

Cloninger's Psychobiological Model of Temperament and the Discounting of Delayed and Effortful Outcomes Among Adolescents^{*}

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The aim of the presented study was to investigate the relationship between Cloninger's personality dimensions of temperament (Harm Avoidance, Novelty Seeking, Reward Dependence, and Persistence) and rates of delay and effort discounting among adolescents. Generally speaking, discounting refers to a decrease in the subjective value of a reward as its delay (delay discounting), or an effort required to obtain the reward (effort discounting) increases. 198 adolescents participated in the experiment, ranging in age from 13 to 18 years. Data was collected using paper-and-pencil Junior Temperament and Character Inventory and computerized Delay and Effort Discounting Questionnaire. The analysis has indicated that the more one tries to avoid harm, the more steep his effort discounting is. The same is truth for reward dependency. At the same time, a positive correlation between the rate for effort and delay discounting was revealed. Thus, both processes cannot be treated completely separately.

Keywords: delay discounting, effort discounting, Cloninger's psychobiological theory, temperament

Introduction

Discounting is a behavioral measure of decision-making and refers to a decrease in the subjective value of a reward following an increase in the value of a specific environmental factor that the reward is contingent on. The type of discounting most often studied within behavioral psychology is temporal discounting (also known as delay discounting; i.e., decrease of the subjective value of a reward as delay to its receipt increases; for a review, see Green & Myerson, 2004), because it is recognized as a possible mechanism of impulsive behavior (for a review see Madden & Bickel, 2010). On the other hand, there is much less research on effort discounting (i.e., decrease of the subjective value of a reward, when effort required to obtain the reward increases). To the author's best knowledge, there are only a few studies published on this topic within behavioral psychology (Malesza & Ostaszewski, 2013; Mitchell, 1999, 2004; Ostaszewski, Bąbel, & Swebodziński, 2013; Sugiwaka & Okouchi, 2004). However, there is a growing number of results showing the involvement of neurobiological factors in determining the rate of temporal discounting and of effort discounting, showing that the nucleus accumbens has been implicated in playing a fundamental role in certain forms of decision-making, as inactivation of its function reduces preference for larger rewards that are either delayed, or associated with a greater effort cost (e.g., Cardinal, Pennicott, Sugathapala, Robbins, & Everitt, 2001; Hauber & Sommer, 2009;

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Ishiwari, Weber, Mingote, Correa, & Salamone, 2004; Walton, Kennerley, Bannerman, Phillips, & Rushworth, 2006).

This lack of behavioral studies done on effort discounting seems unfortunate, because effort constitutes an important factor in everyday decision-making. Steep discounting of different outcomes is associated with abuse of a board range of substances. Individuals who abuse nicotine (Baker, Johnson, & Bickel, 2003), alcohol (Petry, 2001), cocaine (Coffey, Gudleski, Saladin, & Brady, 2003), and heroin (Kirby & Petry, 2004) discount delayed rewards more steeply than controls. These findings are often interpreted as implying that individuals who steeply discount delayed outcomes are impulsive (Ainslie, 1975).

Since both delay and effort discounting play a fundamental role in behavior and are natural processes, observed and studied in humans (e.g., Mitchell, 1999, 2004; Rachlin, Raineri, & Cross, 1991), the author was specifically interested in relations of the two types of discounting to biologically grounded dimensions of temperament proposed by Cloninger (1986). According to Cloninger's psychobiological theory of personality (Cloninger, 1987; Cloninger, Przybeck, Svrakic, & Wetzel, 1994; Cloninger, Svrakic & Przybeck, 1993) temperament reflects the basic organization of independently varying brain systems for the activation, maintenance and inhibition of behaviour in response to stimuli and include basic emotional response patterns. Cloninger's (1986; 1987) initial elaborations of his psychobiological model of personality included three dimensions of temperament: Novelty Seeking, Harm Avoidance, and Reward Dependence. Formulations of these temperament dimensions included descriptions of their hypothesized associations with neuroanatomy and neurophysiological processes, behavioral tendencies (e.g., approach, avoidance, escape), and sensitivity to various environmental events (e.g., novelty, reward, punishment; Cloninger, 1997). Further studies showed that one of the Reward Dependence subscales (i.e., Persistence) was relatively independent of the three postulated temperament dimensions (Cloninger, 1987). This fact was consequently included as an additional independent temperament dimension (Cloninger et al., 1993; Cloninger et al., 1994). Recently, the model was extended by including three character dimensions in order to be more comprehensive and to improve the assessment of personality disorders (Cloninger et al., 1993). Thus, Cloninger's revised psychobiological theory of personality includes four temperament dimensions (Novelty Seeking, Harm Avoidance, Reward Dependence and Persistence) and three character dimensions (Self-Directedness, Cooperativeness and Self-Transcendence), and allows the assessment of personality disorders (Cloninger et al., 1994).

