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An Examination of Risky Choice from a Nature-via-Nurture Perspective: Group Size as a Contextual Variable on Risk Preference:

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Abstract: This study has two purposes; firstly, we examine the evolutionary validity of "size effect" pointed out by Wang and Johnston (1995): the increase in risk-seeking decisions when the contextual size becomes smaller in the "life-death decision problem"; secondly, by considering interactive relationship between "nature" and "nurture," we investigate decision maker's risk attitude more minutely. For these purposes, we have conducted an experiment, in which participants had to choose either sure plan or gambling plan for the company survival: a dismissal problem. As a result, our experiment support the argument that "size effect" is a product of human mind hardwired by their evolutionary process and show that both people's workplace size and their position in company, that is elements of "nurture," can affect their decision-making.

Keywords: size effect; framing effect; nurture; dismissal problem.

Introduction

"By nature emplanted, for nurture to enlarge." (Richard Mulcaster)

All seem to acknowledge that the human brain is a product of evolutionary process. While it has adapted over time to perform a variety of vital functions, it has been forced to survive by selectively ridding itself of its more needless functions. These selection procedures, in turn, enhanced the functional abilities of the cognitive architecture in accordance with the changing needs of human being. Over the past few decades by relying on this evolutionary knowledge, a considerable number of studies have been made on human cognition, especially on functions of human memory or information processing system (Sweller, 2003). However this knowledge is rarely applied to the domain of decision-making under risk.

One of a few studies that analyzed human risky choice on the basis of evolutionary idea is done by Wang and Johnston (1995): by the systematic manipulation of content variables -group sizes- of a "life-death decision problem" paradigm (Tversky and Kahneman, 1981), they have shown a "size effect": decision makers are more risk seeking for small group sizes than for a large group sizes. Although they suppose that this effect is cause by human mind hardwired by their evolutionary process, we think a further discussion is necessary to confirm this causality and to understand more precisely the size effect from an evolutionary perspective: nature-via-nurture perspective. Our present study has two purposes; firstly, developing the argument of Wang and Johnston, we will examine if size effect can be considered as a product of human evolution; secondly, by introducing bi-directional relationship between gene and experience, we will investigate decision maker's risk attitude more minutely.

After addressing the background of our study in the first and second sections, in the third section ("Nature-via-nurture"), we insist that in order to understand the choices that people make in the realm of adaptive related decision, it is important to consider not only nature but also nurture. We then present an experiment based on the argument mentioned above. The experiment re-examines the size effect in other adaptive paradigm than life-death decision problem and tests the significance of the nurture effect on human risk attitude. In the last section, we conclude with a summary and discussion of some points of debate in our argument.

The Framing Effect in Life-Death Decision Problem

Due to the close relation of the framing effect to the discovery of the size effect, we begin with a general sketch about the framing effect in life-death decision problems (see especially Kahneman and Tversky, 1979; Tversky and Kahneman, 1981). In their study, subjects were presented with a cover story, which explained that 600 people were suspected to be infected with a fatal Asian disease for which only two curative plans are available. Specifically, Plan A has a deterministic outcome, while Plan B has a probabilistic outcome. The deterministic outcome ensures the survival of one-third of the patients (i.e., 200 survivors), while the probabilistic outcome results in a one-third probability that all of the patients will survive, and a two-thirds probability that no one will survive. After the subjects read the cover story, they were asked to choose one of the two plans.

A classic demonstration of the framing effect, performed by Tversky and Kahneman (Tversky and Kahneman, 1981) is as follows: on the one hand, when this problem was represented in terms of saving lives (a "positive frame"), most subjects (72%) were risk-averse: the certain survival of 200 lives was more attractive than the risky choice, with a one-third chance of saving all 600 lives. When this problem was represented in terms of losing lives (a "negative frame"), in contrast, most subjects (78%) favored the risky choice: the assured death of 400 people was less attractive than the two-thirds probability that 600 could die.

A number of studies have been conducted to test the reliability and generality of Tversky and Kahneman's original work on framing effects. On the one hand, with the standard cover story, strong framing effects have been replicated not only in different kinds of respondents, such as university faculty, students, and physicians (McNeil et al., 1982) but also in various applied areas (Burton and Babin, 1989; Kramer, 1989; Travis et al., 1989). On the other hand, some studies have shown little or no framing effect when the context or cover story was manipulated. This suggests that the framing effect may not be a general and robust choice phenomenon, and that it is sensitive both to the context in which the problem is described (Fagley and Miller, 1987; Schneider, 1992; Wang and Johnston. 1995; Wang, 1996a, b; Wang, et al., 2001) and to various cognitive and social variables (Shoorman et al., 1994; Miller and Fagley, 1991; Roszkowski and Snelbecker, 1990).

