were elderly and also responded to two differently framed versions of item 1, and exhibited no susceptibility to framing effects. Indeed, all four items showed the same patterns: no framing effect for elderly respondents and unidirectional or bidirectional framing effect for non-elderly respondents. Results from χ^2 tests clearly indicated that a significant difference existed between the two groups.

Frequencies of responses to the risk-aversive option are shown in Figures 1 and 2. The data points on the far left correspond to item 1 with 90 human lives at risk, as indicated on the x axis. The risk level in terms of number of human lives was designed to be incrementally larger from item 1 to item

Table 1. Response frequencies for the risk aversive option in four framing items

Item	Age group	Lives at risk	Frame type	Numberof samples	Risk aversive option (%)	Framing effect	χ^2 statistic
1	non-elder	90	positive	327	33.4	unidirectional (risk seeking)	$\chi^2(1,661)=8.11^{**}$
			negative	334	23.4		
	elder	90	positive	87	36.8	no framing effect	$\chi^2(1,168)=2.72$
			negative	81	49.4		
2	non-elder	600	positive	327	39.8	unidirectional (risk seeking)	$\chi^2(1,661)=12.21^{**}$
			negative	334	26.9		
	elder	600	positive	87	37.9	no framing effect	$\chi^2(1,168)=1.04$
			negative	81	45.7		
3	non-elder	9 000	positive	327	52.6	bidirectional framing effect	$\chi^2(1,661)=26.95^{**}$
			negative	334	32.6		
	elder	9 000	positive	87	46.0	no framing effect	$\chi^2(1,168)=.00$
			negative	81	45.7		
4	non-elder	600 000	positive	327	42.5	unidirectional (risk seeking)	$\chi^2(1,661)=16.27^{**}$
			negative	334	27.5		
	elder	600 000	positive	87	46.0	no framing effect	$\chi^2(1,168)=.19$
			negative	81	49.4		

Note: ** $p < .01$.

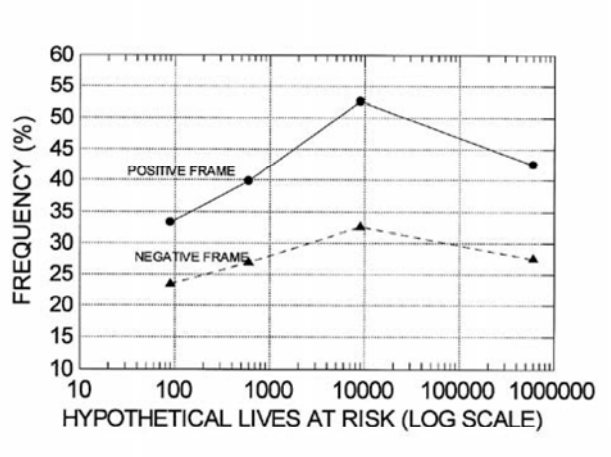

Figure 1. Frequencies of risk-aversive responses in non-elderly adults

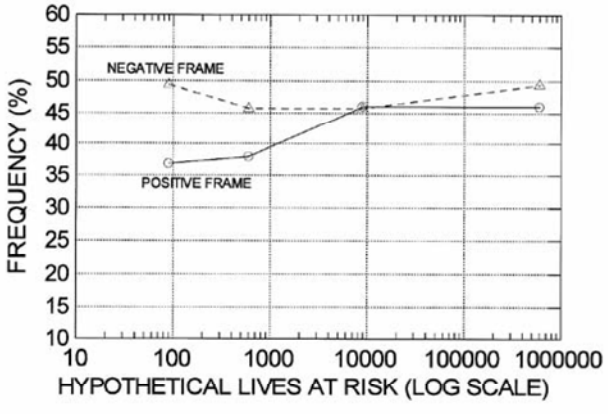

Figure 2. Frequencies of risk-aversive responses in elderly adults

4 (indicated in Table 1). The framing effect in the non-elderly group was clearly observable in Figure 1; frequencies of risk-aversive options were always higher in the positive frame than in the negative frame. The discrepancy in frequencies between the positive and negative frame were about the same throughout different risk levels. Frequencies of choosing the risk-aversive option among non-elderly participants were higher at higher risk levels in both frame conditions, with the exception of item 4. The pattern of increased response frequencies with higher risk levels halted in item 3, although the frequency for item 4 was the second highest.

