The Psychological Record, 2002, 52, 479-492

CROSS-CULTURAL COMPARISONS OF DISCOUNTING DELAYED AND PROBABILISTIC REWARDS

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In order to assess the cross-cultural generality of monetary decision-making processes, American, Chinese, and Japanese graduate students were studied on two tasks: In the delay discounting task, participants made choices between immediate and delayed hypothetical monetary rewards; in the probability discounting task, participants made choices between certain and probabilistic rewards. Some notable cross-cultural similarities were observed. Two-parameter hyperbola-like functions described both delay and probability discounting for all three groups. Moreover, for all three groups the rate at which delayed rewards were discounted was higher for the smaller amount whereas the rate at which probabilistic rewards were discounted was lower for the smaller amount. Some group differences were also observed. As measured by the area under the empirical discounting curve, the Americans and Chinese discounted delayed rewards more steeply than the Japanese. In addition, the Americans discounted probabilistic rewards the most, whereas the Chinese discounted probabilistic rewards the least. Despite these differences, the similarities in the form of the discounting functions and in the effects of amount suggest that there are fundamental commonalities among the three groups with respect to the processes underlying their evaluation of delayed and probabilistic rewards.

The major goal of the present study was to assess the cross-cultural generality of monetary decision-making processes by comparing the discounting of delayed and probabilistic rewards by groups of participants raised in quite different cultures (i.e., Americans, Chinese, and Japanese). The term *discounting* refers to the decrease in subjective value of a reward as its uncertainty increases or as the delay until its receipt increases. For example, the subjective value of a 1-in-a-100 chance of receiving $1,000 is less than the subjective value of a 1-in-10

This research was supported by Grant MH55308 from the National Institute of Mental Health. Correspondence concerning this article should be directed to Leonard Green, Department of Psychology, Campus Box 1125, Washington University, Saint Louis, MO 63130. (E-mail: lgreen@artsci.wustl.edu).

chance of receiving the $1,000; similarly, the present, subjective value of receiving $1,000 in 1 year is less than the subjective value of receiving it in 1 month. The concept of discounting plays an important role in self control and impulsivity and is crucial in accounting for decision making that involves temporal and risk factors typical of many everyday choice situations (e.g., financial investments and health-related life-style choices) (e.g., Ainslie, 1992; Green & Myerson, 1993; Heyman, 1996; Loewenstein & Elster, 1992; Prelec & Loewenstein, 1991; Rachlin, 1990, 1995).

Cultures may differ in their attitudes toward risk or in their perception of risk (Weber & Hsee, 1998), and these differences could lead to differences in probability discounting. Similarly, cultures may differ in their attitudes toward time or in their perception of time (Gell, 1992; Helfrich, 1996), and such differences could lead to differences in temporal discounting. In both cases (i.e., temporal and probability discounting), one might observe qualitative differences in discounting, as indicated by differences in the form of the discounting function (i.e., the mathematical function relating subjective value to delay or odds). In contrast, one might observe quantitative differences, as indicated by differences in how steeply delayed or probabilistic rewards are discounted.

Despite the potential importance of cultural similarities and differences in discounting, the topic of culture and decision making has received little attention from researchers in the areas of either judgment and decision making or cross-cultural psychology (for a review, see Weber & Hsee, 2000). This relative lack of cross-cultural research on decision making is particularly notable with respect to delayed outcomes, especially when contrasted with the amount of research on choice involving risky outcomes (e.g., Hsee & Weber, 1999; Weber & Hsee, 1998). The one cross-cultural study that involved discounting delayed outcomes reported no differences in temporal discounting rates between Canadian undergraduates and foreign undergraduates of Chinese descent (Tan & Johnson, 1996). This result is intriguing given the often-noted differences between social and cultural groups in attitudes about and conceptions of time (e.g., Gell, 1992).