In the second line of inquiry, size effect, mentioned above, was discovered. Let us make a brief literature review concerned with the size effect on human cognition and explain its evolutionary cause.

Size Effects and Evolutionary Background

The general importance of group size as a variable affecting human cognition and decision making has been widely recognized.

A considerable number of studies in both cognitive and social psychology have clarified that our cognitive processes are frequently influenced by our sense of group membership (e.g., Brewer, 1979; Tajfel, 1970, 1981). Moreover, in a series of experiments involving a public goods provision (or social dilemma) game, significant group size effects were found in subjects' cooperative behavior (e.g., Messick, 1973; Marwell and Ames, 1979; Bonacish et al., 1976).

However, only a few studies have been conducted regarding the size effect on decisions that involve risk factors. Wang and Johnston (1995), in particular, obtained an exceptionally significant result in this area by manipulating group sizes that ranged from 6000 to 600, 60, and 6 people, that is, "size effect": people tended to take more risks with life-death decisions when the contextual size was small (6 or 60 people) than when it was large (6000 or 600 people).[1] The increase in risk-seeking decisions when the contextual size becomes smaller has been replicated cross-culturally (Wang, 1996a, b; Wang et al., 2001; Bloomfield, 2006; Shimizu and Udagawa, 2011) and shown to be very stable.

Now, it will be useful to clarify a difference of size effect and "peanuts effect" to understand the characteristic of size effect. "Peanuts effect" means that people are more willing to take gamble when playing for "peanuts (small-payouts)" (Markowitz 1952, Prelec and Lowenstein 1991). Thus as phenomenon, both effects seem to be similar. For

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[1] Wang and Johnston (1995) have also shown an instability of the framing effect: sometimes people could be so risk-seeking under both positive and negative outcome framing conditions that the framing effect would disappear in a small group context.

peanuts effect, however, “by this definition, it is not actually necessary to become risk-seeking for very small-gains, merely to become less risk-averse for smaller payouts” (Weber and Chapman, 2005, p.32); size effect shows that people become most risk-seeking in the small group context, say 6 people: more than 50% of the participants choose a gambling alternative. More important difference of both effects is a context against which respondents come up: while peanuts effect is observed in the context of small monetary payoff, size effect is in the context of a small number of people. When we pick a 10% chance of $1 over $0.10 for sure, we can say “Who cares if I lose? I’m only passing a dime”. However when we give up 4 lives of 6 people for sure, we cannot think it is only a small deal. Since psychological motives can be different between two effects, it is reasonable to look for each cause for each effect.

Regarding a cause of size effect, Wang writes, “In a small group or a family context, subjects may hold a risk attitude that ‘we all live or die together,’ and tend to be risk seeking under both framing conditions. In contrast, in a large group situation, they may become more susceptible to the dichotic effects of positive frame and negative frame” (Wang, 1996b, p.147). Behind this explanation, we can see an evolutionary rationale: “From this [adaptive] viewpoint, the human species has been living in small face-to-face groups for most of its evolutionary history, and most people spend most of their lives dealing with problems in a small social context. Such species and individual experiences in small group living should have shaped the human psyche to be sensitive to social group size” (Wang and Johnston, 1995, p287). To explain the adaptive foundations of the size effect in greater detail, let us turn to the evolutionary argument regarding human group size.

As evolutionary psychologists insist, it is interesting to bear in mind that if some pattern is generally observed in human decision-making or behavior, evolutionary causes can be found behind the empirical findings. Human beings -that is, the genus Homo- appeared between 1.5 and 2.5 million years ago, a time that roughly coincides with the beginning of the Pleistocene Era, 1.8 million years ago. Since the Pleistocene Era ended a mere 12,000 years ago, most human adaptations either newly evolved during the Pleistocene Era or were maintained by stabilizing selection pressure during the Pleistocene Era. Evolutionary psychology therefore suggests that the human mind consists of psychological mechanisms that are adaptive in the human EEA (Environment of Evolutionary Adaptedness): for example, the Pleistocene hunter-gatherer society, whose maximum size was estimated to be around 100 to 200 people (Cosmides and Tooby, 1989, 2000; de Waal, 1996). A considerable number of studies support that figures around 150 are frequently observed among a wide range of contemporary human societies, like farming communities, sub-disciplines of academic communities, basic army units (Hardin, 1988; Mange and Mange, 1980; Becher, 1989). Mange and Mange, (1980) have demonstrated that the mean size of the 51 communities in the Schmedenleut section of the Hutterites (a fundamentalist group who live and farm communally in South Dakota and Manitoba) is 106.9 people. According to Hardin (1988), the Hutterites consider 150 individuals to be the limiting size for their farming communities: once a community reaches this size, it takes a step to split into two daughter communities. These results coincide with a result obtained in brain science field. According to brain science, the size of a social animal's neocortex is causally related to that of group size. Dunber (1995) calculated a size of hunter-gatherer society by a regression equation between group size and human neocortex size. A predicted

