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A cross-cultural study of reference point adaptation: Evidence from China, Korea, and the US ☆

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ABSTRACT

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 is designed to close the mental account for a prior outcome, Americans showed *greater* adaptation toward the new price than their Asian counterparts. We offer possible explanations both for the cross-cultural similarities and the cross-cultural differences.

Introduction

Prospect theory (Kahneman & 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., Barberis & Huang, 2001; Grinblatt & Han, 2005; Hardie, Johnson, & Fader, 1993; Heath, Huddart, & Lang, 1999; Heath, Larrick, & Wu, 1999; Keasey & Moon, 1996; 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 variations, and if so, what are the possible causes of these variations.

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 the initial paper gain or loss is realized, adaptation both to losses and gains appeared to be enhanced. The current paper applied the measurement approach of Arkes et al. to encompass both East-Asian and US subjects. In addition, we employed two additional questionnaire designs to estimate reference points. In all approaches we identified both cross-cultural similarities and differences in reference point adaptation.

Performing cross-cultural studies in reference point adaptation was motivated by recent research that has documented important differences in several judgment and decision making phenomena across countries. East-Asians, who live in collectivist societies, exhibit behavioral differences in many aspects from Americans, who live in an individualist society. Research has shown that, relative to Americans, East-Asians appear to be more overconfident (Yates, Lee, & Shinotsuka, 1996), more risk seeking in the financial domain (Hsee & Weber, 1999), more holistic than analytic, more likely to

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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."

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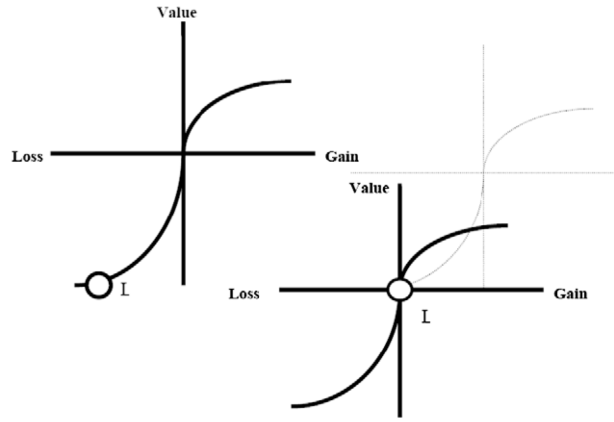

Fig. 1. (left): No adaptation to the loss that is depicted at point L. (right): Full adaptation to the loss that is depicted at point L.

attribute outcomes to contextual rather than to internal factors (Morris & Peng, 1994), more prone to detect stronger associations between events and apt to place less value on having personal control (Ji, Peng, & Nisbett, 2000), and more likely to expect that changes that have occurred in the past will reverse in the future (Ji, Nisbett, & Su, 2001). All of these factors represent potential influences on the determination of reference points.

Cross-cultural study of reference point adaptation can help us to understand the potential sources of variations in financial market behavior across the world. Scholars have used prospect theory to understand a number of anomalous stock market phenomena, including excess volatility, the equity premium puzzle, the value effect, the momentum effect, the disposition effect, and IPO underperformance (e.g., Barberis & Huang, 2001; Barberis & Xiong, 2009; Bernartzi & Thaler, 1995; Shefrin & Statman, 1985). There is evidence that the high equity premium, the value effect, the momentum effect, and the disposition effect are present outside the United States to varying extents.[2] The issue of reference point updating is potentially important for applications of prospect theory to these empirical findings.

Motivation and literature review

Reference point adaptation in prospect theory

Kahneman and Tversky (1979) proposed prospect theory as an alternative to the normative theory of expected utility maximization. There are three main elements of prospect theory: 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 & Tversky, 1979), aspiration levels or norms can also serve this function (Heath, Larrick, et al., 1999; Kahneman & Tversky, 1979, p. 286). Second, the value function is concave in the domain of gains and convex in the domain of losses. 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").

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

Consider the prospect theory value function depicted in Fig. 1. If a loss has occurred, the decision maker is at point L in Fig. 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 Fig. 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 Fig. 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 & Blumer, 1985) or the disposition effect (Shefrin & 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."

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, which are the focus of our study. There are a very few studies testing the dynamic aspects of prospect theory using US subjects. Using both hypothetical outcomes depicted in questionnaire studies and monetary outcomes from a coin-toss game, Chen and Rao (2002) found that the order in which two equal but opposite events (gain/loss) occurred affected the subject's final affective state, suggesting that a shift in the reference point must have occurred after the first event. They also found that adding a time lapse between the two events generated results consistent with greater shift in reference points. However, their method does not allow estimates of the location of new reference points. Gneezy (2005) endowed subjects with a stock and then queried them about their willingness to hold or sell it as its price varied over several trading periods. Gneezy 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. Gneezy's method can position the reference point relative to prior stock prices only when the subject sells the stock. Baucells, Weber, and Welfens (2010) estimated the reference point by asking subjects which selling price would make them neither happy nor unhappy after they observed a stock price path. By regressing the reference point indicated by the subject on the purchase price, the current price, and the intermediate prices, Baucells et al. showed that the reference point is most heavily influenced by the first and the last observed stock price.

