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THE EFFECTS OF SELF-REGULATION, FUTURE ORIENTATION, AND SENSATION SEEKING ON DELAY DISCOUNTING DURING ADOLESCENCE

by

Morgan Louise Pristupa

A thesis submitted to the Department of Psychology

in partial fulfillment to the requirements for the degree of

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UNIVERSITY OF NORTH FLORIDA

COLLEGE OF ARTS AND SCIENCES

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Abstract

The first hypothesis was self-regulation and future orientation would mediate the effects of age on delay discounting. The second hypothesis was future orientation would be a stronger mediator than self-regulation of the effects of age on delay discounting. The third hypothesis was sensation seeking would moderate these mediation effects. A total of 216 participants, ranging from 12 years old to 18 years old, completed the Future Orientation Scale (Steinberg, Graham, O'Brien, Woolard, Cauffman, & Banich, 2009), the Self-Regulation Questionnaire (Neal & Carey, 2005), the UPPS Impulsive Behavior Scale (Whiteside & Lynam, 2001), the Original Monetary Choice Questionnaire (Kirby, Petry, & Bickel, 1999), and the general demographics survey on Inquisit. Andrew Hayes' (2013) PROCESS program was used to analyze mediation and moderated mediation models. Mediation and moderated-mediation were not supported. It's possible a restriction in age range, selection bias and/or attrition bias, and inappropriate measurement of delay discounting led to null results. Furthermore, using longitudinal designs and including multiple measures of self-regulation, future orientation, and delay discounting in future research may better represent adolescents' decision making.

The Effects of Future Orientation, Self-Regulation, and Sensation Seeking on Delay Discounting during Adolescence

There seems to be a change in delay discounting during adolescence since the rates of discounting delayed rewards tends to decrease until approximately age 21 (Steinberg, Graham, O'Brien, Woolard, Cauffman, & Banich, 2009). The reasoning behind this change is still being explored by researchers. By utilizing existing theoretical models that help explain adolescent behaviors, researchers may better understand the maturation effect on delay discounting. Steinberg's (2008) dual system model helps explain adolescent decision making. The model describes how a neurological interaction between cognitive control systems and socioemotional systems influences adolescent behaviors. The aim of this study was to evaluate this theoretical dual system model by testing a proposed moderated mediation model. The moderated mediation model investigated the maturation effects on delay discounting through self-regulation, future orientation, and sensation seeking. The mediators, self-regulation and future orientation, represented cognitive control systems. The moderator, sensation seeking, represented a socioemotional system. Lastly, delay discounting represented decision making.

Maturation Implications of Delay Discounting

Delayed discounting is a construct involving impulsivity and indicates the process of decision making. Delay discounting refers to the preference for a smaller, immediate reward over a larger, delayed reward (Towe, Hobkirk, Ye, & Meade, 2015). The preference occurs when the delayed reward's value subjectively decreases as the time it will take to obtain the reward increases.

Individuals display discontinuity in delay discounting tendencies across the lifespan, meaning individuals may delay discount at any given age, but the frequency of displaying this

tendency is different during specific life periods (Lerner, Lewin-Bizan, & Warren, 2011; Read & Read, 2008). Middle-aged adults have a lower inclination to devalue delayed rewards than do younger and older people (Gollner, Ballhausen, Kliegel, & Forstmeir, 2018). This frequency difference in delay discounting across the lifespan is attributed to cognitive abilities and implies middle-aged adults more frequently use higher cognitive capacities (e.g. mental processing in the prefrontal cortex) than do younger and older individuals (Hirsh, Morisano, & Peterson, 2008). Gollner and colleagues' (2018) cross-sectional study included participants who ranged from nine to 25 years old. Their analysis indicated a negative correlation between age and delay discounting - as age increased, delay discounting tendencies decreased. These results converge with another cross-sectional study conducted by Steinberg and others (2009). Delay discounting rates lowered as the age of the participants increased, particularly between ages 12 and 21 years old.

Development of Higher Cognitive Capacities

As previously mentioned, age differences in delay discounting partly result from differences in higher order cognitions (i.e. cognitions that are more reflective and flexible than reflexive and automatic) (Hirsh et al., 2008). Higher order cognitions such as self-regulation and future orientation are relevant to delay discounting since an individual does not engage in self-regulation and opts against a future, larger reward in favor of a more short-term reward. To better understand the decision-making process during delay discounting, it's important to describe in detail the concepts of self-regulation and future orientation.

Self-Regulation. Self-regulation refers to the ability to exert effortful control over personal behavior and/or emotions. Understanding the development of self-regulation can aid in predicting impulsivity/delay discounting during adolescence (Bandura, 1982). Self-regulation

can be divided into two categories that are separate, yet interactive: top-down and bottom-up processes (Bridgett, Burt, & Edwards, 2015). The top-down processes include behavioral self-regulation and emotional self-regulation. Behavioral self-regulation is referred to as effortful control, self-control, and executive functioning (Gottfredson & Hirschi, 1990; Miyake & Friedman, 2012; Rothbart, Ellis, Rueda, & Posner, 2003) whereas emotional self-regulation involves reappraisal or suppression strategies (Gross, 2015). The bottom-up processes are behavioral inhibition/fear and impulsivity. Behavior inhibition/fear is a reactive, automatic mechanism identified by reserving and cautious behaviors. Individuals high in behavioral inhibition self-regulation tend to display shy and fearful behaviors (Calkins, Fox, & Marshall, 1996). This is distinguished from impulsivity, which is a reactive, automatic, under-controlled behavior (Eisenberg, Edwards, Spinrad, Sallquist, Eggum, & Reiser, 2013). Impulsivity occurs when an individual automatically regulates behavior without much consideration (Sharma, Markon, & Clark, 2014). Figure 1 displays a visual organization of the different categories.