It is worth mentioning that Cloninger's model is also related to clinical issues and is one of the more popular models in current psychiatric practice and research to describe individual differences in psychopathological behaviour. In addition, recent study tested the utility of Cloninger's temperament theory in predicting early-onset substance problems (Hartman, Hopfer, Crowley, Corley, Hewitt, & Stallings, 2013). Overall, this study provides evidence that Cloninger's theory may hold true for predicting problem use of alcohol, cigarettes, and illicit drugs among adolescents. Moreover, because the discounting process has important implications for many clinical and social problems related to impulsive behavior (e.g., Critchfield & Kollins, 2001; Manwaring, Green, Myerson, Strube, & Wilfley, 2011), it is important to know how individual differences in the steepness of discounting are related to personality traits relevant to clinical issues. In the current study, the relations between dimensions of temperament proposed by Cloninger and the rate of two types of discounting in adolescents sample was examined. No previously reported research has examined delay and effort discounting processes as related to Cloninger's temperament profiles among adolescents. However,

delay and effort discounting are logical measures to consider in relation to adolescents temperament profiles in that both have been predictive of discounting rates in adults (Malesza & Ostaszewski, 2013). Adolescents are overrepresented in most categories of risky and reckless behavior (Arnett, 1995). Studying how adolescents evaluate temporal and effortful rewards in a relation to temperament factors may illuminate why their behavior often differs from adults.

The behavior-analytic research on the discounting process of delayed and effortful conditions has paid little attention to the role that individual differences might play in such decision-making. An understanding and analysis of the discounting of delayed and effortful rewards is important for several reasons. In general, the utility of measuring discount rates will increase as the number of specific behavioral patterns predicted by discount rates increases (Green & Myerson, 2004). Thus, the present research looks for differences in the discounting rate between different groups based on the differences in temperament profiles. Investigation into this problem may give a more complete picture of discounting (e.g., a phenomenon relating to both delayed and effortful conditions which are an integral part of the consequences of human behaviour). Second, the way we approach delayed and effortful rewards is important for practical reasons because many important decisions depend on how we perceive the value of both outcomes. That is, there is every reason to suppose that the relation between temperament and the rate of discounting may be a fruitful avenue for further research, especially in light of the implications for a fuller understanding of self-control and various forms of addiction (Ostaszewski, 1997).

The Present Study

In order to empirically test associations between delayed and effortful outcomes and Cloninger's four-dimensional temperament model, a group of adolescents was tested, using temperament along with delay and effort discounting measures. These four temperament dimensions are supposed to be stable throughout life, highly heritable and underlined by specific neurotransmission systems. Novelty Seeking, the first of Cloninger's temperament factor, is defined as a tendency to respond actively to novel stimuli with impulsive and quick-tempered decision-making (Cloninger et al., 1993). Subjects with high scores on Harm Avoidance, the second temperament dimension, are thought to be pessimistic, worrying and are thought to manifest passive rapid fatigability or passive-avoidant behaviors such as the fear of uncertainty (Cloninger et al., 1993). Reward Dependence, the third dimension, is defined as a continuation of ongoing behaviors that have been previously associated with reinforcements, and is manifested as sentimentality and attachment (Cloninger et al., 1993). Finally, Persistence, the last temperament factor, reflects perseverance in behavior despite fatigue, frustration and lack of reward (Cloninger et al., 1994).

It was hypothesized that the higher one's Novelty Seeking and Reward Dependence, the steeper one's delay (Hypothesis 1) and effort discounting (Hypothesis 2), because Novelty Seeking is directly related to impulsivity and positive responses to stimuli that signal potential rewards, and because Reward Dependence is related to positive reactions to stimuli signaling a forthcoming reward (Cloninger et al., 1993). It was further assumed that the higher one's Harm Avoidance, the steeper one's effort discounting, because effort might be considered a type of punishment (Hypothesis 3; Cloninger et al., 1993). Finally, it was hypothesized that the higher one's Perseverance, the shallower one's effort discounting (Hypothesis 4), because it should be easier to fulfill effort requirements for people with a higher tendency to maintain behavior despite frustration or fatigue (Cloninger et al., 1993).

An additional aim of the study was to reveal if steepness of delay and effort discounting correlate with each other. As suggested by Rachlin, Logue, Gibbon, and Frankel (1986), one possible reason participants respond to probability discounting procedures in a risk-averse manner is that they spontaneously equate certainty in the probability discounting paradigm with immediacy. In analogous choice situations, an effortless option in a purely effort scenario should be delivered immediately. However, if an effortful option was chosen and delivered after giving an effort due to its effortful nature, then an indefinite delay is imposed on the delivery of that choice option. From this perspective, delay is incorporated into, and is an integral part of, the effort paradigm. As proposed by Sugiwaka and Okouchi (2004), one possible reason participants respond to effort discounting procedures in an effortless manner is that they spontaneously equate lack of effort in the effort discounting paradigm with immediacy. From this perspective, delay is incorporated into, and is an integral part of, the effort discounting paradigm. To choose an effortful option is to risk incurring a delay, and therefore represents loss of an immediate reinforcer. The expending of effort usually takes time, therefore effortful rewards are delayed. Thus, it was hypothesized that delay and effort discounting rates would be significantly positively correlated (Hypothesis 5). Results obtained from recent study (Malesza & Ostaszewski, 2013) where a positive correlation was observed between delay and effort discounting supported this hypothesis. Thus, this finding indicated that effort discounting was related to, but not equivalent to, delay discounting.