group size is 147.8, and the 95% confidence limits around this prediction are from 100.2 to 231.1. Along the same line of inquiry, Caporael et al. (1989) have argued that small groups, as a basic form of social structure in EEA, would have given rise to selected mental adaptations, favoring emotional and cognitive mechanisms that worked well in small-group living. We can also add a result of Traulsen and Nowak's recent research (Traulsen and Nowak, 2006). By using a multilevel selection model, they show that one of the important conditions for the evolution of cooperation is small group size. If our cooperativeness has been evolved in a small group, it seems reasonable to suppose that a small group size reminds us of collaborative togetherness.

On the basis of this discussion, it is natural to suppose that people tend to consider a small sized group to be a community held together emotionally by fate. Thus, they might prefer make-or-break situations (the "proximate causes" of the size effect). These proximate causes should rely on "ultimate causes" derived from adaptation. Two kinds of arguments, which are not incompatible, exist. One concerns population dynamics, the other, resource distribution. In life-death decision problems, the probabilistic choice outcome is adaptive because the deterministic outcome of "losing two-thirds of small group members" should result in the total disappearance of this group (Wilson and Sober, 1994; Boehm, 1996). The egalitarian distribution of scarce resources, e.g., survival chance in the life-death problem, is adaptive, because it could protect individuals from risks over which they have no control (Brosnan and de Waal, 2003).

We shall now incorporate a nature-via-nurture perspective into the argument above.

Nature-via-Nurture

It is important to note that, at this moment in time, evolutionary thinking is removed from genetic determinism. On the contrary, it supposes that the human mind evolves through the interplay of biology and culture: "nature via nurture" (Ridley, 2003). On the one hand, our inherited neurobiological traits cause us to view the world in a particular way and to prefer certain behaviors to others; on the other hand, this preference also arises from acquired elements and is reinforced by them (e.g., education, environment, and culture).[2] Let us paraphrase this argument with reference to the case of the size effect.

Due to our inherited bias, we considered 6000 and 600 sizes to be the anonymous groups and sizes 60 and 6 to be the interdependent groups or a family, because 6000 and 600 are larger than the typical group size in EEA and 6 and 60 are within the range of typical group size in EEA. As the size of the hunter-gatherer society plays a role of threshold, human beings consider groups of this size (around 150, with some margin) or less as small and those beyond this size as large. Hence, by nature, we are more risk-seeking in the size 6 and 60 contexts than in the size 6000 and 600 contexts.

On the other hand, it is not so easy to predict by nurture that we become linearly risk-seeking when contextual size decreases. Size 6 is similar to the size of a family, which has remained one of the most important communities since the hunter-gatherer society, an experience that may make people the most risk-seeking. In contrast, it is unusual for us to consider groups of 6000 and 600 people as communities because, in modern society, we are rarely familiar with a group of 6000 or 600 people; therefore, we tend not to be risk-seeking in this group size context. Whether or not people consider 60 to be a small group may depend on their environment or past experiences. For example, compared to residents

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[2] Regarding the synergic effect of nature-via-nurture for captive-bred monkey, see Mineka et al., (1984).

of a metropolis, soldiers belonging to a platoon in the military could consider a group of 60 as an intimate community. Soldiers are likely to be more risk-taking than urban residents when presented with life-death decision problems in the context of a group of 60. [3]

These arguments lead us to predict that, in general, subjects are the most risk-seeking when the context size is 6, the least risk-seeking when the context size is 6000 or 600, and somewhere in the center when the context size is 60. While the difference in risk-seeking intensity should be statistically significant between sizes 6 and 6000/600, it is difficult to observe a stable significant difference between group sizes 6 and 60 and between group sizes 60 and 6000/600. This is because the size effect of group size 60 could vary due to the nurture factor.