Activation of the top-down self-regulation processes occurs in the frontal lobes and the anterior cingulate cortex, while bottom-up processes activate the subcortical structures, such as the amygdala and hippocampus. Developmental improvements in brain connectivity results in overall improvement in self-regulation. Earlier in development (i.e. late infancy and toddlerhood), the bottom-up processes are greater than the top-down processes, but top-down processes strengthen over time (i.e. in adolescence through early adulthood) and eventually regulate the subcortical structures (Bridgett et al., 2016).

Self-regulation requires monitoring internal and external cues allowing one to adapt accordingly to obtain personal goals (Moilanen, 2007). Thus, the development of self-regulation depends on environmental situations and an individual's cognitive abilities (Dinsmore,

Alexander, & Loughlin, 2008). To accurately predict an individual's delay discounting tendencies with self-regulation, one must consider how well the top-down process has developed and the magnitude of the external cue.

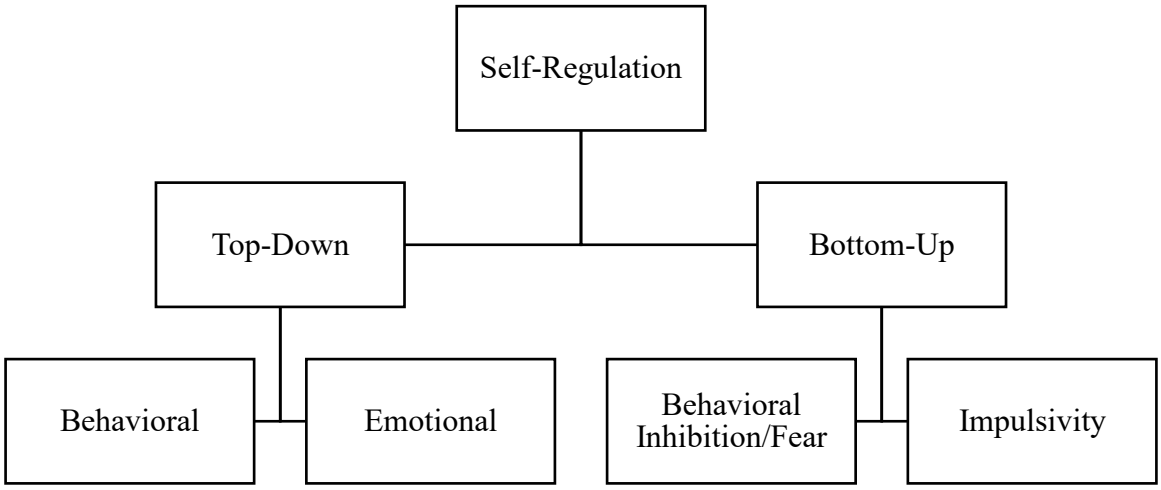

Figure 1. The broad categories of self-regulation.

Future Orientation. Since delay discounting involves a decision based on the present and the future, future orientation is also important to consider. Future orientation is the way individuals view their future, including how far into the future individuals thinks, what individuals thinks is important, and individuals' level of optimism about the future (Nurmi, 2005). Future orientation is a multidimensional construct, meaning it has several criterions that develop independently to create a cohesive perspective (Baltes, 1987; Werner, 1957). This concept is depicted in Figure 2. Future orientation is comprised of three facets: cognitive, motivational, and affective. The cognitive dimension includes the ability to plan, anticipate, and acquire knowledge. The motivational dimension shapes the cognitive aspects with influences of values, interest, and concerns. The last dimension is the affective addition of emotions such as optimism, hope, pessimism, and despair. Previous research shows those who are more oriented

to the future discount future rewards less than those less oriented to the future (Steinberg et al., 2009). Therefore, it is pertinent to examine future orientation as it relates to delay discounting.

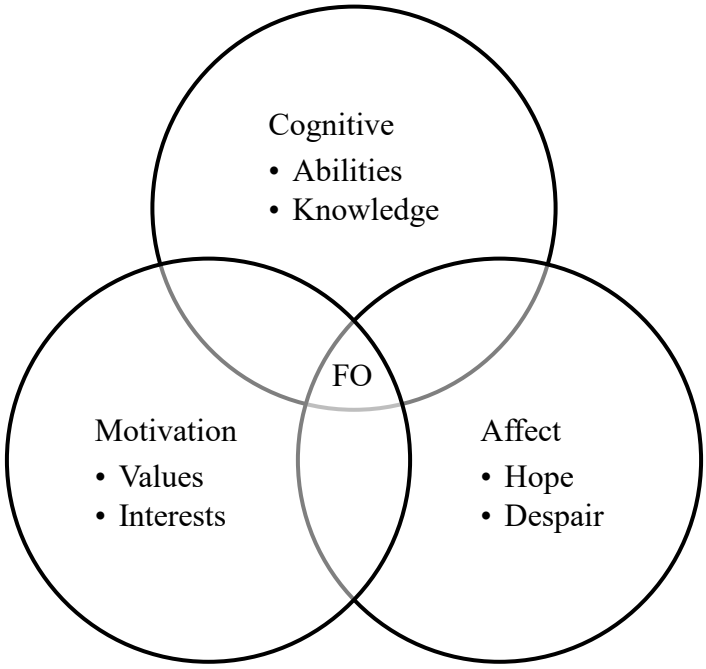

Figure 2. The orthogonal dimensions of future orientation (FO) interacting to create a single construct.

