A Cross-Cultural Study of Reference Point Adaptation: Evidence from the China, Korea, and the US

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9 July 2007

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August 4, 2008

We examined reference point adaptation following gains or losses in security trading using participants from China, Korea, and the US. In both questionnaire studies and trading experiments with real money incentives, reference point adaptation was larger for Asians than for Americans. Subjects in all countries adapted their reference points more after a gain than after an equal-sized loss. When we introduced a forced sale intervention that highlighted a prior price change, Americans showed *greater* adaptation toward the new price, whereas Asians showed *less* adaptation. We offer possible explanations both for the cross-cultural similarities and the cross-cultural differences.

Keywords: Prospect theory; cross-cultural differences; reference point adaptation; mental accounting; security trading

1. Introduction

Prospect theory (Kahneman and Tversky 1979) is one of the—if not the—most prominent descriptive theories of decision making under uncertainty. Although originally designed as a static model, it has been widely applied to dynamic settings in economics and business research to understand work effort, brand choices, capital budgeting, stock returns, trading volumes, and option exercises (e.g., Hardie, Johnson, and Fader 1993; Keasey and Moon 1996; Heath, Huddart, and Lang 1999; Heath, Larrick, and Wu 1999; Barberis and Huang 2001; Grinblatt and Han 2005; Mas 2006). An important premise of these applications of prospect theory is that reference points shift over time, but only recently have scholars started to explore systematically the dynamic properties of reference points. Furthermore, research that examines such properties across different cultures is almost non-existent. Given the large body of research showing that culture affects individual judgment and decisions, a primary purpose of this manuscript was to ascertain whether reference point adaptation exhibits cross-cultural variation, and if so, what are possible causes of this variation.

A natural hypothesis for the dynamics of reference point adaptation is that the reference point moves in a manner consistent with the prior outcome, shifting upward following a gain and downward following a loss. Using subjects from the US, Arkes, Hirshleifer, Jiang, and Lim (2008) found that reference points adapt asymmetrically: such adaptation was significantly larger following a gain than following a loss.[1] They also found that when realization of the initial gain or loss was emphasized, adaptation both to losses and gains appeared to be enhanced. Applying the measurement approach of Arkes et al. to encompass both east-Asian and US subjects, we identify cross-cultural similarities and differences in reference point adaptation. Our findings suggest that both westerners and easterners tend to adapt more to prior gains than to their losses, but that eastern and western cultures differ in their tendency to adapt to their prior outcomes due to their differences in loss aversion and in the tendency to expect reversals in fortune.

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[1] In a somewhat similar spirit, Strahilevitz and Loewenstein (1998) conjectured that " . . . adaptation to losses takes longer than adaptation to gains and would therefore require a greater time interval to observe."

Performing cross-cultural studies in this domain was motivated by recent research that has documented important differences in several judgment and decision making phenomena across countries, such as overconfidence (Yates, Lee, and Shinotsuka 1998), attribution of responsibility (Morris and Peng 1994), and risk preferences (Hsee and Weber 1999). The results of these studies suggest that previous findings mostly generated in the United States may not generalize completely to other countries. In fact, given the various cross-cultural differences enumerated above, we should expect substantial differences in the way people from different cultures react to gains and losses by shifting their reference point.

Scholars have also used prospect theory to understand a number of anomalous stock market phenomena, including excess volatility, the equity premium puzzle, the value effect, the disposition effect, and IPO underperformance (e.g., Shefrin and Statman 1985; Bernartzi and Thaler 1995; Barberis and Huang 2001; Barberis and Xiong 2008). There is evidence that the high equity premium, the value effect, and the disposition effect are present outside the United States to varying extents (e.g., Fama and French 1998; Grinblatt and Keloharju 2001; Feng and Seasholes 2005; Dimson, Marsh, and Staunton 2007). Understanding cross-cultural differences in reference point adaptation may also help us better understand these variations in market behavior around the world.

2. Motivation and Literature Review

2.1. Prospect Theory

Kahneman and Tversky (1979) proposed prospect theory as an alternative to the normative theory of expected utility maximization. Three main elements of prospect theory are most relevant to our research. First, people derive utility from gains and losses relative to a reference point, while traditional utility theory assumes that people derive utility from total wealth or consumption. Although the reference point is generally one's current wealth (Kahneman and Tversky, 1979), aspiration levels or norms can also serve this function (Kahneman and Tversky, 1979, p. 286; Heath, Larrick, and Wu, 1999). Second, the value function is concave in the domain of gains and convex in the domain of losses with a steeper slope in the loss domain. The shape of the function captures "dual risk attitudes": individuals tend to be risk averse in the gain domain but risk seeking in the loss domain. Third, the effect of a loss on utility is much larger than that of a gain of the same size ("loss aversion").

Kahneman and Tversky (1979) showed that prospect theory described the behavior of subjects in the US as well as in European countries such as Sweden, and in Israel. Past studies suggested that losses have an effect approximately 2 to 2.5 times that of a gain of the same size (e.g. Tversky and Kahneman, 1992). However, there is relatively limited research that assesses the magnitude of the loss aversion and risk aversion among east-Asians, who tend to differ from westerners in several aspects of judgment and decision making (e.g., Wright and Phillips 1980; Yates et al. 1989; Weber and Hsee 1998; Levinson and Peng 2006). Thus, to measure reference point adaptation, we included an estimation of the loss aversion and the exponent of the value function among east-Asians.

There are two prior studies somewhat related to this aspect of our study. Kachelmeier and Shehata (1992) provided evidence consistent with the probability weighting function in prospect theory, using high monetary incentives for Chinese subjects. Hsee and Weber (1999) examined choices over sure versus risky outcomes in both gain and loss domains. They found that Chinese subjects are less risk-averse than US subjects.

Our paper has a different goal from these two papers: to measure cross-cultural differences in reference point adaptation across two different cultures and to explore the sources of such differences. Our paper also differs in that we estimated the parameters of the value function as means of quantifying such adaptation.

2.2. Reference Point Adaptation in Prospect Theory

Prospect theory has most commonly been applied to static decision environments. When one applies this model to more realistic dynamic settings such as stock trading, repeated bargaining and negotiation, work efforts, and firm investments, it is important to understand how reference points are updated after such individuals experience outcomes over time.

Consider the prospect theory value function depicted in Figure 1. If a loss has occurred, the decision maker is at point L in Figure 1a. If a subsequent decision is to be made and the reference point has not adapted to the initial loss, the decision maker will likely be risk seeking, in that a further loss will cause only a small decrease on the y-axis, whereas a further gain will result in a larger increase. However if the decision maker adapts fully to the initial loss, then Figure 1b depicts this situation. Now the decision maker will be less risk seeking, because the "re-centering" of the origin of the graph on the current state of affairs causes a loss to be more painful than it would have been in Figure 1a. Thus, if the reference point does not budge following a loss, then the decision maker is likely to become risk seeking and to try to recover the loss, leading to such phenomena as the sunk cost effect (Arkes and Blumer 1985) or the disposition effect (Shefrin and Statman 1985). On the other hand, if the reference point adapts downward following a loss, the decision maker is able to "make peace" with this loss and will be less likely to "throw good money after bad."

