Self-Reported Impulsivity and its Relation to Executive Functions in Interned Youth

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In adolescence, antisocial behaviors increase in prevalence, an occurrence that has been related to the parallel increase of impulsive behaviors. However, impulsivity is a conglomerate of unidimensional impulsogenic traits, divided into aspects of behavioral dyscontrol and sensation seeking. In the present study, we examine how these traits differ between interned youth and an aged-matched control group, and how they relate to executive functioning. Results indicate that impulsogenic traits related to behavioral dyscontrol, but not sensation seeking, are more pronounced in interned adolescents. Also, executive functioning was predictive of lack of premeditation, a trait specifically related to antisocial behavior. One implication of this is that interventions improving executive functioning could be beneficial in the rehabilitation of interned adolescents with impulsivity-related problems.

Key words: adolescence; antisocial behavior; executive function; impulsivity; interned youth; self assessment; UPPS.

Introduction

Impulsivity and Antisocial Behavior

Impulsivity develops in parallel to the behavioral changes occurring during adolescence. Multiple pathways are thought to influence these behavioral changes, including neuronal (Casey, Jones, & Hare, 2008) and cognitive development (Romer et al., 2009) as well as socioeconomic factors (Lynam, Caspi, Moffitt, Loeber, & Novak, 2000). Impulsivity has been associated with both prosocial behavior (Sercombe, 2014) and antisocial outcomes (White et al., 1994). In particular, a positive relation between adolescent impulsivity and antisocial behavior has been argued by several authors (Gordon & Egan, 2010; Loeber et al., 2012; Lynam, Moffitt, & Stouthamer-Loeber, 1993). This is supported by observations of

adult community samples (d'Acremont & Linden, 2005; Pharo, Sim, Graham, Gross, & Hayne, 2011) and clinical populations (Swann, Bjork, Moeller, & Dougherty, 2002). However, most of these studies have been conducted on community and university samples (but see Carroll et al., 2006). By contrast, adolescents with an actual history of antisocial behavior are markedly understudied, particularly so with regard to more recent models of impulsivity. Addressing this, the current study examines trait-based impulsive behavior and its relationship to executive functioning (EF) in a group of youths detained in juvenile correctional facilities. This group (hereafter denoted “interned group”) is interned due to a history of antisocial, delinquent, or criminal behavior. The interned group is compared to an age-matched control group

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of noninterned adolescents (hereafter denoted as the “control group”). Furthermore, we also investigate how trait-based impulsivity relate to central EF as conceptualized by the tripartite unity/diversity model (Miyake et al., 2000; Miyake & Friedman, 2012), encompassing the three executive functions *inhibition*, *shifting*, and *updating*.

Research in this field is warranted for several reasons. Antisocial behaviors in adolescence run the risk of consolidating and becoming life-course persistent (Moffitt, 1993; Raine et al., 2005). Also, the factor structure of personality traits related to impulsivity has been shown to differ between adolescents and adults (Leshem & Glicksohn, 2007), implying that predicting adolescent impulsive behavior from results based on adult studies can be erroneous. Gaining increased knowledge on how impulsivity is expressed in populations with a history of maladaptive behavior can be of value in both assessment and rehabilitation, not only for interned youth. Indeed, in a study on impulsivity in adults with borderline personality disorder, the employment of multiple methodological approaches has been demonstrated to be useful for identifying clinical conditions (Jacob et al., 2010).

Trait-Based Impulsivity

Impulsivity is a complex construct, which subdivides into multiple aspects (Duckworth & Kern, 2011; Sharma, Markon, & Clark, 2014). Two main approaches have emerged in recent years: trait-based (Reynolds et al., 2008; Whiteside & Lynam, 2001) and cognitively based impulsivity (Romer et al., 2009; Steinberg, 2008; White et al., 1994). Previous research indicates that these approaches largely tap different constructs, though with some overlap (Cyders & Coskunpinar, 2012; Gay, Rochat, Billieux, d’Acremont, & Van der Linden., 2008; Reynolds et al., 2008; Sharma et al., 2013; Toplak, West, & Stanovich, 2013). Trait-based impulsivity is related to personality, goal-directed, and socioemotional behavior and is associated with affective action, self-regulation, and novelty-

seeking behaviors (Sharma, Kohl, Morgan, & Clark, 2013). It is commonly studied using self-report instruments, and previous research employing factor analyses has yielded subdivisions of impulsivity into separate but inter-related *impulsigenic* traits (Duckworth & Kern, 2011; Reynolds et al., 2008; Whiteside & Lynam, 2001). In general, all models contain one or more facets related to propensity for affective action, self-control, and novelty-seeking behaviors (Sharma, Kohl, Morgan, & Clark, 2013). In the present study, measures of trait-based impulsivity were obtained using the UPPS impulsivity scale, a self-report instrument specifically developed to capture the multifaceted nature of trait-based impulsivity (Whiteside & Lynam, 2001; Whiteside, Lynam, Miller, & Reynolds, 2005). This instrument operationalizes impulsivity into four distinct impulsigenic traits. The propensity to act rashly under negative affect is conceptualized as *Urgency*, the inability to employ forethought as (lack of) *Premeditation*, the inclination to abandon tedious tasks as (lack of) *Perseverance*, and the propensity to seek out novel situations and experiences as *Sensation Seeking*. The first three UPPS facets all relate to distractibility and dyscontrolled behavior and tend to intercorrelate, whereas Sensation Seeking is more distinctive (Duckworth & Kern, 2011; Magid, Maclean, & Colder, 2007), possibly reflecting a differing level of analysis (Gay et al., 2008).

