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THE RELATIONS BETWEEN AN INVENTORY-BASED MEASURE OF EXECUTIVE FUNCTION AND IMPULSIVITY FACTORS IN ALCOHOL- AND CANNABIS-RELEVANT OUTCOMES

The Relations between an Inventory-Based Measure of Executive Function and Impulsivity Factors in Alcohol- and Cannabis-Relevant Outcomes

Keywords: Executive function; Assessment; Drug and Alcohol Abuse

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Abstract

Objective: While the lack of relation between performance- and inventory-based executive function (EF) measures is well documented, there remains ambiguity between self-report EFs and closely related constructs (e.g., impulsivity) assessed via the same method. The degree of convergence between purported EF measures with similar yet distinct constructs contain important theoretical implications for available EF assessment strategies and their construct validity. A newer measure of EF, the Behavior Regulation Inventory of Executive Functions – Adult (BRIEF-A), allows for more direct comparisons to self-reported measures of impulsivity, such as the commonly used Urgency, Planning, Perseverance, Sensation Seeking – Positive Urgency (UPPS-P) assessment.

Method: The present study used factor analysis and hierarchical regression to explore the associations between the BRIEF-A and UPPS-P, using alcohol and cannabis consumption across various outcomes (i.e., quantity-frequency and consequences) as an external criterion. Participants were 339 undergraduate students (M_{age} = 19.35; Female = 63%) from a large southwestern university.

Results: The BRIEF-A and UPPS-P demonstrated strong correlations at both higher- and lower-order facets. While the BRIEF-A was a significant correlate to many substance use outcomes, these relations were generally weaker than those seen with the UPPS-P. Hierarchical regression suggested limited contributions of the BRIEF-A over and above the UPPS-P.

Conclusions: Overall, this study suggested substantial overlap between impulsigenic factors and EFs when measured by self-report, and limited utility of EF measures to account for unique variance with substance use outcomes in this sample.

Introduction

Executive functions (EFs) are commonly described as a family of cognitive problem-solving abilities that assist with the directing of behavioral, emotional, and metacognitive abilities (Goldstein & Naglieri, 2013). There are two major approaches for evaluating EFs. The first are lab-based performance measures such as traditional neuropsychological tasks such as the Wisconsin Card Sort Test (WCST; Grant & Berg, 1948), Trail Making Test (Reitan & Wolfson, 1985), Stroop Color Word Test (Stroop, 1935), and various tower-type tests (e.g., Tower of Hanoi; Simon, 1975). The other approach relies on self-report measures (e.g., Dysexecutive Questionnaire [DEX; Wilson et al., 1996]; Frontal Systems Behavior Scale [FrSBe; Grace & Malloy, 2001]; Behavior Rating Inventory of Executive Function [BRIEF; Gioia et al., 1996]) of behaviors associated with domains of EFs (e.g., the modulation of emotions or the adjustment of behavior to changing environments). The DEX is a 20-item measure which provides information on four EF domains (emotional, behavioral, cognitive, and motivational), though many users calculate a single composite score. One issue frequently raised with the DEX is the inconsistent factor structure (Simblett & Bateman, 2011), such that some studies have shown three- (Burgess et al., 1998; Wilson et al., 1996) or five-factor (Amieva et al., 2003; Chan, 2001) solutions. Notably, similar concerns have been raised about the FrSBe (Niemeier et al., 2013) and the BRIEF (Roth et al., 2013; Egeland & Fallmyr, 2010). The FrSBe is a 46-item self-report tool with three factors (apathy, disinhibition, and executive dysfunction). The FrSBe is roughly comparable to the BRIEF but is shorter and was initially designed to assess frontal lobe behavioral syndromes, though several items cover EFs as well. Comparatively, the BRIEF's assessment of EFs is more comprehensive (spanning many more EF domains) and the self-report version was normed on 1,050 individuals based on U.S. census data (Roth et al., 2005), unlike

the FrSBe. The BRIEF, including the BRIEF-Adult Self-Report (BRIEF-A; Roth et al., 2005) is a self-report instrument used to examine EFs and assesses two higher-order dimensions (Behavioral Regulation Index [BRI] and Metacognition Index [MI]) in addition to nine lower-order constructs (BRI indicators: Inhibit, Shift, Emotional Control, and Self-Monitor, and MI indicators: Initiate, Working Memory, Task Monitor, Plan/Organize, and Organization of Materials).

