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Explaining Individual Differences in Reward-Seeking and Harm-Avoidance in Adolescence Using a Childhood Behavioral Inhibition Measure

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Abstract

Research on self-control often groups many traits under a more general reference to sheer power of will. This study seeks to examine whether or not this broad descriptor can be further broken down into more specific proclivities to get at the question of what specifically motivates such inhibition in children, a population where the concept of self-control is more challenging to identify. Data came from the Colorado Longitudinal Twin Study, which included a behavior prohibition task used to measure self-control in children aged 14 – 36 months. The task required them to restrain themselves, for 30 seconds, from playing with a toy placed in front of them. I regressed adolescent personality traits (harm avoidance and novelty seeking) on ability to wait (measured as latency to touch the toy), controlling for sex. I also examined genetic contributions to these measures. The results supported a relationship between latency scores in toddlerhood and both personality traits in adolescence; Longer latencies at 3 years old were predictive of higher harm avoidance scores and lower novelty seeking scores at age 17 within some of the conditions. Extensions of this study might look into further isolating particular behaviors that constitute general self-control abilities, to examine whether or not such tendencies persist throughout development.

Keywords: self-control, behavior prohibition, harm avoidance, novelty seeking, personality development, behavioral genetics

Introduction

Self-control is a habitual and routine part of adult life, becoming more implicit with age. This makes children an ideal population in which to measure its development, since postponed or delayed gratification is difficult for them. This is consistent with research on the timeline of prefrontal cortex development; self-control, a skill belonging to the umbrella category of executive functioning and mediated by the PFC, takes years to develop. And even without consideration of these biological limitations, children's incompetence when it comes to self-control is quite easy to discern. After all, with such minimal learning and lacking in the life experience with which a strong moral compass might be formed, feelings about what one *ought* to/not to do, despite *wanting* to/not to do it, vary tremendously with age. However, psychological research has established some level of continuity between an ability to inhibit behavior as a child and certain measures of success in adulthood. Pivotal in the canon of self-control research is Walter Mischel's well-known marshmallow test, where the child's ability to wait a few minutes, in order to be granted a second marshmallow instead of eating the first one immediately, predicted success in several aspects of life, including health, employment and stable romantic/interpersonal relationships (Mischel, 1988). The results were integral in demonstrating the direct nature, and the level of continuity, between self-restraint in childhood and achievement in adulthood. In this study, I examine the connection between compliance with a "don't touch" instruction at age three and adolescent/teenage personality tendencies toward harm avoidance and novelty seeking, rather than self-restraint overall.

Needless to say, these connections established in prior literature point to some type of pattern that is worth attention. But whether it makes sense to call the behaviors in youth something as sophisticated as self-control remains to be seen, especially when considering the

conceptual differences in the present experiment when compared to the marshmallow task. The data analyzed in this study come from a test given to twins from ages one to three years, in which a toy was placed in front of them, and they were only given directions not to touch it. There were no further instructions about the overall task structure; they did not have any incentives for waiting or any sense of how long they would have to wait, or even if they would ever be granted permission. So unlike Mischel's marshmallow test, where delaying gratification was the variable of interest, the twins in the current study had to deal with an indefinite amount of wait time, not knowing whether or not they would be rewarded. In such a vague and mysterious frame of reference, one can hardly say with certainty that they were consciously exercising self-control.

In further support of this reconsideration of the broad "self-control" characterization, a firsthand viewing of the videos that captured the task showed that a portion of the children who waited until permission was given were hesitant to touch the toy, even once they were told they could. This phenomenon stood out, since it looked so much more like nervousness or caution than like self-restraint. If this were true, what might be called an ability to wait might be more appropriately deemed a certain cautiousness in trusting the adult who has given two very different instructions. A strong connection between things identified as self-control and other functions like decision-making, or even reward theory, have been found (Pang, Otto, & Worthy, 2014). So perhaps the differences in the calculation of expected consequences and rewards might explain how the children behave. This could indicate that maybe because all of these things co-occur and cluster, "self-control" may be an imprecise term. Based on these initial observations, the following basic analyses seek to shed light on more important features of executive functioning, or simply personality differences, that could be more specific indicators of what we might more appropriately call self-control later in life.

