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Future rice is discounted less steeply than future money in Thailand.

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FUTURE RICE IS DISCOUNTED LESS STEEPLY THAN FUTURE MONEY IN THAILAND

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There is evidence that people discount food more steeply than money, suggesting that primary or consumable reinforcers lose value quickly, whereas conditioned or nonconsumable reinforcers lose value slowly. In the present study, discounting rates of baht (unstable currency) and rice (preservable food) were compared during a period of unstable economic conditions in Thailand. Delay discounting of 2 amounts of hypothetical money and 2 matched amounts of hypothetical rice were examined. For smaller amounts of rewards, there was no difference in rates of discounting between money and a matched amount of rice. For larger amounts of rewards, however, money was discounted more steeply than a matched amount of rice. It was suggested that the unstable currency might be discounted more severely than a durable good of comparable monetary value in some circumstances.

In choosing long-term and short-term alternatives, people frequently weigh the value of immediate rewards more heavily than the value of delayed rewards (Green, Myerson, Lichtman, Rosen, & Fry, 1996). This phenomenon can be viewed as a process in which the subjective value of a reward decreases with time to its receipt. This change in the value of a reward as a function of its temporal proximity is termed temporal discounting (Green, Fry, and Myerson, 1994; Green & Myerson, 1993; Lowenstein & Prelec, 1992; Raineri & Rachlin, 1993).

Rachlin, Raineri, and Cross (1991) proposed a useful method for examining a temporal discounting function of a reward. They asked participants to

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make a series of choices between two hypothetical monetary rewards to find the indifference point at which a smaller immediate reward is equivalent to a larger delayed reward. The indifference points are viewed as the present subjective values of delayed rewards. When indifference points are obtained for different delays, an indifference curve can be plotted. Previous research has proposed a hyperbolic function to describe the indifference curve:

$$V = A / (1 + kD), \quad (1)$$

where V is the present subjective value of a delayed reward, A is the amount of the reward, D is the duration of the delay, and k is a parameter indicating the degree of temporal discounting (Mazur, 1987). Higher values of k indicate that the reward is discounted to a greater degree. Equation 1 has empirical support in studies of humans choosing hypothetical monetary rewards (for a review, see Green & Myerson, 2004; Ostaszewski, Green, & Myerson, 1998).

On the other hand, Myerson, Green, and Warusatitharana (2001) indicated that measures of discounting based on estimates of k have several disadvantages. First, the data from a number of individuals were poorly fit by Equation 1. Second, there has been considerable variability between participants. Third, the use of estimates of a model's parameters may have potential problems created by the lack of consensus regarding the mathematical form of the discounting function. Fourth, distributions of individual parameter estimates were skewed, and such distributions require the use of nonparametric tests that are less powerful than the counterparts of parametric tests (Myerson, Green, & Warusatitharana, 2001). To avoid these problems, they proposed a method of calculating the area under the empirical discounting function (the area under the curve: *AUC*) as a more appropriate measure of discounting.

Previous studies on temporal discounting have delineated several factors that affect the degree of discounting represented by k or *AUC* values, such as amount of reward (Green, Myerson, & McFadden, 1997), age of participants (Green, Myerson, Lichtman, Rosen, & Fry, 1996), income levels of participants (Green et al., 1996), and monetary inflation (Ostaszewski et al. 1998). In addition, recent studies have suggested that rates of discounting might be different between different outcome types within subjects (for a review, see Odum & Rainaud, 2003). For example, drug-dependent persons discounted their drug of abuse delayed in time more steeply than money delayed in time (Bickel, Odum, & Madden, 1999; Coffey, Gudleski, Saladin, & Brady, 2003; Madden, Petry, Badger, Bickel, 1997; Petry, 2001). People with no self-reported problems with money, alcohol, or food also discounted food more steeply than money (Kirby & Guastello. 2001; Odum & Rainaud, 2003; see also Forzano & Logue, 1992). Although the reasons underlying the differences in discounting rates for food and money are unknown at present, Odum and Rainaud (2003) suggested that steep discounting of food may occur as part of a general process by which primary or consumable reinforcers are discounted more steeply than conditioned or nonconsumable reinforcers.