Impulsivity and the Relation to Antisocial Behavior and Executive Functioning

Within the UPPS framework of impulsivity, lower levels of Premeditation and higher levels of Sensation Seeking behaviors have been reported in undergraduate and community samples (DeShong & Kurtz, 2013; Lynam & Miller, 2004; Miller, Flory, Lynam, & Leukefeld, 2003). In antisocial drug rehabilitants, on the other hand, lower Perseverance has been reported (Sargeant et al., 2012) whereas Urgency has been associated with aggression (Carlson, Pritchard, & Dominelli, 2013; Derfinko, Dewall, Metze, Walsh, & Lynam, 2011).

and borderline personality disorder (DeShong & Kurtz, 2013; Jacob et al., 2010). The facet Sensation Seeking has also been related to the frequency with which maladaptive impulsive behaviors are engaged in (Smith et al., 2007) whereas Urgency has been related to the severity of such behaviors (Anestis et al., 2007; Smith et al., 2007). In adolescent samples with a history of antisocial behavior, studies assessing trait-based impulsivity are rare, however (but see Burke, Loeber, & Lahey, 2007).

The idea that measures of impulsivity could be predictive of everyday behavior and more specific of antisocial behavior has been previously investigated (Billieux, Rochat, Rebetez, & Van der Linden, 2008). Swann, Lijffijt, Lane, Steinberg, and Moeller (2009) and Anestis, Selby, and Joiner (2007) found trait-based impulsivity to be associated with response inhibition and urgency, respectively. However, it has also been suggested that the relationship between impulsivity and antisocial behavior is driven by intelligence (Raine et al., 2005; White et al., 1994) or, more specifically, by the EF of working memory (Arce & Santisteban, 2006; Herraro et al., 2010; Romer et al., 2009), which is in line with what has been reported on real-life risky adolescent behavior (Pharo et al., 2011). In Romer et al. (2009) it was found that one EF was inversely related to impulsivity. In addition, Herraro et al. (2010) did show that the EF updating, together with fluid intelligence, differentiated incarcerated offenders from a control group.

This Study

The study aimed at investigating how trait-based impulsivity differs between interned youths and an age-matched control group. The study also aimed at investigating the associations between separate EFs (updating, inhibition, shifting) and trait-based impulsivity.

It was expected that:

- Interned youth to a greater extent would rate themselves as more

impulsive than the control group (Sharma et al., 2014).

- Trait-based impulsivity is associated with EF, in particular the executive function updating (Herraro et al., 2010; Romer et al., 2009).

Method

Participants

This study presents data consisting of preintervention measures from an ongoing project on cognitive training. The study included two groups of youth: one interned and one control group. The interned group consisting of 41 individuals (females = 17, $M_{\text{age}} = 17.4$ years, $SD = 1.8$) was recruited from a population of adolescents in the care of the Swedish Board of Institutions (*Statens Institutionsstyrelse; SiS*), which is a national agency providing special residential homes and treatment facilities throughout Sweden, intended for compulsory care of young people. It provides care for individuals of mixed backgrounds, including social deviance, psychosocial issues, substance misuse problems, and involvement with the juvenile justice system. The interned group was recruited from five facilities, and participation was voluntary. The criteria for inclusion were age between 15 years and 19 years at time of testing and Swedish speaking. Further requirements were a minimum of 10 weeks' estimated placement, an absence of explicit aggressive behavior, and at least three drug-free weeks prior to participation. Of the interned group, four individuals did not complete the test session, and thus the final interned sample consisted of 37 individuals (females = 14, $M_{\text{age}} = 17.7$ years, $SD = 1.4$). The control group consisted of 39 individuals (female = 19, $M_{\text{age}} = 17.3$ years, $SD = 1.1$) recruited from local upper secondary schools. The total sample thus consisted of 76 individuals (female = 33, $M_{\text{age}} = 17.5$ years, $SD = 1.2$). All participants were informed of the ethics guidelines (in accordance with the Helsinki declaration). All participants gave written consent prior to initiating the study.

Procedure

The participants filled out the UPPS self-report questionnaire and were tested on a battery of cognitive tests, from which measures of EF were obtained, which were used in the present study. The entire test session was administered individually and lasted approximately three hours. In the majority of cases, it was delivered in two parts with a break in between. Trained staff tested the interned group on location at their respective SiS facilities. As cognitive testing occasionally is included in the admission procedure, a few of the interned group had been tested prior to beginning the study. In these cases data from the admission tests were used in the study whenever tests had been taken in the preceding six months. This was done in order to reduce the burden on the interned group and to reduce the risk of test–retest effects. The control group was tested on campus by a trained research assistant.

Measures

Impulsigenic Traits: UPPS

In the current study, we assessed impulsigenic traits using the Swedish translation (Marklund, 2008) of the UPPS Impulsive Behavior Scale (Whiteside & Lynam, 2001). This is a self-report instrument that operationalizes impulsivity into four distinct impulsigenic facets: Urgency, (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking. Alpha reliabilities for these have been found to be .89, .87, .83, and .85, respectively (Whiteside et al., 2005). The UPPS consists of 44 four-scale, 4-point Likert scale items (1 = strongly agree, to 4 = strongly disagree), with each item summing up to one of the four impulsigenic facets. Some items are reverse-scored in order to avoid response bias. Distinct UPPS facets have shown univariate association to antisocial behavior (Pihet, Combremont, Suter, & Stephan, 2012; Sargeant et al., 2012), aggression (Derefinko et al., 2011), attention disorders (Miller, Derefinko, Lynam, Milich, & Fillmore, 2010), and borderline personality disorders (DeShong & Kurtz, 2013; Jacob et al., 2010), arguably marking it as a

promising tool in surveying psychopathological and maladaptive populations. In the interest of presentational consistency, low scores have been made to indicate more impulsive behavior in all four UPPS-facets throughout this study.