Although lab-based EF measures have long been regarded as the gold-standard in EF research, they tend to lack predictive validity for real-world outcomes (see McCoy, 2019; Toplak et al., 2013; Miranda et al., 2015; Mcauley et al., 2010). Meanwhile, self-report assessments of EF are thought to reflect a greater degree of ecological validity that may target EF features which do not lend themselves to performance-based measures (e.g., meta-cognitive strategies; Toplak et al., 2013; Niendam et al., 2007; Toplak et al., 2008; Shuster & Toplak, 2009; McAuley et al., 2010). Importantly, extant literature suggests little empirical overlap between lab-based measures of EF and their self-report counterparts (Soto et al., 2020; Toplak et al., 2013, Miranda et al., 2015; Duckworth & Kern, 2011; Enticott et al., 2006). Although the reasons for this lack of overlap remain unclear, some researchers speculate that performance-based and self-report measures of executive abilities capture unique components of the EF construct (Soto et al., 2020; Toplak et al., 2013). Other teams, however, have used bifactor models with self-report and performance-based impulsivity measures that produced general latent factors which are independent of measure-specific influences (Crane et al., 2020). Still, available evidence from prior meta-analyses suggests consistently limited relations, but that the strength of relation may vary somewhat dependent on the measurement construct (e.g., higher average convergence among performance-based attention tasks; Duckworth & Kern, 2011).

Beyond this general lack of association between different assessment methods, there remains further ambiguity between EFs and related constructs (e.g., impulsivity) using the same method. Research indicates multiple connections between impulsivity and the broader domain of EFs. Bickel and colleagues (2012) described neurological, conceptual, and measurement overlap between impulsivity and EFs (see Bickel et al., 2012, for a review). Although impulsivity has been included under the umbrella of EFs, not all EF processes include impulsivity. Indeed, some lab-based measures of impulsivity (e.g., Flanker tasks; see Cyders & Coskunpinar, 2011a, for more details) are also widely considered measures of EF. However, this conceptual overlap (or lack thereof) in impulsivity and EF measurement can be extended to self-report measures and has received less examination.

Similar to EFs, researchers examine impulsivity using a multitude of paradigms (e.g., Congdon & Canli, 2008; Meda et al., 2009; Dawe et al., 2004), with current assessment recommendations suggesting a multi-faceted approach (Hamilton et al., 2011). Much of the prior research into impulsivity has coalesced around the model of impulsivity captured by the UPPS-P (Cyders et al., 2007). The UPPS-P is a commonly used assessment of five traits: Sensation Seeking (the tendency to seek out novel experiences), Lack of Planning (the tendency to act without fully considering potential results), Lack of Perseverance (the inability to maintain engagement with prior tasks), Positive Urgency (acting rashly when experiencing positive affect), and Negative Urgency (acting rashly when experiencing negative affect). These facets can be used to create higher-order constructs of Urgency (Positive and Negative Urgency as indicators), Deficits in Conscientiousness (Lack of Planning and Lack of Perseverance as indicators) and Sensation Seeking (Smith et al., 2007).

The nature of the relation between purported measures of EF (e.g., BRIEF-A) and impulsivity (e.g., UPPS-P), is critical to understanding the degree of overlap between two separate yet related constructs, their mutual relations to key outcomes of interest, and the potential for incremental validity between each measure on such outcomes. For example, there is an extensive literature associating EFs with a variety of risky real-world behaviors including alcohol misuse (see Day et al., 2015; Clark et al., 2017; Hagen et al., 2016; Piche et al., 2018) and cannabis use (Solowij et al., 2002; Meil et al., 2016; Becker et al., 2014). Specifically, the BRIEF-A has been associated with increased alcohol use, sobriety length, and age of drinking onset (Clark et al., 2017; Clark et al., 2012; Hagen et al., 2016). Literature linking the BRIEF-A with cannabis use is scant, but two recent studies have found moderate associations between both BRIEF-A index scales (i.e., BRI and MI) and past year cannabis consumption (Clark et al., 2017; Piche et al., 2018).

Substantial research associates the construct of impulsivity with substance use outcomes (e.g., see Littlefield & Sher, 2016; Littlefield et al., 2014). Using the UPPS-P, Verdejo-Garcia et al. (2010) found elevated self-reported Lack of Perseverance and Urgency (both Positive and Negative) alongside worse performance on a variety of EF measures (e.g., Iowa Gambling Task [IGT], Stroop, Letter-Number Sequencing) among substance users relative to healthy controls. Dolan et al. (2008) also found greater Negative Urgency and poor EF (e.g., IGT, WCST, Digit Span, Stroop Color Word Test) among substance dependent participants compared to controls. Broadly, the extant literature suggests poor EF and high impulsivity appear common in substance consuming populations.

As discussed by Reynolds et al., (2019), many EF and impulsivity investigations involve participants drawn from clinical populations. As a result, much of the relations between EF and

impulsivity assessments remain undefined; especially among important non-clinical samples, such as emerging or young adults. This point is particularly relevant given the prevalence of substance involvement is consistently greatest among young adults (aged 18 to 25; Grant et al., 2016). Prior studies have shown college attending young adults report greater alcohol consumption than their noncollege attending peers, though cannabis use has appeared more frequent among the noncollege counterparts (Miech et al., 2020; Blanco et al., 2008). Relatedly, young adults in the United States have proportionately low rates of substance use treatment despite a present need (Blanco et al., 2008; Wu et al., 2007) relative to their noncollege age-equivalent counterparts (Wu et al., 2007; Lipari et al., 2016). As such, understanding the effectiveness of assessment performance represents an important public health need, which extends to non-clinical college samples.