Methods

The study was designed and conducted using a within-subjects design, with each participant being exposed to all of the conditions of the experiment. Research participation involved the completion of several questionnaires and behavioral tasks, only two of which are reported here. Measures discussed here include computerized Delay and Effort Discounting Task, and the paper-and-pencil Junior Temperament and Character Inventory. Both discounting tasks were programmed in Z-Tree (Zurich Toolbox for Ready-made Economic Experiments). Following completion of the delay and effort discounting part of the experiment, participants were given Junior Temperament and Character Inventory to complete. All tasks were administered in the same order to all participants.

Participants

198 adolescents participated in the experiment (76 boys and 122 girls, ranging in age from 13 to 18 years, M = 15.8, SD = 1.15). Individuals under age 18 were recruited from a parent volunteer database. Individuals in the target age range were identified, telephoned, and invited to participate in a study. Individuals ages 18 and up were recruited through posted advertisements at the local university. Inclusion criteria included being 13–18-years-old, being a native German speaker, having normal or corrected-to-normal hearing and vision, and having no history of neurological or psychological illness, or mental retardation. These criteria were assessed through parent and child interviews using the German version Kiddie-SADS-Present and Lifetime Version (K-SADS-PL, Version 1.0.; Kaufman et al., 1997) and an in-house health questionnaire. All participants and parents provided informed consent or assent after the nature of the study had been explained to them. The Institutional Review Board at Max-Planck-Gesellschaft approved the research.

Materials

Junior Temperament and Character Inventory (JTCI). The Junior TCI (JTCI) is a self-administered questionnaire. Lubywith colleagues adapted the questionnaire for use with children (Luby, Svrakic, McCallum,

Przybeck, & Cloninger, 1999) from original version of Temperament and Character Inventory designed for assessment of adults (TCI; Cloninger et al., 1993; 1994). The German version of JTCI (Schmeck, Goth, Poustka, & Cloninger, 2001) was shortened from 105 items of original English version to 80 items (Novelty Seeking—12 items, Harm Avoidance—16 items, Reward Dependence—9 items, Persistence—5 items, Self-directedness—16 items, Cooperativeness—14 items, Self-transcendence—8 items). The German JTCI was provided with 'true-false' answers format for each of 80 items and adapted for use with children and adolescents between 12 an 18 years of old.

German version of JTCI is characterized, with the exception of harm avoidance (Cronbach's $\alpha = 0.81$), by medium but acceptable internal consistencies range for four scales (novelty seeking $\alpha = 0.67$, self-directedness $\alpha = 0.67$, cooperativeness $\alpha = 0.67$, self-transcendence $\alpha = 0.66$) but in an unacceptably low range for the two temperament scales reward dependence ($\alpha = 0.51$) and persistence ($\alpha = 0.48$). Thus, reliability of the German version of JTCI is somewhat lower than reliability of TCI for adults (studies done on e.g., American, German and Swedish samples) but in a similar range than reliability of JTCI in an American version (Richter, Brandstrom, & Przybeck, 1999; Schmeck, Goth, Poustka, & Cloninger, 2001).

Delay and effort discounting task. A computerized procedure developed for the purpose of studying choice behavior was used for assessing delay and effort discounting paradigm (adapted from Richards, Zang, Mitchell, & de Wit, 1999). Discounting was assessed at five delays intervals (1, 7, 30, 180, and 365 days later) and five values of effort intervals (3rd, 5th, 10th, 20th, and 30th floor). Each participant completed both discounting tasks.

On each delay task trial, participants chose between amount of money of \in 50 available after a delay (i.e., 1, 7, 30, 180, or 365 days) and a smaller amount available immediately (i.e., "Would you rather have \in 30 now or \in 50 in 30 days?"). On effort task trials, the choice was between a effortless amount of money or \in 50 available after putting an effort (i.e., climbing stairs up to a specified floor: the 3rd, 5th, 10th, 20th, and 30th floor) (i.e., "Would you rather have \in 20 without doing anything or \in 50 after climbing 10th floor?").