With respect to risky outcomes, Weber and Hsee have repeatedly reported cultural differences. Specifically, they find that Chinese are less risk-averse than Americans with respect to financial decisions (Hsee & Weber, 1999; Weber & Hsee, 1998). They explain their findings in terms of the "cushion" that a collectivist society like that of the People's Republic of China provides for an individual's financial losses. Consistent with the cushion hypothesis, Chinese individuals perceive financial options as less risky than Americans (Weber & Hsee, 1998), and differences in risk-aversion between Chinese and Americans are confined to financial decisions and are not present in other decision domains (Hsee & Weber, 1999).

It has been frequently hypothesized that Japan, like China, is a collectivist society (e.g., Hofstede, 1980; Markus & Kitayama, 1991), thereby leading to the prediction that Chinese and Japanese should show similar decision making involving risks and should differ from those from individualistic cultures like the United States. It is interesting to note that Orpen (1983) reported that Japanese managers were more willing than Americans to take risks in potentially profitable but not losing situations. In a recent review, however, Takano and Osaka (1999) argued that the results of questionnaire studies and of behavioral studies are inconsistent with the hypothesis that Japanese are more collectivistic than Americans. Despite the interest in the topic of culture and decision making, there are no studies comparing Japanese with both Americans and Chinese on discounting delayed or probabilistic outcomes, and such research is clearly needed.

Even in cases where groups are observed to differ in choice behavior, it is important to discover whether there are similarities in the underlying decision-making processes. With respect to temporal discounting, for example, there are differences in discounting rates between age groups. Children discount delayed rewards much more steeply than do young adults who, in turn, discount delayed rewards more steeply than older adults. Nevertheless, the same mathematical discounting function (see Equation 1, below) accurately describes discounting in all three age groups (Green, Fry, & Myerson, 1994; Green, Myerson, & Ostaszewski, 1999b). This finding strongly suggests that despite quantitative differences in discounting rates (as reflected in the parameters of the discounting function), the underlying processes do not change qualitatively with age.

By the same token, even if some differences between the behavior of individuals from different cultures exist, there still may be underlying similarities in decision making. For example, Weber and Hsee (1998) suggest that the observed differences in the risk preferences of Americans and Chinese actually may be caused by differences in risk perception, and that both groups may make similar decisions when the options are of equivalent perceived risk for the two groups. The existence of similarities may be of considerable importance because such similarities may be indicative of cross-cultural universals in human decision making.

It has been shown that the discounting of both delayed and probabilistic rewards can be described by mathematical functions of the same form (Green, Myerson, & Ostaszewski, 1999a; Ostaszewski, Green, & Myerson, 1998; Rachlin, Raineri, & Cross, 1991). Although a simple hyperbola provides a reasonably good description (Rachlin et al., 1991), it tends to systematically underestimate subjective value at long delays and low probabilities and may not describe all individuals (Myerson & Green, 1995; Simpson & Vuchinich, 2000). Raising the denominator of the hyperbola to a power eliminates such systematic underestimation and increases both the proportion of explained variance and the number of individuals adequately described (Green et al., 1999a; Myerson & Green, 1995; Ostaszewski et al., 1998).

For delayed rewards:

$$V = A / (1 + k D)^s \tag{1}$$

where V is the present, subjective value of a reward of amount A, and D is the delay between the decision and receipt of the reward. The parameter k governs the rate at which subjective value decreases, and the parameter s reflects nonlinear scaling of time and amount. The k parameter has been shown to decrease with the amount of the delayed reward (Green, Myerson, & McFadden, 1997; Kirby & Maraković, 1996) whereas the s parameter is unaffected by reward magnitude (Myerson & Green, 1995).

For probabilistic rewards:

$$V = A / (1 + h\,\Theta)^s \qquad (2)$$

where Θ represents the odds against receiving the reward (i.e., $\Theta = (1-p)/p$, where p is the probability of receipt), the parameter h governs the rate of discounting, and the other symbols have the same meaning as in Equation 1. Although Equations 1 and 2 both have the same mathematical form,[1] amount of reward appears to affect the rate of discounting differently depending on whether the choice involves delayed or probabilistic rewards. With delayed rewards, larger amounts are discounted at a lower rate than smaller amounts (Green et al., 1997; Kirby & Maraković, 1996) whereas the opposite is true with probabilistic rewards (Green et al., 1999a).