Ostensibly, there is conceptual overlap between facets of the UPPS-P and BRIEF-A constructs. However, to our knowledge, no studies have examined: 1) the overall relations between the UPPS-P and BRIEF-A, 2) the relative associations between the BRIEF-A and UPPS-P with alcohol and cannabis consumption outcomes, and 3) whether the BRIEF-A instrument demonstrates incremental validity over more commonly used measures in the alcohol and cannabis use literature, such as the UPPS-P.

Purpose of the Present Study

In sum, although behavioral and self-report measures have been developed to assess both impulsivity and EFs, there is a lack of research examining empirical relations among self-report assessments of both constructs. Both theoretically and clinically, it is essential to understand the empirical overlap between measures purported to assess EFs and assessments of impulsivity. Theoretically, weak empirical overlap would suggest distinct constructs in the respective

domains of EF and impulsivity, whereas strong overlap would suggest these constructs are quite similar (at least when assessed via the same method). This contains important implications for future research, as appropriate measurement selection by researchers is essential due to its capacity to drive subsequent findings. Clinically, the incremental validity of the BRIEF-A over existing assessments of impulsivity to predict substance use outcomes is also not well understood, and thus, its application with respect to substance use remains questionable. While studies such as Dolan et al., (2008) have provided some evidence for the above noted overlap, such findings were found in clinical populations where more pronounced markers of executive dysfunction were likely. As discussed above, these same findings may not translate well into non-clinical young adults (Reynolds et al., 2019) despite a clear need (Blanco et al., 2008; Wu et al., 2007, Miech et al., 2020) and limited research. Moreover, one limitation by studies such as Dolan et al. is a frequently low sample size (n = 38). Due to the (presumably) lesser impairment in the present sample relative to clinical samples, this project sought to increase this number substantially (n = 339). Taken together, the current paper had three primary aims: 1) assess the empirical overlap among the UPPS-P facets with BRIEF-A constructs, 2) examine the relations between the UPPS-P and BRIEF-A with alcohol and cannabis quantity-frequency of use and consequences, 3) determine the incremental validity of the BRIEF-A relative to the UPPS-P to predict alcohol- and cannabis-related outcomes.

Methods

Participants and Procedure

Participants were 339 undergraduates (M_{age} = 19.35; SD = 1.96; female = 63%) recruited from a large southwest university. Each participant was actively enrolled in a psychology-related undergraduate course. Participants were individually administered all measures during a single

3.5-hour in-person session as part of a larger study examining cognitive and social contributors to mental health and adjustment within undergraduate students. This study followed the protocol approved by the Institutional Review Board, which was obtained by study authors. All data was archived within locked lab room file cabinets or within the password protected tablet used for the performance-based measures. Participants were required to be fluent in English, but there were no other exclusion/inclusion criteria established for this study.

Measures

Demographics. Demographic information consisted of age, gender (coded as: male = 1 [*n* = 97]; female = 0 [*n* = 215]), socioeconomic status via annual household income (SES; mode = $50,000-$74,999), ethnicity (coded as: 0 = non-Hispanic [*n* = 209]; 1 = Hispanic [*n* = 89]; No response [*n* = 41]), and race (all categories dummy coded with White as the reference group: White [*n* = 226], Native American or Alaskan Native [*n* = 10], Asian [*n* = 16], African American [*n* = 32], Native Hawaiian or Pacific Islander [*n* = 0], Other [*n* = 19], No response [*n* = 36]). These data are presented in Table 1.

Behavior Rating Inventory of Executive Functions – Adult Self-Report. The BRIEF-A (Roth et al., 2005) is a standardized 75-item assessment (with three-response options labeled “Never,” “Sometimes,” and “Often”) of past month EF in adults, such that elevated scores represent greater executive dysfunction. The BRIEF-A assesses nine clinical scales that load onto two index scores (Behavioral Regulation Index and Metacognition Index), one overall score (the Global Executive Composite), and three validity scales. Raw scores from the Global Executive Composite demonstrated an alpha coefficient of .96. The Behavioral Regulation Index (α = 0.91) contains four clinical scales: Inhibit (α = .76), Shift (α = .72), Emotional Control (α=.88), and Self-Monitor (α = .75). The Metacognition Index (α = 0.94) contains five clinical scales: Initiate

(α = .78), Working Memory (α = .83), Task Monitor (α = .74), Plan/Organize (α = .81), and Organization of Materials (α = .86).