This computerized task used an adjusting amount procedure (adjusting the immediate amount in increments or decrements of $\pm \in 2$) to derive indifference points between the delayed standard and immediate adjusting options for each of the five delays assessed (or in case of effort discounting task: for each of the five floors number assessed). The immediate/effortless amount was determined by a random adjusting-amount procedure (Richards et al., 1999) involving random selection within a fixed interval that depends on previous participant's choices. The procedure was repeated until an indifference value was obtained for each delay/effort condition. Each indifference value was determined for each participant by taking the smallest amount of money at which the participant switched preference from immediate (effortless) instead of the delayed (effortful) standard amount (\in 50) at the specific delay (effort) (see Reynolds et al., 2003). Task instructions for both tasks appeared on screen and were read aloud.

Although the outcomes were hypothetical, participants were instructed to act as if they were real. Previous research has demonstrated that adults discount real and hypothetical rewards to similar degrees (Johnson & Bickel, 2002; Madden & Bickel, 2010), none of the studies compared discounting of real versus hypothetical outcomes by adolescents. Moreover, studies have found good test-retest reliability of discounting assessment methods (Beck & Triplett, 2009).

Analyses

Two methods were used to estimate rate of discounting. First, by estimating the individual discounting rate with the hyperbolic function (Madden & Bickel, 2010) using nonlinear regression, and second, by measuring the extent of individual discounting by using area under the curve (AUC; Myerson, Green, & Warusawitharana, 2001). Individual and group (median) indifference point data were fit to Equation (1) and Equation (2) using non-linear regression. Equation (1) for delay discounting data: V = A / (1 + kD), where V is the present subjective value of a reward of amount A to be received after a delay of D time units (e.g., Green & Myerson, 2004). The parameter k reflects the rate at which subjective value decreases. For effort discounting data Equation (2) was used: V = A (1+ lE) where V is the subjective value of a reward A, and E represents the effort required to obtain A. The parameter l represents the steepness of the effort discounting process (e.g., Sugiwaka & Okouchi, 2004). Moreover, to reduce error associated with random or random responding on the both discounting tasks, Johnson and Bickel's (2002) algorithm for defining non-systematic data for individual participants was used. Specifically, if any indifference point was 20% greater than the preceding indifference point, or if the last indifference point was not less than the first indifference point by at least 10% of value of the largest reward value, that individual's data were removed from analysis. The k and l parameters derived from Equations (1) and (2) provided a measure of discounting rate, which is tied to the hyperbolic discounting function (Data were also fit to the exponential model of discounting, but the hyperbolic function provided a better fit of the data). In order to verify the statistical significance of differences in the steepness of discounting, a second measure, area under the curve (AUC) (Myerson, Green, & Warusawitharana, 2001), was used also to provide an atheoretical measure of discounting rate that is more appropriate for parametric analyses than are k and *l* parameters, since outliers in these parameters may generate skewed distributions. Also, the AUC calculations tend to produce normal distributions and allow parametric statistics to be used. The lower the AUC, the more the curve approximates the axes, and therefore, the steeper the discounting.

Results

Equations (1) and (2) were fitted to the median of the subjective values (i.e., the indifference points) that were observed across all participants for each experimental condition (delay or effort discounting). The discounting function was also fitted to the data from each individual. For delay discounting, the hyperbolic model in Equation (1) accounted for 73.6% of the variance for the \notin 50 reward with k = 0.217. For effort discounting, the hyperbolic model in Equation (2) accounted for 96% of the variance for the \notin 50 reward with l = 0.46.

The hyperbolic model in Equation 2 was also fitted to the data from each individual. Table 1 summarizes the median discounting parameter l and the median amount of variance (with interquartile ranges) that was accounted for by the model for the fits to each individual for both the delay and effort conditions. For the delay discounting condition, the median value of R^2 for the reward was 0.828 (however, in nine individuals the model could not be fitted reliably, i.e., $R^2 = 0$). The median *l*-value was 0.037 for the effortful reward. For the effort discounting condition, the median value of R^2 for the \in 50 reward was 0.846 ($R^2 = 0$ for 16 individuals).

Individual delay and effort discounting patterns were categorized as systematic and nonsystematic on the basis of Johnson and Bickel's (2008) criteria for identifying atypical response patterns that suggest random or inconsistent patterns of responding. Specifically, individual participants were considered nonsystematic responders if analysis of their delay or effort discounting data revealed that (1) any indifference point (except

for the first one) was larger than the previous one by more than $\notin 10$ and (2) the last indifference point was not less than the first by at least $\notin 5$. In case of delay discounting, 19 data sets out of the 198 total examined were identified as nonsystematic due to criterion 1. That is, at least one indifference point (starting with the second delay, i.e., seven days) was greater than the preceding indifference point by a magnitude greater than 20% of the larger later reward (i.e., $\notin 10$). In each of these data sets, at least one indifference point suggests a departure from a monotonically decreasing function. Ten data sets out of the 198 total examined were identified as nonsystematic due to criterion 2. That is, the last (i.e., 1 year) indifference point was not less than the first (i.e., 1 day) indifference point by at least a magnitude equal to 10% of the larger later reward (i.e., $\notin 5$). Inspection of the data sets suggests that these participants were not sensitive to delay.

