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INTERTEMPORAL DECISION-MAKING FOR A GROUP

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Abstract

Temporal discounting assessments measure the reduction in the subjective value of a reward as a function of the delay to that reward, and are correlated with behavior in social dilemma. Among the solutions proposed for defection in social dilemmas is a single individual making the decisions for the group. The present study examined the influence of group context on temporal discounting. Participants completed temporal discounting procedures when the outcomes affected only the individual and when outcomes affected a group of 10, including the individual. Though no overall difference was observed between the individual and group conditions, sex was found to be a moderating variable: Males discounted significantly more when discounting for the individual, but females discounted significantly more when discounting for the group. These results indicate that sex is an important variable when making intertemporal decisions for a group.

Keywords

decision-making; group; temporal discounting; gender

Behavioral economics describes temporal discounting as a “decrease in the subjective value of a commodity as a function of the amount of and delay to that commodity, or reward” (Bickel et al., 2007, p. 88). Demographic variables are related to an individual’s degree of temporal discounting: Studies have discovered that children typically discount delayed rewards more than adults (Green, Fry, & Myerson, 1994; Green, Myerson, & Ostaszewski, 1999; Whelan & McHugh, 2009). In addition, various forms of maladative behaviors have been shown to be associated with high rates of temporal discounting (Reimers, Maylor, Stewart, & Chater, 2009), including substance abuse (reviews in Bickel & Marsch, 2001; Reynolds, 2006; Yi, Mitchell, & Bickel, 2009) and pathological gambling (Dixon, Marley, & Jacobs, 2003).

Some scientists have theorized that intolerance for delay indicated by a high rate of discounting is similar to defection in social dilemmas (Ainslie, 1992; Rachlin, 2000): Defection in a reciprocal environment results in larger immediate outcomes but smaller delayed outcomes. Studies have confirmed this relationship, finding significant correlations between discount rate and defection in an iterated prisoner’s dilemma game (Harris & Madden, 2002; Yi, Buchhalter, Gatchalian, & Bickel, 2007; Yi, Johnson, & Bickel, 2005). In these studies, participants played an iterated prisoner’s dilemma games versus a computer

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opponent that applied a tit-for-tat strategy; the computer cooperated on the first trial and then reciprocated the participant's previous choice on the next trial. Against this opponent, the participant's optimal strategy is to cooperate on all trials. Individuals who exhibited suboptimal behavior in this social dilemma (i.e., did not cooperate) exhibited high rates of temporal discounting.

An extensive body of research has examined the variables that improve (optimize) behavior in social dilemmas. Two related solutions that have been proposed to address social dilemmas are to increase group identity and to elect a leader. Both solutions may have in common increased feelings of personal responsibility (Fleishman, 1980) resulting from a perception that individual actions are representative of a larger social entity (Messick & Brewer, 1983). Kramer and Brewer (1984; Brewer & Kramer, 1986) have in fact shown that participants demonstrate individual restraint in social dilemmas when labeled as members of a common group. Relatedly, the belief that individual decisions will affect others may also result in greater responsibility (Messick & Brewer, 1983).

Given enhanced cooperative behavior when individuals make decisions that affect a group, the present article explores temporal discounting when the choices of the individual affect others as well as the self. The psychological processes an individual employs when making intertemporal decisions that affect the group should share features of the processes employed when making intertemporal decisions that affect only the self. Thus, we expect that the mathematical description of the discounting behavior (the hyperbolic model) applies to both types of discounting processes. Furthermore, measures obtained from both discounting procedures should be related (positively correlated). However, intertemporal decisions should be different; more "optimal" decisions should be made when an individual's choices affect the group than when the choices only affect him or her, and temporal discounting should be reduced within the group context. We note that while Rachlin and Jones have examined discounting as a function of interpersonal distance (Jones & Rachlin, 2006; Rachlin & Jones, 2008a, 2008b), that literature is not directly relevant to the reported study.

Method

Participants

Sixty participants (20–61 years of age) were recruited locally. Three participants were excluded from analyses (2 as outliers and 1 with missing data). The data from the remaining 57 participants (31 female, 26 male), with a mean age of 33.09, were included in all analyses.