All of these studies suggest that reference points are path-dependent: past prices, in addition to the purchase price, appear to have significant impacts on the current reference point. This implies that reference points adapt to outcome payoffs. However, these studies do not estimate the exact magnitude of reference point adaptation after a gain or loss. They therefore do not allow comparative analyses such as the test of gain-loss asymmetry.

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, which we adopted and will explain in detail in the current Studies 1 and 3. Also, when subjects were forced to sell a stock and then repurchase it at the same price at which it had been sold (Weber & Camerer, 1998), Arkes et al. found that reference point adaptation was accelerated; reference points moved closer towards the new purchase price.

[2] E.g., Fama and French (1998), Rouwenhorst (1998), Grinblatt and Keloharju (2001), Chui, Titman, and Wei (2010), Feng and Seasholes (2005), and Dimson, Marsh, & Staunton (2008).

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, under a general risk-return framework, 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) suggest that Chinese are less risk averse because a financial "cushion" that is available in a collectivist culture makes Chinese less afraid of risk. Consistent with this hypothesis, they found that the cross-cultural differences between the Chinese and Americans in perceived financial risks became insignificant once they controlled for social network variables, such as the number of people an individual could rely on for financial assistance.

Ji et al. (2001) documented greater expectation of reversals by Asians than Americans. In five studies, Ji et al. (2001) showed that Chinese students were more likely to predict change from an initial trend than were Americans. In the research mostly closely related to our studies, Ji, Zhang, and Guo (2008) presented North American and Chinese subjects – both college students and experienced investors – with graphs illustrating upward, downward, or stable price trends of various stocks. Compared to the North American subjects, the Chinese participants were more likely to buy stocks whose prices were decreasing and sell stocks whose prices were increasing. Protocol analyses indicated that this contrarian tendency on the part of the Chinese was due to their belief that a change was likely in the future. 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 experimental designs used in Arkes et al. (2008) and two additional methods to infer reference points. We have four goals in mind. 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 the magnitude of reference point adaptation between East-Asians and Americans. Third, we ascertained whether the intervention of the sale and repurchase of stocks accelerated reference point adaptation in the Asian culture, as was previously demonstrated in the American sample. Finally, we explored the possible explanations for the observed cross-cultural variation in reference point adaptation.

Study 1: questionnaire study of reference point adaptation following Arkes et al. (2008)

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 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: $P^* - R_1 = P_1 - R_0$. 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.

Method

Subjects

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). All subjects were business majors, either college sophomores or juniors, and the American and Asian groups contained a similar percentage of males (66% male in the US, and 70% in Asia).

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 Korean Won (KRW), 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 local market.[3]

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 1000 in Korea, because one US dollar was about 1000 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 most prices range from ¥5 to ¥50 in Chinese stock markets. 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 1000 so that we could compare the results across countries.

Results

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.

[3] 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 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.

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	Mean	6.15	4.21	5.18	1.94	6.49
		Std. dev.	3.74	3.26	2.93	3.87	
US	81	Mean	3.63	2.56	3.10	1.07	3.08
		Std. dev.	2.67	3.27	2.54	3.12	
All	249	Mean	5.33	3.67	4.50	1.66	7.14
		Std. dev.	3.62	3.35	2.97	3.66	

Note: ΔRP(G), defined as $R_1 - R_0 = P^* - 36$, measures the reference point adaptation to a \$6 gain. ΔRP(L), defined as $R_0 - R_1 = 24 - P^*$, 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.

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 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.[4]

However we observed 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.[5]

Using an ANOVA 2 (gain/loss) × 2 (cultures) design, we find evidence consistent with our observations. First, the gain/loss factor is significant [$F(1, 247) = 37.2$, $p < .01$], suggesting that the asymmetric adaptation exists across the two cultures. The culture factor is significant [$F(1, 247) = 29.9$, $p < .01$], indicating greater adaptation among Asians than among Americans. The interaction term (gain/loss × culture) is marginally significant [$F(1, 247) = 3.11$, $p = .079$].

Study 2: estimating prospect theory value function parameters

In a later experiment we will examine individual reference point adaptation in experimental stock trading settings, in which subjects' trading profits were tied to monetary payoffs, following the procedure employed by Arkes et al. (2008). Since that experiment requires the estimates of the loss aversion parameter (λ) and the exponent (α) in the cumulative prospect theory value function (Tversky & Kahneman, 1992), we first estimated those parameters for each culture in Study 2. It should be noted that λ represents the extent to which the loss portion of the value function is steeper than the gain portion, and α represents the curvature of the value function.

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

[4] Throughout our studies, we have relied on the prospect theory postulate that individuals derive utilities from absolute (dollar amount) deviations from the reference point. There is, however, an alternative interpretation of our results if individuals focus on proportional deviation (e.g., Bartels, 2006). We conjecture that whether absolute or proportional thinking dominates may heavily depend on the framing of questions. To test this, we did a study (details not reported here) with American subjects that framed questions in terms of stock returns, not in dollar amount of price changes. Again, we found greater adaptation to gains than to losses.

[5] 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.

Tversky and Kahneman (1992) modeled the nonlinearity (curvature) for gains and losses using two different parameters. However, their experimental data yielded the same median estimates for the two parameters, 0.88 (Tversky & Kahneman, 1992, p. 311). Thus we will use the same curvature parameter value for both gains and losses.

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.

Method

Subjects

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.

Materials

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

Table 2
Parameter estimates of the value function (Study 2).