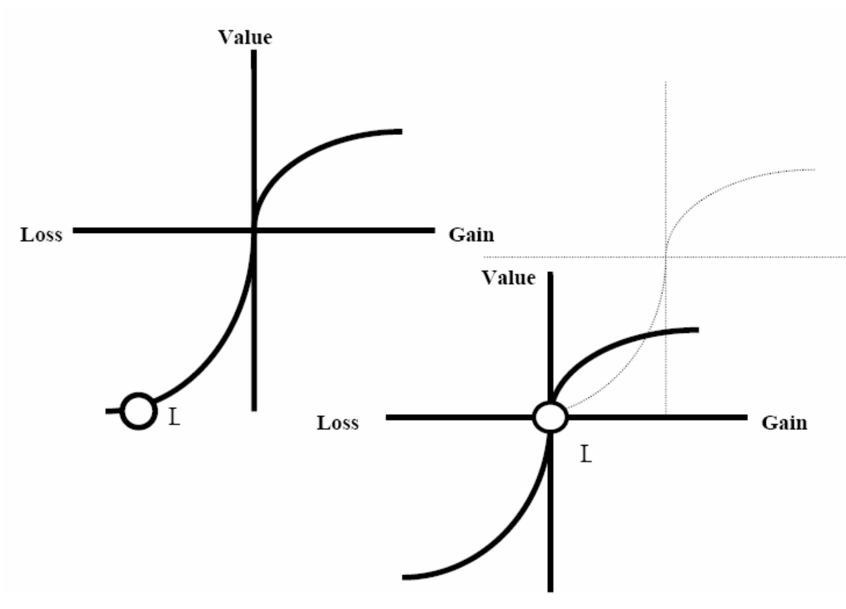

Figure 1a (left): No adaptation to the loss that has occurred at point L.
Figure 1b (right): Full adaptation to the loss that has occurred at point L.

There are a very few cross-cultural studies pertaining to the static aspects of prospect theory. However, we know of no cross-cultural research on its dynamic aspects. There are a very few studies testing the dynamic aspects of prospect theory using US subjects. Chen and Rao (2002) found that the order in which two opposite events (gain/loss) occurred affected the subject's final affective state, suggesting that a shift in the reference point occurred after the first event. Gneezy (2005) assumed that subjects are most willing to sell when the current price is equal to the reference point, and showed that assuming a stock's peak price to be the reference point best explained subjects' willingness to sell that stock. Baucells, Weber, and Welfens (2007) estimated the reference point by asking subjects which selling price would make them neither happy nor unhappy. Using a weighting function approach Baucells et al. showed that the reference point is most heavily influenced by the first and the last observed stock price. Both Gneezy (2005) and Baucells et al. (2007) focused on which price in the past price history had a bigger influence on the current reference point, but they did not estimate the magnitude of reference point adaptation after a gain or loss, which is the main focus of our study.

Arkes et al. (2008) estimated the changes in reference point location following stock trading gains and losses using both questionnaires and real money incentives. They found that the reference point adapts to prior gains to a greater extent than to prior losses using two main procedures. In their Experiment 1, for example, subjects were asked to indicate the stock prices that would render the same utility as that caused by a prior gain or loss. If the shape of the prospect theory value function remains unchanged, the distance between the indicated stock price and the new reference point must be equal to the distance between the prior stock price and the old reference point. Therefore, one can infer the change in the reference point ("reference point adaptation") from the indicated change in stock prices.

The second procedure is exemplified in their Experiment 6. Subjects purchased a stock at a certain price and experienced either price appreciation or depreciation. Then subjects were informed of the possible stock prices in the next trading period and offered a chance to sell the stock by stating their minimum selling price. Using the Becker, DeGroot, and Marschak procedure (1964), Arkes et al. obtained each subject's minimum selling price—the certainty equivalent of the gamble—and then solved for the implied new reference point using the prospect theory value function. They then measured the reference point adaptation by comparing the distance between the new reference point and the initial reference point, which was assumed to be the purchase price.

Using either procedure, the primary result was that reference point adaptation was asymmetric; adaptation following a gain was significantly greater than that following an equal-size loss. Also, when subjects were forced to sell a stock and then repurchase it at the same price at which it had been sold (Weber and Camerer 1998), Arkes et al. found that reference point adaptation was accelerated. The authors hypothesized that this sale/repurchase intervention emphasized the new price following the prior gain or loss, and thus facilitated the closing of the old "mental account" (Thaler 1985, 1999) that encompassed that prior gain or loss. This would, in turn, cause more adaptation to the outcome, whether it was a gain or loss.

2.3. Cross-Cultural Differences in Decision Making

Weber and Hsee (1998) and Hsee and Weber (1999) showed that Chinese are less risk-averse than Americans in their financial decisions, but not in other domains such as medical and academic decisions. Weber and Hsee (1998) found that the perception of the riskiness of financial investment options is lower among Chinese than Americans, and argue that this difference in risk *perception* can explain cross-cultural differences in risk preferences.

Hsee and Weber (1999) advanced the "cushion hypothesis" to account for cross-cultural differences in risk perception in the financial domain. In collectivist cultures such as present in China, the members of one's social network can provide assistance to cushion financial losses. Thus Chinese participants in this research might understandably perceive financial risks to be less than would Americans due to this safety net. However members of one's family or social network cannot provide the same magnitude of assistance in medical or educational domains, so differences in risk perception between Chinese and Americans were neither predicted nor found in these areas. In support of the cushion hypothesis, Hsee and Weber (1999) found that when they controlled for social network variables such as the number of people an individual could rely on for financial assistance, the cross-cultural difference between the Chinese and Americans became non-significant.

To gain further insight into the sources of cross-cultural differences in risk-taking, Weber, Hsee, and Sokolowska (1998) examined risk advice contained in national proverbs. They found that Chinese proverbs seem to provide more risk-seeking advice than American proverbs, and that Chinese perceived their proverbs to advocate greater risk-seeking than Americans perceived in their proverbs, but only for financial and not for social risks.

Ji, Nisbett, and Su (2001) documented an important difference between Asians' and Americans' attitudes toward change. In five studies, Ji et al. (2001) showed that Chinese students were more likely to predict change from an initial state than were Americans. In one experiment (Study 2) some of the questions posed were economic, such as: "The global economy growth rates (annual percentage change in real GDP) were 3.2%, 2.8%, and 2.0% for 1995, 1997, and 1999, respectively. . ." Subjects were asked to predict the probability of the trend remaining the same, going up, and going down. Chinese subjects in this study and others were more likely than Americans to predict that the current trend would reverse. Thus, compared to Americans, Chinese subjects—or Asian subjects in general—might be more likely to predict that gains would be followed by losses, and conversely. Any such difference would have important implications for the valuation and willingness to continue holding a stock following an initial price movement.

