Speaker's choice of frame based on rarity information

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Abstract

Previous studies have discussed how speakers select a frame (e.g., "half full," or "half empty"), and have proposed a hypothesis such as *reference point hypothesis* (e.g., Sher & McKenzie, 2006, 2008). In this paper, we propose a new hypothesis, *frame choice based on information about rarity*. This hypothesis predicts that speakers tend to select a frame denoting a rare event. Four studies provide evidence that speakers' choice of frame is consistent with the prediction from our hypothesis. Furthermore, our hypothesis is reconciled with the *positive bias* in frame choice, which cannot be accounted for by the reference point hypothesis. We discuss the possibility that linguistic behaviors are widely explained from people's sensitivity to rarity information.

Keywords: Framing effect; speaker's choice of frame; reference point hypothesis; sensitivity to rarity; positive bias in frame choice

Introduction

Since Tversky and Kahneman (1981) documented the original research, many researchers have studied framing effect (for reviews, see Levin, Schneider, & Geath, 1998; Soman, 2004). One example of the framing effect is the "Asian disease problem" proposed by Tversky and Kahneman (1981):

> Imagine that the US 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 the programs are as follows:
>
> If Program A is adopted, 200 people will be saved.
>
> If Program B is adopted, there is a 1/3 probability that 600 people will be saved and a 2/3 probability that no people will be saved.

For this problem, a majority of the participants preferred Program A to Program B. Another group was presented with the same cover story, but with the two programs rephrased:

> If Program C is adopted, 400 people will die.
>
> If Program D is adopted, there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die.

Although Program C is only a rewording of Program A and Program D is a rewording of Program B, a majority of the participants preferred Program D to Program C. Thus framing effect refers to the effects such that the framing of a problem influences decision making.

Many studies on the framing effect have examined how listeners, or those presented with frames, behave based on the frames. Various models have been proposed to explain the framing effect. However, relatively few studies have been conducted on how speakers frame a problem. For instance, what influences speakers to describe the Asian disease problem with the "save" frame or "die" frame?

Some researchers have recently discussed how speakers frame outcomes (Keren, 2007; McKenzie & Nelson, 2003; Sher & McKenzie, 2006, 2008; Teigen & Karevold, 2005; van Buiten & Keren, 2009; Wang, 2004). For example, McKenzie and his associates have examined problems such as "Which do speakers select to describe a 4-ounce cup with 2 ounces of water, half full or half empty?", and have proposed the *reference point hypothesis* (McKenze & Nelson, 2003; Sher & McKenzie, 2006, 2008). This hypothesis assumes that a speaker tends to use a frame that corresponds to the label that has increased. In the above example, the reference point hypothesis predicts that a speaker uses the full frame when a cup has been previously empty, and that a speaker uses the empty frame when a cup has been full of water. Therefore, the reference point influences speaker's choice of frame.

The reference point hypothesis is intriguing in that it not only predicts how a speaker selects a frame, but also explains why decision makers are influenced by framing (Sher & McKenzie, 2006, 2008). However, we point out that the reference point hypothesis does not predict one of the interesting findings of frame choice, *positive bias*, which has been repeatedly reported in the previous studies. The positive bias refers to the tendency that in choosing from two frames which have positive and negative valenced meanings such as "gain"-"loss" or "success"-"failure," people tend to prefer the positive valenced frame (e.g., Keren, 2007; Sher & McKenzie, 2006; van Buiten & Keren, 2009; Wang, 2004). For example, Sher and McKenzie (2006) showed that in describing results of the last 50 projects in which 20 projects have succeeded and 30 projects have failed, participants generally used a positive frame (e.g., 20 out of the last 50 projects have succeeded) rather than a negative one (e.g., 30 out of the last 50 projects have failed). In Wang (2004), participants were presented with probabilistic life-death or monetary problems by pie

charts, and asked to complete sentences that summarized the problems. It was found that participants tended to complete sentences with positive frames (e.g., save, help) rather than negative ones (e.g., killed, die).

These findings suggest that psychological mechanisms other than those explained from the reference point hypothesis exist when speakers select a frame.