In case of effort discounting, two data sets out of the 198 total examined were identified as nonsystematic due to criterion 1. That is, at least one indifference point (starting with the second effort condition, i.e., 5th floor) was greater than the preceding indifference point by a magnitude greater than 20% of the larger later reward (i.e., \in 10). In each of these data sets, at least one indifference point suggests a departure from a monotonically decreasing function. Five data sets out of the 198 total examined were identified as nonsystematic due to criterion 2. That is, the last (i.e., 30th floor) indifference point was not less than the first (i.e., 3rd floor) indifference point by at least a magnitude equal to 10% of the larger later reward (i.e., \in 5). That is, even at delays ranging from 1 day to 1 year, or effort conditions from 3rd floors to 30th floors, the independent variable (delay or effort) had no demonstrated influence on the dependent variable (indifference point). Comparison of the frequencies of systematicand nonsystematic response patterns across the delay and effort tasksusing McNemar's χ^2 revealed no significant differences for either criterion 1 (p > 0.05) or criterion 2 (p > 0.05) discounting, which suggests that each tasks, delay and effort, did not generate more nonsystematic response patterns from one another.

The mean AUC obtained for delay discounting was 0.51 (SD = 0.26), and the mean AUC obtained for effort discounting was 0.64 (SD = 0.31). Statistically significant positive correlation between the rates of delay and effort discounting (r = 0.45; $p \le 0.01$; effect size r = 0.73) was reported. For delay discounting, the AUC was normally distributed (skewness value was equal to 0.84). The AUC was also normally distributed for effort discounting condition (skewness value was equal to 0.14).

The relationships between the temperament variables and discount rates across two tasks were established using the entire sample by way of a series of bivariate correlations and regression analyses. Table 1 presents descriptive statistics for different temperament dimensions measured by the Temperament and Character Inventory.

TCI scale	Minimum value	Maximum value	Х	SD	Ν	
Novelty seeking	0.00	11.00	6.35	2.19	198	
Harm avoidance	1.00	14.00	6.84	3.66	198	
Reward dependence	0.00	9.00	5.10	1.80	198	
Persistence	0.00	5.00	2.88	1.29	198	

Table 1

Descriptive Statistics f	for TCI Temperament S	Scales
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Pearson correlation coefficients are reported to examine the equivalence of the Junior TCI scales and the delay and effort discounting rates. Furthermore, multiple regression analysis was used to evaluate the trait

variance shared by the Junior TCI factors and two types of discounting. Table 2 presents correlations between four dimensions of personality based on Cloninger's model and the rate of temporal and effort discounting in the whole sample (N = 198).

Table 2

Correlations of JTCI Scales With the Rate of Delay and Effort Discounting.

	AUC for delaydiscounting	AUC for effort discounting	
Novelty seeking	-0.12	-0.03	
Harm avoidance	-0.08	-0.44***	
Reward dependence	-0.02	-0.39**	
Persistence	0.01	0.12 ^a	

Notes. *Significance level p < 0.05; **Significance level p < 0.01; ^a = *p*-value 0.09.

The analysis of AUC parameters has showed a negative correlation between the rate of effort discounting and Reward Dependence (r = -0.39; $p \le 0.01$; effect size r = 0.86), and a negative correlation with Harm Avoidance (r = -0.44; $p \le 0.01$; effect size r = 0.77). In other words, the results showed the higher one's Harm Avoidance and Reward Dependency, the steeper one's effort discounting. In case of delay discounting, the analysis of AUC did not show any statistical significance in relation between the rate of temporal discounting and any dimension of temperament. Next, each TCI dimension was entered simultaneously in a multiple regression analysis as a predictor, and each type of discounting as a dependent variable (delay discounting: F(4, 194) = 0.460; p > 0.05; effort discounting: F(4, 194) = 16.88; p < 0.01; $R^2 = 0.33$; adjusted $R^2 = 0.32$). The analysis showed similar results with those described above: Reward Dependence (Beta= -0.36; t = -2.89; p <0.001), and Harm Avoidance (r = -0.41; t = -3.04; p < 0.01) were significant predictors for effort discounting.

Discussion

The purpose of this study was to determine the nature of the relation between selected temperamental dimensions proposed by Cloninger's psychobiological theory of personality and the dynamics of discounting of delayed and effortful rewards. Additionally, the present study testifies the utility of the hypothesis stating inseparability between two types of discounting, delay and effort discounting.

According to hypothesis, the analysis has revealed a negative correlation between AUC for effort discounting and both Harm Avoidance and Reward Dependence (Hypothesis 2 & 3). Moreover, the rate of effort discounting was positively correlated with the rate of delay discounting (Hypothesis 5). On the other hand, the analysis of AUC did not show any statistical significance in relation between the rate of delay discounting and any dimension of temperament proposed by Cloninger's theory (Hypothesis 1).