Discrepancies in frequencies to the risk-aversive option between the two frames were opposite of what would be expected of the framing effect in items 1 and 2, and almost the same in item 3. Frequencies of choosing the risk-aversive option among all negative items in the elderly group maintained extremely high levels, higher than 45%. The higher the frequency is of choosing the risk-aversive option in a negative item, the more difficult it is for a pair of positive and negative items to show the framing effect, since the frequency of choosing the risk-aversive option in a positive item is rarely higher than 50%. The only item that showed over a 50% frequency of choosing the risk-aversive option was item 3 in the non-elderly group (52.6%). This tendency was clearly shown in Figures 1 and 2. Frequencies in the positive frame were about the same between the two age groups, however, discrepancies in frequencies between the two age groups in the negative frame were extremely large.

The interaction between the aging and the risky-choice framing effect was evaluated by judging whether the framing effect was present or absent in the twelve age groups for each item indicted in Table 2. The rows of 'younger than age group'

Table 2. Presence or absence of risky-choice framing effect in different age groups

Item		Cut off age for the grouping					
		30	40	50	60	65	70
1	younger than age group	nfe	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)
	age group and up	unidirectional (risk seeking)	unidirectional (risk seeking)	nfe	nfe	nfe	nfe
2	younger than age group	nfe	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)
	age group and up	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	nfe	nfe	nfe
3	younger than age group	unidirectional (risk seeking)	unidirectional (risk seeking)	bidirectional framing effect	bidirectional framing effect	bidirectional framing effect	bidirectional framing effect
	age group and up	bidirectional framing effect	bidirectional framing effect	unidirectional (risk seeking)	nfe	nfe	nfe
4	younger than age group	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)	unidirectional (risk seeking)
	age group and up	bidirectional framing effect	bidirectional framing effect	unidirectional (risk seeking)	nfe	nfe	nfe

Note: nfe stands for no framing effect.

indicate the evaluation of the frequencies of participants whose ages are younger than the designated age; therefore the cell defined by '30' and 'younger than age group' indicates the evaluation of the participants who are less than 30 years old. On the other hand, 'age group and up' rows indicate the evaluation of the frequencies of participants whose ages are in the designated age category and older; therefore the cell defined by '30' and 'age group and up' indicates the evaluation of the frequencies of participants whose ages are older than 30 years old. Participants older than 60 years of age were not susceptible to the framing effect at all in any item, while 'younger than age group' analyses indicated presence of the framing effect in all four items in all groups, except in item 1 and 2 with the cut off age of '30' which indicates the results from the participants with ages between 20 to 29. The framing effect disappeared at the age of 60, although the framing effect was observed when the data from younger participants were combined.

7. Discussion

The three key results of this study can be summarized as follows:

① The risky-choice framing effect was present in the non-elderly group, which confirms the findings of previous studies.

② Elderly participants did not show the risky-choice framing effect under any circumstance.

③ The risky-choice framing effect disappeared around age 60, based on the results of the analyses of the groups with 10 year and 5 year age increments.

The framing effect was observed among non-elderly participants in all four items, while no framing effect was present among the elderly participants. The result of the non-elderly participants confirmed information gleaned from previous studies. However, the results from the elderly participants raised the issue of why participants are not susceptible to the framing effect. The risk-aversive tendency in a positively framed condition was about the same between the two age groups. However, the risk-aversive tendency in a negatively framed condition among the elderly participants was significantly higher than in the non-elderly group. The same trend found in the non-elderly group was also observed in previous studies that used the Asian disease problem format, such as Tversky & Kahneman[24], Wang[25] and Wang & Johnson[26]. However, the frequencies of the risk-aversive option observed in this study were higher in the negatively framed situation compared to previous studies especially among the elderly participants. The participants in previous studies were intellectually uniform and similar in age. On the other hand, the participants in this study encompassed a variety of ages, cognitive abilities, incomes, and occupations. This demographic non-uniformity is thought to have contributed to the increased variability of responses in this study, since the frame is constructed in the editing phase and the editing phase is affected by the social norm and expectations of the respondent[24]. While the elderly participants did not indicate any susceptibility to the framing effect, the risk-aversive tendency in the negatively framed condition among elderly participants was significantly higher than in non-elderly adults. In order to achieve the framing effect, the risk-aversive frequency has to be higher in the positive frame condition and it has to be lower in the negative frame condition. This criteria becomes very hard to achieve when frequencies of the risk-aversive options in the negative frame is very high.