In order to assess the cross-cultural generality of monetary decision-making processes, the present study examined three aspects of the discounting of delayed and probabilistic rewards. In addition to determining whether there are group differences in how steeply delayed and probabilistic rewards are discounted, the present study evaluated whether the same mathematical form describes discounting by American, Chinese, and Japanese individuals, and whether the degree of discounting is similarly affected by the amount of the reward (i.e., whether larger delayed rewards are discounted less steeply than smaller ones, and whether the opposite is true for probabilistic rewards) in all three groups.

Method

Participants

Participants were 28 American, 28 Chinese, and 23 Japanese students enrolled in graduate programs at three universities in Saint Louis, Missouri. They received $10 compensation. All of the Chinese and Japanese students

[1]The form of Equations 1 and 2 may be derived from specific assumptions about the underlying decision process and the meaning of the parameters (e.g., Loewenstein & Prelec, 1992; Myerson & Green, 1995; Rachlin, Logue, Gibbon, & Frankel, 1986). For example, the k parameter has been interpreted as reflecting subjects' estimates of the time required to consume (or spend) an 'immediate' reward (Raineri & Rachlin, 1993) and the h parameter may be interpreted as subjects' interpretations (i.e., weighting) of the nominal odds. As Myerson and Green (1995) have shown, the parameter s may be derived from the well-established power law for psychophysical scaling (Stevens, 1957) and reflects the relation between the scaling of time and amount in Equation 1 and odds and amount in Equation 2.

had been in the United States or in countries other than their homelands for less than 4 years. The mean amount of time since they left their homeland was 12.4 months for the Chinese and 13.6 months for the Japanese. Among the 79 participants, 36 were female (15 American, 10 Chinese, and 11 Japanese) and 43 were male (13 American, 18 Chinese, and 12 Japanese). The mean ages for the American, Chinese, and Japanese participants were 26.8, 26.2, and 29.2 years, respectively.

Procedure

Participants were tested individually in a small, quiet room. Stimuli were presented and responses were recorded on a personal computer using software developed in C++ by the first author. The nature of the experimental tasks may be understood by considering the instructions that were displayed on the computer monitor at the beginning of the session:

> The purpose of the present study is to compare your preferences between hypothetical amounts of money. On some trials, you will be asked to make choices between an amount that can be received immediately and another amount that can be received after a given delay. On other trials, you will be asked to make choices between an amount that can be received for sure and another amount that can be received with a particular probability. You will not actually receive the money. However, please make your decision as if the choice was real.

Instructions regarding the delay discounting task then were displayed, followed by 12 practice choices, after which instructions regarding the probability discounting task were displayed, followed by an additional 12 practice choices on this task. The delay discounting instructions were as follows:

> You will be asked to make a group of choices between hypothetical monetary alternatives. These choices will be displayed on the screen. On some trials, one amount of money is to be paid right now, and this amount will vary from trial to trial. The other amount of money will remain fixed, but its payment will be delayed. The screen will show you how long the delay will be. For each choice, if you would prefer to have the amount that is shown on the left, then press the 'Z' key. If you would prefer to have the amount that is shown on the right, then press the 'M' key. If at any time you change your mind about a choice, you can return to the start of that group of choices by pressing the 'B' key. There are no correct or incorrect choices. We are interested in the option you would prefer.