Apparatus and Procedure

Participants completed all procedures in one experimental session. Participants first completed the temporal discounting procedure for the individual, followed by a set of assessments unrelated to this article and not reported here, followed by the temporal discounting procedure for the group. Participants were monetarily compensated for completing all assessments.

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Temporal discounting for the individual (TDI)—During each trial of this computerized procedure, participants were asked to choose between two outcomes for the self: a hypothetical amount of money available immediately and a hypothetical $1,000 following a delay. The alternatives were presented on a laptop computer monitor, with the immediate and delayed alternatives listed left of center and right of center, respectively. Participants indicated preference by clicking on the preferred alternative using a computer mouse. Based on the algorithm of Holt, Green, and Myerson (2003), the immediately available alternative increased or decreased over six trials to determine the indifference point for delayed $1,000. Indifference points were obtained at delays of 1 day, 1 week, 1 month, 6 months, 1 year, 5 years, and 25 years.

Temporal discounting for the group (TDG)—This procedure was completed using a paper questionnaire. Participants were asked to choose between two outcomes for a group of 10 people (the self and 9 unknown others): a hypothetical amount of money available immediately and a hypothetical $10,000 following a delay. Participants were asked to assume that the outcomes would be divided equally among the 10 people; the amounts and number of people were selected so as to be easily and transparently divisible and so that when divided 10 ways, the outcome for the individual would be identical to the TDI condition. Similar to the procedure of Yi, de la Piedad, and Bickel (2006), each sheet of the paper assessment listed a column of money amounts available immediately (left of center) and a column of $10,000 available following a specific delay (right of center). The delays were 1 week, 1 month, 6 months, 1 year, and 5 years. The left column had ascending or descending values in 5% increments of $10,000, resulting in 21 rows where the participant had a choice between immediate and delayed outcomes. Participants indicated preference by marking an "X" next to the preferred alternative for each pair of alternatives. Participants completed both ascending and descending immediate-amount conditions, in counterbalanced order. The indifference point was calculated as the arithmetic mean of the largest immediate value for which the delayed alternative was preferred and the smallest immediate value for which the immediate alternative was preferred.

Statistical Analysis

Indifference points obtained from the 1-day and 25-year delays from the TDI condition were excluded to equate the TDI and TDG delays used to obtain the discounting parameter. Nonlinear regression was used to determine discounting parameters (k) for both TDI and TDG procedures. Mazur's (1987) hyperbolic discounting model was fit (Equation 1) to the obtained indifference points:

$$V=\frac{A}{1+kD}, \quad (1)$$

where V represents the present subjective value of delayed outcome, A refers to the amount of the outcome, D is equal to the delay, and k is a reliable free parameter (Simpson & Vuchinich, 2000) that indicates the rate of discounting. A high k value indicates impulsiveness, or an unwillingness to wait for the larger, delayed alternative, while a low k value indicates self-control, or a willingness to wait. The standard exponential function (Equation 2) was also fitted to indifference points:

$$v_d = Ve^{-kd} \quad (2)$$

This function is frequently included with the hyperbolic function as a point of comparison.

Other than model-comparisons, identical statistical analyses using area-under-the-curve (AUC) were conducted to confirm results obtained by using discount rate *k*. AUC is a model-free method of determining a discounting parameter.

Results

First, the hyperbolic (Equation 1) and exponential (Equation 2) models of discounting were compared with a repeated-measures *t* test on the standard deviation of the residuals, a measure of prediction error. The hyperbolic model ($\bar{X}$ = .098) provided a better fit to data from TDI compared to the exponential model ($\bar{X}$ = .112; *t*[56] = 4.06, *p* < .001). The same result was obtained when using data from TDG, with the hyperbolic model (= .106) providing a better fit than the exponential model ($\bar{X}$ = .126; *t*[56] = 4.85, *p* < .0001). From this point, the discount rates obtained from the hyperbolic model are considered. Because the distribution of *k* is nonnormal, estimated *k*s were normalized with the natural logarithm transformation. Unless stated otherwise, all parametric analyses were conducted with these ln(*k*) values. Pearson correlations were computed on log-transformed discount rates to evaluate the relationship between TDI and TDG. The analysis as seen in Figure 1 revealed a positive and significant correlation (*r* = .76, *p* < .05), indicating that individuals who highly discount delayed rewards for the self also highly discount delayed rewards for the group (and vice versa). A significant and positive correlation was also observed using AUC.