Urgency, Planning, Perseverance, Sensation Seeking – Positive Urgency. The UPPS-P is a 59-item self-report impulsivity instrument developed by Cyders et al., (2007). The UPPS-P addresses five factors of impulsivity with 10-14 items per factor: Negative Urgency (α = .89), Positive Urgency (α = .91), Lack of Planning (α = .83), Lack of Perseverance (α = .82), and Sensation Seeking (α = .86). Items are measured on a four-point Likert scale (1 = "Agree Strongly"; 4 = "Disagree Strongly"). The UPPS-P does not designate a time frame to orient responses (e.g., symptoms over the past two weeks).

Brief – Young Adult Alcohol Consequences Questionnaire (B-YAACQ). The B-YAACQ (Kahler et al., 2005) was developed to assess negative consequences (M = 4.69, SD = 4.93) associated with alcohol involvement in college populations. The B-YAACQ (α = .89) is a unidimensional scale which consists of 24 items and all responses require either a yes or no. Originally developed to reflect a 12-month time frame, the B-YAACQ was later validated with a 30-day assessment period (Kahler et al., 2008).

Brief – Marijuana Consequences Questionnaire (B-MACQ). The B-MACQ (Simons et al., 2012) is a 21-item, unidimensional measure adapted from the B-YAACQ. The B-MACQ (α = .88) is designed to assess negative outcomes resulting from cannabis involvement (M = 1.46, SD = 2.89). All responses are coded as yes or no. The B-MACQ is scored via sum-total. All questions were limited to past month use.

National Institute on Alcohol Abuse and Alcoholism (NIAAA) recommended alcohol questions. In 2003, the NIAAA Council's Task Force on recommended alcohol questions convened to compose a six-item alcohol consumption question set. The six-item ordered polytomous set

addresses frequency (past month; *M* = 3.69, *SD* = 2.05), quantity (past month; *M* = 4.45, *SD* = 5.47), maximum QF over a 24-hour period (past month), frequency of binge drinking (defined as five or more drinks consumed for males or four or more drinks consumed by females in a two-hour period; past month), and maximum quantity (lifetime) of standard 12 oz. alcoholic drinks (or equivalent) consumed.

Daily Sessions Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU). The DFAQ-CU (Cuttler & Spradlin, 2017) is a 39-item (with varying response categories across items) self-report questionnaire which was psychometrically validated to assesses cannabis use across methods of administration, quantity (grams; *M* = 0.99, *SD* = 1.48) and frequency (number of days in past month; *M* = 4.52, *SD* = 8.20) of consumption, and includes pictures of differing quantities of cannabis to increase respondent consistency. The following scales from the DFAQ-CU were employed: Daily Sessions (a = 0.69), Frequency of Use (a = 0.95), and Marijuana Quantity (a = 0.88). Only past month endorsement of use was entered for data analysis; longer time frames were scored as zero.

Statistical Analysis Plan

Measurement models of latent variables. Confirmatory Factor Analysis (CFA) was used to model the factor structure of the UPPS-P and BRIEF-A. We considered both facet-level factor solutions (i.e., five UPPS-P facets and nine subdomains of the BRIEF-A) as well as higher-order factor solutions (i.e., three-factor model of the UPPS-P and two-factor model of the BRIEF-A). Measurement models evaluated the comparative fit index (CFI) and root mean square error of approximation (RMSEA) fit indices. RMSEA of ≤ .05 was considered good model fit, .08 fair, and .10 marginal (Browne & Cudeck, 1993). CFI values of .90 indicated good model fit and ≥ .95 indicated excellent fit (Hu & Bentler, 1999; Kline, 2005). Estimation of missing data with

Full Information Maximum Likelihood (FIML) was conducted for continuous indicators (e.g., parcels for the UPPS-P models) and Weighted Least Square Mean and Variance (WLSMV) for categorical indicators (e.g., BRIEF-A) in *Mplus* 7.11 (Muthén & Muthén, 2013). Non-normal distributions were managed using Maximum Likelihood Robust Estimation (MLR; Mallinckrodt et al., 2006). All statistical models were estimated with and without adjustment for demographics.

Using a structural equation modeling framework, the five lower-order UPPS-P factors were modeled as latent variables with three continuous indicator parcels per facet (see Cyders et al., 2009). A second higher-order UPPS-P CFA with three factors was constructed, which utilized Positive and Negative Urgency latent variables as continuous indicators to form a higher order Urgency factor, Sensation Seeking as its own factor, and Lack of Planning alongside Lack of Perseverance as continuous latent indicators for a higher-order Deficits in Conscientiousness factor. Similarly, the nine lower-order BRIEF-A clinical scales were modeled as latent factors with categorical (ordinal) indicators. A second higher-order BRIEF-A CFA was constructed in which the BRI and MI latent variables were estimated (Goldstein & Naglieri, 2013), which were comprised of lower-order continuous latent indicators. Quantity-frequency outcomes of both alcohol and cannabis use were constructed from a simple product of quantity and frequency items (i.e., past month quantity and frequency items from the NIAAA recommended alcohol questions and the DFAQ-CU).