Choice of frame based on rarity information

We propose a new hypothesis, *frame choice based on rarity information*. We predict that information about rarity influences choice of frame, and that the speakers frame outcomes in terms of rarity. Consider the following problems: There is a die colored both black and white. One of the 6 sides of this die is black, and the other 5 sides are white. In rolling this die, the occurrence of black side is rare. In contrast, the occurrence of white side is common. We predict that when speakers describe results of rolls of this die, they prefer using the black frame because the occurrence of black side is expected to be rare. Imagine that someone rolls this die 6 times and the black side came up once, and the white sides came up 5 times. We predict that s/he will describe the results, "With 6 rolls, black came up once", rather than "white came up 5 times." Hence, our hypothesis states that speakers focus on the rarity and prefer using the frame describing rare events rather than those describing common events.

This hypothesis is based on the findings about hypothesis testing. Previous studies on hypothesis testing have shown that people are very sensitive to information on rarity, and that they adaptively use such information in hypothesis testing (e.g., Klayman & Ha, 1987; McKenzie & Mikkelsen, 2000; Oaksford & Chater, 1994). Furthermore, the finding in McKenzie, Ferreira, Mikkelsen, & McDermott (2001) is more relevant. They examined the people's sensitivity to rarity in the context of how to phrase a conditional hypothesis. Imagine the conditional hypothesis, "If X1, then Y1," where each variable, X and Y, has two levels (X1 and X2, Y1 and Y2). In this case, this hypothesis can be denoted with another form, "If X2, then Y2." McKenzie et al. (2001) showed that when participants observed rare X1 & Y1 and common X2 & Y2, they tended to phrase the conditional hypothesis "If X1, then Y1" rather than "If X2, then Y2," suggesting that people phrase a conditional hypothesis in terms of rarity. Although this finding in McKenzie et al. (2001) was limited to how to phrase conditional hypothesis, other linguistic behaviors such as frame choice might be explained from the same perspective. That is to say, speakers choose a frame in terms of information about rarity.

In this paper, we conducted 4 studies, and examined our hypothesis regarding to the speaker's choice of frame. In Study 1, we conducted an experimental study to examine our hypothesis. In Studies 2-A, 2-B, 2-C, we discussed the positive bias in frame choice, and examined whether our hypothesis is reconciled with the positive bias.

Study 1

In study 1, we examined our hypothesis using a frame choice task. We predict that frame choice is influenced by information about rarity. In particular, participants will choose a frame describing a rare event.

Method

Participants. The participants were 614 Aoyama Gakuin University students, who received partial course credit. There were from 64 to 72 participants in each of nine conditions (see Table 1).

Task and experimental conditions. We conducted a frame choice task that was analogous to that in McKenzie and Nelson (2003) using a questionnaire. In one of the 9 conditions, participants read the following story:

> There is a die that is painted black on one side and painted white on the other five sides. You have rolled this die 6 times, and the results are as follows:
>
> | Side of the die | Frequency |
> |---|---|
> | Black | 1 |
> | White | 5 |
>
> Which is the most natural way to describe these results, "The die came up black 1 out of 6 times" or "The die came up white 5 out of 6 times"?[1]

In this question, participants were required to choose one of two frames (i.e., "black" frame or "white" frame) to describe the outcomes.

There were 9 experimental conditions. Three dies differed in the color (i.e., black rare, white rare, black-white equal), and there were three patterns of outcomes from the roll of die. These three dies and three outcomes were varied orthogonally with respect to one another (see Table 1).

Results and discussion

Figure 1 shows proportions of black frame choice for 9 conditions. It was found that in describing the 3 outcomes (i.e., Black1-White5, Black3-White3, Black5-White1), participants in the Black-rare condition significantly preferred the black frame than those in the White-rare condition in each of the 3 outcomes ($p<.0001$, Fisher's exact test). We also found general preference for the rare side frame. 67.6% of participants in the three Black-rare conditions significantly chose the black frame, and 62.4% of those in the three White-rare conditions significantly chose the white frame ($p<.001$, binomial test).