Important contributing factors to the lower susceptibility for the framing effect among elderly adults may include:

① The demographic non-uniformity of the participants

② Higher risk-aversive tendency in the elderly group than in the non-elderly group in negatively framed conditions.

The above mentioned factors warrant further investigation to understand the differences in elderly participants' behavior patterns.

According to the frequency analysis of the groups with the 10 year and 5 year age increment, the framing effect disappears around age 60 (Table 2). The groups under age 60 did indicate the framing effect, with the exception of respondents in their 20s. Frequencies of the risk-seeking option in the positively framed question for the respondents in their 20s were very high, from 77.5 to 80.0%. Simply put, there was no room to increase the frequencies for the risk-

seeking option, even with the influence of the negative frame.

Results from many previous framing effect studies have been unclear, with most indicating only a weak relationship between aging and the framing effect. Kim, Goldstein, Hasher, and Zacks[10] reported the bidirectional framing effect in both age groups. Mayhorn, Fisk, and Whittle[17] and Rönnlund, Karlsson, Laggnas, Larsson, and Lindstrom[19] reported similar results, including both unidirectional and bidirectional framing effects for the two age groups, with no significant difference between age groups. This study differed from prior aging and framing effects studies in terms of research design, relying on an ex post facto survey design instead of an experimental design. The most significant difference was participant selection; however, other factors such as payoff size and procedural differences that may influence the framing effect, were also present. The most important factor for explaining the discrepancy between the results of this study and previous studies is the variability among the participants, an element that was introduced to the ex post facto design to better reflect the Japanese population at large. This study was designed to reflect the real world situations in three specific ways: (a) participants were randomly selected from a voter list, (b) tasks were randomly assigned, and (c) a large number of participants were surveyed. In addition to more closely approximating the population at large, these three factors ensured the fidelity of statistical analyses conducted between groups such as the positively vs. negatively framed questions and elderly vs. non-elderly participants. No differences should be found between those groups when there is no framing effect or effect from the aging, since those groups are randomly equivalent.

According to prospect theory, the mechanism of the framing effect can be explained using asymmetric value functions in the gain and loss region separated at the reference point. This reference point is then shifted depending on the frame taken by the respondent. In the positive frame, the reference point is located at zero, interpreted as no one is saved, with a concave value function indicating that the risk-aversive option has a higher value than the risk-seeking option (Figure 3). Thus, the risk-aversive tendency is enhanced in the positive frame condition. On the other hand, as the reference point shifts toward the gain direction, interpreted as no loss of life, a convex value function illustrates that the risk-seeking option has a higher value than the risk-aversive option. The convex value function for losses is generally steeper than the concave value function for gains. According to the results of this study, the risk-aversive tendency is enhanced in the negative frame condition among elderly participants. The results can be