As suggested by Ostaszewski et al. (1998), however, money may lose value more quickly than other commodities under unstable economic conditions. In addition, there is a possibility that some types of staple food, such as rice for Asians and pasta for Italians, may lose value more slowly than unstable money, since people can preserve them for a long period. To examine generality of the finding that food is discounted more steeply than money, the present study was designed to compare discounting rates of unstable

currency (baht) and preservable food (rice) during a period of unstable economic conditions in Thailand. The Thai currency crisis started in 1997, and the Thai baht depreciated from 31.34 baht per U.S. dollar to 50.00 baht per U.S. dollar by 1998 (Sussangkarn, 1998), which led to a sharp decline of the gross domestic product (GDP). In particular, GDP in the financial sector declined by 30%, 34%, and 8% in 1998, 1999, and 2000, respectively (Dekle, Karnchanasai, & Hoontrakul, 2005). When the present study was carried out in August 2000, the baht was expected to lose value quickly. On the other hand, rice is one of the staple foods in Thailand, and it is common for Thai people to preserve rice for many months. Therefore, it is possible that rice does not lose value quickly in spite of the fact that it is a primary and consumable reinforcer.

Method

Participants

Forty-eight undergraduate students of Chulalongkorn University (25 men and 23 women) between the ages of 18 and 24 (M = 20.8) years were paid for their voluntary participation in this study. The participants were treated according to the Ethical Principles of Psychologists and Code of Conduct (American Psychological Association, 1992).

Procedures

The survey took place in a room of Chulalongkorn University in August 2000. All participants sat at desks facing a blackboard, and an experimenter stood at a desk in front of the blackboard. Eight to 20 participants were tested simultaneously in this room. The participants made a series of choices regarding hypothetical amounts of rewards. One of the alternatives was a hypothetical reward available immediately (for example, 100 baht now), and the other was a reward available after a specified period of delay (for example, 200 baht within 5 years). The two alternatives were printed on a piece of paper (11 × 8 in. [29.7 × 21.0 cm). The experimenter stood at the desk in front of the participants and showed them one of the pieces of paper. After the experimenter read two alternatives aloud, each participant indicated his or her preference by checking one of the alternatives on answer sheets described below. The experimenter showed each set of alternatives for about 10 seconds.

Participants were divided into 2 groups, identified as the 200 group (n = 28) and the 2,000 group (n = 20). The sizes of the two groups were unequal owing to failure to recruit participants according to plan. Twenty of the 28 participants in the 200 group and 10 of the 20 participants in the 2,000 group were presented with a choice between hypothetical amounts of money (a money condition) and hypothetical amounts of rice (a rice condition) in that order. The remaining 8 participants in the 200 group and 10 participants in the 2,000 group underwent a rice condition and a money condition in that order. The "200" indicated 200 baht and the "2,000" indicated 2,000 baht. That is, the maximum amount of hypothetical alternatives for the 200 group was 200 baht (about 5.5 U.S. dollars) or 10 kg of rice (the participants being instructed that 10 kg of rice was worth about 200 baht), whereas the maximal

amount of hypothetical alternatives for the 2,000 group was 2,000 baht (about 55 U.S. dollars) or 100 kg of rice (the participants being instructed that 100 kg of rice was worth about 2,000 baht). Therefore, there were four conditions: a 200-baht money condition, a 10-kg rice condition, a 2,000-baht money condition, and a 100-kg rice condition.

At the start of money conditions, participants in each group were given the following instructions in English. For each two-word pair in parentheses, the first word was read and the second word was ignored. The instructions for participants in the 200 group included "200 baht," and the instructions for participants in the 2,000 group included "2,000 baht" at point [A]. There was no sentence at point [B].

> The purpose of the present study is to compare your preference between different amounts of (money/rice) available at different points in time. In this study you will be asked to make a series of choices between hypothetical (monetary/rice) alternatives. As you can see, there are two sets of alternatives. The alternative on your left will offer you an amount of (money/rice) to be (paid/delivered) right now. This amount will vary from card to card. The amount on the alternatives on your right will be always [A], but its (payment/delivery) will be delayed. [B] Please look at the example alternatives at this time [indicating a sample sheet of paper on which two alternatives were written]. I will read the alternatives aloud. It will be your job to choose between the two alternatives presented and to check the box of the alternative you would prefer. It is important to base your decision on only two alternatives presented on each trial. Do not base your decision on sets of alternatives previously seen or ones you expect to see. There are no correct or incorrect choices. We are interested in the options you would prefer. You will be given five practice trials before you begin. You will get enough practice so do not worry if you feel that you do not understand completely at this time. During the practice please ask me as many questions as you like because once practice is over I can no longer answer your questions.

At the start of rice conditions, participants in each group were also given the above instructions. For each pair of words in parentheses, the first word was ignored and the last word was read. The instructions for participants in the 200 group included "10 kg" and the instructions for participants in the 2,000 group included "100 kg" at point [A]. At point [B] there was a sentence saying "Please assume that this rice is food for you and you are not allowed to sell it or give it to others."