In this paper, we employed the methods of Arkes et al. (2008) to pursue four goals. First, we measured reference point adaptation among east-Asians to ascertain if the greater adaptation to gains than losses was present across cultures, as was documented among US participants in Arkes et al. (2008). Second, we examined if there is a cross-cultural difference in reference point adaptation between east-Asians and Americans. Third, we ascertained whether the intervention of the sale and repurchase of a stock accelerated reference point adaptation in the Asian culture, as was previously demonstrated in the

American sample. Finally, we explored the robustness of and possible explanations for the observed cross-cultural variation in reference point adaptation.

3. Reference Point Adaptation Using a Questionnaire (Study 1)

In this questionnaire study we asked subjects to indicate a stock price today that would generate the same utility as a previous stock price change. Assume that the first stock price P_1 resulted in a level of utility $V(P_1 - R_0)$ which is a function of the difference between the first stock price P_1 and the reference point R_0. Subjects indicate the price of the stock today P^* that would generate the same utility as the previous price. Assuming a constant shape of the prospect value function, we have $V(P^* - R_1) = V(P_1 - R_0)$. Thus $P^* - R_1 = P_1 - R_0$. So the reference point adaptation $R_1 - R_0 = P^* - P_1$. That is, reference point adaptation can be inferred from the subject's indication of the stock price today that would generate the same utility as the previous price change.

3.1. Research Participants

The participants were undergraduate students at Florida State University in the United States (81 subjects), Nanjing University in China (89 subjects), and Korea University in Korea (81 subjects). The subjects answered brief questionnaires in a classroom setting. All students voluntarily filled out the questionnaires for a raffle prize within each class. The raffle prizes were adjusted to ensure a similar monetary incentive across three countries from the perspective of an average subject. In the US, the prize was $20. According to official exchange rates when the experiment was conducted, this amount was equivalent to 20,000 KRW (Korean Won), which served as the prize for our Korean subjects. The prize for our Chinese participants was ¥80, which was the equivalent of $10 according to the official exchange rate. However the three countries' prizes were chosen to be similar in purchasing power, because the raffle prize could pay for approximate 3-4 equivalent McDonalds meals in each country.[2]

[2] The exchange rate between the US dollar and Korea Won is close to the ratio of the purchasing powers of two currencies. However, there is a discrepancy between the exchange rate and the purchasing power ratio for the US dollars and China ¥. For instance, an equivalent McDonald meal or an hour of math tutoring costs roughly 2-3 times more in the US than in China. Therefore, for the Chinese subjects we made an adjustment to their prize based on the

3.2. Questionnaires and Procedure

We conducted a questionnaire study where we asked two questions regarding reference point adaptation, similar to those used in Arkes et al. (2008). In one question, subjects were asked to indicate the stock price that would make them just as happy with the stock's price this month as they were when they learned the stock had risen from $30 to $36. In the other, they indicated the stock price that would make them just as sad as when they learned the stock had dropped from $30 to $24 last month. To ensure that original meanings were preserved during translation, the questionnaire was first translated into Chinese or Korean by one person and then back-translated into English by a different person, and we made minor corrections when there were discrepancies (Brislin 1986).

The US payoff numbers were multiplied by 1,000 in Korea, because one US dollar was about 1,000 KRW in Korea. In China, we opted to use the same US figures but in local currency. In other words, we replaced $30 with ¥30, and so forth. In our later stock trading study, we also used the same practice to reflect the fact that average Chinese stocks are traded around ¥20-¥30. For simplicity in reporting, we later do not distinguish the numbers in $ from those in ¥, but refer to all of them in $, instead. The reference point adaptation of Korean subjects was divided by 1,000 so that we could compare the results across countries.

3.3. Results and Discussion

We report the results in Table 1. Two observations from Asian countries (one from China, the other from Korea) were deleted due to entry errors. Since we found no statistical difference between the risk taking behaviors between Chinese and Koreans, we aggregated them into one factor, namely Asian culture.

The responses to the two reference point adaptation questions yielded a finding similar to that of Arkes et al. (2008): reference points adapted to gains to a greater extent than to losses of equal size. Table 1

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relative price of a McDonald meal or payment for tutoring services in the two markets. This strategy ensured similar incentives from the perspective of an average subject across all countries.

shows that the implied adaptation to a \$6 gain minus that to a \$6 loss, calculated as ΔRP(G) − ΔRP(L), is positive and statistically significant both in Asia and the US. Our evidence suggests that asymmetric adaptation in reference points is a general phenomenon in individual decision making and can be generalized across cultures.

Table 1. Reference point adaptation to gains and losses (Study 1)

	N	ΔRP(G)	ΔRP(L)	[ΔRP(G) + ΔRP(L)]/2	ΔRP(G) − ΔRP(L)	*t-stat*
Asia	168	6.15	4.21	5.18	1.94	*6.49*
US	81	3.63	2.56	3.10	1.07	*3.08*
All	249	5.33	3.67	4.50	1.66	*7.14*

Note. ΔRP(G), defined as $R_1 - R_0 = P^* - 36$, measures the reference point adaptation to a \$6 gain. ΔRP(L), defined as $R_1 - R_0 = 24 - P^*$, measures the reference point adaptation to a \$6 loss. The *t-stat* tests whether the asymmetric adaptation, ΔRP(G) − ΔRP(L), is different from zero.

Furthermore, we observe some cross-cultural variations in adaptation. First, Asians appear to adapt more to prior outcomes than Americans, as measured by the average adaptation [ΔRP(G) + ΔRP(L)]/2. On average, Asians adapt \$5.18 to a \$6 prior outcome while Americans adapt \$3.10, a \$2.08 difference. Second, the asymmetric adaptation seems larger among Asians than among Americans. On average, reference points adapt \$1.94 more to gains than to losses among Asians, but only \$1.07 among Americans.[3]

Using an ANOVA 2 (gain/loss) x 2 (cultures) design, we find evidence consistent with our observations. First, the gain/loss factor is significant ($F(1, 247) = 37.2$, $p < 0.01$), suggesting that the asymmetric adaptation exists across the two cultures. The culture factor is significant ($F(1,247) = 29.9$, $p < 0.01$), indicating greater adaptation among Asians than among Americans. The interaction term (gain/loss x culture) is marginally significant ($F(1,247) = 3.11$, $p = 0.079$).

4. Reference Point Adaptation Using Real Money Incentives

The advantage of the questionnaire study (Study 1) is that the inference of reference point adaptation is parameter-free; one needs no assumption about the parameters of the prospect theory value function. However, a general criticism to questionnaire studies is the lack of a monetary incentive. Therefore, we

[3] Arkes et al (2008) estimated that the asymmetry is equal to \$1.73 for their US subjects, larger than our US estimate of \$1.07. We used a within-subject design instead of a between-subject design used by Arkes et al (2008), which might have possibly reduced the asymmetry.

also studied individual reference point adaptation in experimental stock trading settings, in which subjects' trading profits were tied to monetary payoffs.

We followed the procedure employed by Arkes et al. (2008). Subjects purchased a share of stock for $20. After the stock price moved up or down by $6, subjects were informed of the two equally-likely future prices at which they would have to liquidate the stock. Before a coin flip determined the second-period stock price, subjects were asked to indicate a minimum price at which they were willing to sell the stock to the experimenter. Since the value of the certain payoff indicated by the minimum selling price should be equal to the expected value of the future liquidation values, we could infer the new reference point and the reference point adaptation.