The probability discounting instructions were as follows:

> You will be asked to make a group of choices between hypothetical monetary alternatives. These choices will be displayed on the screen. On some trials, one amount of money is to be paid for sure, and this amount will vary from trial to trial. The other amount

> of money will remain fixed, but its payment will be probabilistic. The screen will show you what the probability will be. As before, for each choice, if you would prefer to have the amount that is shown on the left, then press the 'Z' key. If you would prefer to have the amount that is shown on the right, then press the 'M' key. If at any time you change your mind about a choice, you can return to the start of that group of choices by pressing the 'B' key. Remember, there are no correct or incorrect choices. We are interested in the option you would prefer.

After the participant completed the practice choices and had any further questions answered, the experimenter left the room, and the experiment began. The delay and probability discounting tasks each consisted of two amount conditions: a $200 condition and a $10,000 condition. All participants were studied in all four conditions (two delay and two probability); the order of these conditions was selected randomly for each participant.

For each amount condition of the delay task, participants made choices between an immediate reward (that could be received "now") and the delayed reward. Each participant was studied with seven delays in the following order: 1 month, 3 months, 9 months, 2 years, 5 years, 10 years, and 20 years. For each amount condition of the probability task, participants made choices between a certain reward (that could be received "for sure") and the probabilistic reward. Each participant was studied with seven probabilities in the following order: .95, .90, .70, .50, .30, .10, and .05. Probability was expressed on the screen as a percentage chance of receiving the probabilistic reward (e.g., 95% chance).

In each condition of the delay task, participants made six choices at each of the seven delays. The first choice was between the delayed reward and an immediate reward whose amount was half that of the delayed reward (e.g., $100 now versus $200 in 3 months). For the five subsequent choices, the amount of the immediate reward was adjusted based on the participant's previous choice. If the participant had chosen the immediate reward, the amount of the next immediate reward was decreased; if the participant had chosen the delayed reward, the amount of the next immediate reward was increased. This procedure was designed to converge on the subjective value of the delayed reward.

The size of the adjustment, either increase or decrease, itself decreased with successive choices. The first adjustment was half of the difference between the immediate and delayed rewards. For example, if the participant had chosen $100 now over $200 in 3 months, then the next choice was between $50 now and $200 in 3 months. For subsequent choices, the size of the adjustment was half of the previous adjustment. Continuing with the previous example, if the participant chose $200 in 3 months over $50 now, then the next choice would be between $75 now and $200 in 3 months; alternatively if the participant chose $50 now over $200 in 3 months, then the next choice would be between $25 now and $200 in 3 months. This procedure was repeated until the participant had made six choices, after which a new series of choices at a new delay was begun.

An analogous procedure was followed in each condition of the probability task to estimate the subjective value of the probabilistic reward. Participants made six choices at each of the seven probabilities, with the amount of the certain reward adjusted based on the participant's previous choice. It should be noted that for both the delay and probability tasks, the position of the immediate/certain amount on the screen was randomized (i.e., for any given choice, the immediate/certain amount was equally likely to be presented to the left or the right of the delayed/probabilistic amount).

For both the delay and the probability tasks, the subjective value of the delayed/probabilistic amount was calculated as the midpoint between the last amount of the immediate/certain reward that had been chosen over the delayed/probabilistic alternative and the last amount of the immediate/certain reward that had been rejected. Nonlinear least-squares techniques were used to estimate the parameters of Equations 1 and 2 that best described the effects of delay and odds-against on the subjective value of delayed and probabilistic rewards, and to evaluate how well these equations fit the data of American, Chinese, and Japanese participants at both the individual and group levels.

Distributions of estimates of the parameters of Equation 1 are typically quite skewed and thus require the use of nonparametric tests. However, no nonparametric test is available for comparing discounting by different groups when experimental factors (e.g., amount of delayed or probabilistic reward) also differ. Moreover, Myerson, Green, and Warusawitharana (2001) have argued that it is inappropriate to compare discounting rates (as measured by k and h parameters) when individuals or groups vary in their s parameters. To deal with these problems, Myerson et al. have proposed using the area under the empirical discounting function to measure degree of discounting. They showed that the distribution of area measures typically is not significantly skewed. Therefore, we calculated the area under each individual participant's empirical discounting function for use in analyses of variance (ANOVAs) to assess possible differences in the extent of discounting.[2]