Measures of Executive Function

This study used a battery of executive functioning tasks based on the unity/diversity model (Miyake et al., 2000). The three executive functions of the model (*inhibition*, *shifting*, and *updating*) were assessed by two performance-based tasks each. This study employed both computerized and manual tasks, with the latter being labeled as such in the following section. Part of this data has previously been used in an article comparing performance-based and self-reported executive functioning (Nordvall, Jonsson, & Neely, 2016).

Inhibition Tasks

Stroop test. Variants of this task are used in studies on both cognitive impulsivity and executive functioning (Bickel, Jarmolowicz, Mueller, Gatchalian, & McClure, 2012). The participant is shown a sequence of stimuli, associated with a prepotent response, and is required to respond to a nonlearned aspect of the stimuli. In this study, a sequence of words was shown, with the participants being required to indicate the color of the letters rather than the words themselves (MacLeod & Macdonald, 2000; Stroop, 1935). The task was given in four blocks, each consisting of 12 congruent, 12 incongruent, and 8 neutral trials, presented in random order. The entire task thus comprised a total of 128 trials. Color words (black, blue, red, and yellow in Swedish) constituted both the congruent and incongruent trials. The color of the lettering matched the words in the congruent trials and mismatched in the incongruent trials. The neutral trials consisted of Swedish nouns presented in colored letters. The three dependent measures obtained from the Stroop task was

the mean reaction time (RT) for each of the trial types (neutral, congruent, and incongruent). Performance on the incongruent trials was used as a measure for the executive function inhibition. All measures were assessed in milliseconds.

Delis–Kaplan Executive Function System (D-KEFS) Color–Word Interference (manual). In this variant of the Stroop task, the participant is required to respond verbally to stimuli in separately presented conditions (Delis, Kaplan, & Kramer, 2001). Condition 1 required color naming, Condition 2 required word naming, and Condition 3 required the naming of the letter coloring of conflicting color words. The performance on all conditions was assessed by completion time (CT), measured in seconds. Dependent measures were completion times for each of the three conditions. Performance on Condition 3 was used as a measure for the executive function inhibition, whereas performance on Conditions 1 and 2 was used as measures for perceptual speed.

Shifting Tasks

Alternating Runs (Rogers & Monsell, 1995). The participant is tasked with responding to presented stimuli according to two periodically alternating sets of rules. In this study, the stimuli consisted of single digits (1–4 and 6–9), serially presented within a 2×2 grid. The two uppermost fields of the grid required odd-or-even classification of the presented digits whereas the lowermost fields required higher-or-lower-than-five classification. As the stimuli were presented in a clockwise fashion, a change in rule set was required every two trials. This task consisted of four blocks of 33 trials each for a total of 132 trials. The dependent measure was the reaction time for the shift trials, assessed in milliseconds.

D-KEFS Color–Word Interference (manual). This is Condition 4 of the task presented above. Here the participant is required to repeatedly

switch between naming color words and naming the ink color of the conflicting color words (Delis, Kaplan, & Kramer, 2010). The dependent measure used was the completion time.

Updating Tasks. In the *n-back task*, the participant is presented with a sequence of stimuli and is required to indicate whether or not each one is the same as the one presented a specified number, *n*, of positions previously in the sequence (Jaeggi, Buschkuhl, Perrig, & Meier, 2010; Nyberg, Dahlin, Neely & Bäckman, 2009). The difficulty of the task increases with the size of *n* and is typically a number between 1 and 3. In this study, the stimuli used were digits (1–9), and the response (yes/no) was given using standard computer keyboard. The task consisted of three blocks (*n* = 1, 2, and 3) with 32 trials each for a total of 96 trials. Within each block were 13 correct “yes” trials, randomly distributed. The performance was determined by the accuracy by which the participants responded within each block. Accuracy was calculated as the sum of correctly given “yes” responses subtracted by the number of incorrectly given “yes” responses. The dependent measure was the total accuracy, being the sum of the accuracy in all three blocks. The *n-back task* has been found to share variance with complex working memory and has been argued to constitute a useful tool in assessing individual cognitive differences (Schmiedek, Hildebrandt, Lövdén, Lindenberger, & Wilhelm, 2009).

The *Running Span task* presents the participant with a sequence of stimuli of unknown length with the requirement to indicate which four stimuli are presented last, and in serial order (Dahlin, Nyberg, Bäckman, & Neely, 2008; Miyake et al., 2000; Pollack, Johnson, & Knaff, 1959). In this study, letters (A, B, C, and D) were used as stimuli in a total of 10 sequences, the length of which was 5–14 items long and randomized without replacement. The total number of correctly reported letters through all sequences served as dependent measure for this task.

Statistical Analyses

To reduce the number of comparisons, a composite score for each executive function was used. These were computed from the mean of the *z*-transformed measures related to each of the three executive functions – that is, *updating* (n-back & Running Span), *shifting* (D-KEFS 4 and Alternating Runs), and *inhibition* (D-KEFS 3 and Stroop; incongruent). These scores were then used in the subsequent analyses.