Co-Development of Future Orientation and Self-Regulation. From the dialectical perspective of nature and nurture, there is an interaction of biological and social reasons that influence why self-regulation and future orientation co-develop during adolescence (Sameroff, 2010). Steinberg (2008) argues the adolescent brain undergoes three changes that explain how future orientation and self-regulation develop at the same time: 1) the decrease in prefrontal gray matter indicates the removal of unused neural pathways and allows for improvements in basic information processing, 2) the increase in prefrontal white matter reflects myelination and is associated with improvements in executive functioning (such as planning ahead, response inhibition, and filtering through information coming from multiple sources) and 3) the increased connectivity between cortical and subcortical areas facilitate in the regulation of affect and

cognition. The addition of social pressures and cultural allowance of autonomy creates opportunities to practice self-regulation and future orientations, thus prompting further development over time (Nurmi, 2005). Biological maturation and cultural norms create an important period of growth for self-regulation and future orientation.

Existing literature supports that future orientation influences the development of self-regulation in adolescents. Schmid and colleagues (2011) observed that hopeful expectations of the future and self-regulation were strong predictors of positive youth development. With the use of structural equation modeling, they explained that the earlier an adolescent develops hopeful expectations of the future, the more self-regulation abilities he or she will develop later in life. Hoyle and Sherrill (2006) argue future orientation sets the behavior standards which self-regulation works toward. Future orientation could be a guiding force of self-regulation and therefore more predictive of delay discounting. Self-regulation is a broad construct that is relevant in many settings, not just future related situations. Therefore, it may be unfair to say future orientation is the sole reason behind the general development of self-regulation, but as it pertains to delay discounting and other future-related decisions, it is likely a guiding force.

Dual System Model. Although adolescents are gaining cognitive control, such as self-regulation abilities and orienting themselves to the future, another powerful brain circuit is developing as well. The circuit that governs sensitivity to rewards and promotes sensation seeking becomes heavily activated in early adolescence. According to Steinberg's (2008) dual system model, this brain circuit is referred to as the socioemotional system and it processes rewards in the striatum and prefrontal cortex (Shulman et al., 2016). The socioemotional system develops in an inverted-parabola pattern with an increased sensitivity toward rewards from the onset of puberty until approximately 18 years of age, followed by a decline of reward sensitivity

from 18 years old into emerging adulthood. In contrast to the socioemotional system, the aforementioned cognitive control system activates the prefrontal, parietal, and anterior cingulate cortices. The cognitive control system continues to strengthen with age and suppresses the arousal from the socioemotional system. Figure 3 illustrates the developmental trajectories of the two brain circuits in this dual system model. Steinberg's (2008) dual system model theorizes that adolescents' risky behavior (including impulsivity and delay discounting) is due to increased sensitivity to rewards without the cognitive control system being strong enough to overpower this sensitivity until emerging adulthood. The desire for an immediate reward may be more powerful than the cognitive control systems, and it's expected that delay discounting will be high, while future orientation and self-regulations are low.

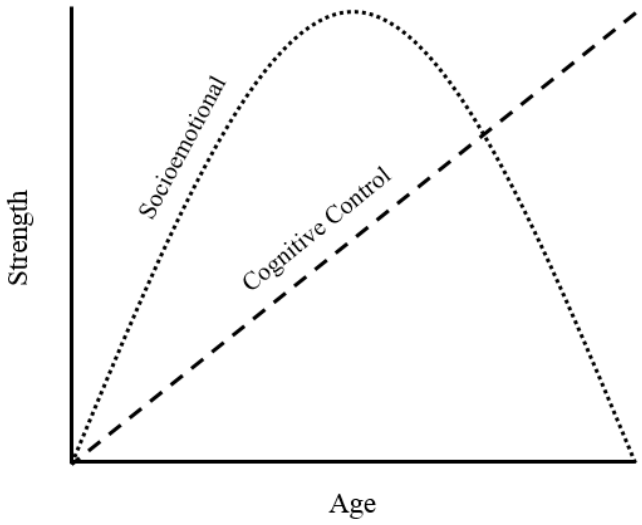

Figure 3. The dual system model depicts the socioemotional system peaking at approximately 18 years old and the cognitive control system eventually developing enough to subdue sensitivity to rewards.

Sensation Seeking. Sensation seeking, a variable involved in the socioemotional system, was originally defined as "the need for varied, novel, and complex sensations and experiences,

and the willingness to take physical and social risks for the sake of such experiences" (Zuckerman, 1979, p. 10). Arnett (1994) later added that sensation seeking is more than a need, but actually a predisposition with probabilistic epigenetics, meaning the predisposition will be expressed or suppressed depending on how an individual's genetic makeup interacts with the environment (Gottlieb, 1992). Sensation seeking tends to be triggered by the onset of puberty (Shulman et al., 2016), which occurs on average around age 10 (German, Shmoish, & Belsky, 2018). Hormones during puberty change neural structures, specifically the limbic regions that are associated with dopamine and processing the pleasure of rewards. In accordance with Steinberg's (2008) dual system model, sensation seeking may override cognitive control systems early in adolescence, which is relevant when analyzing adolescent decision making.

Steinberg and colleagues (2009) confirmed that around age 13, qualitative shifts occur in future orientation, which may be due to the activation of the socioemotional system. From ages 10-13, adolescents show declines in anticipating consequences and then from 13-25 years old there is a positive linear trend (indicating at around age 13 teenagers begin thinking about consequences at increasing rates with age). Similar patterns show a decline in overall future orientation scores from age 10-13 and then substantial inclines from age 14- 25. This shift around age 13 is also reflected in delay discounting. From ages 10-13, participants preferred the immediate small rewards over delayed large rewards at increasing rates, then at age 14 began to prefer the future reward more often. These patterns suggest that the onset of puberty and sensitivity to rewards may overpower future orientation and self-regulation when making decisions about the future for at least a few years.