After the participants were given instructions at the start of each condition, they underwent a practice session that included five pairs of alternatives, with the fixed amounts of reward (200 baht, 2,000 baht, 10 kg of rice, or 100 kg of rice) delayed by 2 months on the right and the immediate reward ranging from 91% to 8% of the fixed reward (91%, 87%, 63%, 28%, 8%, in that order) on the left. From the participants' questions during practice, it was clear that the English instructions were adequately understood. After the practice for a 10-kg rice condition, all participants were instructed that 10 kg of rice corresponded to 200 baht. After the practice for a 100-kg rice condition, all participants were instructed that 100 kg of rice corresponded to 2,000 baht.

In experimental sessions, there were two alternatives on each sheet of paper for both money and rice conditions. The left alternative was money or rice available immediately, and the right one was money or rice available after a specified period of delay. There were 5 delays—6 months, 1 year, 5 years, 10 years, and 20 years—and all the participants were presented these delays in that order. Each delay condition consisted of 50 choice trials. There were 25 amounts of money or rice on the left (immediate money or rice) ranging from 1% to 99% (1%, 2.5%, 5%, 7.4%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 92.5%, 95%, 97.5%, and 99%) of the delayed, with the amount of money or rice on the right fixed. For the first 25 trials (descending cycle), the amounts of money or rice printed on the left decreased from the maximum to the minimum. For the last 25 trials (ascending cycle), the amounts of money or rice printed on the left increased from the minimum to the maximum. Each participant was given 10 answer sheets (11×8 in. [29.7×21.0 cm]), on each of which 25 trial numbers and alternatives (now vs. delay period) were printed.

For each participant, indifference points were calculated by taking the average of the last immediate amount that was chosen on the descending cycle and the first immediate amount that was chosen on the ascending cycle at each of the six delays. Fortunately, the participant did not switch back and forth among the immediate and delayed outcomes. The discounting equation was fit to individual and collective data using StatSoft Statistica 4.1J software. Delays measured in months were used to fit the discounting equation.

Results

Table 1 (see Appendix) shows indifference points obtained at each of the six delays for each participant in each condition. Theoretically, indifference points should decrease across successively longer delays, as pointed out by Dixon, Marley, and Jacobs (2003). In the present study, indifference points were generally a monotonically decreasing function of delay. However, there were some deviations from this theoretically ideal pattern. To accommodate some variability in the data, criteria proposed by Dixon et al. (2003) were adopted. Data were considered generally consistent with delay discounting when the indifference points decreased at least twice across successive delay values and did not increase more than once across successive delay values (Dixon et al., 2003). With these criteria, the data from 7 participants in the 200 group (S16 through S22) and 5 participants in the 2000 group (S42 through S46) were considered inconsistent with delay discounting in money or rice conditions, or both, and were excluded in the following k-value analyses.

For each condition of each participant, values of k were estimated by means of nonlinear curve fitting. Values of k for each individual in each condition are shown in Table 1. The function corresponding to Equation 1 could not account for the data (that is, r^2 values were not provided) in 6 of 28 cases for a 200-baht money condition (S17 through S20, S23, and S24), 11 of 28 cases for a 10-kg rice condition (S17 through S23 and S25 through S28), 3 of 20 cases for a 2,000-baht money condition (S43 through S45), and 8 of 20 cases for a 100-kg rice condition (S43 through S50). Because of the within-participant nature of the comparison between money and rice in the present study, k values for 12 participants in the 200 group (S17 through S28) and 8 participants in the 2,000 group (S43 through S50), whose r^2 values were not provided in

money or rice conditions, or both, were excluded from the *k*-value analyses. Six participants in the 200 group (S17 through S22) and 3 participants in the 2,000 group (S43 through S45) had already been excluded by means of Dixon's criteria mentioned above. Moreover, *k* values for 4 participants in the 200 group (S12 through S15) and 6 participants in the 2,000 group (S31, S35, S38, S39, S40, and S41) were also excluded from the *k*-value analyses, since the proportion of variance accounted for by the hyperbolic equation was less than 0.500 in money or rice conditions, or both, indicating that the hyperbolic model failed to provide an adequate description of discounting in those cases (Dixon et al., 2003).

Figure 1 plots group median subjective values of a reward as a function of the delay until its receipt for 16 participants whose data were considered consistent with delay discounting according to Dixon's criteria and provided r^2 values greater than 0.500 for both money and rice conditions (S1 through S11 in the 200 group and S32, S33, S34, S36, and S37 in the 2,000 group). The subjective value of a reward is represented as a proportion of its nominal amount. The *k* values obtained for a 200-baht money condition, a 10-kg rice condition, a 2,000-baht money condition, and a 100-kg rice condition were 0.101 (r^2 = 0.949), 0.140 (r^2 = 0.891), 0.195 (r^2 = 0.972), and 0.040 (r^2 = 0.922), respectively.