[2]To calculate the area under the empirical discounting function, we began by converting the data for each individual into proportions. First, each delay was expressed as a proportion of the maximum delay, and each odds-against was expressed as a proportion of the maximum odds-against. Second, the subjective value for each delay and odds-against was expressed as a proportion of the nominal amount (i.e., the subjective value divided by the actual, delayed or probabilistic amount). These proportions then were used as x coordinates (delays and odds-against) and y coordinates (subjective values) to construct a graph of the empirical temporal discounting function and a graph of the empirical probability discounting function for each individual.

For each graph, vertical lines were drawn from each data point down to the x axis, subdividing the graph into a series of trapezoids. The area of each trapezoid is equal to $(x_2 - x_1)\,[(y_1 + y_2) / 2]$ where x_1 and x_2 are successive delays or odds-against, and y_1 and y_2 are the subjective values associated with these delays or odds-against. For the first trapezoid, the value of x_1 and y_1 was defined as 0.0 and 1.0. The area under the empirical discounting function was calculated as the sum of the areas of these trapezoids. Because the x and y values are both normalized, the area under the curve could vary between 0.0 (steepest possible discounting) and 1.0 (no discounting). The steeper the discounting (i.e., the lower the subjective value of delayed or probabilistic rewards), the smaller the area under the curve.

Results

The results for the delay discounting task are presented in the left panels of Figure 1. For each group, the median subjective values of the $200 and $10,000 delayed rewards, plotted as proportions of their