Sex Comparison. Although the dual system model accounts for the general developmental patterns of the cognitive control and socioemotional systems, there are some sex

differences observed. Research suggests that males may experience prolonged time periods of sensation seeking and impulsivity compared to females (Shulman, Harden, Chein, & Steinberg, 2014). Females' sensation seeking tendencies peak earlier than males and declines quicker. Additionally, males tend to experience higher levels of sensation seeking than females. These differences may be due to the dissimilarities of puberty hormones between the sexes.

For instance, sex differences are displayed when comparing pubertal status and sensation seeking (Steinberg et al., 2008). For males, there are differences in sensation seeking, depending on the stage of puberty, regardless of age. As puberty progresses, levels of sensation seeking increase in males. For females, there is no difference in sensation seeking during different stages of puberty, even when accounting for age.

Comparative psychology studies with mice indicate the dopaminergic system (prevalent in the socioemotional system) undergoes changes during preadolescence and then again in early adolescence (Sisk & Foster, 2004). During preadolescence, male rodents endure a larger reduction of dopamine receptors than females. Then dopamine receptors redistribute during early adolescence at a higher rate than any other developmental period, among both sexes. Since males experience a more dramatic shift in dopamine receptors during this period than females, it may help explain the higher levels of sensation seeking in males.

The Current Study

During adolescence, humans undergo multiple neurobiological changes that reflect as changes in behavior. The current study set out to analyze behavioral differences among adolescents and a possible influence of cognitive tendencies. Considering self-regulation and future orientation as higher order cognitions (involving abstract thinking and relying less on primitive reflexes) that strengthen during adolescent neurobiological development, this study

evaluated these variables' predictive value on decisions (e.g. delay discounting). This study also includes an element of an adolescent's socioemotional development by analyzing how sensation seeking interacts with the influences of self-regulation and future orientation on delay discounting.

Proposed Mediation

The current study proposes self-regulation and future orientation mediate the relation between age and delay discounting during adolescence. Using terminology outlined by Hayes (2009), it is proposed that there is a total effect of maturation leading to less delay discounting (i.e. more preference for a larger delayed reward than an immediate lesser reward) across adolescence. However, the total effect of age on delay discounting is the sum of the direct effect and the product of two indirect pathways. The indirect pathways include the maturation effect of self-regulation and future orientation, as well as the effect of self-regulation and future orientation on delay discounting. Figure 4 displays the proposed mediation model.

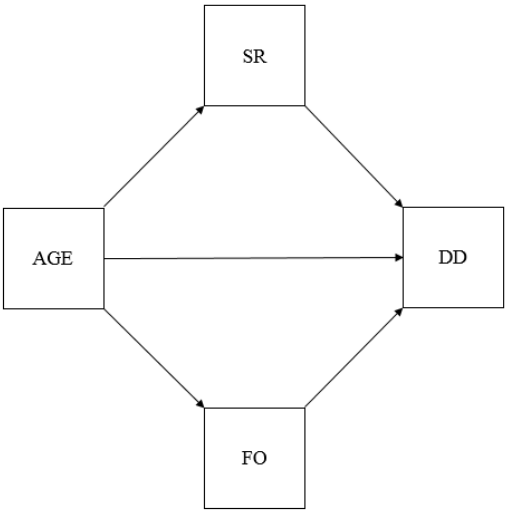

Figure 4. A proposed mediation model. DD = delay discounting, SR = self-regulation, and FO = future orientation.

The first hypothesis stated that self-regulation and future orientation would mediate the maturation effects of delay discounting during adolescence. These two variables represented the cognitive control system, attempting to evaluate Steinberg's (2008) dual system model and its ability to predict adolescent decision making. Two mediation models were analyzed (one investigating self-regulation and one examining future orientation). The second hypothesis stated future orientation would more predictive of delay discounting than self-regulation. Since delay discounting is a decision between the present and future, future orientation was expected to have a stronger mediation relation between maturation and delay discounting than self-regulation. Self-regulation and future orientation were run parallel in a single mediation model and analyzed which was more predictive of delay discounting. The third hypothesis was sensation seeking would moderate the effects of future orientation and self-regulation on delay discounting. Sensation seeking represented the socioemotional system in Steinberg's (2008) dual system model and was expected to alter the cognitive control system's influence on delay discounting. It was predicted that participants with higher sensation seeking and low self-regulation/future orientation scores would devalue delayed rewards more than participants with lower sensation seeking scores. Figure 5 represents the moderating mediation model. Sex was entered as a control variable.

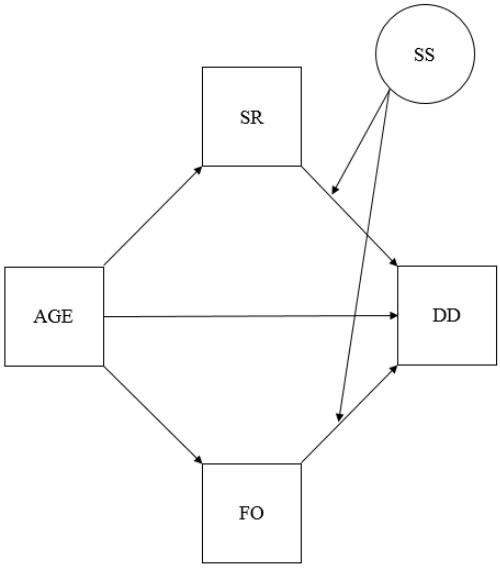

Figure 5. The indirect pathway of sensation seeking **(**SS) moderating FO and SR on DD.