A repeated measures analysis of variance (ANOVA) was conducted having sex (male vs. female, an among-individuals factor), condition (TGI vs. TDG, a within-individual factor), and their interaction as factors (see Figure 2). Sex was included because preliminary data management suggested that it was a moderating variable. The comparison of TDI ($\bar{X}$ = −7.01) and TDG ($\bar{X}$ = −7.06) was not significant, *F*(1, 55) = 0.06, *p* = .815); males ($\bar{X}$ = −6.16) discounted more than females ($\bar{X}$ = −7.92; *F*[1, 55]= 9.23, *p* = .004), and the condition × sex interaction was significant, *F*(1, 55) = 11.12, *p* = .002. These results were confirmed in statistical analyses using AUC measures. Simple effects analyses were examined to clarify this interaction.

TDI and TDG were compared for each sex. Mean discount rates were higher in TDI than TGD, *F*(1, 55) = 5.86, *p* = .019, for males. In contrast, mean discount rates were higher in TDG than TDI, *F*(1, 55) = 5.27, *p* = .026, for females. Though the same pattern of results was observed using AUC measures, the differences were not statistically significant (*p* = 0.06 and *p* = 0.16 for males and females, respectively). To examine this further, males and females were compared in each discounting condition. Males discounted significantly more than females in TDI, *F*(1, 55) = 16.02, *p* < .001), but not so in TDG, *F*(1, 55) = 2.89, *p* = .095. Males discounted significantly more than females in both TDI and TDG using AUC measures (*p* < .05).

Discussion

The present results provide initial indication that group and individual temporal discounting processes are similar; like discounting when decisions are only for the self, indifference points when decisions are for the group monotonically decreased as a function of delay. Furthermore, the hyperbolic model was superior to the exponential model in both conditions, consistent with previous comparisons (Kirby & Markovic, 1995; Madden, Bickel, & Jacobs, 1999). A highly significant and positive correlation between group and individual discount rates indicates relatedness of the discounting processes within individuals.

Overall, no differences in discounting between conditions were observed. This was surprising given the theoretical rationale for a decrease in temporal discounting when individual decisions affect the group (i.e., the TDG condition). However, the analysis did reveal a moderating effect of sex. That males discount more than females overall has been previously observed (Kirby & Markovic, 1996). However, the condition × sex interaction indicated that the TDI and TDG conditions had different effects on males and females. Males discounted less in the group condition than in the individual condition, while females discounted more in the group condition than in the individual condition. This provides one explanation for the lack of a main effect for the comparison of TDI and TDG.

A review of the literature examining the influence of sex on related group processes reveals mixed results (see Eckel & Grossman, 2008, for a review). Some research suggests that females are less cooperative in public goods dilemmas (Brown-Kruse & Hummels, 1993; Sell, 1997; Sell, Griffith, & Wilson, 1993; Sell & Wilson, 1991), and this is consistent with the present results. However, other studies indicate that females are more cooperative (Nowell & Tinkler, 1994; Seguino, Stevens, & Lutz, 1996) or that males and females behave similarly (Cadsby & Maynes, 1998). And in Dictator games, where one individual dictates the distribution of a resource for another individual, females are more cooperative (Andreoni & Vesterlund, 2001; Bolton & Katok, 1995; Eckel & Grossman, 1998). Though the structures of these social dilemmas (e.g., number of trials, identifiability of the “other”) certainly influence the specific outcomes observed, the sex of the participant does appear to be a moderating variable, and, important for the purpose of this study, reduction in cooperative (i.e., self-controlled) behavior for females in a group context is not unprecedented.