		Amount of loss prospect			Within-subject average	Within-subject std. dev.
		$25	$50	$100		
Panel A: Loss aversion coefficient (λ)						
Asia	Mean	1.55	1.64	1.78	1.66	0.20
	Std. dev.	0.77	0.84	1.13	0.85	
	N	167	167	167	167	167
US	Mean	1.89	1.78	1.91	1.86	0.23
	Std. dev.	1.13	0.76	1.00	0.88	
	N	80	80	80	80	80

		X = $50				*X* = $100			
		Gain domain	Loss domain	Within-subject average	Within-subject std. dev.	Gain domain	Loss domain	Within-subject average	Within-subject std. dev.
Panel B: Exponent of the value function (α)									
Asia	Mean	0.92	0.94	0.93	0.25	1.03	0.97	1.00	0.27
	Std. dev.	0.49	0.75	0.53		0.59	0.52	0.43	
	N	155	145	139	139	162	159	152	152
US	Mean	0.86	0.66	0.83	0.50	0.82	0.78	0.79	0.42
	Std. dev.	0.94	0.95	0.61		1.15	0.77	0.77	
	N	96	90	79	79	104	95	90	90

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. *N* is

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 Eq. (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.

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 1.86 for the US. The estimates indicate that the US subjects are more loss averse than the Asians. The difference in loss aversion between the two cultures was marginally significant [$t(150) = -1.73$, $p = .087$]. 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.[6]

[6] We only included subjects that have a pair of solvable alpha estimates for a given magnitude ($50 or $100). The number of respondents for which we could not obtain parameter estimates for both $50 and $100 magnitudes was 27 for Asia (15%) and 16 for the US (13.6%). The number of respondents for which we could not obtain a parameter estimate for either $50 or $100 magnitude is 42 for Asia (23.3%) and 41 for the US (34.7%).

Our estimate of the alpha based on the average over the two pairs of questions is 0.84 for Americans, close to the estimate of 0.88 by Tversky and Kahneman (1992). The mean alpha estimate is 0.97 for Asians. The difference between the two cultures in their alpha estimates was marginally significant [$t(104) = -1.67$, $p = .098$]. A lower loss aversion coefficient and a higher exponent estimate for 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.

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.

Study 3: reference point adaptation in a stock trading game with a monetary incentive

Method

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 h of math tutoring services or 2–4 McDonald's meals in local markets.

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 four trading rounds. The timeline of the trading game is displayed in Fig. 2. 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.

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 min, 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.

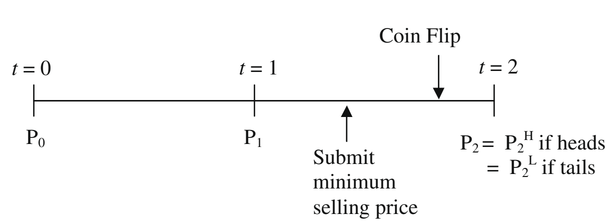

Fig. 2. Time-line of the trading game used in Study 3.

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.[7]

Like Studies 1 and 2, the stock prices presented to subjects in China were the same as the numbers used in the US, and the numbers presented to subjects in Korea were the US prices multiplied by 1000. The reference points inferred from Korean subjects' minimum selling prices were divided by 1000 so that we could compare the results across countries.

Results and discussion

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:

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

where $P^{\min}$ is the dollar amount a subject indicates for the minimum selling price, and R^* is the implicit reference point. After solving Eq. (2) with the function forms in Eq. (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 Eq. (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 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 Study 2 because the reference point was solvable only for 20–30% of the observations using our estimates for α. Instead we use $\alpha = 0.5$ which gave us a reasonable number of usable observations (96–99% for Asians and 80–85% for Americans, depending on the stock). In the Appendix A, we show that our results are robust with respect to parameter values (including the choice of alphas and lambdas, and the use of the Tversky and Kahneman (1992) probability weighting function). 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) × 2 (outcome: win, loss) ANOVA on the mag-

[7] 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).

nitude 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 2 × 2 ANOVA using the two stocks with a prior gain or loss but without the sale/repurchase intervention, the outcome effect was highly significant [$F(1, 289) = 112.86$, $p < .001$] due to the greater adaptation following gains compared to losses. The between-subject factor, culture, was significant [$F(1, 289) = 8.063$, $p = .005$], indicating that Asians show greater adaptation than do Americans. The culture × outcome interaction term was marginally significant [$F(1, 289) = 3.59$, $p = .059$]. Asians, however, 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) 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 [$F(1, 242) = 120.43$, $p < .001$]. This evidence replicates the US findings of Arkes et al. (2008) and extends this conclusion to other cultures.

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 [$F(1, 242) = 3.478$, $p = .063$]. The sale/repurchase × culture interaction was significant [$F(1, 242) = 11.73$, $p = .001$]. 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 [$F(1, 242) = 0.958$, $p = .329$] 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.

Table 3
Mean reference point adaptation to $6 gain/loss: base and intervention (Study 3).

	Gain (base)	Loss (base)	Gain (intervention)	Loss (intervention)
Requiring observations for the base case only				
Asia ($n = 172$)	6.66	5.50		
US ($n = 119$)	6.61	4.94		
Total	6.64	5.27		
Requiring observations for both the base and the intervention cases				
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 $\alpha = 0.5$.