In the Equivalent conditions, wherein explicit information about rarity was not available to participants, 52.2% of participants in the 3 Equivalent conditions chose the black frame. This result indicated that participants did not have a

[1] The order of these options was reversed for half of the participants in each condition in each experiment (Studies 1 and 2-C).

Table 1. 6 conditions in Experiment 1.

Die (number of side)	Outcome (Black, White)
Black-rare (Black1-White5)	(1,5; n=71)
	(3,3; n=68)
	(5,1; n=71)
White-rare (Black5-White1)	(1,5; n=64)
	(3,3; n=72)
	(5,1; n=66)
Equivalent (Black3-White3)	(1,5; n=71)
	(3,3; n=64)
	(5,1; n=67)

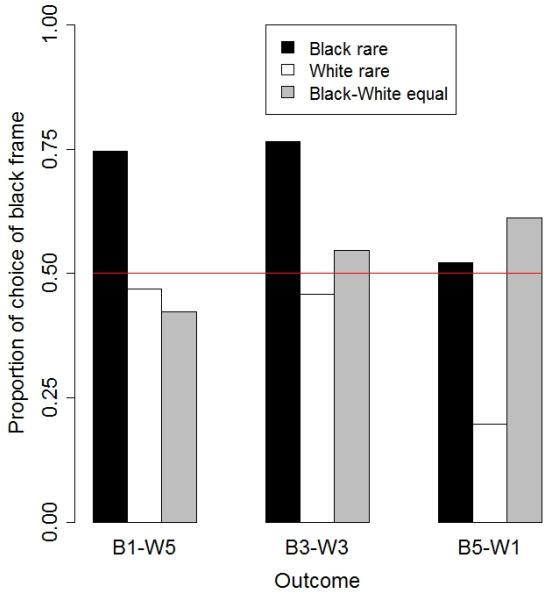

Figure 1. Proportion of black frame choice in Study 1

specific preference between the two frames ($p=.574$, binomial test).

Taken together, these results show that information about rarity of side of a die influenced participants' choice of frame. In particular, participants preferred the rare side frame. In addition, when the information about rarity was not available, participants were indifferent between the two frames. Hence, these results supported our hypothesis about frame choice based on information about rarity.

Study 2

In Study 2, we discuss whether the hypothesis about frame choice based on rarity information is reconciled with the positive bias in frame choice (e.g., Keren, 2007; Sher & McKenzie, 2006; van Buiten & Keren, 2009; Wang, 2004).

Why do people prefer a positive frame? Our hypothesis is that the positive bias derives from belief of rarity about what positive or negative words describe. We predict that people generally have the belief that what positive words describe are rarer than what negative words describe, and this belief influences frame choice. In other words, speakers tend to prefer a positive frame because of its rarity. Therefore, if people explicitly know that a negative frame describes a rare event and a positive frame describes a common event, preference for the positive frame will disappear.

In order to examine this hypothesis, we conducted three studies. In study 2-A, we examined whether the positive bias observed in laboratory experiments is also observed in a naturalistic environment. In study 2-B, we examined belief of rarity about what positive and negative words describe. In study 2-C, we conducted an experimental study and tested whether the positive bias disappears when participants explicitly know that a negative frame denotes a rare event and a positive frame denotes a common event.

Study 2-A

The positive bias in frame choice reported in the previous studies suggests that people generally prefer using positive expressions rather than using negative ones. Study 2-A examined whether a positive bias is observed in a naturalistic environment. Specifically, we counted a number of articles in a Japanese newspaper that contains positive or negative words. If positive bias is to be observed, there ought to be more articles containing positive words than those containing negative words.

Method

We used 26 positive-negative Japanese pairs of antonyms for this study. Table 2 illustrates 5 examples of positive-negative pairs of antonyms. These 26 pairs were selected using the following procedure. First, one rater, who did not know the hypothesis of the current study, randomly picked out 35 pairs of antonyms that he thought had positive-negative valenced meanings from Japanese dictionary of antonyms (Kitahara & Togo, 1989). Then two other raters, neither of whom knew the hypothesis, judged whether each of the 35 pairs had positive-negative meanings. We adopted 26 pairs (i.e., 52 words) that these theree two raters regarded as having positive-negative meanings.