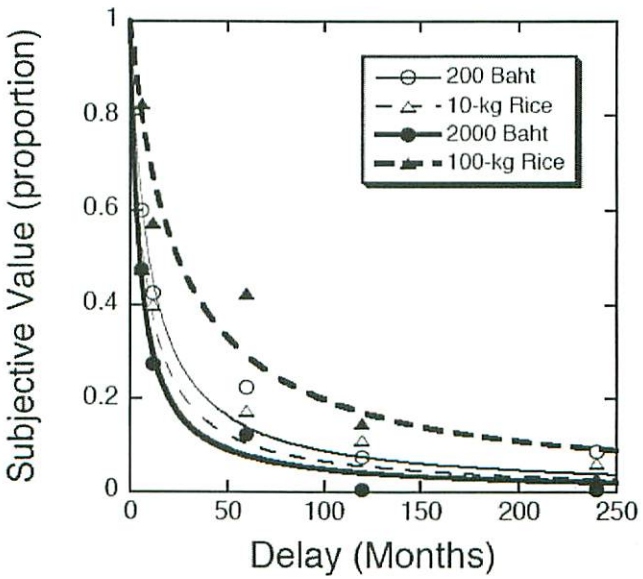

Figure 1. Subjective value of a reward as a function of the delay until its receipt. The subjective value of a reward is represented as a proportion of its nominal amount. Points show group medians of subjective values for a 200-baht money condition (open circles), 10-kg rice condition (open triangles), a 2,000-baht money condition (filled circles), and a 100-kg rice condition (filled triangles). Curves represent the best-fitting discounting functions (Equation 1) for a 200-baht money condition (thin solid line), 10-kg rice condition (thin broken line), a 2,000-baht money condition (thick solid line), and a 100-kg rice condition (thick broken line).

Green et al. (1994) proposed a hyperbola-like discounting function in which the denominator of the hyperbola is raised to a power:

$$V = A/(1 + kD)^s \quad (2)$$

The parameter s represents the nonlinear scaling of amount or time, or both. The k values obtained for a 200-baht money condition, a 10-kg rice condition, a 2,000-baht money condition, and a 100-kg rice condition were 0.206 (s = 0.654, r^2 = 0.979), 0.445 (s = 0.537, r^2 = 0.987), 0.186 (s = 1.031, r^2 = 0.972), and 0.050 (s =0.876, r^2 = 0.943), respectively. Values of r^2 obtained for Equation 2 were larger than or equal to those obtained for Equation 1 in all conditions. These findings confirmed the results of earlier studies which reported that Equation 2 provides better fits to discounting data than the simple hyperbola (for a review, see Green & Myerson, 2004). However, there continues to be some controversy regarding how to interpret the parameter s in the hyperbola-like discounting function (Green & Myerson, 2004; Myerson & Green, 1995), although Green et al. (1994) suggested that s might represent sensitivity to delay and difference in values of s may reflect differences in the amount of experiences with long delay for each participant. On the other hand, comparisons between conditions would be greatly simplified by using a function with a single free parameter. Therefore, Equation 1 was used in the following analyses.

As shown in Figure 1, the subjective value of a reward for a 100-kg rice condition was discounted distinctly less steeply than the remaining three conditions. These differences were assessed statistically through comparison of the estimated discounting parameter (k) obtained by fitting Equation 1 to data from each individual in each group. Regarding amounts of rewards (magnitude effect), there was no significant difference between the median values for the 200-baht and the 2,000-baht conditions (0.073 vs. 0.167, Mann-Whitney U test, p = 0.34). Likewise, there was no significant difference between the median values for the 10-kg and the 100-kg conditions (0.122 vs. 0.034, Mann-Whitney U test, p = 0.25). Regarding type of reinforcers (type effect), there is no significant difference between the median values for the 200-baht money condition and the corresponding 10-kg rice condition (0.073 vs. 0.122, Wilcoxon signed rank test, p = 0.59). However, the median value of k in the 2,000-baht money condition was significantly greater than that in the corresponding 100-kg rice condition (0.167 vs. 0.031, Wilcoxon signed rank test, p = 0.04).

AUC was another well-established measure of delay discounting and has the advantage of being able to deal with a wider range of data than the hyperbolic model (Dixon et al., 2003; Myerson et al., 2001). Unlike data analysis with the hyperbolic function, the *AUC* does not require that the data conform to any particular model and can be calculated regardless of the form of the indifference curve. As mentioned earlier, however, it might be inappropriate to include individual data that were theoretically inconsistent with delay discounting, since control by independent variable is dubious when indifference points did not decrease across successively longer delays (Dixon et al., 2003). Therefore, individual data that were considered inconsistent with delay discounting by using Dixon's criteria mentioned above (S16 through S22 and S42 through S45) were excluded. The data with r^2 less than 0.500 were included, since *AUC* does not require that the data conform to Equation 1. The *AUC* were calculated on the basis of normalized values (i.e., subjective value expressed as a proportion of nominal value and delay expressed as

a proportion of their maximum value). Subjective values were plotted as a function of delay until its receipt. Vertical lines were then drawn from each data point to the x axis, subdividing the graph into a series of trapezoids. The area under the curve is equal to the sum of the areas of these trapezoids (for details, see Myerson et al., 2001). *AUC* values for each individual in each condition are shown in Table 1.