Study 4: questionnaire study of reference point adaptation: comparing two price paths

A possible criticism of Study 3 is that it relies on the particular functional form of the cumulative prospect theory value function (Tversky & Kahneman, 1992). Even if a subject's preference shows the three characteristics of prospect theory (reference dependence, loss aversion, and dual risk attitude), her preferences may not be best described by the power function we employed. This can be one of the reasons why we could not solve for the reference point for some subjects.

A further possible criticism is that, as past studies have pointed out, the BDM procedure can elicit certainty equivalents of all lotteries if and only if the preference relation is represented by an expected utility framework. However, this problem is not just limited to the BDM procedure but to all other experimental procedures (e.g., *N*th price auctions). For instance, Karni and Safra (1987) show that any experimental procedure would fail to elicit the certainty equivalent of some lotteries for some reasonable preference relations. If the BDM procedure fails to solicit the certainty equivalent of the gamble accurately for some subjects, it can also contribute to the unsolvable observations we had in Study 3.

In Studies 4 and 5, we used two new questionnaire designs as alternative ways to elicit reference points. Both designs do not rely on the particular form of prospect value functions to solve for reference points. In one, we inferred reference points in a way similar to Study 1 but used a benchmark scenario. In the other, we directly solicited subjects' reference points using a question similar to that of Baucells et al. (2010). Although we do not need the value function parameters to estimate the reference points in Studies 4 and 5, we verified our previous findings in Study 2 using the same subject pool.

Method

Subjects

The participants were undergraduate students at Florida State University and DePaul University in the United States (154 subjects), Ximen University and Guizhou Normal University in China (82 subjects), and Chosun University in Korea (46 subjects). All subjects were business majors, either college sophomores or juniors. The data from three US subjects and two Korean subjects were deleted either due to suspected entry errors or missing observations for one of the pair questions. After deleting these subjects, 54.8% of the Asian subjects (69 out of 126) and 59.6% of the US subjects (90 out of 151) were male.

The subjects answered brief questionnaires in an online survey or in a classroom setting. All students voluntarily filled out the questionnaires for a raffle prize within each class. In the US, the prize was $20. In Korea, this amount was 50,000 KRW (Korean Won), and in China, it was ¥100 (RMB). These amounts were determined by communicating with local professors to ensure a sufficient number of participants. As in Studies 1–3, the numbers in the questionnaires of Studies 4 and 5 were converted into Korean currency by multiplying them by 1000, and into Chinese currency by changing the label of the currency.

Materials

Each subject answered a pair of questions (gain and loss) pertaining to either the base case (1) or the intervention case (2). We also asked subjects questions that were used in Study 2 about loss aversion and risk aversion in the gain/loss domains.

(1) Base case scenario (parentheses for the loss case)

The following two possible scenarios describe the stock price 2 months ago, 1 month ago, and then today. In each scenario, we are interested in the emotional impact on you of learning the final stock price.

Scenario I:
Two months ago: You purchased 100 shares of stock A for $50 per share.
One month ago: You found out that Stock A's price was $60 ($40) per share.
Today: You find out that Stock A's price is $*X* per share.
Scenario II:
Two months ago: You purchased 100 shares of stock A for $50 per share.
One month ago: You found out that Stock A's price did not change; it was still trading at $50 per share.
Today: You find out that Stock A's price is $55 ($45) per share.
Indicate the price of A today ($*X*) in Scenario I that would make you feel equally (dis)satisfied as the stock price of $55 ($45) in Scenario II.

(2) With the sale intervention: the question is the same as the base case in (1) except for Scenario I (change indicated in italics):

Two months ago: You purchased 100 shares of stock A for $50 per share.
One month ago: You found out that Stock A's price was $60 ($40) per share. *You sold 100 shares of stock A for $60 ($40) per share, locking in the gain (realizing the loss). Then you purchased 100 shares of another stock, C, for $60 ($40) per share.*
Today: You find out that Stock C's price is $*X* per share.
Indicate the price of C today ($*X*) in Scenario I that would make you feel equally (dis)satisfied as the stock A's price of $55 ($45) in Scenario II.

Results and discussion

If R_1 is the reference point with a prior gain/loss (Scenario I) and R_0 is the reference point without a prior outcome (Scenario II), we can set up the following equation, since subjects feel equally about the final stock price in Scenarios I and II:

$$V(X - R_1) = V(55 - R_0) \text{ for the gain scenario,}$$
$$= V(45 - R_0) \text{ for the loss scenario.}$$

Like Study 1, we can compute the change in the reference point assuming that the shape of the value function is constant:

$$X - R_1 = 55(45) - R_0 \Rightarrow R_1 - R_0 = X - 55\ (45)$$

Again the change in reference points after losses is multiplied by -1 to obtain adaptation to past losses. Table 4 reports the average reference point adaptation from four questions (base/intervention, gain/loss). First, we focused on the data generated without the stock sale intervention to compare the result with that of Study 1. We performed a 2 (culture: Asia, US) × 2 (outcome: gain, loss) ANOVA on the magnitude of adaptation. The outcome effect was significant [$F(1, 158) = 4.753$, $p = .031$], indicating greater adaptation following gains compared to losses. Asians show greater adaptation than do Americans as the between-subject factor, culture, was significant [$F(1, 158) = 8.841$, $p = .003$]. We also performed a 2 (culture: Asia, US) × 2 (outcome: gain, loss) × 2 (sale intervention: yes, no) ANOVA on the magnitude of reference point adaptation. Culture and the sale intervention were between-subjects factors.