Then we counted a number of articles in a Japanese newspaper. We used *Yomidasu* as the search system. This search system includes the data-base of *Yomiuri shibun*, which is one of the most subscribed newspapers in Japan. Using this system, we counted the number of articles that had been published from January 1990 to December 2007. We conducted this search using each of the 52 words.

Results and discussion

We calculated the *positive bias index* (*P-Bias index*) for each of 26 pairs. In a certain positive-negative antonym pair, when the numbers of articles in which the positive or negative word is mentioned are N_p and N_n respectively, the P-Bias index is defined by the following equation:

$$P\text{-}Bias\ index = N_p/(N_p+N_n)$$

For example, when number of articles is 400 for a positive word and 100 for a negative word in a certain pair, the calculated P-Bias index is 0.8. Therefore, when the P-Bias index is more than 0.5, a positive word is used more often than a negative word in a positive-negative antonym pair. Figure 2 illustrates the P-bias index for 26 positive-negative antonym pairs. The mean value of the P-bias for the 26 pairs was 0.678 (*SD*=0.240, maximum=0.997, minimum=0.065), and this value was significantly higher than 0.5 ($t(25)=3.78$, $p<.001$). These results suggest that in positive-negative antonym pairs, people tend to use positive words more often than negative words in a naturalistic environment.

Study 2-B

In Study 2-B, we examined belief of rarity about what positive and negative words describe. We predicted that people generally have the belief that what positive words describe is rarer than what negative words describe.

Method:

Participants. The participants were 116 Aoyama Gakuin University students, who received partial course credit.

Task and materials. Participants were asked about their belief of rarity on what positive and negative words describe using a questionnaire. The question was as follows:

> There are 26 pairs in this booklet. Two words in each of pairs have opposite meanings. Imagine "people," "things," or "outcomes" that are described by each of the words in a pair. Then which do you think is more unusual to become such people, to make such things, or to achieve such outcomes?

For this question, participants were required to choose either a positive or negative word from a pair. We used the same 26 pairs that were used in Study 2-A. If it is unusual to become, make, or achieve what a word describes, what the word describes must be rare. Hence we assume that a selected word in a pair is judged to refer to something rarer than the reference of the other word in the pair.

Results and discussion

We calculated the proportion of positive word choice for each of the 26 pairs. Figure 3 shows the proportions for the 26 pairs. In 21 out of 26 pairs, participants significantly chose positive words rather than negative words ($p<.05$, binomial test), and no negative words were chosen with more than 50%. Hence these results suggest that people have the belief that what positive words describe are generally rarer than what negative words describe are.

Table 2. Examples of positive-negative pairs of antonyms used in Studies 2-A and 2-B.

positive words		negative words
best	-	worst
success	-	failure
rich	-	poor
safety	-	danger
usefulness	-	uselessness

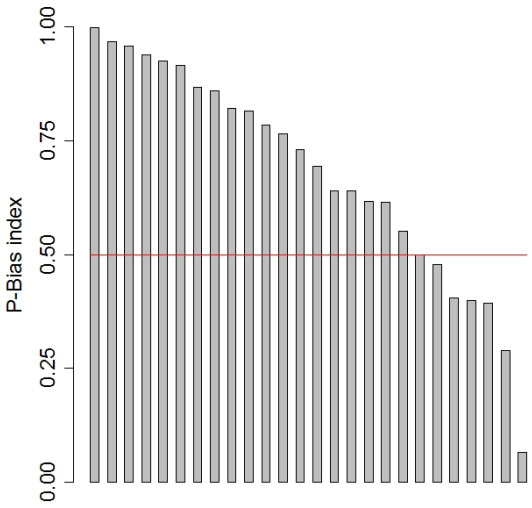

Figure 2. P-Bias index for 26 pairs in Study 2-A.