In order to assess how the impulsigenic traits differ between the interned group and the control group, we compared the two groups on the UPPS instrument using a multivariate analysis of variance (MANOVA). Here group (interned, control) was entered as a between-subjects factor, and the four facets of UPPS served as dependent variables. Pillai's trace (*V*) was used in the multivariate analysis as the sample sizes of the groups was unequal. For the same reason, Box's *M* was not evaluated (Tabachnick & Fidell, 2001).

The second research question, the associations between the EF (updating, shifting, and

inhibition) and the four facets of UPPS were initially investigated by calculating the Pearson's correlations between UPPS facets and the composite scores of EF. The association between the EF and the UPPS facets was further investigated by employing four regression analyses. The influence of EF (updating, inhibition, inhibition) were entered simultaneously as predictors with each impulsigenic trait (UPPS: Urgency, Premeditation, Perseverance, Sensation Seeking) as the dependent variables.

Results

The first research question was about group differences in self-reported impulsive behavior as described along the unidimensional impulsigenic traits of the UPPS model. A MANOVA with group (interned, control) as between-subjects factor and the four facets of UPPS as dependent variables was conducted. It showed a significant main multivariate effect for group: $V = 0.15$, $F(4, 71) = 3.16$, $p = .019$, $\eta_p^2 = .15$.

Table 1. Means, standard deviations, and effects sizes of UPPS traits and EF measures.

	Interned (<i>n</i> = 37)		Control (<i>n</i> = 39)		Cohen's <i>d</i>	<i>p</i>	<i>df</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Age (years)	17.7	1.4	17.3	1.1	0.30		71
<i>UPPS</i>							
Urgency	28.78	8.67	33.03	7.61	−0.52	*	74
Premeditation	28.49	6.55	32.23	4.42	−0.68	**	74
Perseverance	27.24	6.01	29.87	3.88	−0.53	*	74
Sensation Seeking	24.73	6.68	23.33	7.06	0.20	<i>ns</i>	74
<i>Updating</i>							
n-Back total accuracy	16.94	9.37	28.05	4.10	−1.65	***	68
Running Span score	17.77	5.83	23.56	6.92	−0.91	***	68
<i>Inhibition</i>							
D-KEFS 3	64.87	20.29	52.23	14.12	0.73	**	68
Stroop RT: Incongruent	993.72	271.42	756.65	110.64	1.24	***	66
<i>Shifting</i>							
D-KEFS 4	74.90	20.49	57.97	14.12	0.98	***	68
Alternating Runs RT: Shift	962.81	711.89	833.72	210.54	0.28	<i>ns</i>	68

Note: EF = executive functioning; D-KEFS = Delis–Kaplan Executive Function System; RT = reaction time.

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

The follow-up analyses of variance (ANOVAs) showed that significant effects for group were present in all UPPS facets except Sensation Seeking [Urgency: $F(1, 74) = 5.02, p = .028, \eta_p^2 = .06$; Premeditation: $F(1, 74) = 8.38, p = .005, \eta_p^2 = .10$; Perseverance: $F(1, 74) = 5.05, p = .028, \eta_p^2 = .06$; Sensation Seeking: $F(1, 74) = 0.76, p = .386, \eta_p^2 = .01$].

Table 1 displays mean values and Cohens d for each *individual measure* for both impulsogenic traits and measures of EF. A few of the interned group occasionally refused to perform some of the executive function tasks, resulting in nonsystematic missing data as indicated by the differing df values. The groups do differ also on the majority of the EF tasks, with the exception of the measure Alternating Runs RT: Shift.

In accordance with the second research question, the associations between self-reported measures of impulsivity and the composite scores of executive functioning were initially investigated using Pearson's correlational analyses (Table 2). As is illustrated, UPPS Urgency is correlated with the Shifting composite. UPPS Premeditation was correlated with the Updating composite, as was UPPS Perseverance, albeit to a lesser extent. UPPS Sensation Seeking was not correlated with any of the composite scores.

The regression analyses, in which the EF composites was regressed on each impulsogenic trait, are displayed in Table 3. The only significant find regarded UPPS Premeditation, which was significantly predicted by the EF composites Inhibition and Updating.

Table 3. Simultaneous regression analyses: Relations between EF composites and UPPS.

	ΔR^2	B	SE	β
<i>Urgency</i>	.10			
Inhibition		0.59	1.41	0.06
Shifting		2.76	1.55	0.23
Updating		1.36	1.49	0.13
<i>Premeditation</i>	.18**			
Inhibition		-1.92*	0.95	-0.29
Shifting		0.65	1.04	0.08
Updating		3.59***	1.00	0.49
<i>Perseverance</i>	.07			
Inhibition		-0.16	0.87	-0.03
Shifting		0.25	0.95	0.03
Updating		1.71	0.91	0.27
<i>Sensation Seeking</i>	.04			
Inhibition		1.09	1.24	-0.13
Shifting		-0.60	1.36	-0.06
Updating		-0.66	1.30	-0.07

Note: EF = executive function.
* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Discussion

In this study, we set out to examine how trait-based impulsivity differed between interned youths and an age-matched control group. The study also aimed at investigating the relationship between facets of executive functioning (updating, inhibition, and shifting) and trait-based impulsivity.

There was an overall multivariate group effect for UPPS. The follow-up ANOVAs revealed significant effects for (lack of) Premeditation, Urgency, and (lack of) Perseverance but not for Sensation Seeking.

Table 2. Correlations between EF composites and UPPS traits.

	Urgency	Premeditation	Perseverance	Sensation Seeking
Inhibition composite	.206	-.005	.125	
Shifting composite	.281**	.079	.068	-.107
Updating composite	.217	.342**	.239*	-.134

Note: EF = executive functioning.
* $p \leq .05$. ** $p \leq .01$.