Regarding amounts of rewards (magnitude effect), the mean value of *AUC* in the 200-baht condition was slightly greater than that in the 2,000-baht condition (0.238 vs. 0.225), whereas the mean value of *AUC* in the 10-kg condition was smaller than that in the 100-kg rice conditions (0.240 vs. 0.353). Regarding type of rewards (type effect), the mean value of *AUC* in the 200-baht condition was slightly greater than that in the corresponding 10-kg condition (0.238 vs. 0.240) and the mean value of *AUC* in the 2,000-baht money condition was smaller than that in the corresponding 100-kg rice condition (0.225 vs. 0.353). A repeated measures analysis of variance (ANOVA) was conducted for the *AUC* data obtained from four conditions to determine the effects of manipulating (A) type of reinforcers and (B) amounts of reinforcers on the participants' preference for more delayed alternatives. There was a significant main effect for (A) type of reinforcers, $F = 7.83$ (1, 34), $df = 1$, $p < 0.01$, indicating significant difference across reinforcer type. On the other hand, a main effect for (B) amounts of reinforcers was not significant, $F = 0.96$ (1, 34), $df = 1$, $p = 0.33$. However, there was a significant (A) × (B) interaction, $F = 7.54$ (1, 46), $df = 1$, $p < 0.01$. Post hoc analysis with Tukey HSD tests revealed that the future 100-kg rice was discounted less steeply than future 2,000-baht money ($p < 0.01$) and future 100-kg rice was discounted less steeply than future 10-kg rice ($p < 0.01$). However, future 10-kg rice was not discounted less steeply than future 200-baht money ($p = 1.00$) and future 2,000-baht money was not discounted less steeply than future 200-baht money ($p = 0.97$).

Some studies on delay discounting with *AUC* did not exclude data that were inconsistent with delay discounting (e.g., Odum & Rainaud, 2003; Ohmura, Takahashi, & Kitamura, 2005). In fact, it may be natural to include all data in *AUC* analysis if delay discounting can be exemplified by "lower subjective value of a delayed reward relative to immediate reward" (Myerson et al., 2001) without any assumptions regarding mathematical form of discounting function. Therefore, a repeated measures ANOVA was conducted for the *AUC* data of all 48 participants (S1 through S28 and S31 through S50). The results obtained with all data were similar to those obtained with the data from which individual data considered inconsistent with delay discounting using Dixon's criteria (S16 through S22 and S42 through S45) were excluded. There was a significant main effect for (A) type of reinforcers, $F = 6.76$ (1, 46), $df = 1$, $p < 0.05$, indicating significant difference across reinforcer type. On the other hand, a main effect for (B) amounts of reinforcers was not significant, $F = 1.12$ (1, 46), $df = 1$, $p = 0.296$. However, there was a significant (A) × (B) interaction, $F = 4.45$ (1, 46), $df = 1$, $p < 0.05$. Post hoc analysis using Tukey HSD tests revealed that the future 100-kg rice was discounted less steeply than future 2,000-baht money ($p < 0.05$) and future 100-kg rice was discounted less steeply than future 10-kg rice ($p < 0.05$).

However, future 10-kg rice was not discounted less steeply than future 200-baht money ($p = 0.98$) and future 2,000-baht money was not discounted less steeply than future 200-baht money ($p = 0.96$).

Discussion

The purpose of the present study was to examine discounting rates of unstable currency (baht) and preservable food (rice). The results indicated that the individual data deviated from Equation 1 in many cases. The results were consistent with those of earlier studies which reported that Equation 1 frequently provided poor fits to discounting data (for a review, see Green & Myerson, 2004). Therefore, the data inconsistent with Equation 1 were excluded from the *k*-value analyses. For participants whose data were well described with the hyperbolic model in both money and rice conditions, analyses of *k* values indicated that 100 kg of rice was discounted less steeply than the corresponding 2,000-baht money (type effect). Likewise, analyses of *AUC* values obtained from all participants indicated that 100 kg of rice was discounted less steeply than the corresponding 2,000-baht money (type effect), and 100 kg of rice is discounted less steeply than 10 kg of rice (magnitude effect).