To isolate these differences, two of several personality traits were considered. Because of the observation of the hesitancy of many twins who initially obeyed the instructions to touch the toy after they were given permission, the previously studied harm avoidance tendency was a likely explanation. Psychobiological models of personality, aiming to systematically assess differences in disposition and temperament, often include a harm avoidance dimension (Cloninger et al. 1987). And harm avoidance, as it is often called in the literature, is essentially addressing the same areas of interest as risk aversion, synonymously a proclivity for heightened worry about undesired outcomes. Conversely there is novelty-seeking, which describes those less predisposed to cautiousness, and more predisposed to impulsivity, with less regard for potential negative outcomes. These two propensities will henceforth be referred to as harm avoidance and novelty seeking.

The following analysis will examine how much this hesitance in toddlerhood (measured as *latency* to touch) might be correlated with harm avoidance and novelty seeking in adolescence. The children who wait to touch even after they are told they can should have significantly higher scores of harm-avoidance personality traits in adolescence, indicating that general fear and anxiety might be higher in adulthood. The children who touch the toy quickly (including before they are given permission) might have less concern, and be more excitable at the prospect of the new toy than anything else; this should be related to higher scores on a novelty-seeking trait in adolescence, and perhaps less fearful and more willing to take risks in adulthood.

Methods

Participants

The data for this study came from experiments run in the Colorado Longitudinal Twin Study, which had data from 473 families with twins. For the self-restraint task, the sample consisted of 813 individuals, from 435 monozygotic (MZ) individuals (228 female, 207 male), and 378 dizygotic (DZ) individuals, (with 192 female, 186 male) measured either at home and/or in lab. Though 813 individuals completed the task, some scores were excluded due to poor video quality, a failure to complete the self-restraint task, and fatigue, as twins that showed any signs of distress or fatigue at the prompt were absolved from having to participate and prohibition was immediately released. In the end, 658 subjects' data were usable for the home data, and 541 were useable for the lab data. The prohibition task was also conducted at three other time points (14 months, 20 months, and 24 months), but these were not included in the current analysis. This was based on direct viewing of the data, which clearly showed that age groups under 36 were more likely to touch the toy before the prohibition was lifted, resulting in very few phase II latencies scores. Because the phase II latency was an important variable for this particular analysis, only the 36-month data, which had many more phase II latency scores, were used.

Measures

Prohibition Task The prohibition task was conducted both in a lab at the University of Colorado and in the families' homes. The independent variables were the scores from the prohibition task. The data used in this study compiled data from both the lab and home visits at 36 months. Previous studies using these data have been limited to home data. The child's parent sat near the child completing the task (either in a chair in the room or the couch if the child was not seated) while the experimenter produced an enticing toy to capture the child's attention. After briefly demonstrating the features of the toy, and its undeniable appeal, the experimenter would place the object near the child saying "Now [child's name], don't touch!" The

experimenter would then look away, neglecting to pay attention to the child, while a nearby parent remained neutral, and did not give appreciable attention nor instructions to the child. If the child did not touch the toy against the explicit directions, after 30 seconds had elapsed the experimenter would say "It's ok, you can play with it now." At this point, prohibition was officially released, marking the end of phase I of the task and the beginning of phase II. If the child touched the toy against directions, the prohibition would be released at that time. Many children touched the toy right at the start of phase II, though some waited noticeably longer even once permission was given. The time that the children finally touched the toy was recorded. Latency was the time before touching the toy from the beginning of phase I.

The children were grouped categorically, according to whether or not they touched the toy before phase II. Because there were occasional inconsistencies in the timing of prohibition release, those who touched before, even if the latencies were longer than 30 seconds, were truncated to 30, and under 30 seconds were truncated to 31 seconds. Those who never touched the toy were given a latency of 60 seconds. Some analyses used an overall latency measure, as is outlined in results, but usually relationships were analyzed within each group.