Multiple comparisons were adjusted for using the procedure developed by Benjamini and Hochberg (BH procedure; 1995, as cited by Glickman et al., 2014), which adjusts for the false discovery rate. False discovery rate procedures test the probability that a null hypothesis is true given the null hypothesis has been rejected (as opposed to a false positive rate procedure, which

would be the probability a true null hypothesis is incorrectly determined to be statistically significant. In accordance with the BH procedure, we sorted our *p*-values in ascending order for each set of analyses (i.e., the set of correlations from the BRIEF-A, UPPS-P, and the performance-based EF measures with each substance use outcome at higher- and lower-order levels, alongside each hierarchical regression for all substance use outcomes at higher- and lower-order levels). We subsequently calculated adjusted *p*-values using the formula $d * (i / n)$ for each original *p*-value, where $d = 0.05$ (false discovery rate), i = rank of the *p*-value, and n = number of tests conducted.

Analytic Approach

To assess the empirical overlap among the UPPS-P and BRIEF-A facets with substance use outcomes, zero-order correlations among these constructs were calculated. These correlations were examined both at the facet level (i.e., the five UPPS-P facets and nine BRIEF-A domains) as well as among higher-order constructs (i.e., the three-factor solution of the UPPS-P and two-factor solution of the BRIEF-A). The incremental validity of EF measures to predict substance use outcomes over and above the UPPS-P measures was examined in a series of hierarchical regression models. For each substance use outcome, a model that considered all lower-order facets measured was estimated, as was a model that included the higher-order domains described above. The effect size (Cohen, 1988) of these relations (metric of *r*; per Cohen, *r*s of .10, .30, and .50 reflect small, medium, and large effect sizes, respectively) was also described. In addition to the review of relations among self-report measures, performance-based measures were also used for the analysis of aims one through three. This data is described in detail in supplemental materials but is briefly addressed in aim one below.

Results

Measurement Models of Latent Variables

Consistent with prior CFAs, higher-order (i.e., three-factor; $\chi^2[98] = 242.38$, CFI = 0.93, RMSEA = 0.08) and lower-order (i.e., five-factor; $\chi^2[80] = 121.22$, CFI = 0.98, RMSEA = 0.05) UPPS-P factor solutions demonstrated good to excellent fit to the data. Both higher-order (i.e., two-factor; $\chi^2[2335] = 3026.60$, CFI = 0.93, RMSEA = 0.04) and lower-order (i.e., nine-factor; $\chi^2[2309] = 2930.52$, CFI = 0.94, RMSEA = 0.04) BRIEF-A factor solutions also resulted in good fit. Table 2 provides the relations between all UPPS-P and BRIEF-A factors at both higher- and lower-order facets.

Aim 1

Our first aim examined the presumed overlap between the UPPS-P and BRIEF-A. For completeness, we also examined the overlap between these measures and several performance-based EF factors. No performance-based EF task demonstrated significant associations to any BRIEF-A or UPPS-P scales at both higher- and lower-order levels, and the magnitude of this overlap was low (absolute values of *r* ranged from 0.00 to 0.14; performance-based measures were also used for the analysis of aims two and three with similarly weak or non-significant results; see supplemental materials for more details). However, the higher-order relations between the BRIEF-A and UPPS-P were quite strong. Surprisingly, Deficits in Conscientiousness was more strongly related to the MI index ($r = 0.87$ [large], $p < 0.01$) than Urgency ($r = 0.76$ [large], $p < 0.01$), though the BRI-Urgency relations were not much weaker ($r = 0.82$ [large], $p < 0.01$). In fact, apart from Sensation Seeking. every correlate amongst the BRIEF-A and UPPS-P higher-order factors were large (*rs* = 0.71-0.87).

Among the lower-order facet relations, the BRIEF-A's Self-Monitor scale was strongly related to both Urgency facets (*rs* = 0.69-0.77), which was comparable to the correlation between

Positive and Negative Urgency themselves (r = 0.75). Lack of Perseverance was also more closely related to three of the five MI subscales (rs = 0.70-0.77) than any UPPS-P lower-order facet. All other lower-order correlates across the two measures were roughly equivalent (see Table 2).

Aim 2

Our second aim sought to explore alcohol and cannabis consumption and consequence relations with the UPPS-P and BRIEF-A. As a general trend, all UPPS-P and BRIEF-A constructs were found to be small to large positive correlates to all alcohol consumption and consequence outcomes (see Table 3). Cannabis outcomes produced weaker associations across all variables. Consistent correlates included the hypothesized Urgency subscales, Sensation Seeking, and the BRIEF-A's BRI, MI, and Self-Monitor scale (see Table 3).