In order to verify if the evolutionary reasoning of the size effect, discussed above, is valid, we should show; firstly that the size effect is observed, in principle, in any other adaptive contexts concerning human group than the life-death decision problem; secondly that a sufficient consideration of people's "nurture" can contribute to understand their decision-making in such an adaptive problem. For these purposes, we have conducted an experiment, of which we will give a precise account in the next section.

Materials and Methods

Experimental design

As an adaptive context other than life-death problem, we propose a dismissal problem that has the same probability structure as the life-death problem but the different task domain

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[3] Zhang et al (2008) shows that Chinese military undergraduates were clearly risk-seeking across 6000, 600, 60 and 6 contextual group sizes in the life-death decision problem.

from it (as for the text of dismissal problem, see Appendix). We think that this problem is considered adaptive-relevant by Japanese respondents with two reasons; firstly, working (production) has been very important for human beings ever since the hunter-gatherer society in a sense that whether they can work or not is a vital question; secondly although a labor market reform has been launched recently in Japan, the longest duration of tenure and less frequent job mobility among OECD countries are still standing out, at least, for regular workers (see, *Economic Survey of Japan 2008*, *2009*). Hence the unemployment can be considered as a life-threatening matter for Japanese workers.

For this experiment group sizes consisted of 6 categories: 60000, 6000, 600, 150, 60, and 6. Compared to previous researches, this addition of group sizes was meant to explore the size effect a little further and to examine directly a group size that was applicable to the EEA group size, namely 150. Subjects were randomly presented with one of the 6 versions of the dismissal problem and asked to choose a reconstruction plan. After their choice of plan A or plan B, subjects were then posed not only demographic questions but also following two questions related to their work experience. It is to examine impact of the nurture on people's choice. First question concerned the workplace size; "How many people are working in your workplace?" Their answers could range from 1 to 11: 1 corresponds to 1 employee; 2 corresponds to 2–4; 3, to 5–9; 4, to 10–29; 5, to 30–99; 6, to 100–199; 7, to 200–299; 8, to 300-999; 9, to 1000-4999; 10, to 5000-9999 and 11 over 10000. Second question concerned respondent's position in her/his company: "What is your position in the company?" Respondents chose an answer from following seven alternatives: president/director, general manager, manager, section chief, staff, professional job/researcher, or others.

Subjects

For this study, we consigned a web experiment to a private research company and used the members pooled by the company as subjects. These members voluntarily apply for membership to the company, and it is up to them to answer the survey questions diffused over the internet. They can participate in experiments alone in their homes, as experimental instruction is given on their computer screen by using a digital tool. After the experiment, the company randomly extracts the data of the respondents and pays them a fee. When they participated in this experiment, almost of them were working and the rest had worked in the past. Actually, there were few students and no full-time home-makers. The survey took place between 18/02/2010 and 26/02/2010, and the number of subjects was 2336: 1078 female (46.1%) and 1258 male (53.9%). The oldest subject was 69 years old and the youngest was 20 years old. The mean age was 42 and its standard deviation, 12.4. The student sample was very small, occupying only 0.4% of the total sample.

One drawback of such a web experiment, as has been often noted, is a sample bias. Although the company shuffles its members every year and we tried to use as widely distributed a sample as possible, the problem of sample bias may not be negligible when the results are generalized. However, in this case we decided to conduct a web experiment rather than conduct an experiment using university students. One reason is practical: to consider explicitly nurture-related variables in the dismissal problem, it is necessary to use a sample that has an experience of working. The other is methodological: since our first aim is to test our hypotheses, given below, and not to generalize the results, it is more important to assure “internal validity” of experiment than its “external validity.” Moreover

any argument, so far, does not seem to show empirically that the sample bias, caused by web experiment procedure, affects people's risk attitude.

Hypotheses

We have three hypotheses, one concerning the size effect, and the others concerning the nurture effect.

H1: The size effect will exist under the control of positive and negative frames. Subjects will be the most risk-seeking when the contextual size is 6, the least risk-seeking when the contextual size is 60000, 6000, or 600, and somewhere in the middle when the contextual size is 60 or 150. Differences in risk-seeking intensity should be statistically significant between sizes 6 and 60000/6000/600. As for the differences between sizes 6 and 60/150 and between sizes 60/150 and 60000/6000/600, their statistical significance cannot be predicted precisely because, due to nurture, the size effect of group sizes 60 and 150 could vary.

H_1 relies on the inference given in section 3. A mere difference is a content of three categories. We suppose a group of 60000 is belonging to "beyond EEA group size" category like a group of 6000 or 600, and a group of 150 to "around EEA group size" category like a group of 60.