Since the type effect was not found for smaller amounts of rewards and the magnitude effect was not found in monetary conditions, the present results cannot be considered definitive. In addition, as will be mentioned later, the present study has some limitations that must be respected. Nevertheless, some preliminary data of the present study indicate that food may be discounted less steeply than money, at least in some circumstances. This finding seems to contradict the previous finding that food is discounted more steeply than money (Kirby & Guastello, 2001; Odum & Rainaud, 2003). The reasons for discrepancy between the present data and the results of previous studies are not clear at present. However, rice has important features that might be different from food used in the previous studies (pizza in Kirby & Guastello, 2001, and favorite food in Odum & Rainaud, 2003). First, since rice is one of the staple foods in Thailand, it is expected that it will continue to be an attractive reward many years later. Second, since it is easy at least for Thai people to preserve rice for a long period, rice is not a perishable reward for Thai people. Accordingly, it seems possible that these two features make rice retain its value over time.

For monetary rewards, on the other hand, the present study found steep discounting of money during a period of unstable economic conditions. Ostaszewski et al. (1998) showed that inflation selectively modulates discounting rates of future zloty and the U.S. dollar. They concluded that inflation caused higher rates of discounting for zloty than U.S. dollars, since probabilistic zloty was not discounted so steeply as delayed zloty. Similarly, the present result can be interpreted as suggesting that macroeconomic conditions affected discounting rates of money and rice to different extents. At present, however, the steep discounting of money seen in the present study cannot be attributed solely to economic conditions, since in the present study discounting rates of delayed and probabilistic rewards were not compared. Moreover, the relation between steep discounting of baht and macroeconomic conditions would be more robust if conditions involved choices among comparable amounts of

a stable currency and choices among comparable amounts of a highly perishable food. Clearly, further research is necessary before a conclusion can be reached about the reasons for steep discounting of baht obtained in the present study.

For magnitude effect, 100 kg of rice was discounted less steeply than 10 kg of rice. This result is consistent with previous studies which showed that the rate of discounting is larger when the amount of reward is smaller (e.g., Green et al., 1997). However, magnitude effect was not significant for money in the present study. The reasons that the present participants did not show magnitude effect for money are unknown at present, but a few speculations can be made. First, the discrepancy may be due to the fact that for the present study, within-group comparison with small and unequal group sizes was adopted, whereas for most of the previous studies of magnitude effect, within-subject comparison was adopted. Second, it is possible that rates of discounting for 200-baht and 2,000-baht conditions were so large that there was no room for magnitude effect to appear in the present study. In a typical study in which distinct magnitude effect was reported (e.g., Green et al., 1996), the delayed amounts were 1,000 U.S. dollars and 10,000 U.S. dollars, respectively. Thus the amounts of reward used in the present study (5.5 U.S. dollars and 55 U.S. dollars) seemed too small even if we take into account that nominal gross domestic product per capita in Thailand (1,952 U.S. dollars) was about one-eighteenth that in the United States (35,069 U.S. dollars) in the year 2000 (International Monetary Fund, 2001) and subjective value of 55 U.S. dollars might be much larger in Thailand than in the United States.

Certain limitations must be considered in the interpretation of the present results. First, amount of reward was manipulated in a within-group design with small and unequal group sizes. Fortunately, there was a significant magnitude effect in the *AUC* data for rice conditions in spite of the between-group nature of the amount comparison. However, considering that the magnitude effect was not found for the monetary conditions and the primary effect (more discounting of money than of food) was not found in the larger group (the 200-baht group), it is preferable to conduct future studies with a completely within-subjects design to provide more definitive data. Second, the hyperbolic model failed to account for a relatively large portion of the present data. Moreover, the well-established magnitude effect was not confirmed in the present monetary conditions. Consequently, there is a possibility that control by independent variables was insufficient in the present study. Thus future research should involve a methodology (e.g., instructions, practice, discriminative stimuli, and so on) to increase the degree to which choices are controlled by amount, delay, and type of rewards. Third, the present study examined only delay discounting of two amounts of money and rice and type effect was found for the larger amounts (the 2,000 group) but not for the smaller amounts (the 200 group). Therefore, type effect may not be found for amounts of rewards that are different from those used in the present study. Clearly, future research should examine the type effect for a wider range of amounts.

In conclusion, the present study, coupled with previous studies in which the effects of reward type (food, drug, and money) on temporal discounting were examined (Bickel et al., 1999; Coffey et al., 2003; Kirby & Guastello, 2001; Madden et al., 1997; Odum & Rainaud, 2003; Petry, 2001), suggests that there

might be various patterns of type effects on temporal discounting. Hence, further research is needed before a general conclusion can be reached on the effects of primary, or consumable, and secondary, or nonconsumable reinforcers on temporal discounting.