Again, we found greater adaptation to gains than losses: the outcome main effect was significant [$F(1, 273) = 13.69$, $p < .001$]. The sale intervention × culture interaction was significant [$F(1, 273) = 7.64$, $p = .006$]. The sale intervention increased the average adaptation among the Americans while decreasing it among the Asians. As a result, the difference in adaptation between the two cultures became smaller and the culture main effect was no longer significant [$F(1, 273) = 0.869$, $p = .352$]. The results are consistent with what we found in Study 3.

We also found that the loss aversion parameter was smaller among Asians than among Americans in this subject pool, replicating our finding in Study 2. The average loss aversion was 1.88 for Asians and 2.88 for Americans, with the difference being statistically significant [$t(266) = 2.98$, $p = .003$]. The exponent (alpha) estimate is closer to 1.0 for Asians than for Americans, although the difference between the two cultures is not statistically significant (0.86 for both gain and loss domain among Asians, 0.80 in the gain domain and 0.70 in the loss domain among Americans), similar to our findings in Study 2.

Table 4
Mean reference point adaptation: base and intervention (Study 4).

	Gain (base)	Loss (base)	Gain (intervention)	Loss (intervention)
Asia	6.30 ($n = 67$)	4.54	6.34 ($n = 59$)	2.70
US	3.41 ($n = 93$)	2.52	6.71 ($n = 58$)	4.77
Total	4.62	3.36	6.52	3.73

Note: Each subject answered either the base case scenarios or the intervention scenarios.

Study 5: questionnaire study of reference point adaptation following Baucells et al. (2010)

Study 5 questions were adopted from Baucells et al. (2010) who deemed the reference point to be the selling price the makes the subject neither happy nor unhappy about the sale of a stock.

Method

Subjects

Study 5 was run together with Study 4 in China and Korea, so the Asian subjects of Study 5 are identical to those in Study 4. In the US 172 undergraduate students at Florida State University and DePaul University participated in the study. A subset of the US subjects in Study 5 also participated in Study 4 (130 out of 172). The data from three US subjects and two Korean subjects were deleted due to a suspected entry error or missing observations for one of the pair questions. Of the US subjects 55.6% were male (94 out of 169), comparable to the percentage of male subjects (54.8%) in Asia. Like Study 4, the subjects answered brief questionnaires in an online survey or in a classroom setting for a raffle prize of $20 (US), 50,000 KRW (Korea), and ¥100 (China).

Materials

(1) Base case

A few days ago, you purchased stock A at $30 per share and went on vacation on the same day. During your vacation you could not monitor the price of the stock.

Today, while waiting for your 14-h flight home, you see on the airport TV that the current price of stock A is $35 ($25) per share! You ask yourself how you would feel if you were going to sell stock A when you return home.

At what selling price would you feel neither happy nor unhappy about the sale of stock A? In other words, please indicate the selling price at which you would neither have positive nor negative emotions about the sale of stock A.

(2) With the sale intervention

The question is the same as in (1) except that, after "you see on the airport TV that the current price of stock A is $35 ($25) per share," we added "*You call your broker and tell him to sell stock A at $35 ($25) per share and buy stock B that is also trading at $35 ($25) per share.*" For approximately half of the subjects we replaced "Stock A" with "Stock B" in the final two sentences.

Results and discussion

Subjects' answers to the question can be interpreted as their reference points after a $5 gain/loss per share. Therefore we compute the magnitude of reference point adaptation as $(X-30)$ for the gain scenario and $(30-X)$ for the loss scenario, where X is the selling price that makes the subject neither happy nor unhappy. Table 5 reports the average adaptation.

The ANOVA showed that most results from Study 5 are qualitatively the same as those of Studies 1, 3, and 4: There was a significant asymmetry in adaptation, Asians showing greater adaptation than Americans in the base case, but the difference disappeared when we add the reference point adaptation data with the intervention. Using the data generated by the base case without the sale intervention, a 2 (culture: Asia, US) × 2 (outcome: gain, loss) ANOVA showed a significant outcome effect [$F(1, 133) = 24.54$, $p < .001$] and also a significant culture effect [$F(1, 133) = 4.055$, $p = .046$].

After adding the data on the magnitude of reference point adaptation with the intervention, a 2 (culture: Asia, US) × 2 (outcome: gain, loss) × 2 (sale intervention: yes, no) ANOVA showed a significant outcome effect [$F(1, 291) = 58.56$, $p < .001$], a significant sale × culture interaction effect [$F(1, 291) = 5.63$, $p = .018$], but an insignificant culture main effect [$F(1, 291) = 0.045$, $p = .832$]. Consistent with the findings in Studies 1 and 4, adding the sale intervention increased the reference point adaptation significantly more for Americans than for Asians. However, in this case, adding the reference point adaptation did not decrease the adaptation for Asians, as compared to the case without the sale intervention.

The loss aversion parameter is again smaller among Asians (1.88) than among Americans (2.83) in this subject pool [$t(285) = -2.89$, $p = .004$]. The exponent again follows a similar pattern as in Studies 2 and 4 (0.86 among Asians in both gain and loss domains, 0.75 for the gain domain and 0.72 for the loss domain among Americans).