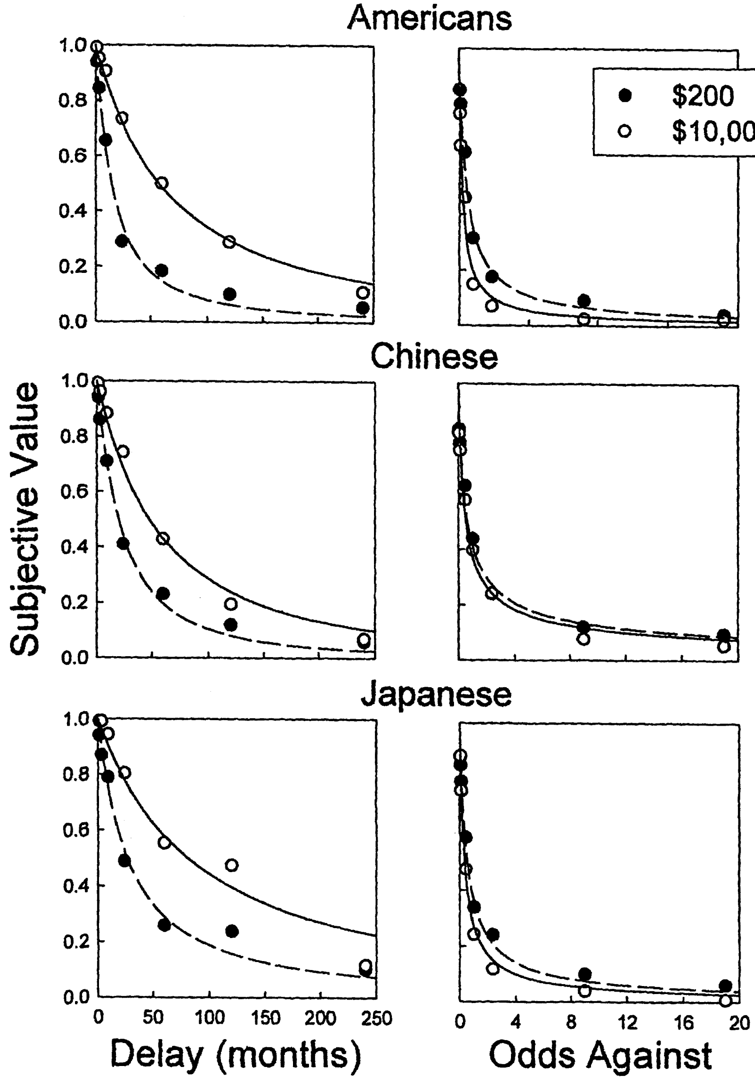

Figure 1. Relative subjective value (i.e., subjective value as a proportion of the nominal amount) as a function of delay until receiving a reward (left panels) and as a function of odds against receiving a reward (right panels). Data are medians for the American, Chinese, and Japanese groups and represent the relative amount of an immediate, certain reward judged equal in subjective value to a delayed or probabilistic monetary reward. The curved lines are the best-fitting discounting functions: Equation 1 for delayed rewards and Equation 2 for probabilistic rewards.

nominal values, are shown as a function of the time until their receipt. The curves represent the discounting function, Equation 1, fit to the data from both amounts simultaneously using three free parameters: one *s* parameter (a nonlinear scaling parameter) and two separate *k* parameters (reflecting the rate of discounting for each amount). Previous research has shown the value of *s* to be independent of the amount of the delayed reward whereas the value of *k* is amount-dependent (e.g., Myerson & Green, 1995). As may be seen, the data for the American, Chinese, and Japanese groups are all well described by Equation 1, all R^2s > .97, and in keeping with previous findings, the smaller ($200) amount was discounted more steeply than the larger ($10,000) amount.

The results for the probability discounting task are presented in the right panels of Figure 1. For each group, the median subjective values of the $200 and $10,000 probabilistic rewards are plotted as a function of the odds against their receipt. The curves represent Equation 2 fit to the data from both amounts simultaneously using one *s* parameter and two separate *h* parameters. The data for the American, Chinese, and Japanese groups are all well described by Equation 2: all R^2s > .97. In keeping with previous findings (e.g., Green et al. 1999a), the smaller probabilistic amount was discounted less steeply than the larger probabilistic amount in each of the three groups, the opposite pattern from that observed with the delayed rewards.

The form of functional relations based on group data is not necessarily representative of relations at the individual level (Sidman, 1952). Accordingly, hyperbola-like discounting functions, Equations 1 and 2, were fit to the data from each participant. The median proportions of variance explained by the delay discounting function, Equation 1, were .937, .962, and .956 for the American, Chinese, and Japanese participants, respectively; the median proportions of variance explained by the probability discounting function, Equation 2, were .949, .938, and .935 for the American, Chinese, and Japanese participants, respectively.

Further analyses compared discounting by the three groups using the area-under-the-curve measure (Myerson et al., 2001). These data are presented in Figure 2. A 3 (Group: Americans, Chinese, Japanese) x 2 (Task: delay, probability) x 2 (Amount: $200, $10,000) repeated measures ANOVA revealed main effects of group, $F(2, 76) = 3.17$, $p < .05$; task, $F(1, 76) = 82.72$, $p < .001$; and amount, $F(1, 76) = 10.46$, $p < .01$. In addition, there were significant two-way interactions between task and amount, $F(1, 76) = 70.31$, $p < .001$, and between task and group, $F(2, 76) = 6.35$, $p < .01$. The two-way interaction between group and amount was not significant, $F(2, 76) < 1.0$, nor was the three-way interaction, $F(2, 76) = 1.38$.

The interaction between task and amount reflects the fact that the small delayed amount was discounted more steeply than the large delayed amount whereas the small probabilistic amount was discounted less steeply than the large probabilistic amount. At the individual level, 82% of the participants discounted the small amount more steeply on the delay task, whereas 71% of the participants discounted the small amount less steeply on the probability task.