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Appendix
Indifference Points at Each Delay for All Participants

Table 1a
Indifference points for 200 baht money at each delay

	200-Baht Money Condition							
	Delay (months)							
	6	12	60	120	240	*k*	r^2	*AUC*
S1	120.0	70.0	30.0	15.0	20.0	0.124	0.953	0.154
S2	100.0	45.0	7.5	7.5	1.0	0.211	0.952	0.074
S3	80.0	65.0	25.0	7.5	3.5	0.207	0.949	0.022
S4	175.0	170.0	120.0	45.0	25.0	0.018	0.942	0.381
S5	165.0	105.0	55.0	40.0	30.0	0.049	0.929	0.267
S6	165.0	85.0	45.0	10.0	7.5	0.073	0.923	0.160
S7	135.0	95.0	55.0	40.0	17.5	0.070	0.899	0.242
S8	90.0	20.0	3.5	1.0	1.0	0.304	0.835	0.042
S9	175.0	115.0	95.0	45.0	45.0	0.027	0.831	0.347
S10	120.0	120.0	70.0	35.0	22.5	0.055	0.808	0.268
S11	45.0	30.0	7.5	12.5	12.5	0.525	0.770	0.083
S12	45.0	35.0	17.5	10.0	7.5	0.483	0.752	0.086
S13	120.0	105.0	80.0	60.0	17.5	0.053	0.471	0.311
S14	95.0	75.0	45.0	45.0	25.0	0.132	0.271	0.233
S15	75.0	35.0	47.5	20.0	17.5	0.269	0.166	0.154
S16	100.0	1.0	1.0	1.0	1.0	0.321	0.654	0.030
S17	90.0	80.0	60.0	45.0	35.0	—	—	0.264
S18	1.0	1.0	1.0	1.0	1.0	—	—	0.017
S19	100.0	65.0	90.0	199.0	199.0	—	—	0.107
S20	105.0	95.0	80.0	105.0	100.0	—	—	0.491
S21	140.0	140.0	155.0	135.0	25.0	0.009	0.315	0.568
S22	152.0	80.0	70.0	70.0	55.0	0.479	0.027	0.355
S23	145.0	145.0	115.0	95.0	100.0	—	—	0.545
S24	35.0	12.5	45.0	12.5	12.5	—	—	0.114
S25	130.0	95.0	28.8	22.5	30.0	0.088	0.949	0.194
S26	172.5	150.0	120.0	100.0	50.0	0.011	0.872	0.503
S27	125.0	80.0	85.0	60.0	7.5	0.069	0.353	0.291
S28	145.0	135.0	135.0	105.0	65.0	0.010	0.033	0.537

Note. Also included are derived *k* values, proportions of variance accounted for by means of the hyperbolic model (r^2), and areas under the curve (*AUC*).

Table 1b
Indifference points for 10 kg rice at each delay

	10-kg Rice Condition							
	Delay (months)							
	6	12	60	120	240	*k*	r^2	*AUC*
S1	2.500	2.250	0.750	0.800	0.425	0.392	0.712	0.102
S2	6.750	5.000	1.750	0.375	0.050	0.085	0.986	0.140
S3	5.250	4.500	2.250	1.250	1.500	0.106	0.766	0.211
S4	9.500	8.750	6.750	4.500	3.000	0.009	0.992	0.530
S5	5.500	4.000	1.750	1.125	0.050	0.122	0.965	0.154
S6	4.250	3.250	1.750	0.875	0.175	0.186	0.884	0.136
S7	4.500	3.000	2.000	1.750	0.875	0.172	0.536	0.190
S8	1.500	1.750	0.050	0.050	0.050	0.712	0.772	0.040
S9	4.750	7.500	2.750	2.750	0.875	0.051	0.525	0.296
S10	7.000	6.750	5.750	3.000	2.000	0.021	0.661	0.398
S11	4.250	2.000	0.875	0.875	0.625	0.249	0.902	0.114
S12	4.750	3.750	2.750	1.750	0.875	0.131	0.473	0.216
S13	8.000	5.250	4.000	3.000	2.250	0.034	0.684	0.350
S14	4.750	4.750	4.750	1.750	0.875	0.081	0.032	0.272
S15	1.375	1.375	0.375	0.175	0.175	0.824	0.773	0.051
S16	4.250	6.950	8.750	0.050	0.050	0.028	0.190	0.301
S17	2.500	5.750	3.250	4.000	2.500	—	—	0.369
S18	0.050	0.050	0.050	0.050	0.050	—	—	0.017
S19	7.000	5.000	6.000	4.500	3.000	—	—	0.465
S20	0.050	0.050	0.050	0.050	0.050	—	—	0.017
S21	5.000	5.750	4.500	5.000	1.125	—	—	0.407
S22	7.000	5.250	5.750	5.250	5.750	—	—	0.559
S23	5.500	4.000	3.250	3.000	2.250	—	—	0.313
S24	4.000	3.000	2.250	1.000	0.875	0.196	0.534	0.166
S25	2.250	4.250	2.750	1.500	1.125	—	—	0.212
S26	6.000	6.500	4.500	4.000	3.250	—	—	0.433
S27	4.750	4.750	4.000	3.250	2.000	—	—	0.340
S28	5.750	6.500	3.750	2.750	3.250	—	—	0.369

Note. Also included are derived *k* values, proportions of variance accounted for by means of the hyperbolic model (r^2), and areas under the curve (*AUC*).