Aim 3

Our final aim assessed the incremental validity of available EF measures to predict each substance use outcome relative to the UPPS-P. In a series of hierarchical regressions, the UPPS-P was entered at step one, followed by the BRIEF-A at step two. Separate regression models were conducted for both lower-order (Table 4) and higher-order (Table 5) variants of each measure. None of the lower- or higher-order models produced significant change in variance explained following inclusion of EF measures over and above the UPPS-P facets across either alcohol or cannabis outcomes. The overall model r-squared for the UPPS-P was statistically significant (with unique effects relating generally to Urgency measures and Sensation Seeking; see Tables 2 and 3) at step one across models. Notably, when the BRIEF-A was entered at step one and the UPPS-P at step two, the UPPS-P did indeed explain additional variance over the BRIEF-A on alcohol consequences (at higher- and lower-orders), cannabis consequences

(higher-order), alcohol quantity-frequency (higher- and lower-orders), and cannabis quantity-frequency (lower-order).

To assess risk for multicollinearity, Variance Inflation Factors (VIF) across all models were inspected. VIFs for all variables within the stepwise regression amounted to two or less with the single exception of the UPPS-P higher-order Deficits in Conscientiousness (CON) and Urgency (URG) scales. The VIF between URG and CON was exceedingly high (i.e., 10). However, because these two variables were contained within the same measure and no other variables demonstrated elevated VIFs, the authors believe this had little impact on the overall findings. Overall, the performance across assessments was roughly equivalent and there was no evidence of restricted range.

Discussion

This study examined the overlap between self-reported EF and impulsivity, using substance use outcomes as an external criterion. There were two main findings: 1) high correlations between EF and impulsivity constructs were found when assessed with shared methodologies (i.e., self-report), and 2) incremental validity of the BRIEF-A over the UPPS-P appears negligible (though the reverse was not true) with respect to substance use outcomes in this sample of college students. Implications are discussed below.

Executive Function and Impulsivity Relations with Shared Methodologies

As detailed above, correlations between the BRIEF-A and UPPS-P were large (e.g., the CON with MI index correlation [$r = 0.87$, $p < 0.01$]), which continued for both higher-order and lower-order analyses. As previously observed, UPPS-P Urgency facets demonstrated the strongest overall relations to alcohol- and cannabis-related outcomes (e.g., Coskunpinar et al., 2013; VanderVeen et al., 2016). Meanwhile, the BRIEF-A's BRI index, alongside the Inhibit and

Self-Monitor scales within, demonstrated the strongest correlations with both substance-related outcomes; a finding also consistent with prior literature (e.g., Clark et al., 2017; Piche et al., 2018). Overall, all UPPS-P and BRIEF-A scales were sensitive to measures of alcohol consumption while relatively fewer were associated with cannabis use. Although there is not much data regarding BRIEF-A cannabis relations, UPPS-P relations have a much larger literature. However, the available UPPS-P correlations are seemingly variable across studies. As mentioned in the VanderVeen et al., (2016) meta-analysis described above, correlations with cannabis consumption are typically low (e.g., *r*s between 0.13 and 0.23), or in the case of cannabis consequences, are robustly associated with specific UPPS-P scales (e.g., Positive and Negative Urgency, Sensation Seeking, and [Lack of] Planning). These prior findings are largely consistent with the present study.

Additionally, supplemental analyses revealed little overlap between self-report instruments and performance-based measures. Despite some exceptions (e.g., Enticott et al., 2006; Dolan et al., 2008; Verdejo-Garcia et al., 2010) and consistent with the larger literature, these findings suggest self-report and performance-based measures do not demonstrate much empirical overlap, especially among non-clinical samples (Toplak et al., 2013; Niendam et al., 2007; Toplak et al., 2008; Shuster & Toplak, 2009; McAuley et al., 2010; Miranda et al., 2015; Duckworth & Kern, 2011; Enticott et al., 2006). Extant literature provides an often-cited explanation suggesting the two assessment strategies capture different aspects of executive functioning (Toplak, West, & Stanovich, 2013; Miranda et al., 2015; Mcauley et al., 2010), despite some evidence of a general, shared latent factor after parsing out measurement-specific variables by use of a bifactor model (Crane et al., 2020). Collectively, the above cited studies suggest significant method variance as an important contributor to the apparent lack of overlap

between the constructs assessed by these assessment tools. However, much less is known about the overlap between specific self-report measures of EF including assessments of impulsivity. Many studies have used performance-based measures (Becker et al., 2014; Solowij et al., 2002), self-report measures (Clark et al., 2012; Clark et al., 2017; Crane et al., 2020; Piche et al., 2018), or both (Hagen et al., 2016; Meil et al., 2016; Niendam et al., 2007; Toplak et al., 2008; Shuster & Toplak, 2009; McAuley et al., 2010). Despite this, our study is the first (to our knowledge) to evince strong empirical overlap between the proprietary BRIEF-A and the oft-used UPPS-P measures, at least among young adults attending college. Such insight is essential to avoid jingle (two different things are assumed to be similar because they share a name; e.g., EF as indexed via the BRIEF-A and EF as indexed by performance-based measures) jangle (assumption that two similar things are different because they are labeled differently; e.g., executive dysfunction and impulsivity) fallacies.