Method

Participants

Data were collected from 247 adolescents across the United States, with the majority (*n* = 152) residing in the Midwest (Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, North Dakota, Nebraska, Ohio, South Dakota, and Wisconsin). Table 1 presents the descriptive statistics of the sample's reported residency. The final sample was comprised of 216 participants after the deletion of duplicate response IDs, surveys with 1% or less completion, surveys with only demographic data, and/or those who were over 18 years old. The sample ranged from 12 years to 18 years of age (*M* = 14.71, *SD* = 1.82) and information on age is displayed in more detail in Table 2. Seventy-five participants identified as male (34.7%), 139 as female (64.4%), one as non-binary (.5%), and one participant did not report a gender (.5%).

Table 1

Region of Residency

Region	Frequency	Percent
Southeast- AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV	58	26.9
Northeast- CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT	1	0.5
Midwest- IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI	152	70.4
West- AK, CA, CO, HI, ID, MT, NV, OR, UT, WA, WY	2	0.9
Southwest- AZ, NM, OK, TX	1	0.5
Prefer not to say	1	0.5
Missing	1	0.5

Note. The regions of residency for participants.

Table 2

Age of Participants

Age	Frequency	Percent
12	36	16.7
13	31	14.4
14	30	13.9
15	29	13.4
16	50	23.1
17	32	14.8
18	8	3.7

Note. The age of participants.

Materials

Demographics. Demographic information was obtained by utilizing the general demographics survey on Inquisit. The 14 demographic items included questions about gender, age, ethnicity, education, household information (i.e., "How many people live in your household") and socioeconomic status (i.e., "Are you currently employed for wages").

Future orientation. Participants completed the Future Orientation Scale (Steinberg, Graham, O'Brien, Woolard, Cauffman, & Banich, 2009). There is evidence of reliability and validity for scores on the Future Orientation Scale (Steinberg et. al., 2009). Items were displayed as 15 pairs of statements (α = .80), such as, "Some people like to plan things out one step at a time," but "other people like to jump right into things without planning them out beforehand." Participants chose which statement most accurately described themselves. Then they were asked if the previous item was *sort of true for me* or *really true for me*. A 4-point Likert scale was created and ranged from 1 (low future orientation) to 4 (high future orientation). The scale was coded into mean scores. Participant's whose data was beyond three standard deviations from the mean were considered outliers and removed from the scale.

Self-regulation. Self-regulation was measured with the Self-Regulation Questionnaire (Neal & Carey, 2005). There is evidence of reliability and validity for scores on the Self-Regulation Questionnaire (Pichardo, Justicia, de la Fuente, Martinez-Vicente, & Berben, 2014). It consists of 19 items (i.e., I usually keep track of my progress toward goals), nine of which were reverse coded (i.e., I don't notice the effects of my actions until it's too late.) Each item was presented on a 5-point Likert scale ranging from *strongly disagree* to *strongly agree*. Ultimately, all nine reverse coded items were deleted to achieve an acceptable Cronbach's alpha (α = .79).

Scores were then summed and averaged from the remaining 10 items. Higher scores indicate higher levels of self-regulation and lower scores represent lower levels of self-regulation.

Sensation seeking. A subscale within the UPPS Impulsive Behavior Scale (Whiteside & Lynam, 2001) was used to measure sensation seeking. There is evidence of reliability and validity for scores on the UPPS Impulsivity Behaviors Scale (Cyder, Littlefield, Coffey, & Karyadi, 2015)). This portion of the UPPS Impulsive Behavior Scale was comprised of 12 items and included statements such as, "I generally seek new and exciting experiences and sensations" and "I'll try anything once." Each item was presented on a 5-point Likert scale ranging from *strongly disagree* to *strongly agree*. The scale resulted in a Cronbach's alpha of .88. Then the scale was coded into mean scores; low scores represent lower levels of sensation seeking and high scores represent higher levels of sensation seeking.

Delay discounting. Delay discounting was measured by the Original Monetary Choice Questionnaire (Kirby, Petry, & Bickel, 1999). There is evidence of reliability and validity for scores on the Original Monetary Choice Questionnaire (Myerson, Baumann, & Green, 2014). The participants chose between a smaller immediate reward and a larger delayed reward. One item presented the choice of "$28 today" or "$30 in 179 days." After 27 choices, a pattern emerged that identified when the participant was likely to delay discount. This pattern was referred to as the participants' hyperbolic discount parameter (i.e., *k* value) and was calculated by $V_{immediate} = V_{delayed} / (1+kD)$. V was the reward value in dollars and D was the length of delay in days. Higher *k* values represented participants who preferred immediate, small rewards and lower *k* values represented those who preferred delayed, larger rewards. *K* values were averaged (ranging from .00 to 0.25) then ranked (e.g., values .00016 to .00040 were rank 2) to create 10 ranks ranging from 1 (lowest) to 10 (highest).

Procedure

Participants were recruited via online postings and advised the survey would take approximately an hour to complete, although each participant could pause and resume later. The survey was primarily on Qualtrics, but the behavioral computerized tasks were programmed in Inquisit. Participants were automatically re-directed to the Inquisit tasks at the conclusion of the survey portion. After completing the behavioral tasks, participants were taken to a new Qualtrics survey in order to enter their contact information for the reward gift card. After reading the consent screen, a warning page informed the participant some questions may be perceived as personal and to obtain a private setting before beginning the survey. Participants were offered an incentive and advised money could be earned throughout the computerized behavioral tasks. After completing the battery, each participant was provided a gift card of $15.

Data analysis plan. The first hypothesis stated self-regulation and future orientation would mediate the effects of age on delay discounting during adolescence. This hypothesis was tested in SPSS, using model four in Andrew Hayes' (2013) PROCESS program. Model four is a mediation model that analyzes the direct effect of age on delay discounting in addition to the indirect effect of age on delay discounting through self-regulation and/or future orientation. A separate analysis was used for each mediator and the sex of the participant was statistically controlled for and entered as a control variable within the model.