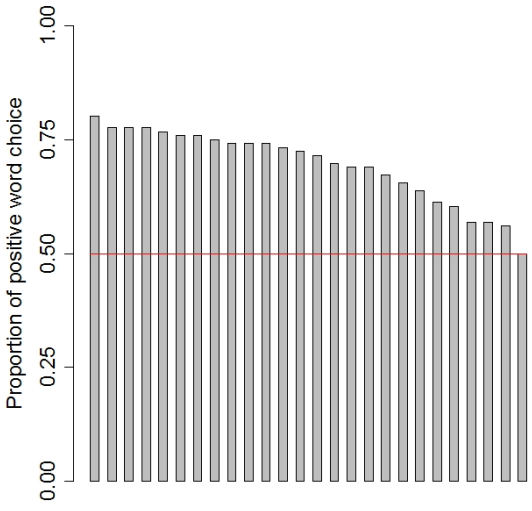

Figure 3. Proportion of positive word choice for 26 pairs in study 2-B.

Study 2-C

Studies 2-A and 2-B indicated that positive bias in frame choice is observed in a naturalistic environment, and that people generally have the belief that what positive words describe are rarer than what negative words describe. We hypothesize that positive bias in frame choice derives from this belief about rarity, and that speakers tend to select a positive frame because of its rarity. Hence, our hypothesis

predicts that when people explicitly know that a negative frame describes a rare event and a positive frame describes a common event, they will choose the negative frame rather than the positive frame. We examined this prediction conducting an experiment.

Method

Participants. The participants were 689 Aoyama Gakuin University undergraduate students, who received partial course credit. There were from 70 to 81 participants in each of nine conditions (see Table 3).

Task and experimental conditions. Task and experimental conditions were the same as those in Study 1 with the exception of the labels of dies. In place of the black-white labels, we used *winning-losing*[2] labels, which have positive and negative meanings. In one of the 9 conditions, participants read the following story:

> There is a die that is described "winning" on one side and described "losing" on the other five sides. You have rolled this die 6 times, and results are as follows:
>
> | Side of the die | Frequency |
> |---|---|
> | Winning | 1 |
> | Losing | 5 |
>
> Which is the most natural way to describe these results, "The die came up winning 1 out of 6 times" or "The die came up losing 5 out of 6 times"?

As in the Study 1, participants were required to choose one of two frames (i.e., "winning" frame or "losing" frame) to describe the outcomes.

For this task, there were 9 experimental conditions as in Study 1. Three dies differed in the description (i.e., winning rare, losing rare, winning-losing equal), and there were three patterns of outcomes from roll of die. These three dies and three outcomes were varied orthogonally with respect to one another (see Table 3).

Results and discussion

Figure 4 shows proportions of winning frame choice for 9 conditions. If the positive bias is observed in the frame choice, the winning frame will be chosen irrespective of rarity of sides in a die. However, the observed choice patterns were not consistent with this prediction. In each of the three outcomes, participants in the Winning-rare condition significantly preferred the winning frame than those in the Losing-rare condition ($p<.0001$, Fisher's exact test). Thus, the rarity of sides in a die influenced frame choice. As a general preference of frame, 78.7 % of the participants in the three Winning-rare conditions significantly preferred the winning frame ($p<.0001$, binomial test). However, only 50.6 % of the participants in the three Losing-rare conditions preferred the winning frame, and this preference was not significant ($p=.90$, binomial test). These results show

[2] Original Japanese labels were "atari" and "hazure." "atari" means winning lotteries, and "hazure" means losing lotteries.

Table 3. 6 conditions in Experiment 2.