Furthermore, correlation analyses between the UPPS facets and composites of the EFs shifting, updating, and inhibition revealed three out of 12 possible associations to be positive. Lastly, in the regression analyses, entering the three EFs simultaneously, (lack of) Premeditation was found to be predicted by both inhibition and updating, with the latter being decidedly stronger. Approximately 18% of the total variance in UPPS Premeditation was accounted for by executive functioning, with the majority of this being on account of updating.

If and How Trait-Based Impulsivity Differs Between the Groups

It was expected that interned adolescents will rate themselves as more impulsive than the control group (Sharma et al., 2014). In regard to group differences in the impulsogenic traits, the interned group rated themselves as more prone to affective and dyscontrolled behavior, as expressed by the first three UPPS facets. This was particularly pronounced for UPPS Premeditation, which is in line with previous studies addressing the relation between impulsivity and antisocial behavior in adult, noninterned populations (DeShong & Kurtz, 2013; Lynam & Miller, 2004; Miller, Flory, Lynam, & Leukefeld, 2003). The current study thus extends these findings to include interned adolescents and lends support to the ecological validity of the UPPS instrument. Yet, it should be noted that previous research comparing minor and serious adolescent offenders has indicated that UPPS Urgency, but not UPPS Premeditation, has been shown to differentiate (Pihet et al., 2012).

Nonetheless, the notion that UPPS Sensation Seeking, together with UPPS Premeditation, are both related to antisocial features (Derefinco et al., 2011, DeShong & Kurtz, 2013) was not supported. As noted, previous studies have for the most part investigated older populations rather than adolescents, as was the focus of this study. Adolescence is a

period in which neural development and changes in behaviors related to sensation and novelty seeking are occurring simultaneously (Steinberg, 2008). It is quite possible that the ongoing socioemotional development in this period would make the items comprising the Sensation Seeking facet less predictive of individual differences regarding antisocial behavior, which could explain the lack of group difference. Furthermore, there is also a possibility that the constraints imposed by internment are limiting the behaviors assessed by the items in this facet, making it less sensitive in this context. An alternative explanation, though not mutually exclusive, is that the UPPS is a factor-analytically derived self-report instrument developed on undergraduate and adult samples. The factor structure in younger populations may very well be different, as has been demonstrated for the Barret Impulsivity Scale (Leshem & Glicksohn, 2007).

To What Extent were the Impulsogenic Traits Associated with the Executive Functioning?

Regarding the relationship between impulsogenic traits and cognitive functioning, this study reports of three associations, all of moderate size. First, the largest correlation is between UPPS Premeditation and the executive function updating. The executive function updating has recently been suggested to be antecedent to antisocial behavior (Herrero et al., 2010), and its relation to UPPS Premeditation, a construct also suggested to be related to antisocial behavior, is arguably an interesting finding. Secondly, UPPS Urgency was related to the executive function shifting. While the executive function shifting appear less researched in relation to impulsivity, a related concept, inhibition of prepotent response, has been linked to acting under negative affect (Cyders & Coskunpinar, 2011; Gay et al., 2008). Thirdly, UPPS Perseverance was also related to the executive function updating. Sensation Seeking was

unrelated to executive functioning, which is in line with what has been previously reported (Romer et al., 2011). Finally, the regression analyses indicated that executive functioning, particularly the facet updating, can account for a significant portion of the variance in UPPS Premeditation. This is of particular interest as it implies a tangible connection between trait-based impulsivity, in the aspect of premeditation, and cognition, in the aspect of specific executive functions, on the issue of antisocial behavior.

Explanatory Models

Taken together, these observations are consistent with predictions posed by the dual systems model (Steinberg, 2010), as well as the striatal imbalance model (Romer et al., 2011). Both models postulate two separate systems: one socioemotional system initiating novelty seeking behaviors, and one cognitive control system guiding action and inhibition. The cognitive control system is related to measures of impulsivity, in turn related to negative emotionality and the propensity to act nonpremeditatedly (Magid, Maclean, & Colder, 2007; Smith et al., 2007). Neuronally, the system has been associated with the dorsal part of the frontostriatal pathway (Romer et al., 2011), a region noted to develop throughout adolescence (Van Leijenhorst et al., 2010). Our study indicates that the cognitive control system, as measured by EF, is associated with the social-emotional system, as measured by UPPS impulsivity facets. Specifically, the executive function updating (Herraro et al., 2010) was significantly associated with (lack of) premeditation, a construct described as forethought or “acting without thinking” (Romer et al., 2011).

The socioemotional system, which includes motivation and reward response, has been linked to sensation-seeking behaviors (Romer et al., 2011). This system is associated with the ventral part of the frontostriatal pathway, a region undergoing rapid development during early puberty, a time that has

been noted to feature an increase in this type of behavior (Steinberg, 2008). Such a system could be predicted to be more fully developed by late adolescence and is potentially less predictive of individual differences regarding sensation seeking vis-à-vis the cognitive control system, at an earlier age. Hence, for the age span present in the current study, sensation-seeking behaviors are unrelated to EF for interned youth. The group differences regarding impulsivity is instead accounted for by delayed or impaired cognitive functioning (Romer et al., 2011), specifically with regard to the executive function updating.