General 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 asymmetric adaptation to gains and losses, according to Arkes et al. (2008), can be caused by fundamental hedonic processes. Specifically, faster adaptation to gains than to losses results from hedonic benefits of segregating intertemporal gains and integrating intertemporal losses (Thaler, 1985, 1999).

After a gain, updating the reference point modestly upward to capture part of the gain generates an immediate hedonic benefit from recognizing the gain, at the cost of reducing any remaining gains to be experienced. However the increase in the immediate gain from 0 is in the steep portion of the value function, whereas the reduction in future gains is from a gently sloping part of the value function. So due to the concavity of the value function within the region of gains, this is a net utility increase. For losses, similarly, recognizing part of a loss immediately has an immediate hedonic cost, and by the convexity of the value function in the realm of losses, this cost outweighs the benefit of reducing future losses. So no updating is preferred to updating after losses. While the hedonic maximization suggests a partial adaptation after a gain and no adaptation after a loss, the sense of reality is likely to encourage adaptation toward the current state in both directions. Therefore we are likely to see some extent of adaptation in both directions, with a greater adaptation after a gain than after a loss.

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 result may be caused by different impacts of culture on balancing the two forces determining the new reference point—recognizing the current state and deviating from it in order to maximize hedonic utility.

We conjecture that there are two culture-related reasons that influence this balance. First, faster adaptation among Asians can be attributed to the smaller loss aversion among Asians that encourages greater adaptation to increase hedonic utility. 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; updating of the reference point means that a subsequent loss will occur in the flatter portion of the gain function rather than in the relatively steep portion close to the origin of the graph where a person would be if no updating had occurred.[8]

Second, cross-cultural research has shown that in many respects East-Asians hold a fundamentally different viewpoint than Americans (e.g., Nisbett, 2004), a viewpoint which might encourage Asians to move the new reference point closer to the current stock price than Americans would do. East-Asians view the world as complex and highly changeable with interrelated components where individuals are less able to impact the course of an event. In contrast, Americans view the world consisting of discrete, independent, and stable objects where each individual is in control of their own behavior and the consequence of such behavior (Ji et al., 2000). Such viewpoints lead to Asians' more malleable and Americans' more stable preferences and personalities (Norenzayan,

Table 5
Mean reference point adaptation: base and intervention (Study 5).

	Gain (base)	Loss (base)	Gain (intervention)	Loss (intervention)
Asia	4.05 ($n = 59$)	0.43	4.69 ($n = 67$)	1.44
US	1.65 ($n = 76$)	1.12	4.89 ($n = 93$)	2.66
Total	2.70	0.82	4.81	2.15

Note: Each subject answered either the base case scenarios or the intervention scenarios.

[8] It was suggested that cross-cultural differences in reference point adaptation 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

Choi, & Nisbett, 2002). As Hsu (1981, p. 13) noted, "the Chinese tends to mobilize his thought and action for the purpose of conforming to the reality, while the American tends to do so for the purpose of making the reality conform to him." These cultural differences suggest that, in the tradeoff between conforming to reality and hedonic maximization that involves personal control, Asians are likely to be dictated by the former while Americans by the latter. Thus, reference points tend to adapt more readily among Asians than among Americans.

As for the third finding, the insertion of the stock sale intervention facilitated adaptation in the US significantly more than that in the two Asian countries. This cross-cultural difference is reflected in 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. This effect is particularly strong in Studies 3 and 4, where Asians' reference point adaptation is decreased when the intervention is introduced while that of Americans is increased. In Study 5, however, the intervention slightly increased the adaptation of Asians while increasing adaptation of Americans to a greater extent. In other words, although the intervention caused greater adaptation in the Americans – again replicating Arkes et al. (2008) – it had a much milder, sometimes an 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 new price at which their gain or loss occurs becomes more salient. This encourages adaptation from the original price toward that new price at which the sale and new purchase occurs. Indeed, that is what happened in the American sample in Arkes et al. (2008) and consistently occurs to our American sample in this manuscript.

The second factor is discussed by Ji, Peng, et al. (2000) and Ji, Nisbett, et al. (2001). Ji, Peng, et al. (2000) showed that compared to Americans, Asians thought that there were stronger associations between objects, consistent with the notion that East-Asians pay more attention to the field and the interaction between objects. In contrast, Americans viewed objects as more independent identities. In our experimental setting the two outcomes – one being the prior outcome payoff and the other being the new gain or loss – may be viewed by Americans as relatively independent. Thus, the outcome payoff in the old mental account becomes distant and less relevant once the new mental account is established, with the new purchase price serving as a salient cue for the new reference point. In contrast, while East-Asians may also close the old and open the new mental account to some extent, they are likely to feel the tug of the prior reference point more than the Americans would and not dismiss it as an independent and irrelevant separate entity.