Personality Measures The twins completed short forms of the Junior Temperament and Character Inventory (JTCI; Luby et al, 1999) and the Tridimensional Personality Questionnaire (TPQ; Cloninger, 1991); 750 individuals completed the TCI at age 12.43 (SD=.37, range = 11.326 to 14.021); 797 individuals completed the TPQ when they were 17.26 years old (SD=.64, range = 16.5 to 20.1). The JTCI was an adapted version of the Temperament and Character Inventory with items re-worded to be appropriate for children aged 9 to 13 (Luby et al.); the version the twins completed only had items related to temperaments (i.e. not character items). Both the JTCI and TPQ consist of true/false questions worded in simple first-person sentences

written to be most comprehensible for their respective age groups. Both JTCI and TPQ included harm avoidance and novelty-seeking subscales. The harm avoidance subscale intended to measure traits like apprehensiveness, nervousness and tendency to fear and anticipate unpleasant or unfamiliar situations (Cloninger, 1987); for example, from the TPQ, "Usually I am more worried than most people that something might go wrong in the future," and from the JTCI "I worry that bad things will happen." Novelty seeking scores sought to encompass traits such as impulsiveness and exploratory excitement for example, from the TPQ, "I often try new things for fun or thrill, even if people think it is a waste of time;" and from the JTCI, "I usually love doing new or unusual things." The JTCI and TPQ scales contained 18 questions for the novelty seeking subscale and 18 for the harm avoidance subscale. Each item was coded as zero for false and one for true, and each score was the average of the items answered, provided that the subject answered at least 75% of the items. Some items were reversed, so that higher scores would indicate more harm avoidance or novelty seeking. The scores are to be interpreted as the proportion of statements endorsed. The internal consistencies for the JTCI were high for both harm avoidance and novelty seeking, .83 and .77 respectively (Luby et al, 1999). The test-retest reliability for the TPQ was also high for both novelty seeking and harm avoidance, .76 and .79 respectively (Cloninger et al, 1991).

Analyses

Latency Analyses. The data were analyzed with Mplus editor, a structural equation modeling program that provided the basic descriptive, basic correlational, and regression results for the present study. The type="complex" option was used to correct the standard errors for the non-independence of the twin pairs. For both lab and home data, harm avoidance and novelty seeking variables were regressed on latency (how long they waited) and

sex in separate groups defined by whether they touched or not during phase I. Home and lab data were analyzed separately; averaging home and lab data for a given twin might obscure unique patterns, or perhaps be combining two very different latencies (e.g. it would not be clear how to group a child who touched in phase I for home but did not touch in phase I for lab). Home and lab data were also kept separate since the number of children who touched before phase II for home data was higher than for lab data, indicating that these two sets of scores might be very different. This is intuitive, since one could expect children to be more uninhibited in their own home, and perhaps more guarded in an unfamiliar setting. This will be further considered in the discussion section.

The harm avoidance variable was used to get at the question of risk aversion, as phrased in the introduction: essentially the tendency to not behave a certain way out of an inclination to avoid potentially bad outcomes. This is very different than something domain-specific like fearfulness, and instead provides a more horizontal measure of the personality trait that might explain a more general fear of negative outcomes. This variable addressed the no-touch group with particularly long latencies after the test – and even those who successfully waited. Perhaps they had done so out of nervousness for consequences more than firm conviction to follow the morally authoritative adult's guidelines. The novelty seeking variable addressed the group of children unable to prevent themselves from touching the toy they were specifically told not to touch. This is a trait related to impulsivity, but hopefully addresses a more conscious decision that seems evidenced by the conduct of these children. Those that touched the toy immediately may have completely ignored the adults, since there were several cases where after they touched, they did not refer to or look at the adult, seemingly forgetting they were even present.

Genetic Analyses. To address the question of the genetic role in latency and the adolescent personality traits of interest, the variance (differences) explained by genetics (A or a^2), the variance explained by shared environment (C or c^2) and the variance explained by non-shared environment (E or e^2) were calculated with the Falconer model formulas. The ACE model is a commonly used conceptualization and set of equations to determine what contributes to similarities and differences between genetically related individuals. In this study, the twins were either MZ or DZ, that is sharing 100% of the additive effects of their genes or sharing 50% of the additive effects of their genes, respectively. Pairs were raised within the same home by the same parents. The formulas were as follows, where r_{MZ} and r_{DZ} are the twin correlations for MZ and DZ twins, respectively:

$$a^2 = 2(r_{MZ} - r_{DZ})$$
$$c^2 = 2r_{DZ} - r_{MZ}$$
$$e^2 = 1 - r_{MZ}$$

While ACE estimates can indicate that genetic influence might be the strongest predictor of traits down the line, further analyses than those conducted in the current investigation would be required to confirm such patterns. These approximations are not the same as fitting an ACE twin model. These rough approximations can lead to particular issues, such as negative variance estimates, that will be addressed later.