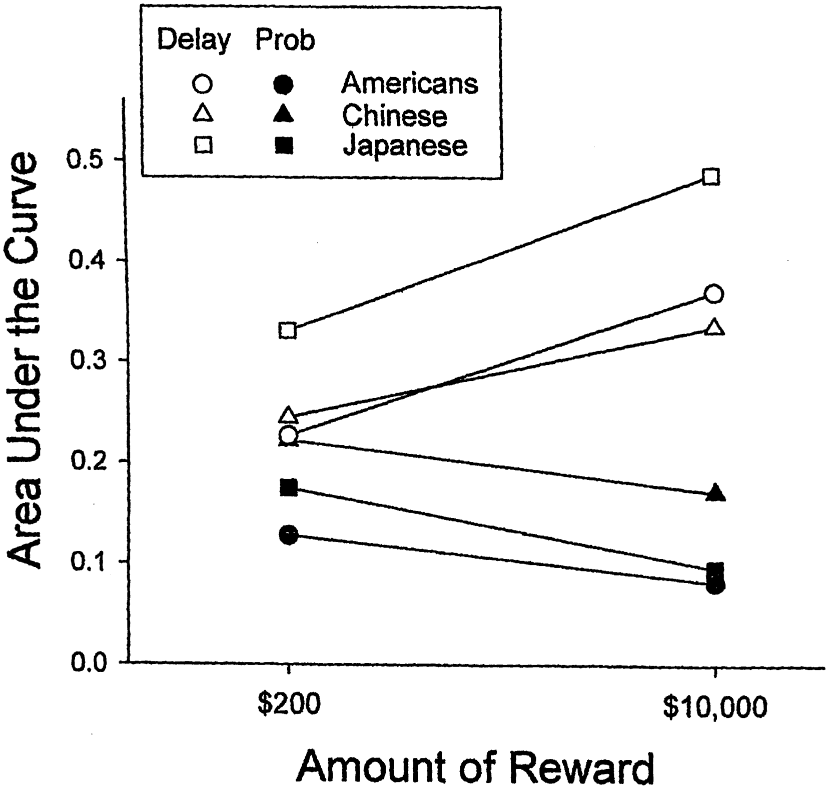

Figure 2. Area under the empirical discounting curve as a function of amount of reward. Data are the group means for the American, Chinese, and Japanese groups. Open symbols represent data for the delay discounting task, and solid symbols represent data for the probability discounting task.

With respect to the interaction between task and group, follow-up one-way ANOVAs on the areas (averaged across the two amounts) revealed that there were significant effects of group on both the delay discounting task, $F(2, 76) = 3.41$, $p < .05$, and the probability discounting task, $F(2, 76) = 11.54$, $p < .001$. For the delay discounting task, the group effect reflects the fact that, on average, the area under the curve for the Japanese ($M = .409$) was larger than that for the Americans ($M = .299$) or the Chinese ($M = .291$), whereas for the probability discounting task, the group effect reflects the fact that the area under the curve for the Chinese ($M = .198$) was larger than for the other two groups ($M = .105$ for the Americans, and $M = .136$ for the Japanese).

Discussion

The discounting of hypothetical delayed monetary rewards by all three groups (i.e., American, Chinese, and Japanese graduate students) was well described by Equation 1. Parallel results were obtained for the discounting of hypothetical probabilistic rewards, in that discounting by all three groups was well described by Equation 2. Moreover, in all three groups the small delayed amount was discounted more steeply than the large delayed amount whereas the opposite pattern was observed with probabilistic amounts. That is, in all three groups the small probabilistic amount was discounted less steeply than the large probabilistic amount. The present findings suggest that despite differences in cultural background, the decision making of the highly educated participants in this study was quite similar in certain, fundamental respects.

There were differences, however, among the groups in the rates at which they discounted delayed rewards, as measured by the area under their discounting functions, as well as in the rates at which they discounted probabilistic rewards. Notably, the present study is the first to test Japanese participants on both temporal and probability discounting tasks and to compare their performance with that of Chinese and Americans. The Japanese showed the least discounting of delayed rewards whereas the Americans and Chinese were virtually equal in this regard. For probabilistic rewards, in contrast, the Chinese showed the least discounting.