Depending how a scenario is framed and presented, a strong contrarian view in prediction among Asians can be triggered. Ji et al. (2001) demonstrated in a very wide variety of assessment tasks that Chinese persons, to a significantly greater extent than Americans, 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. Ji et al. (2008) showed that this contrarian tendency also applied strongly to Chinese participants' beliefs about future stock prices. Such a belief would foster exactly the results we obtained, namely less adaptation to the new price when it is emphasized via a sale and new purchase manipulation. This is due to the fact that in our experimental setting the sale intervention makes that outcome more salient and thus more strongly triggers the contrarian prediction of Asians. If the first price change is positive, Asian participants will have a somewhat greater expectation of an adverse outcome. Therefore, they will be unwilling to adapt their 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, Asians will expect a greater likelihood of a future gain. By adapting less aggressively to the prior loss, Asians will anticipate this future gain and use part of it to offset part of the prior loss. Thus we expect Asian subjects to adapt less to either prior outcome than Americans after a sale and new purchase intervention, due to the contrarian tendency demonstrated by Ji et al. (2008).

Within the stock trading experiment in Study 3, subjects were informed of possible up and down states of future prices. In Scenario II of Study 4 subjects were presented in the gain frame, for example, with no change in the $50 price from the first to the second period and then a gain to $55 for the third period ($50–$50–$55). Subjects also read Scenario I in which there was a gain from $50 to $60 from the first to the second period. They were then asked what price during the third period of Scenario I would make then just as happy as the third period price of $55 in Scenario II ($50–$60–?). To answer this question subjects would have to consider the possibility of a reversal, that is, a lowering of the third period price in Scenario I. By presenting cues of a possible future price reversal, we hypothesize that the contrarian predilection of Asians is likely to be strengthened under either the Studies 3 or 4 methodologies. Thus, the sale intervention would impede adaptation to the new outcome for Asians, as we explained above. In Study 5, however, no future or alternate prospect whatsoever is specified, so the contrarian tendency of Asians is likely to be weaker. Therefore in Study 5 use of the new purchase price as the reference point can eclipse the Asians' usual contrarian view to some extent, thereby resulting in a slight increase in reference point adaptation. Nevertheless, in all studies, the increase in adaptation is much greater for Westerners than for Easterners, suggesting that for Americans the dominant factor is the realization of paper gains/losses which helps close the old mental account and shifts the new reference point toward the new purchase price.

We suggest that reference point adaptation is influenced by many external and internal factors. Its cross-cultural variations encompass a broad set of causes and consequences. Despite the several new findings presented in this manuscript, our knowledge of cross-cultural patterns in the static and dynamic properties of prospect theory or other reference-dependent preferences remains quite limited. Therefore this domain seems ripe for future research. In particular, it may be helpful to study reference point updating and its effects using field data such as investor trading records, aggregate market prices, and analysts' forecasts of earnings.

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Appendix A

A.1. Robustness check of results in Study 3

We reported 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 sale 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. In this Appendix, we assess whether our results are robust to our assumptions concerning the parameter values.

Do the choices of α and λ matter?

We used λ estimated from Study 1 and $\alpha = 0.5$ to obtain a sizable dataset in Study 3. Our choice of parameters can raise a concern because our estimates for λ may contain some estimation errors and using α that is rather small compared to our estimates and also those of other studies. For robustness, we also calculated implied adaptation based on various combinations of α and λ for each culture to check if our findings are sensitive to parameter values. The α ranges from 0.2 to 0.9 with 0.1 increments and the λ ranges from 1.25 to 2.50 with 0.25 increments, resulting in a total of $8 \times 6 = 48$ combinations for each culture. We summarize the findings below.

First, we find asymmetric adaptation for all parameter combinations and in both cultures (Fig. A1). 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 $\alpha = 0.8$ (Fig. A2). 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; Fig. A3). 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. When an alpha is less than 0.6, the results are similar. This is the case even if we allow for the slight difference in the alphas for the gain versus the loss domain. Overall, the results show that our conclusions are generally quite robust to variations of the parameter values.

Does the use of the probability weighting function matter?

Tversky and Kahneman (1992) suggest that individuals use probability weighting functions, instead of the actual probability, to weight different prospect outcome payoffs. The probability weighting functions take the following form:

$$w^{+}(p) = \frac{p^{\gamma}}{(p^{\gamma} + (1-p)^{\gamma})^{1/\gamma}}, \quad w^{-}(p) = \frac{p^{\delta}}{(p^{\delta} + (1-p)^{\delta})^{1/\delta}},$$

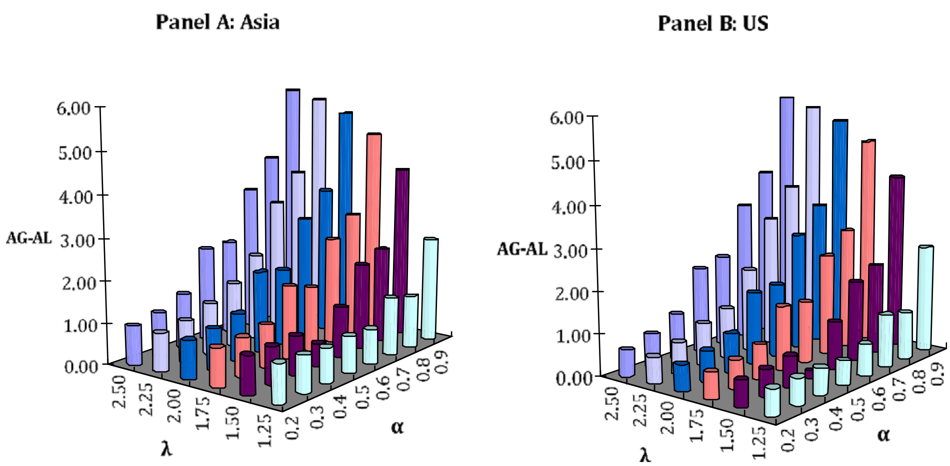

Fig. A1. Asymmetry in reference point adaptation (AG-AL) in the base case of Study 3 using different values of λ and α separately for Asians (Panel A) and for Americans (Panel B). The asymmetry in reference point adaptation is defined as the adaptation to gains minus the adaptation to losses (AG-AL). λ refers to the culture-specific loss aversion coefficient, and α refers to the cultural-specific exponent.