As an initial attempt to examine temporal discounting for a group, this study had a number of limitations. A principal limitation of the study was that different methodologies were used to collect individual (computerized) and group (questionnaire) discounting data. These conditions also differed in the number of delays, though only identical delays were incorporated into the analysis. These differences may have contributed to the lack of overall difference observed between the individual and group conditions. There is evidence that different methodologies can result in different discount rates (Epstein et al., 2003; Kowal, Yi, Erisman, & Bickel, 2007; Navarick, 2004; Robles & Vargas, 2007, 2008). However, the single study to compare paper and computerized binary choice procedures (Smith & Hantula, 2008) found no difference in discount rate, calculated either as *k* (as in the present study) or as AUC. Nevertheless, the TDI and TDG did not simply differ in modality; though both were binary choice procedures, other dissimilarities preclude the dismissal of procedural difference as possible explanations for the nonsignificant differences in the individual and group conditions. A second limitation of the present study was the use of hypothetical outcomes. Though intertemporal decision making for hypothetical outcomes has not been found to differ from real outcomes (Madden, Begotka, Raiff, & Kastern, 2003; Madden et al., 2004), we cannot rule out this possibility. A final limitation of the present study was that the order of the conditions was fixed rather than counterbalanced. We acknowledge that these limitations temper the interpretation of the obtained results and are mindful that the implications are not definitive. Thus, future studies should collect individual and group discounting assessments using the same procedure. Other variables of interest include the size of the group in the TDG condition, as well as the level of affiliation with group members (e.g., family/friends, strangers, enemies).

Though the present results must be considered with some reservation, this article is a preliminary attempt to examine temporal discounting processes when decisions affect others directly and is suggestive of possible effects of group context. Results indicate that the present subjective value of a delayed outcome for a group decreases monotonically as a function of delay, and that the hyperbolic model is a better descriptor of these values than the exponential model. Though no overall difference was observed between discounting for the individual and discounting for the group, it seems that sex is a moderating variable. Given that a high rate of temporal discounting characterizes drug-dependent populations (see reviews in Bickel & Marsch, 2001; Reynolds, 2006; Yi et al., 2009), pathological gamblers (Alessi & Petry, 2003; Dixon et al., 2003), schizophrenics (Heerey, Robinson, McMahon, & Gold, 2007), obese women (Weller, Cook, Avsar, & Cox, 2008), and a host of other populations with disordered behavior, this line of research may have implications for the theoretical interpretations of psychiatric and behavioral disorders, as well as for possible treatment approaches. Perhaps conceptualization of intertemporal decisions within a context where the consequences are not limited to the individual but shared by others will reduce temporal discounting associated with a diverse set of problematic behaviors.

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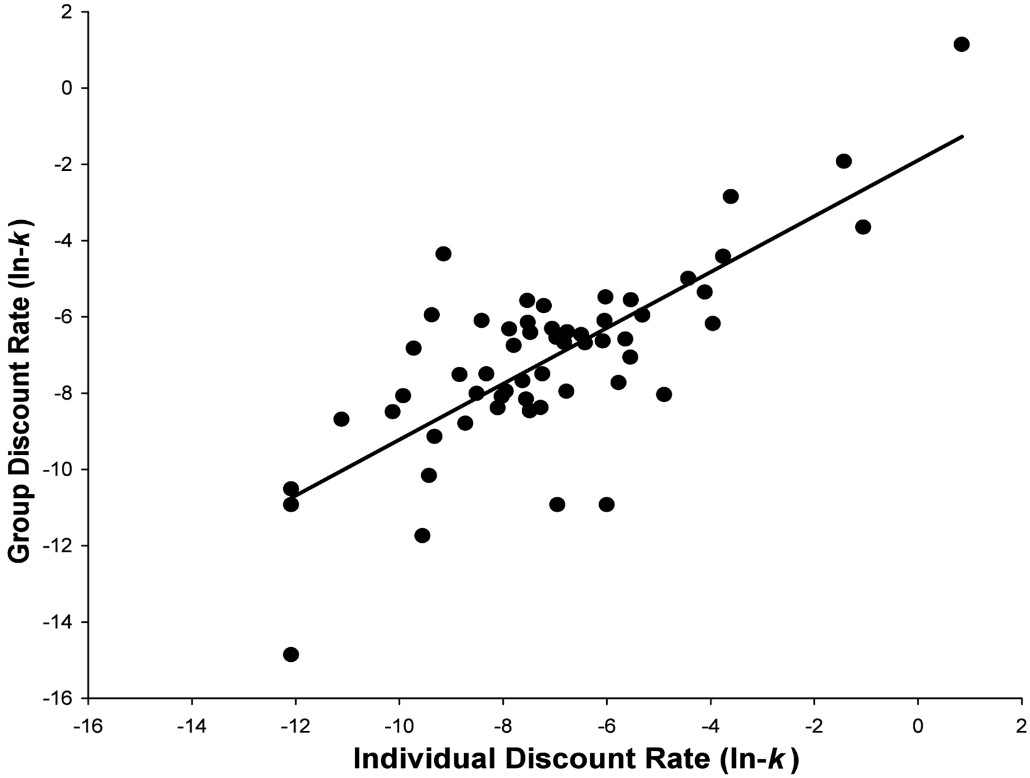