H_2 Workplace effect: experience of small workplace makes people more risk-seeking. On the other hand, the experience of large workplace does not.

Behind this supposition, we think that experience of small workplace improves people's group consideration more than that of large workplace, because people's group familiarity may be more innately fostered in the former experience than in the latter. This

effect should be examined in two distinct cases. The first case is that it appears throughout subjects: statistical analysis will detect a main effect of "workplace size" variable. The second case, more suitable to nature-via-nurture perspective, is that it appears only when subject's prototypical mind is activated by group size in the dismissal problem, that is, when they read the text "Imagine a company which employees are 6 (or 60 or 150)." Statistical analysis will detect an interaction of "workplace size" variable and group size variable. Imagine a company which employees are 6 (60, 150, 600, 6000 or 60000)

H_3 Position effect: subjects who hold a high position in a company are less risk-seeking than those who are not.

Our argument is that subjects, holding a high position in a firm, are more aware of firm's survival, then they prefer a sure plan than a gambling plan. Granted that Japanese workers usually promote step by step in their company during the long duration of tenure and the mobility of labor market is still low, it is plausible to suppose that executives may wish a plan that assures their company's survival in any shape or form, because its bankrupt harms their current life level in a life-threatening way.

Results

To verify the hypothesis 1, we first employed the following model with the results of Table 1:

Model A: Logit $(p_i) = \log (p_i/1-p_i) = \beta_0 + \beta_1 F_i + \beta_2 S(600\text{-}60000)_i + \beta_3 S(60\text{-}150)_i$[4]

[4] If the probability of the ith respondent's probabilistic outcome choice is written by p_i, the dependent variable is defined as Logit (p_i), that is, $\log (p_i/1- p_i)$. β is a standardized binomial Logit regression coefficient. Framing dummy (F_i) is coded 1 if subject i answers to the negative frame problem and otherwise (positive frame), 0; $S(600\text{-}60000)_i$ is coded 1 if subject i answers to the size 600, 6000 or 60000 problems, and otherwise, 0. $S(60\text{-}150)_i$ is coded 1 if subject i answers to the size 60 or 150

Table 1: Results of the Dismissal Problem Across Three Categories

(N = 2336)

Size	Choice / Frame	Plan A (Sure)	Plan B (Risky)	Total	p value of Framing Effect
600, 6000, or 60000 version (N =1149)	Positive	380 68.6%	174 31.4%	554 100.0%	.002
	Negative	355 59.7%	240 40.3%	595 100.0%	
60 or 150 versions (N =784)	Positive	259 64.6%	142 35.4%	401 100.0%	.023
	Negative	217 56.7%	166 43.3%	383 100.0%	
6 version (N =403)	Positive	89 49.7%	90 50.3%	179 100.0%	.455
	Negative	103 46.0%	121 54.0%	224 100.0%	
Total		1403	933	2336	

Note; In group size 600-60000, Pearson's Independence Test: χ^2 (1) = 9.922, p value= .002. In group size 60-150, Pearson's Independence Test: χ^2 (1) =5.165, p value= .023. In group size 6, Pearson's Independence Test: χ^2 (1) =.557, p value = .455.
; Plan A presents the deterministic alternative and Plan B, the probabilistic alternative.

The exponential powered by logit coefficient (β) is intuitively an effect of the independent variable on the "odds ratio": in this case, the odds are the probability of the subject's probabilistic choice divided by the probability of her/his deterministic choice. Let us explain more concretely. In model A, we coded S(600-60000)i dummy variable 1 if subject i answered to the size 600 or 6000 or 60000 problem, and 0 otherwise. If exp β_2 is 0.5, the odds that subjects with contextual size 600/6000/60000 would choose the risky

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problems, and otherwise, 0.

plan is a half of the odds of those with contextual size 6. Put briefly, people are less risk-seeking with contextual size 600/6000/60000 than with contextual size 6.