Because twin pairs could not be split by touch group, two pre/post latency variables were used to determine whether zygosity affected the twin relationship in latency (how much a twin touching at a certain latency before phase II would predict the other twin's touching at an early or late latency before phase II). Two latency scores were computed for each twin: a pre-phase II latency (touching before prohibition was lifted), or a post-phase II latency (if the child waited to touch until the prohibition was released). That meant that if twin 1 touched the toy in phase I but

twin 2 did not, that twin pair could not be used in the correlation estimate, since only twin 1 would have a pre-phase II latency score. Only twins who both touched the toy in phase I were used for pre-phase II latency twin correlations, and only those who both waited were used for the post-phase II latency twin correlations.

Results

Preliminary Analyses

Table 1: Descriptive Statistics for Personality Questionnaires Grouped by Setting and Touch Group Membership

		Touch = Yes					Touch = No				
		n	*M*	s^2	*Minimum*	*Maximum*	*n*	*M*	s^2	*Minimum*	*Maximum*
Home	JTCIHA	189	.288	.033	0	.810	344	.266	.036	0	.864
	JTCINS	189	.384	.025	.056	.833	344	.372	.029	0	.889
	TPQHA	197	.296	.046	0	.944	357	.278	.049	0	.833
	TPQNS	198	.039	.040	.056	1.00	357	.035	.035	.111	.944
Lab	JTCIHA	147	.297	.034	0	.81	281	.271	.035	0	.864
	JTCINS	147	.380	.024	.056	.833	281	.365	.029	0	.889
	TPQHA	150	.294	.045	0	.944	292	.280	.048	0	.833
	TPQNS	151	.501	.037	.056	.944	292	.514	.036	.111	.944

Note. Descriptive statistics of harm avoidance and novelty seeking data from both home and lab settings, at age 12 and age 17. TPQHA = Harm avoidance from Tridimensional Personality Questionnaire (TPQ); JTCIHA = Harm avoidance from Junior Temperament and Character Inventory; TPQNS = Novelty seeking for TPQ; JTCINS = Novelty seeking for JTCI. *n* = size of group, *M* = mean, s^2 = variance.

Table 2. Effects of Sex on Latency and Personality

Variables	*ß*	*p*
Personality Measures		
JTCIHA	-.210	.014
JTCINS	.329	>.01
TPQHA	-.196	.013
TPQNS	.072	.349
Latency Measures		
Home Latency	-.313	>.01
Lab Latency	-.194	>.01

Note. Top: Standardized regression coefficients between harm avoidance tendencies and sex, and novelty seeking tendencies and sex with *p* values for both age 12 and age 17 data. Bottom: overall latency and sex coefficients for home and lab with *p* values. TPQHA = Harm avoidance from Tridimensional Personality Questionnaire (TPQ); JTCIHA = Harm avoidance from Junior Temperament and Character Inventory; TPQNS = Novelty seeking for TPQ; JTCINS = Novelty seeking for JTCI.

Preliminary Analyses

Table 1 provides an overview of the output for each group, in each setting (both lab and home). Overall, the 36-month old group did well in their ability to follow instructions. For the home data, 233 touched the toy in phase I (~35%), before they were given permission, but 424 did not touch the toy in phase I (~65%), and waited to touch it until they were given permission. As for the lab data, 179 touched in phase I (~35%), before they were allowed, while 337 did not touch in phase I (~65%), and successfully waited until being given permission. Very quickly though, sex differences in latency became apparent. Additionally, a sex effect showed up in the harm avoidance and novelty-seeking measures at both ages. As shown in Table 2, for the personality measures overall, the harm avoidance scores for males were significantly lower at both age 12 and age 17. Novelty scores were significantly higher for males at both age 12 and age 17 as well. As for latency in general, males had highly significantly lower latencies in both the home and lab. Because sex was expected to have an effect in this direction, it was not the primary variable of interest in this study. These findings reinforced the intuitive decision to control for sex in all of the regressions.