4.1. Estimating Parameter Values (Study 2)

Since we need to equate the value of the certainty equivalent to the expected value of a risky gamble to infer the reference point, we first estimated the loss aversion parameter (λ) and the exponent (α) in the cumulative prospect theory value function (Tversky & Kahneman, 1992) for each culture.

$$V(x) = \begin{cases} x^{\alpha} & x > 0 \\ -\lambda(-x)^{\alpha} & x < 0 \end{cases} \tag{1}$$

The existing estimates for the loss aversion parameter (λ) and the exponent (α) are based on experiments using western subjects. For instance Tversky and Kahneman (1992) estimated the loss aversion parameter to be 2.25 and the exponent α to be 0.88 using US subjects. However, nowhere in the existing literature are there such estimates for Asians subjects. Since these could differ from those for US subjects, it is important that we estimate these values.

Our questionnaires followed Kahneman and Tversky (1979) and Tversky and Kahneman (1992). We used the same range of hypothetical payoffs as the range of the real monetary payoffs used in our stock trading experiment.

4.1.1 Research Participants

Part 1 of Study 2 was designed to estimate the loss aversion coefficient. It was run together with Study 1. Thus, the participants and procedures were the same as described in Study 1, but the number of observations differs slightly. Among our Korean subjects, three persons did not provide answers to the loss aversion questions, and the data from one US subject were deleted due to a preposterous value provided by that individual.

Part 2 of Study 2, which was designed to estimate the exponent of the value function (α), was run online. We sent out e-mails to undergraduate students enrolled in selected business classes and also made in-class announcements asking for participation. For the online survey, the raffle prize was three $20 prizes in the US, two $50 prizes in Korea, and three $20 prizes in China. Though the prize in the US is smaller than that in Korea and China, the US subjects were given one extra credit for filling out the survey, which served as an additional incentive. One hundred eighteen subjects from Florida State University in the United States, 92 subjects from Sun Yat-Sen University in China, and 88 subjects from Korea University in Korea participated in the online survey.

4.1.2 Questionnaires and Procedure

In Part 1 of Study 2, there were three questions for each subject, each asking for the size of the gain prospect of a gamble that would make a participant indifferent between a sure outcome of zero and the gamble. The three gambles differed in the magnitude of the loss prospect. As described in Study 1, the numbers were converted into Korean currency of equivalent amounts by an approximate ratio based on the exchange rates, and in China by changing the label of the currency. The questions in Part 1 were adapted from Tversky and Kahneman (1992), and the loss aversion coefficient of an individual was measured by the indicated gain prospect, X, divided by the corresponding loss prospect.

Part 1: Loss aversion

Option A: No gain or loss;
Option B: Win $X or lose $25/$50/$100 with equal probability of 50%

Indicate the dollar value of X that will make you indifferent between Options A and B:
$___________

Similarly, in Part 2, there were two pairs of questions per subject, one for the gain domain and one for the loss domain, which estimated the exponent of the value function (α).

> Part 2: Exponent
>
> You are expected to give the dollar value of X to make option B just as attractive as option A. In other words, please indicate the dollar value of X that will make you exactly indifferent between the two options.
>
> Option A: Win (Lose) $X for sure.
> Option B: Win (Lose) $50/$100 or win (lose) nothing with equal probability of 50%
>
> Indicate the dollar value of X that will make you indifferent between Options A and B: $______

Since the value of the sure outcome (Option A) must be equal to the expected value of the risky gamble (Option B) when a subject is indifferent between the two options, the indicated amount X must satisfy $V(X) = 0.5V(0) + 0.5V(P)$, where P is equal to $50 or $100 depending on the question. Using the prospect theory value function in Equation (1), the exponent α is equal to log(2)/log(P/X), where P refers to the gain or loss prospect ($50 or $100) of the risky gamble.

4.1.3 Results and Discussion

Table 2 contains the mean loss aversion and the exponent estimates for each culture. The mean loss aversion coefficient across the three loss prospects is 1.66 for Asia (1.69 for China, 1.61 for Korea) and 2.08 for the US. The estimates indicate that the US subjects are more loss averse than the Asians. Again, we found no statistically significant differences between Chinese and Koreans, so they are aggregated into an Asian culture group.

The alpha estimates from a pair of questions (one pertains to a gain of $50/$100 and the other a loss of the same magnitude) were averaged for each subject, then across subjects within each culture. Some subjects indicated certain payoffs that are equal to one of the possible payoffs of the gamble or greater than the non-zero possible payoff, in which case we could not solve for α. [4]

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[4] We only included subjects that have a pair of solvable alpha estimates for a given magnitude ($50 or $100). For "All" average, we only include those that have both pairs of solvable answers.

Our estimate of the alpha among Americans is 0.84, close to the estimate of 0.88 by Tversky and Kahneman (1992). The mean alpha estimate is 0.97 for Asians. A lower loss aversion coefficient and a higher exponent estimate of Asians compared to those of Americans are broadly consistent with the findings of Weber and Hsee (1998) and Hsee and Weber (1999) that Asians are less risk averse compared to Americans.

Table 2. Mean Parameter Estimates of the Value Function (Study 2)

	Loss Aversion (λ)				Exponent (α)		
	$25	$50	$100	All	$50	$100	All
Asia	1.55	1.64	1.78	1.66	0.93	1.00	0.97
N	(167)	(167)	(167)	(167)	(139)	(152)	(138)
US	1.89	1.78	1.91	1.86	0.83	0.79	0.84
N	(80)	(80)	(80)	(80)	(79)	(90)	(77)

Note: The loss aversion coefficient is defined as the reported amount of the gain prospect divided by the pre-specified loss prospect ($25, $50, or $100) in a 50:50 gamble such that a subject is indifferent between the gamble and a sure outcome of zero. The exponent of the value function (α) is defined as $\alpha = \log(2)/\log(\$50/X)$, or $\alpha = \log(2)/\log(\$100/X)$, where X refers to the reported dollar amount that would make subjects indifferent between a sure amount of X and a 50:50 gamble of a zero and a $50/$100 gain/loss. The α estimates for a gain and a loss gamble of the same magnitude ($50 or $100) were averaged for each subject. The number of observations is in parentheses.

We then proceeded to test reference point adaptation to outcome payoffs. As discussed previously, we employed the experimental design of Arkes et al. (2008) to test whether (a) reference points adapt faster to gains than to losses, and (b) a forced sale/repurchase event helps foster adaptation among Asian subjects. Furthermore, we looked for possible cultural differences in these adaptation patterns.

4.2. Stock Trading Game with Monetary Incentive (Study 3)

4.2.1. Research Participants

The participants were 176 subjects from DePaul University, Florida State University, and The Ohio State University in the US, 94 subjects from Sun Yat-Sen University in China, and 116 subjects from Yonsei University in Korea. We recruited undergraduate business majors through e-mails, fliers, and in-class announcements. The study occurred outside of class time.