The second hypothesis stated future orientation would be more predictive of delay discounting than self-regulation. To test this hypothesis, future orientation and self-regulation were tested as parallel mediators (i.e., both mediators were inputted into a model simultaneously) in model four of PROCESS (Hayes, 2013). Contrasts between the mediators indicated whether the indirect effects were stronger for self-regulation or future orientation and thus which

mediator was more predictive of delay discounting. The sex of the participant was statistically controlled in the analysis.

The third hypothesis stated sensation seeking would moderate the effects of future orientation and self-regulation on delay discounting. This hypothesis was tested in SPSS, using model 14 in Andrew Hayes' (2013) PROCESS program. Model 14 is a moderated mediation model. It analyzed the direct effect of age on delay discounting, while also evaluating the conditional indirect effect of age on delay discounting through sensation seeking as a moderator and self-regulation and/or future orientation as a mediator. A parallel mediation with a moderator was used and the sex of the participant was a controlled variable within the model.

Results

Preliminary Analyses

Descriptive statistics. Preliminary analyses indicated there are no violations for the assumption of normality. All variables fell within the range of -2.00 thru +2.00 for skewness and fell within the -7.00 thru +7.00 range for kurtosis. Table 3 displays the descriptive statistics for all the variables and the table includes means, standard deviation, skewness, kurtosis, and range.

Table 3

Descriptive Statistics for Predictor Variables and Outcome Variable

	Age	Sex	SR	FO	SS	DD
Mean	14.71	1.35	3.67	2.95	8.31	6.13
Standard Deviation	1.82	.48	.53	.51	.57	2.26
Skewness	-.09	.63	.11	-.25	-.12	-.99
Kurtosis	-1.21	-1.62	-.29	-.26	-.47	.26
Range	6.00	1.00	2.70	2.50	4.00	9.00

Note. Descriptive statistics for variables. SR = self-regulation, FO = future orientation, SS = sensation seeking, and DD = delay discounting. * = statistical significance.

Assessment of multicollinearity. The assumption of multicollinearity is violated for self-regulation and future orientation ($r = .56$, $p < .001$). To help the interpretation of which variable is a stronger mediator for delay discounting, the parallel mediation model was set to analyze a pairwise contrast of indirect effects between self-regulation and future orientation. Zero-order correlations between all variables are listed in Table 4.

Table 4

Bivariate correlations between variables

	Age	Sex	SR	FO	SS	DD
Age		.03	.03	.09	-.03	-.04
Sex			-.16*	-.28*	.09	.07
Self-Regulation				.56*	-.03	-.16*
Future Orientation					-.16*	-.18*
Sensation Seeking						-.05

Note. The effects of age on delay discounting scores through self-regulation and future orientation. * = statistical significance.

Mediation

The first hypothesis stated self-regulation and future orientation would mediate the relation between age and delay discounting, while controlling for sex. Mediation was not supported for self-regulation (R^2 = .03, F (3,145) = 1.48, p = .22) or future orientation (R^2 = .03, F (3,141) = 1.51, p = .22). Mediation models are displayed in Figure 6 and results are listed in Table 5 and Table 6 respectively.

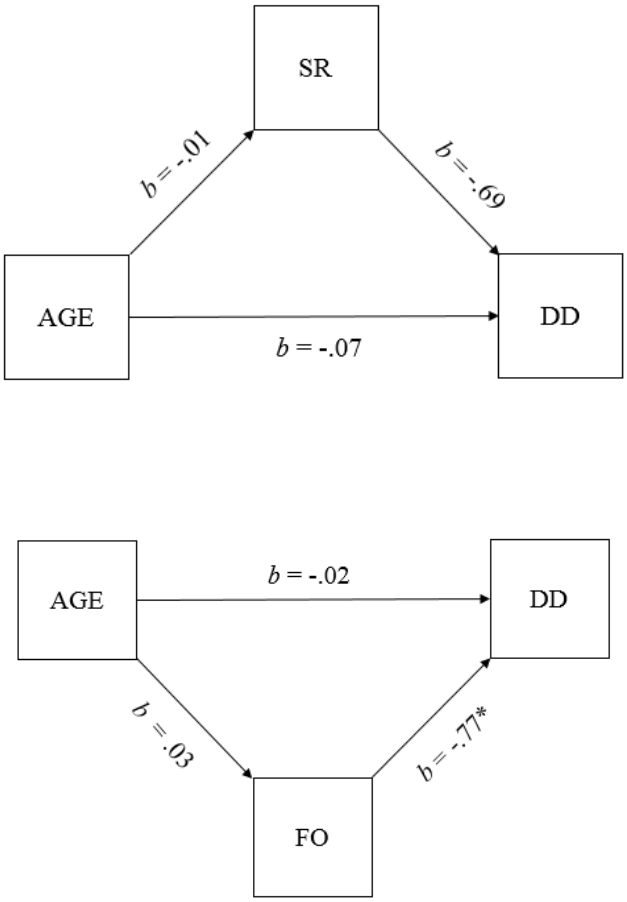

Figure 6. Results of the mediation models. *b* = unstandardized regression coefficient and * = statistical significance. SR = self-regulation, FO = future orientation, and DD = delay discounting.

Table 5

Regression Coefficients, Standard Errors, and Summary Information for Mediation Model with Age-Related Maturation as a Predictor, Self-Regulation as a Mediator, and Delayed Discounting as an Outcome

	Consequent					
	Self-Regulation			Delay Discounting		
Antecedent	*b*	SE	95% CI	*b*	SE	95% CI
Age	-.01	.02	-.06, +.04	-.07	.11	-.28, +.14
Sex	-.20	.10	-.39, -.00	+.13	.42	-.70, +.96
Self-Regulation				-.69	.36	-1.39, +.02
	$R^2 = .03$			$R^2 = .03$		
	$F(2,146) = 2.13$, $p = .12$			$F(3,145) = 1.48$, $p = .22$		

Note. *b* = unstandardized regression coefficient and 95% CIs = lower and upper confidence intervals from 5,000 bootstrap samples.