Main Analysis of Latency Predicting Later Personality

To examine whether the touch latency predicted harm avoidance and novelty-seeking traits later in life, we regressed personality on the latency in separate groups defined by touch. Separate models were run for each personality variable, using the JTCI for harm avoidance at

age 12 and novelty seeking at age 12, and using the TPQ for harm avoidance at 17 and novelty seeking at 17. Table 3 presents the standardized regression coefficients for these models. The model also controlled for sex based on the initial determination that sex would have significant predictive power, although it was not the variable of interest. For this reason, the written analyses will focus on the latency variable, but information on sex effects can be found in Table 3.

Table 3. Standardized regression coefficients for models predicting personality with latency

	Predictors			
	Phase I Touch = Yes		Phase I Touch = No	
DV Measure	*Latency*	*Sex*	*Latency*	*Sex*
Models with Home latency predicting personality				
JTCI HA	.051	-.039	.073	-.163*
JTCI NS	-.107	.077	.023	.057*
TPQHA	.045	-.186*	.160*	-.143*
TPQNS	-.083	.071	-.152*	-.024
Models with Lab latency predicting personality				
JTCI HA	.109	-.045	.069	-.130*
JTCI NS	.176*	.130	-.01	.136*
TPQHA	-.199	-.166*	.015	-.132*
TPQNS	.052	.057	-.017	.065

Note. Model output of personality traits regressed on latency and sex. Home and lab data separated vertically. TPQHA = Harm avoidance from Tridimensional Personality Questionnaire (TPQ); JTCIHA = Harm avoidance from Junior Temperament and Character Inventory (JTCI); TPQNS = Novelty seeking for TPQ; JTCINS = Novelty seeking for JTCI. *$p < .05$.

For the self-restraint data obtained at home, the Junior Temperament and Character Inventory (JTCI) measures of harm avoidance and novelty seeking based on home data showed no significant relationship with latency for either group. The harm avoidant personality traits measured at age 17, with the Tridimensional Personality Questionnaire (TPQ), were not significantly predicted by latency for the children who touched the toy in phase I, before they were given permission. They did not follow the predicted pattern that lower latencies in phase I

would predict lower harm avoidance scores. As for the group that did wait to touch until phase I was over, longer latencies did significantly predict higher harm avoidance scores, as expected (ß= .160). The TPQ novelty seeking data showed no significance for latency or sex for the group of children who touched in phase I. However, for the children that waited until permission was given, longer latency did significantly predict lower novelty seeking scores (ß= -.152).

For the self-restraint data obtained in the lab, latency in phase I or phase II did not significantly predict JTCI harm avoidance at age 12. However, longer latencies in phase I did significantly predict higher novelty-seeking scores, contrary to what would be expected (ß= .176). In the group that did not touch in phase I though, longer latencies did not predict lower novelty-seeking scores. Harm avoidant tendencies measured at age 17 with the TPQ were not predicted by latency in the group that touched in phase I. This pattern also held in the group who waited until phase II to touch, or until they were given permission; latency was not predictive of harm avoidance in either direction. As for the TPQ novelty seeking data, latency, for neither the phase I touch group nor the phase I no-touch group, was significant.

Genetic Correlational Analyses

Basic correlational analyses were also run to determine whether or not there might be genetic influences of harm avoidant tendencies and novelty seeking tendencies. The post-latency variable was coded by assigning to those who did touch in phase I a "pre-phase II latency," and those who did not touch until phase II a "post-phase I latency." The negative values in the c^2 estimates are a result of the MZ correlation being greater than twice the DZ twin correlation. The negative a^2 value for post-latency reflects an odd pattern of a numerically higher DZ correlation, which may just be a matter of small sample size. This will be explained in greater detail under the conclusion section.