Like Studies 1 and 2, we adjusted the range of the possible final payoff to ensure similar monetary incentives from the perspective of a college student. The subjects were promised a $20 base payment in the US, ¥60 in China, and 20,000 KRW in Korea for their participation. In addition, subjects were told that their trading profit or loss would be added to the participation fee to yield their final payment. Specifically, we told them that two stocks out of all stocks they had traded would be randomly drawn and their trading profits on those stocks would count toward their final payoff. This created a pecuniary incentive for the participants to follow the optimal strategy in each round of trading. Further, since trading profits were not cumulative across rounds, their decision on each round should not have been influenced by their decisions from prior outcomes. The final payoffs ranged from $15 – $25 in the US, ¥40 – ¥ 80 in China, and 15,000 – 25,000 KRW in Korea, all equivalent to about 2-3 hours of math tutoring services or 2-4 McDonald's meals in local markets.

4.2.2. Procedure

We used the stock trading game procedure of Arkes et al. (2008, Experiment 6), which is based on the Becker, DeGroot, and Marschak (1964) procedure (BDM). The same procedure was used with our participants in China, Korea, and the US.

Subjects traded one stock in each of 4 trading rounds. Each round consisted of three dates and two periods. At the beginning of the trading round, subjects were told that they had previously purchased a stock at a certain price (P_0) and had held the stock for a week. They were then informed of the current price P_1, which was either higher or lower than their purchase price P_0. Also, they were informed of the two future possible prices of the stock in the next trading period (P_2). Before the realization of the second period price P_2, subjects had a chance to sell the stock to the experimenter by stating their minimum selling price. Following the BDM procedure, a buying price was drawn from a uniform distribution of prices at 10-cent intervals between the two possible future prices P_2^H and P_2^L, which correspond to the high and low future price possibilities, respectively. If the randomly drawn buying price exceeded or equaled the subject's minimum selling price, the subject sold the stock at the randomly drawn buying price. If the buying price was less than the minimum selling price, the subject held the stock and sold it at the next trading period's price P_2 which was to be determined by a coin flip.

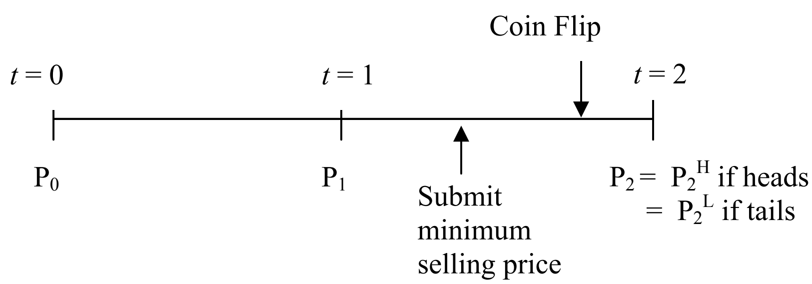

Figure 2: Time-line of the Trading Game

Under the BDM procedure, it is optimal for the subjects to set their minimum selling price equal to their valuation of the gamble. Thus, the BDM procedure reveals through subjects' minimum selling prices their certainty equivalents of risky gambles, given their new reference point.

Among the four stocks, two were winners and two were losers. The price paths used in the US experiments were as follow: The winner stocks, which were purchased at \$20, went up to \$26 after the first period. The subjects were informed that the stocks would have to be sold at either \$30 or \$22 with equal probability in the next trading period. The loser stocks were purchased at \$20 and dropped to \$14 with a future price of either \$18 or \$10 with equal probability. The BDM valuation procedure was used to solicit subjects' minimum selling prices after we informed the subjects of the next trading period stock prices.

One winner and one loser stock had the intervention consisting of the sale and repurchase of that stock at the same price at which it had just been sold. After subjects were informed of the first period price movement, they had to sell the stock and repurchase it for the same price after a time delay. During the time delay, the subjects traded other stocks that were not involved in this experiment. This time delay ranged between 20 and 30 minutes, and was designed to help subjects segregate the prior outcome—a gain or a loss—from the upcoming BDM procedure. Arkes et al. (2008) hypothesized that this forced sale and repurchase would help close the mental account occasioned by the prior price movement ($P_1 - P_0$).

After subjects repurchased a stock, they learned the possible future prices of the stock and submitted their minimum selling prices.

Following Arkes et al. (2008), we explicitly instructed subjects about why it was optimal for subjects to ask their true valuation of the stock. We included illustrative examples showing how asking above or below one's true valuation causes suboptimal outcomes. All subjects in each session had a chance to gain experience in two practice rounds. Arkes et al (2008) reported that the subjects showed good understanding of the procedure and the optimal strategy.[5]

In China, the stock prices presented to subjects were the same as the numbers used in the US. Most stock prices range from ¥5 to ¥50 in Chinese stock markets. Therefore the purchase price of ¥20 and possible future prices of ¥30/¥22 or ¥10/¥18 sound more realistic than the US prices multiplied by the exchange rate ¥8.0. In Korea the numbers presented to subjects were the US prices multiplied by 1,000. This conversion reflects the exchange rate between Korea and the US, and the converted numbers are close to typical stock prices in Korean stock markets. The reference points inferred from Korean subjects' minimum selling prices were divided by 1,000 so that we could compare the results across countries.

4.2.3 Results

The reference point at time 1 is the value R^* that equates the utility from selling the stock for $P^{\min}$ to the expected utility from retaining the stock and bearing the risk of an up or down movement:

$$V(P^{\min} - R^*) = 0.5V(P_2^H - R^*) + 0.5V(P_2^L - R^*), \qquad (2)$$

where $P^{\min}$ is the dollar amount a subject indicates for the minimum selling price, and R^* is the implicit reference point. After solving Equation (2) with the function forms in Equation (1) for the reference point, the adaptation is defined as the deviation of the new reference point from the original reference point, assumed to be the purchase price, toward the direction of the prior outcome.

For the value function in Equation (2), we used the average loss coefficient estimated in Study 2 using payoff amounts similar to what we used in this study ($25; the first column in Table 2); 1.55 for

[5] Subjects gave an average 5.3/6 rating to their understanding of the experimental procedure, and an average rating of 3.8/5 to their acceptance of the optimal strategy under the BDM mechanism in Arkes et al. (2008).

Asia, 1.89 for the US. The results, however, are similar if we use the mean loss coefficient across the $25 and $50 scenarios. We could not use the estimates for α from in Study 2 because the reference point was solvable only for 20-30% of the observations using our estimates for α. Instead we use α = 0.5 which gave us a reasonable number of usable observations (96-99% for Asians and 80-85% for Americans, depending on the stock). We checked the robustness of the results with respect to parameter values; we will present those analyses in Section 5. We defined the amount of reference point adaptation as $R^* - P_0$ when there was a prior gain and $P_0 - R^*$ when there was a prior loss.

For a comparison with our questionnaire study findings, we first focused on the data generated without the sale/repurchase intervention. We wanted to ascertain whether the three findings from the questionnaires were also present in the stock trading data: overall asymmetric adaptation plus greater adaptation and greater asymmetry among Asians compared to Americans. We performed a 2(culture: Asia, US) x 2 (outcome: win, loss) ANOVA analysis on the magnitude of adaptation. For very high or low minimum selling prices, we were not able to solve for reference points, so we ended up with 172 subjects from Asia and 119 subjects from the US with usable data for the two stocks, one with a prior $6 gain and the other with a $6 loss.