The present results are consistent with those of Tan and Johnson (1996) who found that both Chinese and North American (i.e., Canadian) students showed steeper discounting of small rather than large delayed amounts. Tan and Johnson also reported no difference between these two groups in temporal discounting rate. The present study further suggests that Japanese may show less temporal discounting than either Americans or Chinese. With respect to probabilistic gains, the present results are consistent with those of Hsee and Weber (1999) who found that both Chinese and American students showed steeper discounting of large rather than small probabilistic amounts. Overall, however, the Chinese showed less discounting than the Americans (i.e., the Chinese were more risk-seeking). In contrast, Sinha (1996) found no difference between ethnically Chinese students in Singapore and American students. The present results support Hsee and Weber's finding of differences in discounting between American and Chinese students, and in addition, suggest that Chinese students show less discounting of probabilistic rewards than Japanese students.

The observed differences in discounting could be caused by cultural differences in attitudes toward delay or probability (i.e., impulsivity and risk-aversion) or differences in perception of time or risk (Weber & Hsee, 1998). In addition, there could be differences in the perceived magnitude of the monetary outcomes (i.e., independent of probability and delay, the same nominal amount could be worth more to one group than another). Further research that attempts to separate these possibilities for the group differences observed in the present study seems warranted. Moreover, a theoretical account must take into account the possibility that groups that differ on one discounting task may not necessarily differ on the other task. For example, the Americans and Chinese showed differences in probability discounting, but not in temporal discounting.

Such a selective effect of cultural group is reminiscent of the selective effect of inflation on temporal and probability discounting. Specifically, Ostaszewski et al. (1998) observed that inflation affected rates of temporal discounting but did not affect probability discounting rates. Ostaszewski et al. pointed out that their results pose problems for a single-process account in which a single mechanism underlies the discounting of both delayed and probabilistic outcomes. Similarly, the present results suggest that a single social/cultural dimension (e.g., collectivism/individualism) may not fully capture more complicated patterns of differences between groups such as those observed in the present study.

The present study, like other research on cultural differences in decision making, used hypothetical monetary rewards. When real rewards have been used in studies of temporal discounting (Kirby, 1997; Kirby & Maraković, 1995, 1996; Rodriguez & Logue, 1988), the results have tended to be similar to those obtained with hypothetical rewards (e.g., Green et al., 1997; Kirby & Maraković, 1995; Rachlin et al., 1991). That is, in both cases, the discounting function for delayed rewards is a hyperbola or hyperbola-like, and discounting rate decreases with amount of reward (for a brief review, see Kirby, 1997). Thus, there is little evidence to suggest that the pattern of results in the present study would have been different if real rewards had been used. However, previous studies examining real rewards have tended to use much smaller amounts than studies involving hypothetical rewards, and the possibility remains that additional cultural differences might emerge if real rewards were to be studied.

Another possible limitation to the present findings concerns the cultural representativeness of the samples in the present study. First, the Asian graduate students were individuals who had chosen to leave their homeland to study in the United States. Second, they were attending graduate school in the United States at the time they were tested (although they had received their primary, secondary, and college education in their home countries). Therefore, it would be desirable to test participants in their country of origin in order to assess the generality of the present findings.

With respect to the similarities between the groups in the present study, it should be noted that although cultural differences are often emphasized, cross-cultural research has as its goals *both* "a delineation of human diversity and a search for psychological universals" (Segall, Lonner, & Berry, 1998, p. 1105). In this context, we find it quite interesting that the same form of mathematical function described the discounting of delayed and probabilistic rewards in groups of individuals from three different countries. Moreover, although magnitude of reward had opposite effects on the rate of discounting delayed and probabilistic rewards, this effect was observed in all three groups. Despite the cultural differences in discounting rates, we would suggest that the cross-cultural similarities in the mathematical form of the delay and probability discounting functions as well as in the effects of amount on discounting rates raise the possibility that there may be fundamental similarities across cultures in the decision-making processes involved in discounting.

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