Correlational Genetic Trends

Table 4. Twin Correlations and ACE Estimates (Falconer Models)

	Twin Correlations				ACE Estimates		
Variable	*n(MZ)*	r_{MZ}	*n(DZ)*	r_{DZ}	a^2	c^2	e^2
JTCIHA	215	.348*	187	.023	.65	-.0302	.652
JTCINS	195	.417*	180	.136	.281	-.145	.583
TPQHA	215	.392*	187	.163*	.458	-.066	.608
TPQNS	195	.470*	180	.277*	.193	.084	.53
Home Pre-latency	96	.172	77	.458*	-.572	.744	.828
Home Post-latency	140	.150	131	.002	.296	-.146	.85
Lab Pre-latency	61	.679*	50	-.132	1.622	-.415	.321
Lab Post-latency	137	.084	115	.422*	-.676	.76	.916

Note. Correlations of harm avoidance and novelty seeking between monozygotic (rMZ) and dizygotic (rDZ) twin pairs. TPQHA = Harm avoidance from Tridimensional Personality Questionnaire (TPQ); JTCIHA = Harm avoidance from Junior Temperament and Character Inventory (JTCI); TPQNS = Novelty seeking for TPQ; JTCINS = Novelty seeking for JTCI; a^2 = variance due to genetic effects; c^2 = variance due to shared environmental effects; e^2 = variance due to non-shared environmental effects. *$p < .05$.

As shown in Table 4, MZ twins were significantly correlated ($r_{MZ} = .348$) for the harm avoidance data at age 12, while DZ twins were not significantly correlated here, leading to .65 of the variance explained by the genetic component. For novelty seeking at age 12, the MZ twin correlation was significant ($r_{MZ} = .417$), while once again the DZ twin correlation was not.

At age 17, for harm avoidance, MZ twins were significantly correlated ($r_{MZ} = .392$), as were DZ twins ($r_{DZ} = .163$). And for novelty seeking, the results showed high correlations for both MZ twins ($r_{MZ} = .470$), and for DZ twins ($r_{DZ} = .277$).

For the latency correlations, the home post-latency correlation was actually higher for DZ twins than for MZ twins, a pattern which might arise out of a low sample size. There was no significant correlation for latency for those twins who both touched before phase II. The pre-phase II latency correlations for the lab data showed that MZ twins were highly correlated, while

DZ twins were not significantly correlated, but the post-latency scores, for the twins who both touched after phase II, also showed the strange pattern of higher DZ correlations. The anomalies in this part of the data explain the strange ACE values. C^2 estimates were often negative because the MZ twins correlations were twice the size of that of the DZ twins. The unusual patterns reported here will be further addressed in the discussion section.

Discussion

The findings from the current study point to a possibility that there may be some continuity between inhibitory behavior in early youth and personality traits in adolescence. Harm avoidance scores at age 17 were significantly higher for those children who waited longer in phase II. Additionally, novelty seeking scores at age 17 were significantly lower for children who waited longer in phase II. These significant findings were true only for home data, which reinforces the preliminary consideration that the settings in which the data was obtained might be meaningfully different. Besides the finding that longer latencies in the group that did not wait until phase II predicted higher novelty seeking scores at age 12, most significant findings pertained to data obtained at age 17. This is noteworthy, since the fact that a stronger connection would exist over a greater window of time does not seem to immediately make sense. However, it is possible that this could be explained by a strengthening of personality with age; some research has supported the notion that personalities are set in stone by age 30 (McCrae & Costa, 1990). These findings could be consistent with the idea that personality strengthens over time. Though even if personality is not cemented by age 17, *that* there is any connection, over and above gender differences, between hesitancy at age 3 and harm avoidance or novelty seeking at age 17 is remarkable, since this is a time of tremendous development. If in fact these risk averse tendencies linger throughout childhood, it does seem that this is a strong proclivity, and one that

is detectable through self-restraint tests at only 36 months old. This might be the sign of strong continuity. However it does seem to be the case that gender remains a much stronger predictor of these personality traits in adolescence, with males consistently lower in harm avoidance, and higher in novelty seeking. It is also important to note the several cases in which latency did not significantly predict higher scores on either personality measures.