Die (number of side)	Outcome (winning, losing)
Winning-rare (Winning1-Losing5)	(1,5; n=75) (3,3; n=70) (5,1; n=76)
Losing-rare (Winning5-Losing1)	(1,5; n=79) (3,3; n=79) (5,1; n=73)
Equivalent (Winning3-Losing3)	(1,5; n=76) (3,3; n=80) (5,1; n=81)

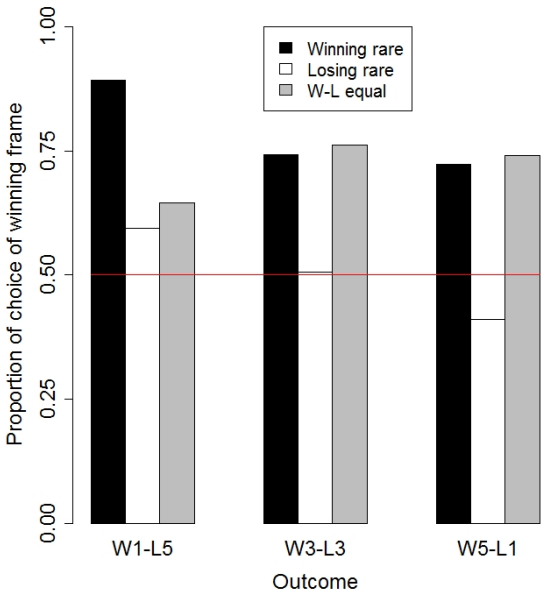

Figure 4. Proportion of winning frame choice in Study 2-C.

that positive bias did not prevail irrespective of information about rarity, and that participants' frame preference shifted from the winning frame to the losing frame when they explicitly knew that the losing frame denoted a rare event.

According to the frame choice based on rarity information, participants in the Losing-rare conditions will prefer the losing frame. However, only 49.4% of participants in the three Losing-rare conditions preferred the losing frame. This result implies that choice of positive frame is a robust bias, and that even when explicit information about rarity was available, participants may have preferred the positive frame.

In the Equivalent conditions, wherein explicit information about rarity was not available to participants, positive bias was observed. In all of the three Equivalent conditions, 71.7% of participants preferred the winning frame ($p<.0001$, binomial test).

Taken together, our hypothesis about positive bias in frame choice was corroborated. Although participants generally preferred the positive frame, participants' preference shifted to the negative frame with the explicit information about rarity. In particular, positive bias disappeared with the

explicit information that the negative frame denotes a rare event and the positive frame denotes a common event.

General discussion

Through the 4 studies, we examined our hypothesis that people choose a frame based on the information about rarity. It was found that information about rarity influenced speakers' choice of frame. In particular, participants tended to prefer a frame denoting a rare event.

The reference point hypothesis (e.g., McKenzie & Nelson, 2003; Sher & McKenzie, 2006, 2008) argues that speakers are sensitive to an increase in proportion relative to a reference point, and use a frame that corresponds to the label that has increased. In short, the reference point hypothesis assumes that speakers select a frame based on a reference point. In contrast, our hypothesis assumes that speakers select a frame based on rarity information. It should be noted that our hypothesis does not necessarily contradict the reference point hypothesis. For example, our hypothesis does not make any predictions about speakers' choice of frame based on a specific reference point. It is mute as to which frame people use to express a content of a cup when a cup has been previously empty (or full of water). On the other hand, when a reference point adopted by speakers is not clear, the reference point hypothesis does not predict specific patterns of frame choice. For instance, the reference point hypothesis does not explain why speakers show the positive bias in frame choice. Therefore, the two hypotheses can be regarded as providing explanations for different psychological mechanisms on frame choice.

We indicated in Studies 2-A and 2-B that usage of positive and negative words in a naturalistic environment is also related to belief about rarity. McKenzie et al. (2001) showed that participants tended to phrase a conditional hypothesis in terms of rarity. These findings suggest that speakers are very sensitive to information about rarity, and that linguistic behaviors are widely explained from the perspective of sensitivity to rarity.

Furthermore, previous studies have suggested that people are very sensitive to rarity information in hypothesis testing (e.g., e.g., Klayman & Ha, 1987; McKenzie & Mikkelsen, 2000; Oaksford & Chater, 1994). The findings on linguistic behaviors and hypothesis testing imply that people have the strong intuition that information about rarity is very informative, and this intuition influences various behaviors as well as linguistic behaviors and hypothesis testing. Hence, reconsideration from the perspective of sensitivity to rarity will provide insightful findings for various human behaviors.

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