Effort Discounting

The correlation between the rate of effort discounting and Harm Avoidance and Reward Dependence was predicted (Hypothesis 2 & 3). The results indicate that the more one tries to avoid harm, the more steep his effort discounting is. The same is truth for Reward Dependency: the more one depends on rewards, the more steep his effort discounting is. In other words, people high in Harm Avoidance and Reward Dependency will rather accept a small reward without any effort than work hard for a larger reward. Perhaps the decision to accept smaller reward results from the fact that people high in Harm Avoidance dimension are risk averse. People high in Harm Avoidance are said to minimize behaviors that may expose them to aversive stimulus

(Cloninger, 1997; Cloninger et al., 1994). This aversion for punishment might result in the preference for smaller, effortless rewards. Individuals who avoid harmful situations may consider effort required to obtained bigger reward in category of loss. That is why they prefer smaller reward without putting any effort instead of the bigger one. What is more, in case of predicted correlation with Reward Dependence, high reward-dependent individuals, who respond strongly to stimuli suggesting the imminence of a reward (Cloninger et al., 1993; 1994), probably present a higher rate of discounting and respond more strongly to a stimulus that indicates the possibility of an immediate, effortless reward, even if the reward is relatively small.

At the same time, a correlation between the rate of effort discounting and Persistence (Hypothesis 4), although expected, was not significantly observed (p = 0.09). Thus, it cannot be assumed that more persistent people should accept larger effort in order to get a larger reward. This result is not consisted with the previous study done on the relationship between effort discounting and temperamental dimensions proposed by Cloninger among adults (Malesza & Ostaszewski, 2013) where a negative correlation was significantly observed, meaning that the more persistent one is, the shallower effort discounting he shows. Since Persistence manifests in perseverance in behavior, despite frustration and fatigue (Cloninger et al., 1993; 1994), for people who are more persistent, the perspective of walking up to a given floor should be less aversive. Perhaps, in the present study, for adolescents even who are more persistent it is not necessarily more easily to lead to the end the beginning before effort, as the results did not manage to capture the statistical significance.

Delay Discounting

In the present study, no significant relations between the rate of delay discounting and traits Novelty Seeking, Reward Dependence, and Harm Avoidance were revealed (Hypothesis 1). It suggests that the relationship between the variables is rather weak that the author did not manage to capture it in the present simple experiment. Maybe placing oneself in choice between uncertain rewards would catch relationship between people with different personality profiles. One may assume that waiting for delayed rewards contains some portion of probability, as no one can predict for sure what will happen during the delay before receiving the outcome (Whiteside & Lynam, 2001). It would be interesting to examine the relationship between the discounting of probabilistic outcomes and Cloninger's personality dimensions among adolescents and adults, as none of these studies has been previously done. Novelty Seeking, Reward Dependence, and Harm Avoidance behaviors would be associated with shallow discounting of probabilistic rewards, indicating that an individual's choices are more controlled by the likelihood of actually receiving the reward than by the magnitude of a reward involved (Green & Myerson, 2004).

Perhaps, because of the higher level of non-systematic results of delay discounting, contrary to effort discounting task, delay discounting data seems to be invalid, thereby explaining some of the null results. Moreover, the lack of significant finding for delay discounting and reporting significant correlations for effort discounting in the current study may be due to effort concepts or questions being easier to conceptualize for adolescents than concepts involving long delays, thus leading to somewhat more sensitive measurement of discounting for adolescent s with effort discounting. In support of this notion about developmental differences in perception of delays, research involving future time perception has demonstrated that from early childhood to young adulthood, more accurate time perceptions of long durations are acquired with increasing age (e.g., Westman, 1987). Such age-related differences in time perception could lead to inconsistencies in the predictive utility of delay discounting across age groups, such as that observed in the current study (Reynolds et al., 2003).

Relation Between Two Types of Discounting

The second aim of the study was to find out if effort discounting and delay discounting are related (Hypothesis 5). In case of the relationship between two types of discounting, the analysis has showed a positive correlation between the rate of delay and effort discounting, pointing out that both processes cannot be completely separated. It seems, that effort discounting is a process similar in form to other types of discounting, however effort seems to be a separate domain. Previous studies also demonstrated that discounting by effort in adults' sample was not identical to discounting by delay (Malesza & Ostaszewski, 2013). In the present task of effort discounting the time required to climb the stairs was not reported in the effort condition because the author assumed that if the time would be instructed, the choices might be affected by temporal variables possibly brought up by such an instruction. However, this procedure did not separate the time from the effort, leaving a possibility that delay for the reward may have affected the results in the effort discounting rate did not reflect those of the delay discounting task. Different personality dimensions were correlated only with the rate of effort discounting. These differences indicate that the results in the effort condition did not depend only on the delay.