Table 3 reports the average reference point adaptation for the four stocks. According to the 2x2 ANOVA analysis using the two stocks with a prior gain or loss but without the sale/repurchase intervention, the outcome effect was highly significant [$F(1,289) = 112.86$, $p < 0.001$] due to the greater adaptation following gains compared to losses. The between-subject factor, culture, was significant [$F(1,289) = 8.063$, $p = 0.005$], indicating that Asians show greater adaptation than do Americans. The culture × outcome interaction term was marginally significant [$F(1,289) = 3.59$, $p = 0.059$]. Asians exhibited smaller asymmetry than Americans, which is the opposite of what we found in Study 1.

For a comparison with the findings by Arkes et al. (2008), we also performed a 2 (culture: Asia, US) × 2 (outcome: win, loss) × 2 (sale/repurchase intervention: yes, no) analysis of variance (ANOVA) on the magnitude of reference point adaptation. Culture was the only between-subjects factor.

We found greater adaptation to gains than losses in both cultures. As can be seen in Table 3, for both cultures the mean adaptation following a loss is always less than that of the corresponding gain, illustrating the outcome main effect, which was significant [$F(1,242) = 120.43$, $p < 0.001$]. This evidence replicates the US findings of Arkes et al. (2008) and extends this conclusion to other cultures.

Table 3. Mean Reference Point Adaptation to $6 Gain/Loss: Base and Intervention (Study 3)

	Gain (Base)	Loss (Base)	Gain (Intervention)	Loss (Intervention)
Asia (n = 148)	6.65	5.54	6.41	5.10
US (n = 96)	6.62	4.92	6.77	5.06
Total	6.64	5.30	6.55	5.08

Note. These mean reference point adaptations are calculated using the mean loss aversion coefficients (λ) for each culture (1.55 for Asia, 1.89 for the US; See Table 2) and $\alpha = 0.5$.

When the sale/repurchase intervention is added to the analysis, there is evidence that the magnitude of this asymmetry differed across countries, as the culture × outcome interaction term was again marginally significant [$F(1,242) = 3.478$, $p = 0.063$]. The sale/repurchase × culture interaction was significant [$F(1,242) = 11.73$, $p = 0.001$]. Whereas the sale/repurchase intervention caused a small increase in adaptation among the Americans, replicating Arkes et al. (2008), it caused a *decrease* in adaptation among the Asians. For the Americans the sale/repurchase intervention resulted in a higher mean adaptation following both gains and losses, but for the Asians, the intervention resulted in a lower mean adaptation following both gains and losses. The culture main effect was no longer significant [$F(1,242) = 0.958$, $p = 0.329$] when we included reference point adaptations after the sale/repurchase intervention. Recall that the culture effect was significant when we examined the base case only, with Asians showing significantly greater adaptation than Americans, but the difference became non-significant after including stocks with intervention. The increase of adaptation for Americans and the decrease of adaptation for Asians due to the sale/repurchase intervention narrowed the difference between the two cultures.

5. Robustness check

We report three major findings from Study 3. First, reference points adapted more to a gain than to an equal-sized loss. Second, adaptation to a prior outcome was greater among Asians than Americans when there was no sales and repurchase intervention. Third, the sale/repurchase intervention appeared to increase adaptation among Americans but decrease it among Asians. The results from our stock trading data are obtained using $\alpha = 0.5$ and culture-specific mean loss aversion (1.55 for Asians, 1.89 for Americans) for the value function. This section assesses whether our results are robust to our assumptions concerning the parameter values and to possible differences in cognitive abilities between the two cultures.

5.1 Do the choices of α and λ matter?

We used $\alpha = 0.5$ to obtain a sizable dataset in Study 3. For robustness, we also calculated implied adaptation based on various combinations of α and λ for each culture. The α ranges from 0.2 to 0.9 with 0.1 increments and the λ range from 1.25 to 2.50 with 0.25 increments, resulting in a total of $8 \times 7 = 56$ combinations for each culture. We summarize the findings below.

First, we find asymmetric adaptation for all parameter combinations and in both cultures (Figure 3). However, the percentage of solvable observations decreases from over 90% to less than 10% as α increases from 0.2 to 0.9. Second, the intervention increases adaptation among the US subjects in all parameter combinations, while it decreases adaptation among Asian subjects in all parameter combinations except when $\alpha = 0.8$ (Figure 4). Third, in the base case, the average adaptation to prior outcomes is greater among Asians than among Americans, except for the very high value of alpha (0.8 and 0.9; Figure 5). However, the solvable observations are only 20-30% of the full sample within that very high range of alpha, which makes the inference within that range less reliable. Overall, the results show that our conclusions are generally quite robust to variations of the parameter values.

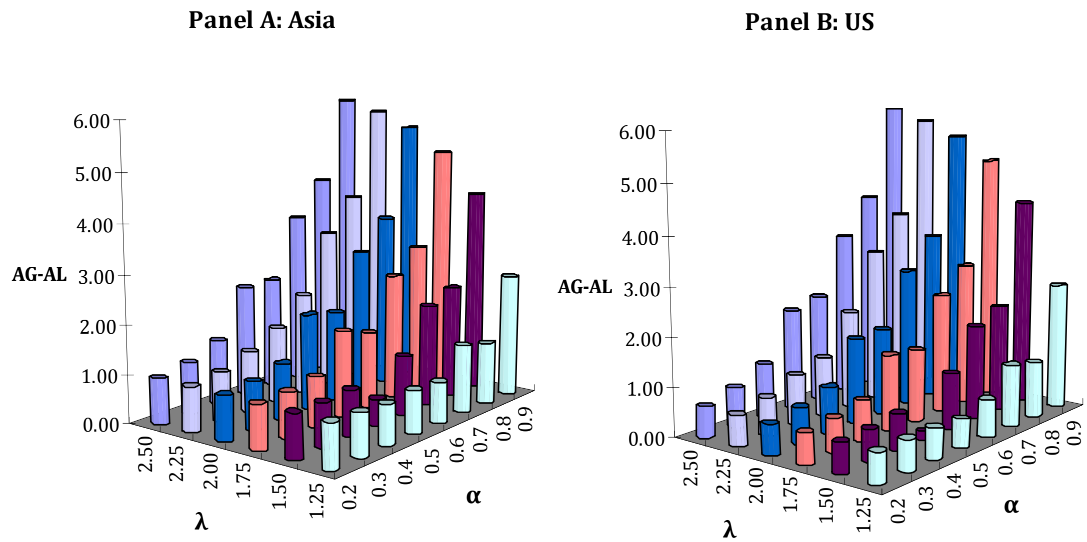

Figure 3. Average Asymmetry Under Different Parameter Values: Base Case

Note. Panel A depicts the asymmetry in reference point adaptation (AG-AL) among Chinese and Koreans in the base case in Study 3, where the asymmetry is defined as the adaptation to gains minus the adaptation to losses. Panel B depicts the asymmetry among Americans. λ refers to the culture-specific loss aversion coefficient, and α refers to the cultural-specific exponent.