Limitations and Future Directions

The relationship between cognitive functioning and adolescent antisocial behavior is an understudied topic. This study provides insights into how cognitive functioning relates to impulsivity, which is a relevant step in the pursuit of understanding adolescent maladaptive behavior. It has important limitations, however. First, it should be noted that the present sample, interned and control groups alike, was recruited to partake in a working memory training program. Their representativeness can thus not be guaranteed. Additional research is required to identify to what extent the findings presented here are representative of the larger, heterogeneous population of interned adolescents. Secondly, longitudinal studies encompassing this age span are needed to determine the causality of the relation between cognitive functioning and impulsivity. Controlling for factors such as socioeconomic and legal background, and medical and psychological history was beyond our reach in this study, as were the ethical possibilities of follow-up observations past discharge. This would need to be taken into consideration in a more comprehensive design. Thirdly, it should be noted that much research on adolescent impulsivity and risk taking has been focused on behaviors in some sense deemed immoral such as intoxicant usage, unprotected sex, and reckless use of

motor vehicles. This is reflected in the instruments employed but does run the risk of omitting aspects of a larger fabric of adolescent behaviors of increasing self-determination and pursuit of agency (Sercombe, 2014). Finally, in the interest of building a fuller understanding of antisocial behavior, future research could contemplate on integrating cognitive and personality related approaches with additional methodologies, such as neuroimaging, social worker perspectives, and qualitative research.

Concluding Remarks

This study sought to compare trait-based impulsivity in interned and noninterned youth as well as to examine relation between said impulsivity and executive functioning. Group differences were found in impulsogenic traits associated with behavioral dyscontrol but not with sensation-seeking behaviors. The most profound group difference regarded the increased lack of premeditation reported by the interned group. This impulsogenic trait was then found to associate with the executive functions and, to a lesser extent, inhibition. The present study confirms previous studies showing that the impulsogenic trait premeditation and the executive function updating are related to antisocial behavior. Hence, the relationship between the cognitive control system and social-emotional responses seems to be particularly important for the development of antisocial behavior. These specific findings are important for ongoing research on adolescent antisocial behavior, a form of research that has the potential to lead to a better understanding of the development of interventions aimed at improving executive functions.

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References

- Anestis, M. D., Selby, E. A., & Joiner, T. E. (2007). The role of urgency in maladaptive behaviors. *Behaviour Research and Therapy*, 45(12), 3018–29. doi:10.1016/j.brat.2007.08.012
- Arce, E., & Santisteban, C. (2006, May). Impulsivity: A review. *Psicothema*. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/17296034>
- Bickel, W. K., Jarmolowicz, D. P., Mueller, E. T., Gatchalian, K. M., & McClure, S. M. (2012). Are executive function and impulsivity antipodes? A conceptual reconstruction with special reference to addiction. *Psychopharmacology*, 221(3), 361–87. Retrieved from <http://doi.org/10.1007/s00213-012-2689-x>
- Billieux, J., Rochat, L., Rebetez, M. M. L., & Van der Linden, M. (2008). Are all facets of impulsivity related to self-reported compulsive buying behavior? *Personality and Individual Differences*, 44(6), 1432–1442. doi:10.1016/j.paid.2007.12.011
- Burke, J. D., Loeber, R., & Lahey, B. B. (2007). Adolescent conduct disorder and interpersonal callousness as predictors of psychopathy in young adults. *Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child and Adolescent Psychology*. American Psychological Association, Division 53, 36(3), 334–346. doi:10.1080/15374410701444223
- Carlson, S. R., Pritchard, A. A., & Dominelli, R. M. (2013). Externalizing behavior, the UPPS-P Impulsive Behavior scale and Reward and Punishment Sensitivity. *Personality and Individual Differences*, 54(2), 202–207. doi:10.1016/j.paid.2012.08.039
- Carroll, A., Hemingway, F., Bower, J., Ashman, A., Houghton, S., & Durkin, K. (2006). Impulsivity in Juvenile Delinquency: Differences Among Early-Onset, Late-Onset, and Non-Offenders. *Journal of Youth and Adolescence*, 35(4), 517–527. doi:10.1007/s10964-006-9053-6
- Casey, B. J., Jones, R. M., & Hare, T. A. (2008). The adolescent brain. *Annals of the New York Academy of Sciences*, 1124, 111–26. doi:10.1196/annals.1440.010
- Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and

- behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review*, 31(6), 965–982. doi:10.1016/j.cpr.2011.06.001
- Cyders, M. A., & Coskunpinar, A. (2012). The relationship between self-report and lab task conceptualizations of impulsivity. *Journal of Research in Personality*, 46(1), 121–124. doi:10.1016/j.jrp.2011.11.005
- d'Acremont, M., & Van Der Linden, M. (2005). Adolescent impulsivity: Findings From a Community Sample. *Journal of Youth and Adolescence*, 34(5), 427–435. doi:10.1007/s10964-005-7260-1
- Dahlin, E., Neely, A. S., Larsson, A., Backman, L., & Nyberg, L. (2008). Transfer of Learning After Updating Training Mediated by the Striatum. *Science*, 320(5882), 1510–1512. Retrieved from <http://doi.org/10.1126/science.1155466>
- Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan executive function system: Examiner's manual*. San Antonio, TX: The Psychological Corporation.
- Derefinko, K., Dewart, C. N., Metzger, A. V., Walsh, E. C., & Lynam, D. (2011). Do different facets of impulsivity predict different types of aggression? *Aggressive Behavior*, 37(3), 223–233. doi:10.1002/ab.20387
- DeShong, H. L., & Kurtz, J. E. (2013). Four factors of impulsivity differentiate antisocial and borderline personality disorders. *Journal of Personality Disorders*, 27(2), 144–56. doi:10.1521/pedi.2013.27.2.144
- Duckworth, A. L., & Kern, M. L. (2011). A Meta-Analysis of the Convergent Validity of Self-Control Measures. *Journal of Research in Personality*, 45(3), 259–268. doi:10.1016/j.jrp.2011.02.004
- Gay, P., Rochat, L., Billieux, J., d'Acremont, M., & Van der Linden, M. (2008). Heterogeneous inhibition processes involved in different facets of self-reported impulsivity: Evidence from a community sample. *Acta Psychologica*, 129(3), 332–339. Retrieved from <http://doi.org/10.1016/j.actpsy.2008.08.010>
- Gordon, V., & Egan, V. (2010). What self-report impulsivity measure best postdicts criminal convictions and prison breaches of discipline? *Psychology, Crime & Law*, 17(4), 305–318. doi:10.1080/10683160903203946
- Herrero, O., Escorial, S., & Colom, R. (2010). Basic executive processes in incarcerated offenders. *Personality and Individual Differences*, 48(2), 133–137. Retrieved from <http://doi.org/10.1016/j.paid.2009.09.009>
- Jacob, G. A., Gutz, L., Bader, K., Lieb, K., Tüscher, O., & Stahl, C. (2010). Impulsivity in borderline personality disorder: Impairment in self-report measures, but not behavioral inhibition. *Psychopathology*, 43(3), 180–8. doi:10.1159/000304174
- Jaeggi, S. M., Buschkuhl, M., Perrig, W. J., & Meier, B. (2010). The concurrent validity of the N-back task as a working memory measure. *Memory*, 18(4), 394–412. doi:10.1080/09658211003702171
- Leshem, R., & Glicksohn, J. (2007). The construct of impulsivity revisited. *Personality and Individual Differences*, 43(4), 681–691. doi:10.1016/j.paid.2007.01.015
- Loeber, R., Menting, B., Lynam, D. R., Moffitt, T. E., Stouthamer-Loeber, M., Stallings, R., ... Pardini, D. (2012). Findings from the Pittsburgh Youth Study: Cognitive impulsivity and intelligence as predictors of the age-crime curve. *Journal of the American Academy of Child and Adolescent Psychiatry*, 51(11), 1136–49. doi:10.1016/j.jaac.2012.08.019
- Lynam, D., & Miller, J. (2004). Personality pathways to impulsive behavior and their relations to deviance: Results from three samples. *Journal of Quantitative Criminology*, 20(4), 319–341. doi:10.1007/s10940-004-5867-0
- Lynam, D., Moffitt, T. E., & Stouthamer-Loeber, M. (1993). Explaining the relation between IQ and delinquency: Class, race, test motivation, school failure, or self-control? *Journal of Abnormal Psychology*, 102(2), 187–96. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/8315131>
- Lynam, D., Caspi, A., Moffitt, T. E., Wikström, P.-O., Loeber, R., & Novak, S. (2000). The interaction between impulsivity and neighborhood context on offending: The effects of impulsivity are stronger in poorer neighborhoods. *Journal of Abnormal Psychology*, 109(4), 563–574. Retrieved from <http://doi.org/10.1037//0021-843X.109.4.563>
- MacLeod, C. M., & MacDonald, P. A. (2000). Interdimensional interference in the Stroop effect: Uncovering the cognitive and neural anatomy of attention. *Trends in Cognitive Sciences*, 4(10), 383–391. Retrieved from doi:10.1016/S1364-6613(00)01530-8
- Magid, V., Maclean, M. G., & Colder, C. R. (2007). Differentiating between sensation seeking and impulsivity through their mediated relations with alcohol use and problems. *Addictive Behaviors*, 32(10), 2046–61. doi:10.1016/j.addbeh.2007.01.015
- Marklund, K. (2008). Impulsivitet som mångfasetterat konstrukt. Stockholms Universitet.
- Miller, J., Derefinko, K. J., Lynam, D., Milich, R., & Fillmore, M. T. (2010). Impulsivity and