However, it should be noted that neither Mitchell (1999) nor Sugiwaka and Okouchi (2004) found significant correlations between measures of steepness of effort and delay discounting. Moreover, neurobiological studies suggest that separate brain subsystems are involved in effort-based and delay-based decision-making (e.g., Prevost, Pessiglione, Metereau, Clery-Melin, & Dreher, 2010). The author replicated the results of behavioral studies by Mitchell (1999) and Sugiwaka and Okouchi (2004), but with larger sample, because these previous research did not have much statistical power, due to small number of participants (around 30 in each case), and with different group of participants (Malesza & Ostaszewski, 2013; subjects were adults). It is very likely, that relatively large sample studied in the present study (N = 198) was responsible for the correlation to reach the level of statistical significance.

Limitations

Despite at least two possible limitations of the present study: lack of control of experience with climbing stairs or endurance of the participants, and arbitrarily chosen type of effort, the present study found the consistent relationships between scales of the TCI and steepness of effort discounting. It would be interesting to replicate the results with student athletes who can report running a half-marathon, or swimming 100 laps, etc., since implementation of real effort conditions can affect the discounting rate differently. Also, one should control direct experience of the participant with doing a physical task. The author cannot be sure, if their participants truly understood how does it feel to climb up to thirty floors. Perhaps, they underestimated the effort expedited in performing such a task. Finally, the results should be replicated with different types of effort. Physical effort, such as climbing stairs, is different in nature from cognitive effort discounting was positively correlated with the steepness of cognitive effort discounting, which suggests that effort is a trait-like characteristic that does not depend on the effort type (Ostaszewski, Bąbel, & Swebodziński, 2013).

Future Directions

Although results have to be interpreted with caution since small and medium effects of temperament characteristics on the discounting rate may be caused also by non-systematic or insensitive data, the pattern of

results found in the present study for delay and effort discounting is strikingly consistent with the finding of previous research with adults in that effort discounting is related to different temperament factor, and that effort and delay discounting are positively correlated (see Malesza & Ostaszewski, 2013). This aspect of the current results may be important in noting that discounting appears to be related to patterns of adults and adolescents temperament profiles in the same way. Future longitudinal research could delineate more specifically the role of effort discounting in adolescents. Such research should emphasize the temporal stability of effort discounting and factors that may lead to increase in effort discounting.

References

- Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin*, 82, 463-496.
- Arnett, J. (1995). The young and the reckless: Adolescent reckless behavior. *Current Directions in Psychological Science*, 4(3), 67-70.
- Baker, F., Johnson, M. W., & Bickel, W. K. (2003). Delay discounting in current and never-before cigarette smokers: Similarities and differences across commodity, sign, and magnitude. *Journal of Abnormal Psychology*, 112(3), 382-392.
- Beck, R. C., & Triplett, M. F. (2009). Test-retest reliability of a group-administered paper-pencil measure of delay discounting. *Experimental and Clinical Psychopharmacology*, 17(5), 345-355.
- Cardinal, R. N., Pennicott, D. R., Sugathapala, C. L., Robbins, T. W., & Everitt, B. J. (2001). Impulsive choice induced in rats by lesions of the nucleus accumbens core. *Science*, 292, 2499-2501.
- Cloninger, C. R. (1986). A unified biosocial theory of personality and its role in the development of anxiety states. *Psychiatric Developments*, *3*, 167-226.
- Cloninger, C. R. (1987). A systematic method for clinical description and classification of personality variants. Archives of General Psychiatry, 44, 573-588.
- Cloninger, C. R. (1997). A psychobiological model of personality and psychopatology. *Journal of Psychosomatic Medicine*, 37(2), 91-102.
- Cloninger, C. R., Przybeck, T. R., Svrakic, D. M., & Wetzel, R. D. (1994). *The temperament and character inventory (TCI): A guide to its development and use*. St. Louis: Washington University Center for Psychobiology of Personality.
- Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. Archives of General Psychiatry, 50, 975-990.
- Coffey, S. F., Gudleski, G. D., Saladin, M. E., & Brady, K. T. (2003). Impulsivity and rapid discounting of delayed hypothetical rewards in cocaine-dependent individuals. *Experimental Clinical Psychopharmacology*, 11(1), 18-25.
- Critchfield, T. S., & Kollins, S. H. (2001). Temporal discounting: Basic research and the analysis of socially important behavior. *Journal of Applied Behavior Analysis*, 34, 101-122.
- Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin*, 130, 769-792.
- Hartman, C. A., Hopfer, C. J., Crowley, T. J., Corley, R., Hewitt, J. K., & Stallings, M. C. (2013). Using Cloninger's temperament scales to predict substance-related behaviors in adolescents: A prospective longitudinal study. *The American Journal on Addictions*, 22(3), 246-51.
- Hauber, W., & Sommer, S. (2009). Prefrontostriatal circuitry regulates effort-related decision making. *Cerebral Cortex, 19*, 2240-2247.
- Ishiwari, K., Weber, S. M., Mingote, S., Correa, M., & Salamone, J. D. (2004). Accumbens dopamine and the regulation of effort in food-seeking behavior: modulation of work output by different ratio or force requirements. *Behavioral Brain Research*, 151, 83-91.
- Johnson, M. W., & Bickel, W. K. (2002). Within-subject comparison of real and hypothetical money rewards in delay discounting. Journal of The Experimental Analysis of Behavior, 77, 129-146.
- Kaufman, J., Birmaher, B., Brent, D., Rao, U., Flynn, C., Moreci, P., Williamson, D., & Ryan, N. (1997). Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL): Initial reliability and validity data. *Journal of the American Academy of Child & Adolescent Psychiatry*, 36(7), 980-988.
- Kirby, K. N., & Petry, N. M. (2004). Heroin and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. *Addiction*, 99, 461-471.