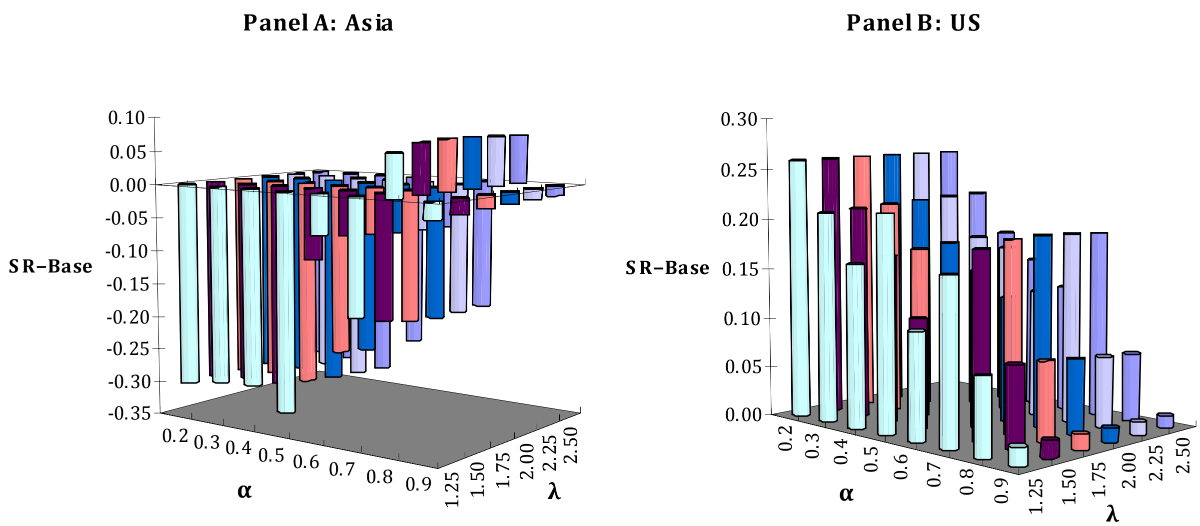

Figure 4. Average Effect of Intervention Under Different Parameter Values

Note. Panel A depicts the effect of the sale/repurchase intervention on reference point adaptation among Chinese and Koreans in Study 3. SR-Base refers to the difference between the average adaptation with the sale/repurchase intervention and that in the base case. Panel B depicts the effect of the intervention on reference point adaptation among Americans. λ refers to the culture-specific loss aversion coefficient, and α refers to the culture-specific exponent.

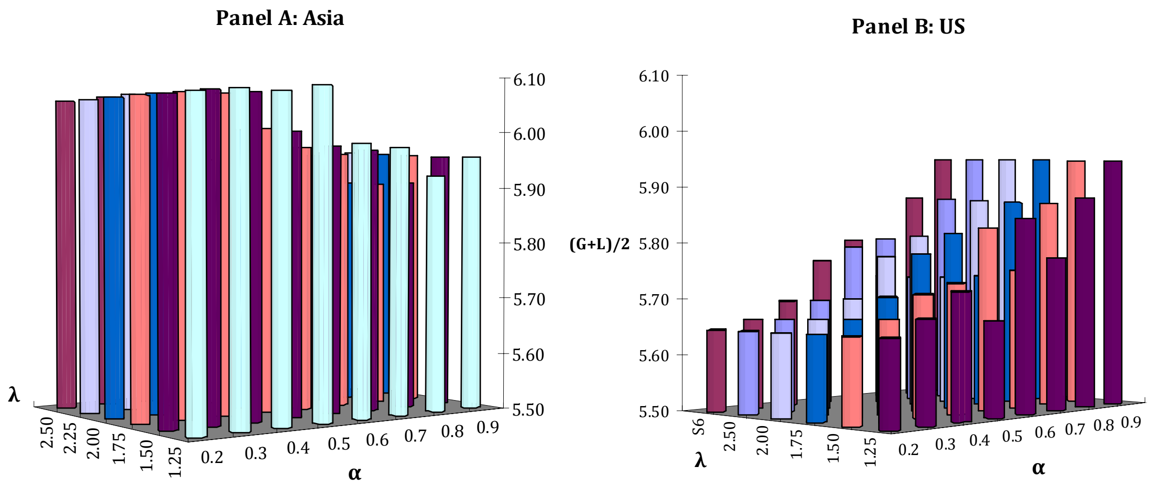

Figure 5. Average Adaptation to Prior Outcomes in the Base Case

Note. Panel A depicts the average of the adaptation to a gain and the adaptation to a loss, (G+L)/2, among Chinese and Koreans in the base case in Study 3. Panel B depicts the average adaptation to prior outcomes among Americans. λ refers to the culture-specific loss aversion coefficient, and α refers to the culture-specific exponent.

5.2. Does individual heterogeneity in loss aversion and exponent matter?

We observed some degree of heterogeneity among subjects in our questionnaire studies on the parameter estimates (Study 2). However, the questionnaire studies and the stock trading experiments were conducted at different times with different subjects. Therefore, to infer their reference points, we had to apply the mean parameters for each culture from Study 2 on all subjects of the same culture in Study 3. In this section we examine whether or not our results are robust to possible individual heterogeneity within each culture.

We employed simulations to assess the sensitivity of our results to individual heterogeneity. Specifically, for each subject, we randomly drew α from a uniform distribution [0.1, 0.9] and λ from a uniform distribution [1.5, 2.5]. Using individual-specific parameters, we solved for their reference points, and calculated the mean adaptation across subjects for each stock within each culture. For comparison, we computed the mean of the randomly generated α and λ across subjects within each culture for each simulation, and used those mean parameters to solve for individual adaptation and mean adaptation within a culture. In other words, the former method follows an ideal approach that applies individual parameters, while the latter mirrors our procedures that applies the same parameter values to all individuals within each culture. If the latter generates results similar to the former, we can safely conclude that our results are robust to possible individual heterogeneity within each culture. We tested for the validity of our three main results—the presence of the asymmetry of adaptation in both cultures, greater adaptation to prior outcomes among Asians than Americans, and the opposite impacts of the sale/repurchase event on the two cultures.

We summarize our results based on 1000 simulations. First, for all simulations, and using both methods of assigning parameter values on each individual, we obtained greater adaptation to gains than losses in both cultures. Second, for all simulated results we found greater adaptation among Asians using either method, suggesting that greater adaptation of Asians compared to the Americans is quite robust even we consider individual heterogeneity. Third, both methods show that the sales-repurchase intervention accelerated adaptation for Americans but decreased adaptation for Asians for 99.1% of simulations (see Table 4). For the remaining 0.9% of the simulations, the results using individual parameters indicated that the intervention increased (0.2%) or decreased (0.7%) adaptation for both cultures, while the results using culture-mean parameters indicated that the intervention increased adaptation for Americans but decreased adaptation for Asians. Thus the results suggest that using group-mean parameters may have slightly strengthened the opposite effects of the intervention on adaptation between the two cultures, but the possible effect is likely to be within a margin of error (only 0.9%).