Incremental Validity

Given the strong correlations between the UPPS-P and BRIEF-A, and to a lesser extent the lack of incremental validity for the BRIEF-A over the UPPS-P when considering substance-related outcomes, our findings suggest that the UPPS-P framework may be applicable to other populations in which the BRIEF-A is used. Further research would be necessary to make such a determination, however. Moreover, proponents of the BRIEF-A as a unique measure of EFs should seek additional evidence that it assesses constructs separate from relatively older measures like the UPPS-P, and to what extent. The UPPS-P confers several distinct advantages as a well-studied instrument (its original variant, the UPPS, published in 2001 with over 4,600 citations since its inception) with an extensive history of application within substance use domains (e.g., Toplak et al., 2013; Hershberger et al., 2017; Stautz et al., 2017) and others (e.g.,

eating disorders [Zapolski et al., 2010; Waxman, 2009]; Attention-Deficit/Hyperactivity Disorder [ADHD; Miller et al., 2010; Zapolski et al., 2010], anxiety disorders [Cyders & Coskunpinar, 2011b], and personality disorders [Poythress & Hall, 2010; Zapolski et al., 2010]). Alternatively, although the BRIEF-A has seen increasing popularity in recent years, with a documented history linking it to various neurocognitive conditions (e.g., autism-related traits [Christ et al., 2010; Wallace et al., 2016], neurocognitive impairment in chemotherapy patients [Kesler et al., 2013], ADHD [Biederman et al., 2012; Roth et al., 2013], and mild cognitive impairment [Rabin et al., 2006]), its breadth of supporting literature is limited by comparison. From the examples above, both measures are often applied in separate populations (other than ADHD and relatively sparse literature in the other shared domains), suggesting ample opportunity to test the translation of either measure to new conditions.

Additionally, the UPPS-P's availability on PhenX toolkit (Hamilton et al., 2011) as an open-access measure encourages similar measure usage across studies, facilitating data harmonization, increasing ease of cross-study comparisons, and thereby bolstering statistical power. The BRIEF-A's proprietary nature necessarily restricts such availability. Finally, these data depict a relatively murky distinction between impulsivity and EF constructs; at least when assessed by self-report in the important population of emerging adults. That is, even though there may be theoretical nuance which distinguishes these constructs, perhaps respondents to these assessments cannot make these same distinctions and answer impulsivity-related questions as they do EF-related questions. In sum, given the novel findings presented in the current work, the UPPS-P may be an effective alternative to the BRIEF-A, at least in some samples and contexts, such as healthy young adults who use substances. Although the UPPS-P may not be a suitable replacement for the BRIEF-A in all contexts (e.g., clinical samples with known executive

dysfunction such as individuals with acquired brain injuries, Maloney et al., 2020; Schmidt et al., 2010, 2014), our current findings suggest these scales are highly correlated.

Limitations and Future Directions

The data concerning the relations between EF, "impulsivity," and substance use outcomes were retrospectively gathered. Longitudinal assessments of EFs and impulsigenic traits would be necessary to accurately assess associated fluctuations between both constructs. In addition, these findings may be limited to this non-clinical young adult sample. There also appears to be relatively limited racial and gender diversity in this sample. As such, the pattern of results highlighted here must be replicated in other samples (e.g., clinical samples). Accordingly, these results should be regarded as tentative. Future studies could benefit from a more complete multi-trait multi-method approach by incorporating other self-report EF measures (e.g., DEX [Wilson et al., 1996], FrSBe [Grace & Malloy, 2001]) or performance-based impulsivity tasks (of note, the supplemental performance-based tasks used in the present study used the National Institutes of Health Toolbox, which incorporates an assortment of lab-based tools). The current paper employed a single self-report tool per construct despite multiple performance-based EF measures. Multiple self-report options per construct could be utilized to bolster our findings, though this concern was mitigated to some degree given both the BRIEF-A and the UPPS-P assess facet-level information.

Relative to the sample size, there were many parameters in the lower-order hierarchical regression models. We elected to include these estimates since readers might be interested in particular facets, though we urge caution when interpreting these parameters. Additionally, although we assessed two common substances of abuse (i.e., alcohol and cannabis), we did not collect nicotine-related information, which may interact with the variables of interest in the

present study. Moreover, our measures of substance use were restricted to past-month use. Future studies could examine relations to other time periods (e.g., lifetime use), and would benefit from a more comprehensive evaluation of substance involvement in a high substance use risk population, university-attending young adults.

Clinically, despite the limited utility of the BRIEF-A in substance use domains, it may still be useful for a variety of executive deficits in co-morbid SUD presentations and stability of results with and without demographic adjustment suggest adequate generalizability. Finally, as was presented above, the BRIEF-A and UPPS-P are frequently employed in separate clinical populations. Yet the findings here suggest strong potential for translation of either measure to a new clinical group (e.g., using the UPPS-P for neurocognitive disorders), as their comparison in such groups is not well understood. Future work would benefit from focused examinations of this possibility.