Table 6

Regression Coefficients, Standard Errors, and Summary Information for Mediation Model with Age-Related Maturation as a Predictor, Future Orientation as a Mediator, and Delayed Discounting as an Outcome

	Consequent					
	Future Orientation			Delay Discounting		
Antecedent	*b*	SE	95% CI	*b*	SE	95% CI
Age	.03	.03	-.02, +.07	-.02	.11	-.23, +.20
Sex	-.36	.09	-.54, -.18	-.01	.45	-.89, +.87
Future Orientation				-.77	.38	-1.53, -.01
	$R^2 = .10$			$R^2 = .03$		
	$F(2,142) = 8.02$, $p < .001$			$F(3,141) = 1.51$, $p = .22$		

Note. *b* = unstandardized regression coefficient and 95% CIs = lower and upper confidence intervals from 5,000 bootstrap samples.

The second hypothesis stated future orientation would be a stronger predictor of delay discounting than self-regulation. Although mediation was not supported for either mediator (R^2 = .04, F (4,134) = 1.53, p = .20), the pathway from future orientation to delay discounting (b = -.77, t (4,134) = 1.40, p = .16) had a higher coefficient than the pathway between self-regulation and delay discounting (b = -.69, t (4,134) = .73, p = .47). The pairwise contrasts of indirect effects indicated there was not a statistically significant difference between the power of each mediator (b = .03, [-.03, +.09]). The parallel mediation model is featured in Figure 7. Further results from the parallel mediation model are presented in Table 7. Although statistically

insignificant, bivariate correlations indicated future orientation had a higher correlation with delay discounting (r = -.18, p < .05) than self-regulation had with delay discounting (r = -.16, p < .05). Correlations between variables are presented in Table 4.

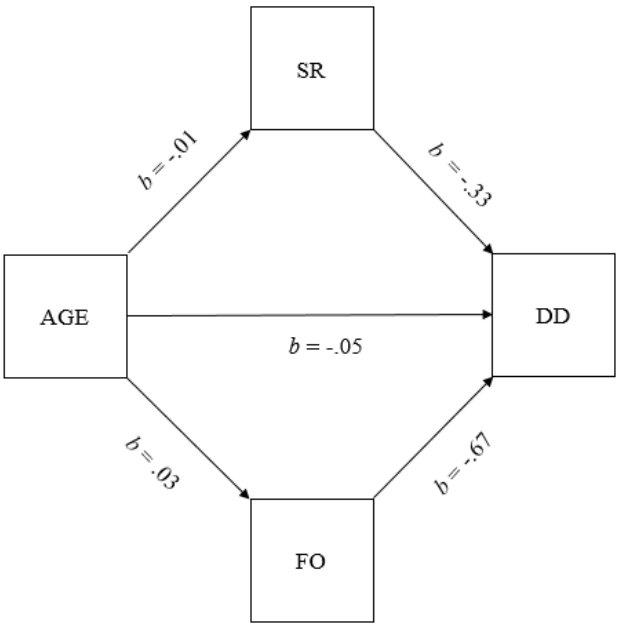

Figure 7. The parallel mediation model with pathways labeled. *b* = unstandardized regression coefficient and * = statistical significance. SR = self-regulation, FO = future orientation, SS = sensation seeking, and DD = delay discounting.

Table 7

Regression Coefficients, Standard Errors, and Summary Information for Parallel Mediation Model with Age-Related Maturation as a Predictor, Self-Regulation and Future Orientation as a Mediator, and Delayed Discounting as an Outcome

	Consequent								
	Self-Regulation			Future Orientation			Delay Discounting		
Antecedent	*b*	SE	95% CI	*b*	SE	95% CI	*b*	SE	95% CI
Age	-.01	.03	-.06, +.04	.03	.03	-.02, +.07	-.05	.11	-.27, +.16
Sex	-.18	.10	-.38, +.02	-.35	.09	-.53, -.15	-.12	.45	-1.01, +.77
SR							-.33	.45	-1.21, +.56
FO							-.67	.47	-1.60, +.27
	$R^2 = .03$			$R^2 = .10$			$R^2 = .04$		
	$F(2,136) = 1.76,\ p = .18$			$F(2,136) = 7.15, p < .05$			$F(4,134) = 1.53, p = .20$		

Note. *b* = unstandardized regression coefficient and 95% CIs = lower and upper confidence intervals from 5,000 bootstrap samples. SR = self-regulation and FO = future orientation.

The third hypothesis stated sensation seeking would moderate the mediation effects that self-regulation and future orientation had on age and delay discounting. Moderated mediation was not supported ($R^2 = .07$, F (7,127) = 1.42, $p = .20$). The moderated mediation pathways are displayed in Figure 8 and listed in further detail in Table 8.

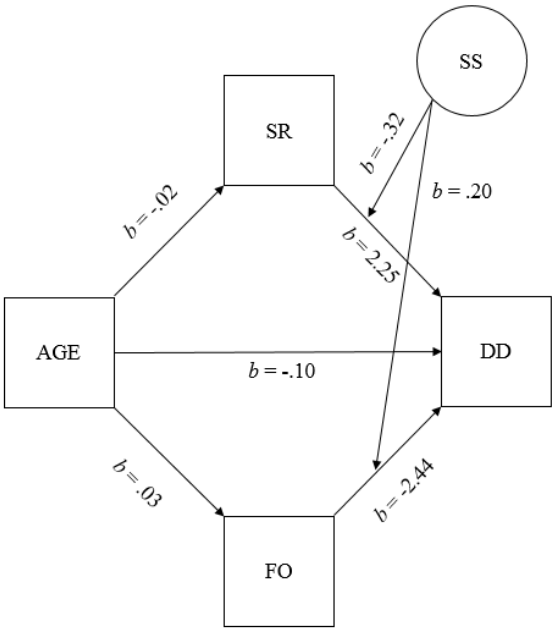

Figure 8. The parallel moderated mediation model with pathways labeled. *b* = unstandardized regression coefficient and * = statistical significance.