Table 4: Reference point adaptation with individual parameters vs. country mean parameters: The intervention effect

Intervention accelerates adaptation for Asians, using individual parameters	Intervention accelerates adaptation for Asians, using culture-mean parameters	Intervention accelerates adaptation for Americans, using individual parameters	Intervention accelerates adaptation for Americans, using culture-mean parameters	# Simulations (Total: 1,000)
N	N	N	Y	7
N	N	Y	Y	9991
Y	N	Y	Y	2

6. Discussion

There were three main results in our studies. First, the asymmetric adaptation found in American students by Arkes et al. (2008) was also found in the Asian participants as well as our new US subjects. Thus this result appears to generalize across cultures. The explanation offered by Arkes et al. (2008), if valid, should apply in every culture, because it is based on fundamental hedonic processes. This explanation is as follows.

Arkes et al. (2008) hypothesized that faster adaptation to gains than to losses is a consequence of mental accounting and hedonic maximization (Thaler 1985, 1999). In particular, asymmetric adaptation results from hedonic benefits of segregating intertemporal gains and integrating intertemporal losses. After experiencing a gain, a person who closes that account and adapts the reference point upward experiences two benefits. The first is the immediate hedonic benefit of closing a mental account to realize a gain. The second is that any subsequent gain includes the steep portion of the value function just to the right of the origin of the new updated graph. Although a possible subsequent loss will have a more negative impact when the reference point is updated upward, the remaining part of the gain that results from incomplete adaptation can be used to cushion the possible loss. Therefore, a partial adaptation to a gain is preferred to no updating of the reference point.

On the other hand, adaptation of the reference point following a loss has two disadvantages. The first is that closing a mental account "in the red" results in a negative hedonic experience. The second is that as a result, a subsequent loss will occur in the steep portion of the value function to the left of the origin of the new graph, and one also forgoes the prospect of negating the prior loss with a possible subsequent gain. Hence, less updating is preferred to more updating.

The goal of such "affective engineering" is hedonic maximization. We hypothesize that culture would have a minimal role to play in the pursuit of this goal. Thus we expect to observe asymmetric adaptation to gains and losses in all countries.

The second main finding was that, without the sales and repurchase intervention, adaptation to prior outcomes was greater among Asians than among Americans. This can be attributed to the smaller loss aversion among Asians we found in Study 2. Based on the model of reference point updating explained above, smaller loss aversion facilitates adaptation to a loss since segregation of a prior loss is now less painful. It also encourages adaptation to a gain since it reduces the negative impact of a possible subsequent loss that results from an upward update of the reference point.[6] Our finding of smaller loss aversion among Asians is consistent with prior research of Weber and Hsee (1998) and Hsee and Weber (1999). The smaller loss aversion among Asians may be reflected in such Chinese proverbs as "Failure is the mother of success" (Weber, Hsee, and Sokolowska 1998), which suggests that failure is not to be feared because it fosters subsequent accomplishment.

As for the third finding, the insertion of the sale/repurchase intervention facilitated adaptation in the US but deterred that in the two Asian countries. In other words, although the intervention caused greater adaptation in the Americans—again replicating Arkes et al. (2008)—it had the opposite effect among Asians. We hypothesize that two factors are responsible for this result.

The first factor is the one that motivated the use of this intervention. Arkes et al. (2008) hypothesized that by having the subject sell the stock and realize the paper gain/loss, the prior outcome becomes more salient, because the sale and repurchase greatly enhances exposure of the subject to the new price at which their gain or loss occurs. This in turn encourages adaptation from the original price toward that new price at which the sale/repurchase occurs. This also facilitates the segregation of that initial price change from the subsequent price change. Indeed, that is what happened in the American sample in Arkes et al. (2008) and in this manuscript.

The second factor is discussed by Ji et al. (2001). These investigators demonstrated in a very wide variety of assessment tasks that Chinese persons, to a significantly greater extent than Americans,

[6] It was suggested that cross-cultural differences in the influence of the sale/repurchase intervention might be caused by cultural differences in the cognitive ability of the subjects. In an unreported study using US participants (available upon request), we found no significant relationship between the magnitude/asymmetry of reference point adaptation and a measure of cognitive ability (Frederick 2005). Therefore a difference in cognitive ability is unlikely to be responsible for the cultural differences we report here.

anticipated that circumstances would change. For example, Chinese subjects, more than Americans, expected a chess champion to lose the next match, bickering children to eventually become lovers, and dating couples to break up. Although most of the demonstrations of this difference were in non-business contexts, the same result was manifested in the domains of economic growth and personal financial trends.

Within the stock trading experiment in Study 3, this contrarian tendency would cause less adaptation among Chinese than among Americans. If the first price change is a positive one and this gain is emphasized through the sale/repurchase intervention, Chinese participants will have a somewhat greater expectation of an adverse outcome. Therefore, they will be unwilling to adapt reference point upward substantially; by adapting sluggishly, they add a cushion to their mental account against the greater possibility of a future loss. In the case with a prior loss, Chinese will expect a greater likelihood of a future gain. By adapting less aggressively to the prior loss, Chinese will anticipate this future gain and use part of it to offset part of the prior loss. Taken together, we expect Chinese subjects to adapt less to a prior outcome than Americans after a sale/repurchase intervention. To the extent that the Korean participants shared many of the same cultural characteristics of the Chinese, we might expect the two groups to behave similarly, which is the result we obtained.

7. Conclusions

We have found two notable cross-cultural differences in reference point adaptation. First, east Asians adapted more to prior outcomes than did Americans, which we attribute to our finding that Asians are less loss averse compared to Americans. Second, the sale/repurchase intervention increased adaptation in the US but decreased it in China and Korea. This cross-cultural difference can be motivated by a Chinese proverb, “A good fortune may forebode bad luck, which may in turn disguise a good fortune,” that describes the belief of Chinese in reversals. However our research has also identified an important similarity across cultures: the difficulty in “making peace with losses,” resulting in asymmetric adaptation of reference points to gains and losses. Despite these insights, our knowledge of cross-cultural patterns in the static and dynamic properties of prospect theory remains quite limited. Therefore this domain seems particularly ripe for future research.

Acknowledgements

We appreciate the helpful comments from David Budescu, David Cooper, and participants at the Society for Judgment and Decision Making annual conference in Houston, Texas in November of 2006, the Carnegie-Mellon Department of Social and Decision Science colloquium, the Ohio State University SBIG colloquium in the Department of Psychology, the Experimental Social Science Research group at Florida State University, and the Behavioral Decision Research in Management conference hosted by UCSD Rady School of Management in April of 2008. We thank Michelle Qu and McKay Price for helpful research assistance and Jin Wan Cho, Joon Ho Hwang, Dong Wook Lee, Hyunhan Shin, Zilong Xie, Shujun Zhang, Yan Wei, and Wei Zhao for their coordination in recruiting subjects. We are grateful for the financial support from the Program in Decision, Risk, and Management Science at the National Science Foundation (0339178 and 0339052). This paper subsumes an earlier version entitled "Prospect Theory and Reference Point Adaptation: Evidence from the US, China, and Korea." The order of the authors is alphabetical.

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