A common incentive used to induce students to serve as subjects in psychological research is course credit, in which hours of participation in research serve as a required component of the student’s final grade in introductory psychology courses. Kangas and Hackenberg (2009) recently examined its use in human operant research and showed that following a period of infrequent use in the 1970s and early-1980s, the use of course credit became very prevalent in the mid-1980s and 1990s, and remains a common practice today. The most recent survey data indicate that 32% of undergraduate psychology departments have subject pools (Landrum & Chastain, 1999), and when surveying only those departments with a graduate program, the prevalence dramatically increases to 74% (Sieber & Saks, 1989). A major advantage of course credit is its economy. Because subjects are compensated in non-monetary ways, many data can be collected at relatively low costs.

Given the high prevalence of course credit contingencies in human research, several researchers have investigated the practice. For example, opportunities to earn course credit through research participation are typically distributed throughout the semester, but students are able to sign up to participate at the time of their choosing. Previous studies have found correlations between various personality traits and the likelihood of signing up early or late in the semester. Questionnaire-derived measures of achievement motivation, conscientiousness, compliance, and internal locus of control all predict a student’s likelihood of signing up for credits earlier in the semester, while questionnaire-derived measures of extraversion and openness predict later-term participation (e.g., Aviv, Zelenski, Rallo, & Larsen, 2002; Bender, 2007; Evans & Donnerstein, 1974; Witt, Donnellan, & Orlando, 2011; Zelenski, Rusting & Larsen, 2003). Impulsivity is another trait variable that has consistently correlated with late-term signing up (e.g., Aviv et al., 2002; Zelenski et al., 2003). In these studies, impulsivity was assessed using comprehensive personality testing questionnaires such as the NEO PI-R (Costa & McCrae, 1992).

What remains unclear, however, is whether course credit sign-up date correlates with a behavioral measure of impulsivity. In the human operant laboratory, impulsivity is often measured using a choice procedure known as a delay discounting task which asks subjects to make (usually hypothetical) decisions about whether they would rather have a smaller amount of money immediately or a larger amount of money after some delay. This behavioral measure of impulsivity is commonly used largely due to the fact that impulsivity as a behavioral process seems to underlie many behavioral classes (see Madden & Bickel, 2010). Behavioral measures of impulsivity have been correlated with a number of negative outcomes, including an increased tendency to abuse drugs (e.g., Bickel & Marsch, 2001; de Wit, 2008), be obese (e.g., Weller, Cook, Avsar, & Cox, 2008), and obtain lower a GPA in college (e.g., Kirby, Winston, & Santiesteban, 2005). However, questionnaire-based measures like those cited above do not always correlate with behavioral measures of impulsivity, such as delay discounting (Lane, Cherek, Rhoades, Pietras, & Tcheremissine, 2003; Mitchell, 1999; Reynolds, Ortengren, Richards & de Wit, 2006). For example, Lane et al. (2003) administered 4 questionnaire-based measures of impulsivity to 32 subjects, and then had the

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same subjects complete 5 behavioral measures of impulsivity, including a delay discounting task. Only one significant correlation was found between any of the behavioral and questionnaire-based measures (hypothetical delay discounting and the Attention-Impulsivity subscale of the Wender Utah Rating Scale). Similarly, Reynolds et al. (2006) administered several psychometric tests and behavioral measures of impulsivity to two large groups of subjects and found no significant correlations between the behavioral and self-report measures. Therefore, the purpose of the present study was to determine whether a behavior-based measure of impulsivity correlated with research participation sign-up date.

A second reason for examining the course credit practice with a delay discounting task is that studies of delay discounting very often use these course credit contingencies to obtain their data (e.g., Jones & Rachlin, 2009; Radu, Yi, Bickel, Gross, & McClure, 2011; Weatherly, Terrell, & Derenne, 2010). Therefore, the present study was designed to allow for integration into an existing body of work on delay discounting by using a behavioral delay discounting measure instead of a questionnaire-based measure, which has more empirical support as a valid indicator of impulsivity. Furthermore, we hope to inform the use of these course credit contingencies to obtain such data by determining if systematic bias along the dimension of sign-up time exists in our sample. And if so, what are the implications for the use of course credit to induce participation in such experiments?

METHOD

Subjects

Thirty-eight students (8 males, 30 females) enrolled in an Introduction to Psychology course at the University of Florida completed the delay discounting task in partial fulfillment of their course requirements. Specifically, students were required to obtain 6 research credits, and could earn 1 credit for each half hour of research participation. Completing the present study fulfilled 2 credits. Research credits counted directly toward student’s grades in their courses: syllabi were arranged such that in order to earn an A, all 6 research credits must be obtained. An A was not possible, regardless of course work, without completing all credits. Credits benefited all students equally, even if they did not earn an A in the class, and all students were eligible to participate in this study. Students who read the informed consent and declined to participate would still have been given 1 credit; however, all participants who read the informed consent agreed to fully participate.

Students were able to sign up for session times through an online scheduling system that coordinated all available studies throughout the psychology department. Furthermore, because there was no guarantee that research availability would be evenly distributed across the semester, students were strongly encouraged to earn all credits as soon as possible. Credits were made available two weeks before the scheduled session and up to 24 hours in advance of the session. A majority of subjects signed up for timeslots within a few days of their scheduled time, as was evident from the pattern of timeslot occupancy across the month.