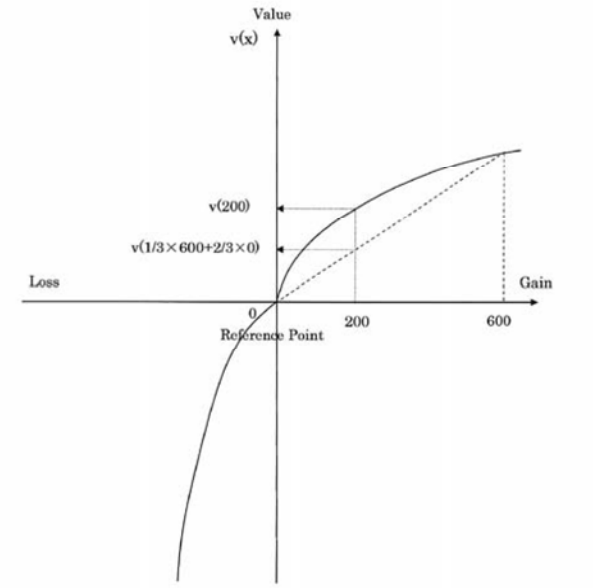

Figure 3. Value function based on prospect theory in a positive frame condition

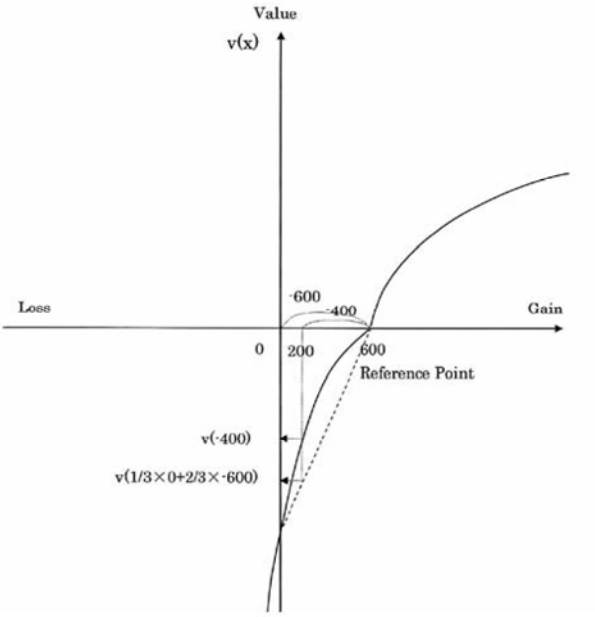

Figure 4. Modified value function for elderly adults in a negative frame condition

explained if the value function for the elderly participants is concave and steeper in the loss region. The value of the risk-aversive option becomes higher than the risk-seeking option, even in the negative frame condition (Figure 4). We propose a modified value function in order to explain the risk-aversive tendency in the negative frame condition. The modified value function indicates differences between non-elderly and elderly respondents in terms of the interpretation of the given condition.

Prospect theory states that frame development is influenced by the social norms and expectations of the respondents[24]. Given this assertion, what specific influences might be claimed to differ between non-elderly and elderly respondents? One factor is referred to as a decision mode[6, 21]. According to Hsee and Rottenstreich[6] when evaluation by calculation is used as the decision mode, values of the options can be expressed by a linear function. However, if the decision mode involves evaluation by feeling, values associated with the options are expressed by a concave function. Schunk and Betsch[21] also reported that if deliberation is used as the decision mode, values of the options are expressed as a linear function. On the other hand, when intuition is used as the decision mode, values of the options again follow a concave function.

Another important factor influencing the shape of the value function is the emotional state of a respondent. Isen, Nygren, and Ashby[7] reported that respondents with a positive attitude toward a decision topic followed a concave value function in a positively framed problem. However, option values placed by the same respondents did not follow a convex function as prospect theory predicted in a negatively framed problem. As mentioned above, the shape of a value function may differ from prospect theory predictions when a respondent evaluates by feeling or intuition rather than evaluating by calculation or deliberation. SST explains that elderly respondents tend to make decisions that satisfy their emotional needs, since they place significant emphasis on the limited time of their lives[2]. Furthermore, according to the positivity effect derived from SST, elderly respondents tend to pay greater attention to positive information in making decisions[3, 11]. One of the possible explanations for elderly respondents not being susceptible to the framing effect is derived from SST. It seems plausible to explain the framing effect susceptibility differences between the non-elderly and elderly adults by the modified value function which is derived based on the differences in decision mode and the SST.

This study is exploratory in nature. The ex post facto research design is useful for identifying relevant variables in terms of the framing effect. Future work in this area could involve an experimental study to evaluate suggested explanations that were presented for the susceptibility differences between the two groups.

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