As for the framing effect, exp β_1 in this model (number of observation = 2336) is 1.387 (p value is .000 and standard error .086). It means that the odds that subjects in the negative frame will choose the risky plan are about 1.4 times as much as the odds that subjects will choose the risky plan in the positive frame. Hence, the framing effect exists under control of three size categories. As for the size effect, it is useful to look at β_2 and β_3. As exp β_2 is 0.517 (p value is .000 and standard error .118), the odds that subjects with contextual group size 6 will choose the risky plan are about 2 times as much as the odds that subjects with the contextual group size 600/6000/60000 will choose the risky plan. Similarly, in terms of "odds ratio", exp β_3 = 0.600 (p value is .000 and standard error .124) means that subjects with group size 6 are about 1.7 times as risk-seeking as those with group size 60/150; expβ_4 (=β_2 - β_3) = 0.862 means that subjects with contextual size 60/150 are about 1.2 times as risk-seeking as those with contextual size 600/6000/60000, but β_4 is not significant at 10% level (p value is .120 and standard error .096). In summary, the odds ratio of risky choice from size 6 to 60/150 to 600/6000/60000 is 1:0.600:0.517. The order of risk-seeking degrees was, by descending order, 6, 60/150 and 600/6000/60000. As the results shows, it can be concluded that our hypothesis of size effect is confirmed. It is also worth noting that the difference of sex does not affect the decision-making of the subject.

However a minute examination of the inside of “beyond EEA size group (600, 6000 or 60000 people)” suggests an anomaly of size effect (see, Figure 1). In terms of risky choice, subjects with group size 6000 or 60000 are as risk-seeking as those with size 60/150.

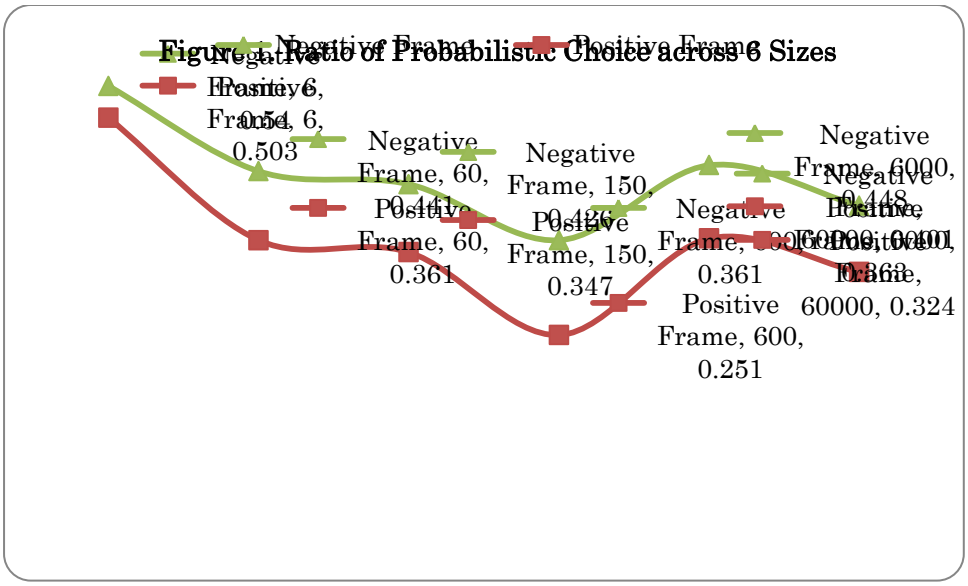

Figure: Ratio of Probabilistic Choice across 6 Sizes

Note: The number of observation is 2366

As long as contextual group sizes are classified into three categories, that is, small group (e.g., 6 people), around EEA group size (e.g., 60 or 150 people) and beyond EEA group size (e.g., 600 or 6000 people), the size effect has been very stably replicated (Wang, 1996a, b, c, 2008; Wang, Simon and Bredart, 2001; Bloomfield, 2006; Shimizu and Udagawa, 2011). However, if we examine the inside of a category–especially inside of "beyond EEA size group" – in detail, we have sometimes observed an anomalistic phenomenon about size effect. For example, in the negative frame, subjects in the context of a group 600 are as risk-seeking as those with contextual size 6 (see, Wang and Johnston, 1995; Wang, 1996b) or subjects in the context of a group of 6000 are as risk-seeking as those with contextual size 6 (see, Wang, 1996c). It may be possible to suppose that when people face a contextual group, which size is largely bigger than EEA group size, their risky choice could be influenced by a cause that we have not supposed, because this sort of big group would totally be unfamiliar to people from both nature and nurture perspective. It seems to be interesting to examine how people make their decision when they are

confronted with such an unfamiliar case. Yet no studies have ever tried to explain this anomaly as far as we have surveyed relevant literature.

To deal with this anomaly, we propose not to use the subjects who replied to 6000 or 60000 size questions for the data analysis. The first reason is that as we do not know yet whether this anomaly is accidental, it is plausible to eliminate a dubious element in advance to strengthen the validity of study. The second reason is that main results do *not* change essentially *at all* between total sample and this limited sample: size effect, workplace effect and position effect exist (we shall show the latter two effects later). Thus from now on, contextual sizes consist of following three categories –small group (6 people), around EEA size group (60 or 150 people) and beyond EEA size group (600 people) and a new model is the below.