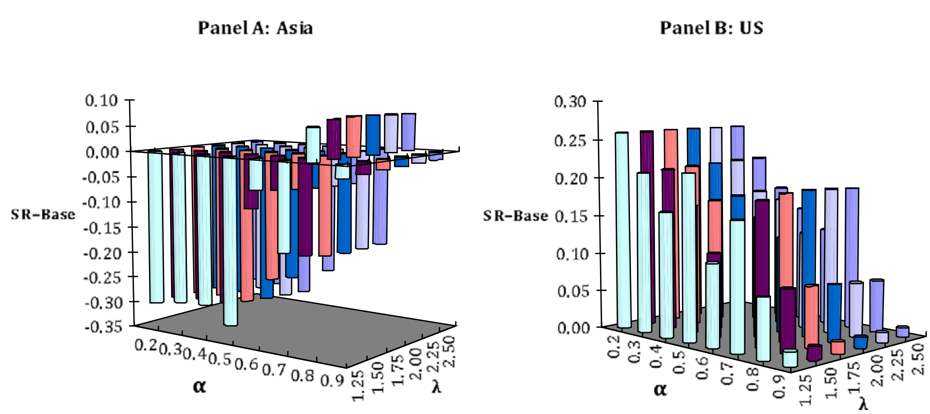

Fig. A2. The effect of the sale/repurchase intervention on reference point adaptation in Study 3 using different values of λ and α, separately for Asians (Panel A) and for Americans (Panel B). The effect of sale/repurchase intervention is measured by SR-Base, which refers to the difference between the adaptation with the sale/repurchase intervention and that in the base case averaged across the gain and loss cases. λ refers to the culture-specific loss aversion coefficient, and α refers to the culture-specific.

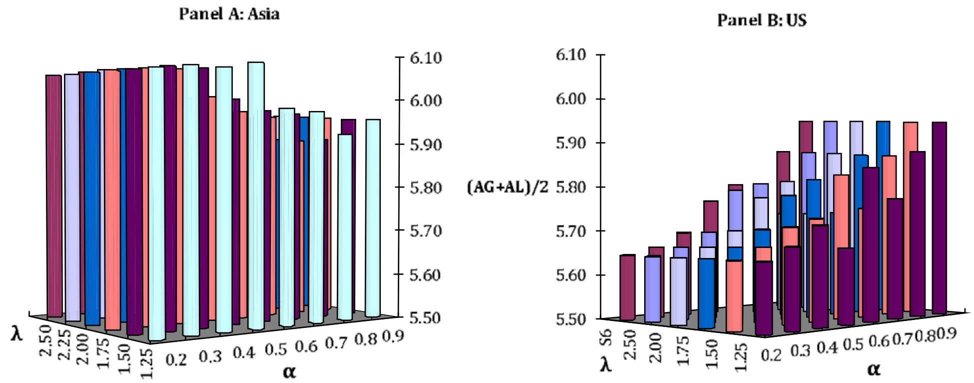

Fig. A3. The average of adaptation to a gain and adaptation to a loss, (AG+AL)/2, in the base case in Study 3 using different values of λ and α, separately for Asians (Panel A) and for Americans (Panel B). λ refers to the culture-specific loss aversion coefficient, and α refers to the culture-specific exponent.

Table A1
Reference point adaptation with probability weighting function (Study 3).

	Gain (base)	Loss (base)	Gain (intervention)	Loss (intervention)
Asia (n = 175)	6.60	5.53	6.38	5.18
US (n = 138)	6.14	5.23	6.30	5.45
Total	6.39	5.40	6.35	5.30

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), α = 0.5, and the probability weighting function that gives the positive prospect with probability 0.5 the weight 0.32, and the negative prospect with probability 0.5 the weight 0.37.

where γ is estimated as 0.61, and δ as 0.69. In our context, subjects dealt with a positive prospect with probability 0.5, implying a weight of 0.32, and a negative prospect with the same probability, implying a weight of 0.37. Shown in Table A1, the results are similar to those in Table 3. Using a 2 (culture: Asia, US) × 2 (outcome: win, loss) × 2 (sale/repurchase intervention: yes, no) ANOVA on the magnitude of adaptation, we found that the outcome main effect was significant [$F(1, 311) = 98.616$, $p < .001$] as was the sale/repurchase × culture interaction [$F(1, 311) = 18.91$, $p < .001$]. Also, the culture main effect was significant [$F(1, 311) = 4.067$, $p = .045$].

Does individual heterogeneity in loss aversion and the 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. 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 A2). 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 A2
Reference point adaptation with individual parameters vs. country mean parameters: the intervention effect (Study 3).

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: 1000)
N	N	N	Y	7
N	N	Y	Y	9991
Y	N	Y	Y	2

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