Figure 1.

A scatter plot indicating the relationship between discounting measures observed in the individual and group discounting conditions. There is a positive and significant correlation between log-transformed discount rates in the TDI (*x*-axis) and TDG (*y*-axis) conditions.

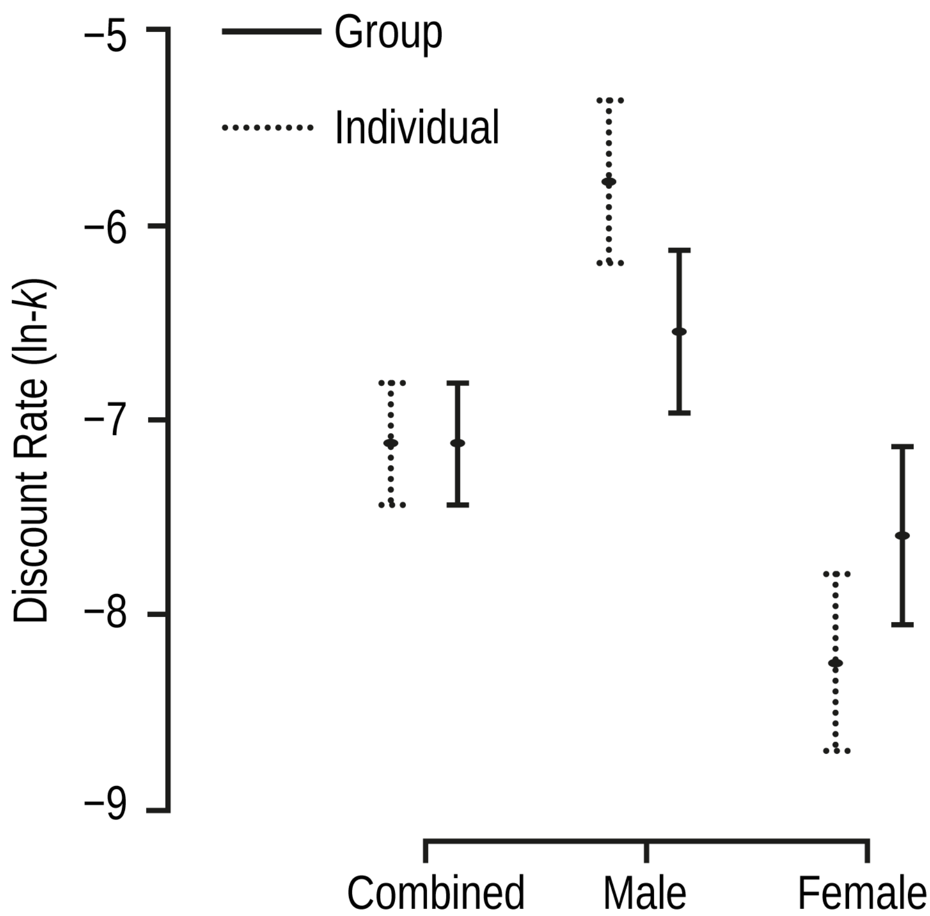

Figure 2.
Graph showing relevant comparisons, where the solid and dotted lines represent means and standard errors in the group and individual conditions, respectively. Across sex, no difference is observed between the log-transformed discount rates of the two conditions. Dividing along sex reveals significant differences. Males discount more in individual than in group conditions, whereas females discount more in group than in individual conditions.