Model A': $\text{Logit}(p_i) = \log(p_i/1-p_i) = \beta_0 + \beta_1 F_i + \beta_2 S(600)_i + \beta_3 S(60\text{-}150)_i$[5]

In this model (number of observation = 1557), exp β_1 is 1.381 (p value is .002 and standard error .105), exp β_2 is .408 (p value is .000 and standard error .151), exp β_3 = 0.600 (p value is .000 and standard error .124), expβ_4 (=β_2 - β_3) is 0.681 (p value is .004 and standard error .135). Hence, the framing effect exists under control of three size categories and the odds ratio of risky choice from size 6 to 60/150 to 600 is 1:0.600:0.408. The order of risk-seeking degrees was, by descending order 6, 60/150 and 600. As the results show, it can be concluded that our hypothesis of size effect is confirmed. The difference of sex does not affect the decision-making of the subject.

To examine the hypothesis 2, we had to define a small/large workplace. We proposed to use EEA size as threshold: while a workplace, which number of employee is from 1 to

[5] Compared to model A, $S(600)_i$ replace $S(600\text{-}60000)_i$ This size dummy is is coded 1 if subject i answers to the size 600 problems, and otherwise, 0.

199, is considered as "small", a workplace beyond this scale as "large". There are, of course, different ways to define small/large workplace. Given that our study is one of the first attempts to examine people's decision-making from "nature via nurture" perspective, we somewhat arbitrarily defined small/large workplace with an evolutionary idea. Further studies may fine-tune or replace this definition.

To know if there is a main effect of workplace size variable (W_i), we used a following model:

$$\text{Model B: Logit } (p_i) = \log (p_i/1-p_i) = \beta_0 + \beta_1 F_i + \beta_2 S_i + \beta_3 W_i$$ [6]

A statistical analysis of model B (number of observation = 1555) reveals that while main effects of both frame and group size exist as previous two models, effect of workplace size does not exist: exp β_1 is 1.384 (p value is .002 and standard error .105), exp β_2 is 1.576 (p value is .000 and standard error .076), exp β_3 = 0.911 (p value is .431 and standard error .118). Then we examined another possible process, by which workplace size could influence human risk preference: interaction of group size and workplace size. Interaction that we have expected is paraphrased as follows: risk-seeking choice is most likely to occur among subjects who face 6 people context and are working in a small size workplace, least likely to occur among people who face 600 people context and are working in a big size workplace, with subjects in the other conditions in between. To verify this interaction, we used a following model:

$$\text{Model B': Logit } (p_i) = \log (p_i/1-p_i) = \beta_0 + \beta_1 F_i + \beta_2 S_i * W_i$$

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[6] Compared to previous two models, S_i and W_i are new. S_i (size variable) is coded 1 if subject i answers to the size 600 problems, 2 if subject i answers to the size 60-150 problems, and 3 if subject i answers to the size 6. W_i (workplace variable) is coded 1 if subject i is (was) working in a workplace which number of employee is from 1 to 199, and otherwise, 0.

Result suggests an existence of the interaction: exp β_2 is 1.301 (p value is .000 and standard error .069). It seems that workplace size variable can influence people's risky choice when their prototypical mind is activated by small contextual group size. But a further examination of data suggests also that it should not be pushed too far. According to Table 2, while subjects who face 6 people context and are working in a small size workplace are most likely to be risk-seeking (52.7% of subjects have chosen a probabilistic choice) and those who face 600 people context and are working in a big size workplace are least likely to be (29.5% of subjects have chosen a probabilistic choice). Nevertheless we should not ignore a high risk-seeking attitude of subjects who reply 6 people context question but are working in a large size workplace (51.7% of subjects have chosen a probabilistic choice).

Table 2: Ratio of Probabilistic Choice

(N= 1555)

	Group Size **Frame**	**6**	**60 or 150**	**600**	Sum
Workplace size variable = 1 **(N of employees < 199)**	Positive	65 (58) 52.8% (47.2%)	87 (165) 34.5% (65.4%)	27 (81) 25.0% (75.0%)	179 (304)
	Negative	71 (64) 52.6% (47.4%)	95 (141) 40.3% (59.7%)	46 (77) 37.4% (62.6%)	212 (282)
Workplace size variable = 0 **(N of employees >= 200)**	Positive	25(31) 44.6% (55.4%)	55(94) 36.9% (63.1%)	18(53) 25.4% (74.6%)	98(178)
	Negative	50(39) 56.2% (43.8%)	71(76) 48.3% (51.7%)	23(45) 33.8% (66.2%)	144 (160)
Total		211 (192)	308 (476)	114 (256)	633 (924)

Note; The number in parenthesis concerns those who have chosen sure choice.