Table 8

Regression Coefficients, Standard Errors, and Summary Information for Parallel Mediation Model with Age-Related Maturation as a Predictor, Self-Regulation and Future Orientation as a Mediator, Sensation Seeking as a Moderator, and Delayed Discounting as an Outcome

	Consequent								
	Self-Regulation			Future Orientation			Delay Discounting		
Antecedent	*b*	SE	95% CI	*b*	SE	95% CI	*b*	SE	95% CI
Age	-.02	.03	-.07, +.03	.03	.03	-.02, +.08	-.10	.11	-.33, +.12
Sex	-.18	.11	-.39, +.03	-.32	.10	-.53, -.13	-.07	.46	-84, +1.00
SR							2.25	4.32	-6.31, +10.81
FO							-2.44	4.32	-10.98, +6.10
SS							.31	1.63	-2.91, +3.53
SR X SS							-.32	.52	-1.35, +.71
FO X SS							.20	.51	-.80, +1.21
	$R^2 = .03$			$R^2 = .08$			$R^2 = .07$		
	$F(2,132) = 1.72$, $p = .18$			$F(2,132) = 5.81$, $p < .05$			$F(7,127) = 1.42$, $p = .20$		

Note. *b* = unstandardized regression coefficient and 95% CIs = lower and upper confidence intervals from 5,000 bootstrap samples. SR = self-regulation, FO = future orientation, and SS = sensation seeking.

Discussion

In this study, it was hypothesized that self-regulation and future orientation would mediate the relation between age and delay discounting. Additionally, it was hypothesized that

future orientation would be a stronger mediator than self-regulation of delay discounting. Last, it was hypothesized that sensation seeking would moderate these mediating effects of self-regulation and future orientation on delay discounting. No support for these hypotheses was obtained from mediation and moderated-mediation analyses.

Some of the findings obtained in this study were consistent with findings from prior studies. First, there was a positive correlation between future orientation and self-regulation. This result is consistent with theory and research which suggests that these two processes co-develop (Steinberg, 2008). Second, self-regulation and future orientation in this sample were related to delay discounting. As self-regulation and future orientation increased, delay discounting decreased. This result was also consistent with previous studies (Bridgett et. al., 2015; Steinberg et. al., 2009). Last, there was a negative correlation between future orientation and sensation seeking; as sensation seeking increase, future orientation decreased. This finding is also consistent with the literature (Robbins, 2004).

Limitations

A lack of support for the hypotheses could be due to several factors. One possible reason is restriction in range (Furr, 2011). Over 40% of the sample was age 16 or older. Given their age and maturation (Steinberg, 2008), these participants may not be representative of range of adolescents' age. If so, then a relationship between age and future orientation and/or self-regulation would be hard to obtain. Consistent with this idea, age in this sample was not significantly correlated with either future orientation or self-regulation.

Another possible reason is selection and/or attrition (Shadish, Cook, & Campbell, 2002). Potential participants who thought they were not good at delaying may have decided not to take part in the study (selection). Participants in the study who could not delaying may have chosen

not to complete the study (attrition). If either or both of these happened, then there would not be enough statistical power to see the real connection between age and delayed discounting. Consistent with this idea, there was no connection in the sample between age and delay discounting.

Additionally, mediation and moderated mediation may not have been supported if the Original Monetary Choice Questionnaire didn't realistically reflect adolescent decision making. This questionnaire measures impulsivity as it pertains to monetary choices (Kirby et. al., 1999). However, a more general measure of impulsivity may have better represented typical adolescent decisions, since this age group may not engage in many financial decisions. It is plausible that another measure such as the Barratt Impulsiveness Scale (Pattron, Standford, & Barratt, 1995) may better represent the type of decision-making in the predicted in Dual System Model (Steinberg, 2008).

Future Directions

Besides focusing on problems of a restriction in range, selection and/or attrition, and measuring delayed discounting, future studies should focus on other matters too. The design of the study was cross-sectional which makes temporal precedence unclear (Winer, McKinney, Bryant, & Llu, 2016). Ambiguous temporal precedence makes it difficult to identify what variables are causes and what variables are effects (MacKinnon, Fairchild, & Fritz, 2007). For example, it would not be possible to conclude that a person's future orientation decreased delayed discounting, because it is possible that increases ion delay discounting could increase future orientation. Future researchers should use longitudinal designs in which temporal precedence is clearer (Winer et al., 2016).

Furthermore, future investigations should avoid the problem of mono-method bias. Mono-method bias is when all constructs are measured using the same method (e.g., self-report) and the method becomes a part of the construct (Shadish et. al., 2002). For example, self-regulation, future orientation, and sensation seeking were measured by self-report. Participants' scores for these constructs may or may not have differed if direct observations were used. Measuring self-regulation, future orientation, and sensation seeking with multiple methods could give a more accurate representation of each construct.

Conclusion

Teens who develop strong self-regulation skills and future orientation tendencies have the ability to plan and monitor behaviors (Steinberg et al., 2008). This creates an opportunity for them to be proactive with academics, socializing, and interpersonal functioning. The growth of self-regulation and future orientation allows adolescents to strategically plan for difficult tasks now and in their future.

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