- Luby, J. L., Svrakic, D. M., McCallum, K., Przybeck, T. R., & Cloninger, C. R. (1999). The Junior Temperament and Character Inventory: Preliminary validation of a child self-report measure. *Psychological Reports*, 84, 1127-1138.
- Madden, G. J., & Bickel, W. K. (Eds). (2010). *Impulsivity: The behavioral and neurological science of discounting*. Washington, D.C.: American Psychological Association.
- Malesza, M., & Ostaszewski, P. (2013). The relationship between Cloninger's dimensions of temperament and the steepness of delay and effort discounting of monetary rewards. *Psychological Reports*, 112(3), 694-705.
- Manwaring, J. L., Green, L., Myerson, J., Strube, M. J., & Wilfley, D. E. (2011). Discounting of various types of rewards by women with and without binge eating disorder: Evidence for general rather than specific differences. *The Psychological Record*, 61.
- Mitchell, S. H. (1999). Measures of impulsivity in cigarette smokers and non-smokers. Psychopharmacology, 146, 455-464.
- Mitchell, S. H. (2004). Effects of short-term nicotine deprivation on decision-making: Delay, uncertainty, and effort discounting. *Nicotine and Tobacco Research*, *6*, 819-828.
- Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, 76, 235-243.
- Ostaszewski, P. (1997). Temperament and the discounting of delayed and probabilistic rewards: Conjoining European and American psychological traditions. *European Psychologist, 2*, 35-43.
- Ostaszewski, P., Bąbel, P., & Swebodziński, B. (2013). Physical and cognitive effort discounting of hypothetical monetary rewards. *Japanese Psychological Research*, 55(4), 329-337.
- Petry, N. M. (2001). Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. *Psychopharmacology*, 154, 243-250.
- Prevost, C., Pessiglione, M., Metereau, E., Clery-Melin, M. L., & Dreher, J. C. (2010). Separate valuation subsystems for delay and eff ort decision costs. *Journal of Neuroscience*, 30, 14080-14090.
- Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior*, 55, 233-244.
- Rachlin, H., Logue, A. W., Gibbon, J., & Frankel, M. (1986). Cognition and behavior in studies of choice. *Psychological Review*, 93, 33-45.
- Reynolds, B., Karraker, K., Horn, K., & Richards, J. B. (2003). Delay and probability discounting as related to different stages of adolescent smoking and nonsmoking. *Behavioral Processes*, *64*, 333-344.
- Richards, J. B., Zang, L., Mitchell, S. H., & de Wit, H. (1999). Delay or probability discounting in a model of impulsive behavior: Effect of alcohol. *Journal of the Experimental Analysis of Behavior*, *71*, 121-143.
- Richter, J., Brandstrom, S., & Przybeck, T. R. (1999). Assessing personality: The temperament and character inventory in a crosscultural comparison of normative samples from Germany, Sweden and the USA. *Psychological Reports*, 84(3), 1315-1330.
- Schmeck, K., Goth, K., Poustka, F., & Cloninger, R. C. (2001). Reliability and validity of the Junior Temperament and Character Inventory. *International Journal of Methods in Psychiatric Research*, 10(4), 172-182.
- Sugiwaka, H., & Okouchi, H. (2004). Reformative self-control and discounting of reward value by delay and effort. *Japanese Psychological Research*, *46*, 1-9.
- Walton, M. E., Kennerley, S. W., Bannerman, D. M., Phillips, P. E. M., & Rushworth, M. E. S. (2006). Weighing up the benefits of work: Behavioral and neural analyses of effort-related decision making. *Neural Networks*, 19, 1302-1314.
- Westman, A. S. (1987). Development of time concepts differentiating clock and calendar from apparent durations. *Journal of Genetic Psychology*, 148(3), 259-270.
- Whiteside, S. P., & Lynam, D. R. (2001). The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, 30(4), 669-689.