Procedure

The delay discounting procedure used in the present study was described in detail in Dallery and Raiff (2007). Briefly, following informed consent and a brief demographics questionnaire, the following instructions were read aloud by the research assistant:

“I am going to present you with a choice between two amounts of money. Please pretend that the two options are for real money, and choose whichever of the two options you would prefer. There are no wrong answers.”

The research assistant then initiated a computer program that automatically generated a choice between $100 available after a fixed delay, and an immediately available amount of money that adjusted based on the subject’s choices. The research assistant then verbally asked the subject to choose between the immediately available amount of money and the delayed amount of money in the following format:

“Would you rather have _____ dollars right now, or wait _____ for 100 dollars?”

The delayed value remained at $100 across all trials. The amount of money available now started at either $0 or $100 (selected randomly), and adjusted upward 15% if the delayed value was chosen on that trial, and downward 15% if the “now” value was chosen on that trial. The research assistant then clicked a button corresponding to the subject’s choice. Trials continued for a minimum of 8 trials.
RESULTS AND DISCUSSION

Figure 1 presents the AUC (Eq. 1) of all 38 subjects plotted as a function of ordinal session number. Each value plotted represents the AUC of one subject. The session variable is an ordinal position that was assigned to each subject and indicates the sequence in which the subjects enrolled in the study. The brackets underneath the abscissa indicate the month in which each ordinal session occurred. Ordinal session number, instead of date, was chosen as the variable of interest because it more accurately reflects the successive opportunities the subjects had to sign up for credit. Larger AUC values indicate lower rates of discounting, while smaller AUC values indicate higher rates of discounting. Therefore, if a relationship exists between time of participation and impulsivity, we should expect to see relatively larger AUC’s earlier in the semester, and relatively smaller AUC’s later in the semester. As the figure shows, a negative correlation between AUC and ordinal session number of study participation was observed, indicating that subjects who signed up later in the semester were, on average, more impulsive on this common delay discounting task per delay and a maximum of 12 trials per delay until the subject’s choices indicated that they were indifferent between an amount of money available immediately and $100 after that particular delay. After an indifference point was reached, the procedure was repeated with a new delay value. Eight delay values (1 week, 2 weeks, 1 month, 4 months, 8 months, 1 year, 5 years, and 10 years) were presented across blocks of trials in a random order.

The data were analyzed using an atheoretical approach known as Area Under the Curve (AUC) to calculate rates of discounting (Myerson, Green, & Warusawitharana, 2001). After normalizing the subjective amounts (with respect to the delayed amount; in this case, $100) and the delay values (with respect to the highest delay value), each successive pair of points along the curve are treated as the four corners of a distinct, trapezoidal area and then summed. The area under the curve is calculated using the following formula:

\[
AUC = \sum x_2 - x_1 \left(\frac{y_1 + y_2}{2}\right)
\]

where \(x\) and \(y\) refer to the delay and subjective amount values, respectively, in each coordinate pair. AUC values can range from 1 (no delay discounting) to 0 (maximum delay discounting).

As the present data indicates, course credit contingencies may engender systematic differences in the research subject pool. However, it is currently unclear whether other incentives for participation would differ. For example, when compensated with money, participants may likely be recruited at a fairly even pace leaving fewer differences in participants across time. In contrast, our data indicates that the population brought in by course credit contingencies may change over time: that is, students who have done poorly over the semester and find they need the extra credits, or who have failed to adequately plan for requirement completion, may rush to sign up later in the semester. This pattern would leave studies conducted towards the end of a semester with a higher proportion of under-achieving, and potentially impulsive, students. Empirical comparison of studies conducted with the same population of students, differing only in reinforcement contingency, would illuminate other potential differences in participant makeup over time, as well as any other systematic differences. To be sure, a perfectly representative sample will remain elusive if researchers continue...
to heavily rely on undergraduate subject pools. In the meantime, we suggest that investigators using course credit contingencies consider that sign-up time may influence the composition of their sample, and either sample from the same sign-up time frame or ensure that all available timeframes are equally represented across all phases of the experiment.

As with all correlations, it is important to emphasize the lack of causal direction in the relationship between delay discounting and time of participation. Nevertheless, these results suggest implications for human operant researchers who make use of available research subject pools. These data indicate that college students who delay completing their research credits (and thus might be colloquially called impulsive) are more likely to show steeper rates of discounting on this common experimental task, and may have other systematically different behavioral traits as well. Therefore, researchers who use course credit contingencies to induce participation, especially when studying the effects of variables on rates of discounting, may attempt to stratify their samples based on signup time. Moreover, these results suggest that if the prevalence of course credit contingencies to induce participation in research remains high, it may be worthwhile to empirically investigate this standard practice more carefully in its own right, as additional unintended effects on research outcomes may very well exist.

Figure 1. Relationship between AUC and ordinal session number. Each value represents the AUC for an individual subject. Line denotes a best-fit simple linear regression minimizing the sum of squared residuals from a general polynomial linear equation. Brackets indicate the calendar month in which each session took place.
REFERENCES