As for potential for genetic influence in these traits, the preliminary, and far from conclusive, tests do point to a likelihood that there are some genetic similarities that appear in personality measures, since MZ trait score correlations were higher than that of DZ. But this is not necessarily a strong connection, nor definitively due to shared genes. More analyses would have to be done to confirm this trend.

While sex was not the factor of interest in this study, the preliminary analyses showing the very significant effect reinforce the importance of identifying specific mechanisms of behavior. For if the measures had been self-control instead of novelty-seeking or harm avoidance, the reasons for and nature of behavior based on sex differences would be obscured. To be worse at self-control is not the same as being generally higher in risk-taking behavior, and novelty-seeking tendencies, the latter of which boys certainly are, but the former we cannot say. It is therefore necessary to consider the various traits mediating self-control, and perhaps also to view the ability to actively inhibit behavior as a combination of maximizing concern for and anticipation of consequences, while also minimizing exploratory, risky behavior.

Potential Limitations

Similar analyses driven by questions regarding self-control throughout development might improve rigor by administering the same questionnaire at both ages of interest – the TPQ and JTCI scales that were decided upon in the original design of the twin study were not very

highly correlated in our analyses. While these differences could be accurate, in that they are reflecting the changes that the subjects have undergone in this time, it could also be an indication that they have not measured what they are intended to. Using questionnaires that are more similar could allow for greater confidence. However, the decisions made in the conception of the JTCI often led to inabilities to approximate TPQ items from JTCI items, since not only was wording changed, but some additional items were added, for reasons difficult to trace. Likely, the correlations between JTCI and TPQ, especially for novelty seeking, are effected by the changes made to the questionnaire.

Additionally, more specific touch-timing categories might have provided greater precision in the hidden decision-making processes of the children; It is possible that within the group that touched before phase I, those who tried to avoid touching but eventually gave in are not particularly novelty-seeking, the way that those who immediately touched the toy with little nervousness were. Of course, this last issue gets at the greater obstacle of having children as subjects. While timing of touching was a relatively objective, stable variable to measure within the task (as opposed to, say, affect, or calmness) children cannot report their thought processes at the time. Their actions are also much more dictated by mood, which, to be sure, is not useless information, but could potentially obscure underlying personality traits and typical temperament. Additionally, the inexplicably higher DZ score for latencies may cause skepticism about sample size, and whether there was enough data to be certain about the findings. Looking at correlations within latencies greatly reduced the sample size, since we could only examine those twins that both touched in phase I or both touched after phase I. These strange results occurred in one of the smallest sample of all of the tests, so hopefully this is how the odd output is explained.

Future Directions

The idea that sometimes unpleasant circumstances must be tolerated in order to achieve more pleasant circumstances in the future is a mysterious area of study even in research on adults. But there has been much more research on general decision making in adults because of the range of tests that they can participate in. There has been little research utilizing models of decision making in children.

Because sex was a highly significant explanation for behavior in this task, we may be able to eliminate the possibility that the differences seen are due to different levels of logical inquiry ability; Çelik (2017) found that sex was not a relevant factor in basic mathematical reasoning in regard to weighing decisions. Additionally, Mata et al. (2013) found that effective decision-making, in a child's gambling task, was not determined by sex in children aged 3-6. However, in this study, sex was extremely influential for many of the personality traits and latency, so perhaps this task measured something beyond logical inquiry abilities, and the decisions made to or to not follow directions are influenced by some other type of calculation, or personal inclination.

Longitudinal studies yield data that is uniquely valuable; few times are researchers given specific information about cognitive abilities in childhood that can then be compared to other traits of interest later in those same individuals' lives. If the research question is one about development, it is the most controlled experiment one can have. Their logistic difficulty makes them rare, and interpreting all available data is vital. Future studies might expand upon this research and take advantage of the very dataset, next time looking at other personality axioms that might be more predicted by these childhood dispositions. However, without longitudinal data, research addressing a similar question might focus on modeling decision-making in children, with particular emphasis on the role of temperament over logical reasoning ability. This

makes sense, as a group with markedly less reasoning ability might rely more on attitude or mood. The question, of course, is if this tendency endures throughout life, and if so, what else such a trait might predispose a person to.

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