- Attention Deficit-Hyperactivity Disorder: Subtype Classification Using the UPPS Impulsive Behavior Scale. *Journal of Psychopathology and Behavioral Assessment*, 32(3), 323–332. doi:10.1007/s10862-009-9155-z
- Miller, J., Flory, K., Lynam, D., & Leukefeld, C. (2003). A test of the four-factor model of impulsivity-related traits. *Personality and Individual Differences*, 34(8), 1403–1418. doi:10.1016/S0191-8869(02)00122-8
- Miyake, A., & Friedman, N. P. (2012). The Nature and Organization of Individual Differences in Executive Functions: Four General Conclusions. *Current Directions in Psychological Science*, 21, 8–14. doi:10.1177/0963721411429458
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100. doi:10.1006/cogp.1999.0734
- Moffitt, T. E. (1993). Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review*, 100(4), 674–701. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/8255953>
- Nyberg, L., Dahlin, E., Stigsdotter Neely, A., & Bäckman, L. (2009). Neural correlates of variable working memory load across adult age and skill: Dissociative patterns within the fronto-parietal network. *Scandinavian Journal of Psychology*, 50(1), 41–6. doi:10.1111/j.1467-9450.2008.00678.x
- Nordvall, O., Jonsson, B., & Neely, A. S. (2016). Self-reported and performance-based measures of executive functions in interned youth. *Psychology, Crime & Law*, 0(0), 1–4. <http://doi.org/10.1080/1068316X.2016.1239725>
- Pharo, H., Sim, C., Graham, M., Gross, J., & Hayne, H. (2011). Risky business: Executive function, personality, and reckless behavior during adolescence and emerging adulthood. *Behavioral Neuroscience*, 125(6), 970–8. doi:10.1037/a0025768
- Pihet, S., Combremont, M., Suter, M., & Stephan, P. (2012). Cognitive and Emotional Deficits Associated with Minor and Serious Delinquency in High-Risk Adolescents. *Psychiatry, Psychology and Law*, 19(August 2014), 427–438. Retrieved from <http://doi.org/10.1080/13218719.2011.598634>
- Pollack, I., Johnson, L. B., & Knaff, P. R. (1959). Running memory span. *Journal of Experimental Psychology*, 57(3), 137–146. <http://doi.org/10.1037/h0046137>
- Raine, A., Moffitt, T. E., Caspi, A., Loeber, R., Stouthamer-Loeber, M., & Lynam, D. (2005). Neurocognitive impairments in boys on the life-course persistent antisocial path. *Journal of Abnormal Psychology*, 114(1), 38–49. doi:10.1037/0021-843X.114.1.38
- Reynolds, B., Penfold, R. B., & Patak, M. (2008). Dimensions of impulsive behavior in adolescents: Laboratory behavioral assessments. *Experimental and Clinical Psychopharmacology*, 16(2), 124–31. doi:10.1037/1064-1297.16.2.124
- Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General*, 124(2), 207–331. <http://doi.org/10.1037/0096-3445.124.2.207>
- Romer, D., Betancourt, L., Giannetta, J. M., Brodsky, N. L., Farah, M., & Hurt, H. (2009). Executive cognitive functions and impulsivity as correlates of risk taking and problem behavior in preadolescents. *Neuropsychologia*, 47(13), 2916–2926. doi:10.1016/j.neuropsychologia.2009.06.019
- Romer, D., Betancourt, L. M., Brodsky, N. L., Giannetta, J. M., Yang, W., & Hurt, H. (2011). Does adolescent risk taking imply weak executive function? A prospective study of relations between working memory performance, impulsivity, and risk taking in early adolescence. *Developmental Science*, 14(5), 1119–33. doi:10.1111/j.1467-7687.2011.01061.x
- Sargeant, M. N., Bornoalova, M. A., Trotman, A. J. M., Fishman, S., & Lejuez, C. W. (2012). Facets of impulsivity in the relationship between antisocial personality and abstinence. *Addictive Behaviors*, 37(3), 293–298. doi:10.1016/j.addbeh.2011.11.012
- Schmiedek, F., Hildebrandt, A., Lövdén, M., Lindenberger, U., & Wilhelm, O. (2009). Complex span versus updating tasks of working memory: The gap is not that deep. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35(4), 1089–96. doi:10.1037/a0015730
- Sercombe, H. (2014). Risk, adaptation and the functional teenage brain. *Brain and Cognition*, 89, 61–9. doi:10.1016/j.bandc.2014.01.001
- Sharma, L., Kohl, K., Morgan, T. A., & Clark, L. A. (2013). "Impulsivity": Relations between self-report and behavior. *Journal of Personality and Social Psychology*, 104(3), 559–75. doi:10.1037/a0031181
- Sharma, L., Markon, K. E., & Clark, L. A. (2014). Toward a theory of distinct types of "impulsive" behaviors: A meta-analysis of self-report and behavioral measures.

- Psychological Bulletin*, 140(2), 374–408. doi:10.1037/a0034418
- Smith, G. T., Fischer, S., Cyders, M. A., Annus, A. M., Spillane, N. S., & McCarthy, D. M. (2007). On the validity and utility of discriminating among impulsivity-like traits. *Assessment*, 14(2), 155–70. doi:10.1177/1073191106295527
- Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Developmental Review*, 28(1), 78–106. Retrieved from <http://doi.org/10.1016/j.dr.2007.08.002>
- Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Developmental Psychobiology*, 52(3), 216–24. doi:10.1002/dev.20445
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), 643–662. <http://doi.org/10.1037/h0054651>
- Swann, A. C., Bjork, J. M., Moeller, F. G., & Dougherty, D. M. (2002). Two models of impulsivity: Relationship to personality traits and psychopathology. *Biological Psychiatry*, 51(12), 988–994. doi:10.1016/S0006-3223(01)01357-9
- Swann, A. C., Lijffijt, M., Lane, S. D., Steinberg, J. L., & Moeller, F. G. (2009). Trait impulsivity and response inhibition in antisocial personality disorder. *Journal of Psychiatric Research*, 43(12), 1057–1063. doi:10.1016/j.jpsychires.2009.03.003
- Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Boston, MA: Allyn and Bacon.
- Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 54(2), 131–43. doi:10.1111/jcpp.12001
- Van Leijenhorst, L., Gunther Moor, B., Op de Macks, Z. A., Rombouts, S. A. R. B., Westenberg, P. M., & Crone, E. A. (2010). Adolescent risky decision-making: Neurocognitive development of reward and control regions. *NeuroImage*, 51(1), 345–55. doi:10.1016/j.neuroimage.2010.02.038
- White, J. L., Moffitt, T. E., Caspi, A., Bartusch, D. J., Needles, D. J., & Stouthamer-Loeber, M. (1994). Measuring impulsivity and examining its relationship to delinquency. *Journal of Abnormal Psychology*, 103(2), 192–205. doi:10.1037/0021-843X.103.2.192
- 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. doi:10.1016/S0191-8869(00)00064-7
- Whiteside, S. P., Lynam, D. R., Miller, J. D., & Reynolds, S. K. (2005). Validation of the UPPS impulsive behaviour scale: A four-factor model of impulsivity. *European Journal of Personality*, 19(7), 559–574. doi:10.1002/per.556