Table 1c
Indifference points for 2000 baht money at each delay

	2000-Baht Money Condition							
	Delay (months)							
	6	12	60	120	240	*k*	r^2	*AUC*
S31	1650.0	1150.0	750.0	450.0	250.0	0.038	0.936	0.298
S32	550.0	175.0	10.0	10.0	10.0	0.531	0.921	0.033
S33	1150.0	450.0	250.0	175.0	75.0	0.167	0.891	0.123
S34	1700.0	1350.0	950.0	750.0	450.0	0.019	0.882	0.413
S35	1400.0	750.0	450.0	350.0	175.0	0.088	0.877	0.210
S36	500.0	550.0	75.0	10.0	10.0	0.370	0.833	0.061
S37	950.0	850.0	600.0	10.0	10.0	0.128	0.768	0.143
S38	1000.0	900.0	550.0	400.0	225.0	0.103	0.505	0.241
S39	1000.0	1450.0	950.0	450.0	175.0	0.037	0.474	0.320
S40	1300.0	1300.0	1200.0	650.0	350.0	0.021	0.443	0.403
S41	1500.0	500.0	900.0	450.0	325.0	0.075	0.217	0.286
S42	1100.0	900.0	450.0	175.0	10.0	0.108	0.940	0.162
S43	1300.0	825.0	1000.0	1045.0	977.5	—	—	0.506
S44	650.0	1050.0	1200.0	750.0	550.0	—	—	0.424
S45	350.0	600.0	225.0	350.0	75.0	—	—	0.151
S46	1050.0	950.0	400.0	225.0	75.0	0.107	0.925	0.176
S47	1500.0	1050.0	1000.0	700.0	350.0	—	—	0.378
S48	1350.0	1250.0	850.0	200.0	200.0	0.045	0.867	0.258
S49	750.0	450.0	400.0	75.0	75.0	0.256	0.746	0.116
S50	550.0	225.0	225.0	75.0	125.0	0.461	0.678	0.087

Note. Also included are derived *k* values, proportions of variance accounted for by means of the hyperbolic model (r^2), and areas under the curve (*AUC*).

Table 1d
Indifference points for 100 kg rice at each delay

	100-kg Rice Condition							
	Delay (months)							
	6	12	60	120	240	*k*	r^2	*AUC*
S31	82.500	47.500	45.000	40.000	20.000	0.028	0.433	0.388
S32	40.000	0.500	0.500	0.500	0.500	0.421	0.675	0.027
S33	82.500	57.500	42.500	22.500	25.000	0.031	0.809	0.340
S34	87.500	82.500	72.500	55.000	47.500	0.006	0.791	0.615
S35	52.500	37.500	35.000	20.000	8.750	0.107	0.330	0.243
S36	52.500	47.500	25.000	5.000	3.000	0.106	0.896	0.162
S37	99.500	99.500	99.500	15.000	0.500	0.012	0.686	0.431
S38	50.000	32.500	17.500	20.000	15.000	0.146	0.477	0.213
S39	85.000	85.000	82.500	52.500	17.500	0.008	0.816	0.556
S40	67.500	55.000	40.000	22.500	8.750	0.048	0.806	0.288
S41	77.500	57.500	40.000	35.000	7.500	0.034	0.813	0.337
S42	65.000	75.000	32.500	8.750	17.500	0.042	0.869	0.263
S43	50.000	50.375	48.750	48.500	48.125	—	—	0.494
S44	50.000	42.750	44.625	34.000	8.750	—	—	0.323
S45	47.500	30.000	27.500	15.000	20.000	—	—	0.226
S46	50.000	52.500	45.000	50.000	27.500	—	—	0.442
S47	85.000	77.500	99.500	99.500	99.500	—	—	0.967
S48	62.500	57.500	55.000	47.500	32.500	—	—	0.476
S49	17.500	27.500	15.000	8.750	0.500	—	—	0.116
S50	17.500	17.500	42.500	0.500	0.500	—	—	0.135

Note. Also included are derived *k* values, proportions of variance accounted for by means of the hyperbolic model (r^2), and areas under the curve (*AUC*).