; There were two subjects who did not answer the workplace size question.

If it is plausible that people's group familiarity can be more innately fostered in a small workplace than large workplace, it is also possible that people's attachment or commitment to group is not necessarily correlated with their workplace size. We think a study, which can examine separately people's attachment to group and its size, is necessary to develop the idea of interaction, mentioned above.

Finally to verify hypothesis 3, we have adopted a model below:

Model C:

$$\text{Logit}(p_i) = \log(p_i/1-p_i) = \beta_0 + \beta_1 F_i + \beta_2 S(600)_i + \beta_3 S(60\text{-}150)_i + \beta_4 P_i$$ [7]

In this model (number of observation = 1555), main effects of frame, group size and position are observed: exp β_1 is 1.398 (p value is .001 and standard error .105), exp β_2 is .408 (p value is .000 and standard error .151), exp β_3 = 0.612 (p value is .000 and standard error .125) and exp β_4 = 1.314 (p value is .016 and standard error .114). The framing effect exists and the order of risk-seeking degrees was, by descending order, 6, 60/150 and 600. And the position effect suggests that subjects engaged in management are less risk-seeking than those who are not. It seems valid to say that the position in a company could influence their choice for company survival. Note that model C is significantly improved compared to model A' in terms of log-likelihood (χ (1)=7.831, p<.01).

Conclusion and Discussion

[7] Compared to model A', P_i (position dummy) is added. P_i is coded 1, if subject i answer "staff, professional job/researcher, or others" and otherwise (president/director, general manager, manager, section chief), 0. There were two subjects who did not answer to the "position question".

Although all seem to recognize that nature versus nurture is a false dichotomy and that humans are a product of an interaction between the two, only few attempts have so far been made on human decision-making from this point of view. On the one hand, our experiment shows that “size effect” is observed in the dismissal problem, other adaptive problem than the life-death problem. It supports the argument that size effect is a product of human mind fostered by their evolutionary process. On the other hand, “workplace effect” and “position effect” suggest that a sufficient consideration of not only the element of nature but also of the element of nurture is necessary in order to understand people’s decision making in an adaptive problem. However, we left at least three points, which call for further discussion.

The first point is related to the question again whether the size effect is *really* an evolutionary product. To complete its confirmation, in addition to the result of this study, we have to show that size effect would not occur in a non-adaptive problem.

The second point concerns the interaction of group size and workplace size. As we have explained when the validity of H_2 was examined, although this interaction was observed, the interpretation is open to some debate. Granted that people’s attachment or commitment to workplace may not be *necessarily* correlated with their workplace size, we could construct more predictive model by introducing a variable, which reflects subject’s attachment to workplace.

The last point is about the anomaly of size effect. It is possible that our prototypical mind is not activated when we face a contextual group, which size is largely superior to EEA group size. In this case, what can explain people’s decision making in a coherent way? Does only nurture matter? As our knowledge on this subject is very limited, much still remains to be done.

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Appendix: Questionnaire(s) used for Dismissal Problem

Positive Frame Version

Imagine a company which employees are 6 (60, 150, 600, 6000 or 60000) and this company is on the brink of a bankruptcy. Two alternative plans to cope with the crisis have been proposed. Assume that the exact estimates of the consequences of the plans are as follows:

If plan A is adopted, just 2 (20, 200, 50, 200, 2000 or 20000) people will work for sure.

If plan B is adopted, there is a one-third probability that all 6 (60, 150, 600, 6000 or 60000) people will work, and a two-thirds probability that none of them will work.

Which of the two plans would you favor?

Negative Frame Version

Imagine a company which employees are 6 (60, 150, 600, 6000 or 60000) and this company is on the brink of a bankruptcy. Two alternative plans to cope with the crisis have been proposed. Assume that the exact estimates of the consequences of the plans are as follows:

If plan A is adopted, just 4 (40, 400, 100, 400, 4000 or 40000) people will not work for sure.

If plan B is adopted, there is a one-third probability that all 6 (60, 150, 600, 6000 or 60000) people will work, and a two-thirds probability that none of them will work.

Which of the two plans would you favor?