Conclusions

Results suggest significant overlap between self-reported EF and impulsivity in non-clinical, substance using collegiate populations. The high correlations between these domains only occurred when assessed with similar methods, suggesting method variance. These findings were consistent with prior research demonstrating little overlap between any self-report measures and performance-based measures of executive functioning. The BRIEF-A does not appear to add any incremental validity over and above the UPPS-P when examining EFs among non-clinical, young adults with respect to substance use outcomes (though the reverse was not true). Our data suggests the strong potential of jingle and jangle fallacies if researchers do not consider the empirical overlap between self-reported EF and impulsivity demonstrated in the current work.

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Footnotes

Analyses were conducted with and without adjustment for demographic variables. Results were largely consistent, regardless of adjustment. Additionally, despite a final model that includes all variables being mathematically equivalent regardless of the ordering of added variables, some readers may wonder if the order of the variables impacted the conclusions. That is, if the BREIF-A assessment was added first, followed by the UPPS-P, would there be evidence of significant incremental variance in the UPPS-P measures? Supplementary analyses found the UPPS-P explained significant variance above and beyond the BRIEF-A when regressed on alcohol and cannabis consequences (at higher- [alcohol: $R^2 = 0.10$, $p < 0.01$; cannabis: $R^2 = 0.06$, $p = 0.04$] and lower-orders [alcohol: $R^2 = 0.11$, $p < 0.01$]), cannabis quantity-frequency (lower-order: $R^2 = 0.09$, $p = 0.02$), and alcohol quantity-frequency (higher-order: $R^2 = 0.05$, $p = 0.01$; lower-order: $R^2 = 0.05$, $p = 0.02$). Thus, there appears to be reliable evidence that the UPPS-P outperformed the BRIEF-A on various substance-related outcomes.

References

Amieva, H., Phillips, L., & Della Sala, S. (2003). Behavioral dysexecutive symptoms in normal aging. *Brain and cognition*, *53*(2), 129-132. doi: 10.1016/S0278-2626(03)00094-0

Becker, M. P., Collins, P. F., & Luciana, M. (2014). Neurocognition in college-aged daily marijuana users. *Journal of clinical and experimental neuropsychology*, *36*(4), 379-398. doi: 10.1080/13803395.2014.893996

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal statistical society: series B (Methodological)*, *57*(1), 289-300.

Bickel W., Jarmolowicz D., Mueller E., Gatchalian K., Mcclure S. (2012). Are executive functions and impulsivity antipodes? A conceptual reconstruction with special reference to addiction. *Psychopharmacology* 221(3): 361-387. doi: 10.1007/s00213-012-2689-x

Biederman, J., Petty, C. R., Woodworth, K. Y., Lomedico, A., Hyder, L. L., & Faraone, S. V. (2012). Adult outcome of attention-deficit/hyperactivity disorder: a controlled 16-year follow-up study. *The Journal of clinical psychiatry*, *73*(7), 577. doi: 10.4088/JCP.11m07529

Blanco, C., Okuda, M., Wright, C., Hasin, D. S., Grant, B. F., Liu, S. M., & Olfson, M. (2008). Mental health of college students and their non–college-attending peers: results from the national epidemiologic study on alcohol and related conditions. *Archives of general psychiatry*, *65*(12), 1429-1437.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit In: Bollen KA, Long JS, eds. Testing Structural Equation Models. *Beverly Hills, CA: Sage*, 136-162. doi: 10.1177/0049124192021002005

Burgess, P. W., Alderman, N., Evans, J. O. N., Emslie, H., & Wilson, B. A. (1998). The ecological validity of tests of executive function. *Journal of the international neuropsychological society*, *4*(6), 547-558. doi: 10.1017/S1355617798466037 P

Chan, R. C. (2001). Dysexecutive symptoms among a non-clinical sample: A study with the use of the Dysexecutive Questionnaire. *British Journal of Psychology*, *92*(3), 551-565.

Christ, S. E., Kanne, S. M., & Reiersen, A. M. (2010). Executive function in individuals with subthreshold autism traits. *Neuropsychology*, *24*(5), 590. doi: 10.1037/a0019176

Clark, D. B., Chung, T., Martin, C. S., Hasler, B. P., Fitzgerald, D. H., Luna, B., ... & Pfefferbaum, A. (2017). Adolescent executive dysfunction in daily life: relationships to risks, brain structure and substance use. *Frontiers in behavioral neuroscience*, *11*, 223. https://doi.org/10.3389/fnbeh.2017.00223

Clark, D. B., Chung, T., Thatcher, D. L., Pajtek, S., & Long, E. C. (2012). Psychological dysregulation, white matter disorganization and substance use disorders in adolescence. *Addiction*, *107*(1), 206-214. doi: 10.1111/j.1360-0443.2011.03566.x

Cohen, J. (1988). Statistical power analysis for the behavioral sciences 2nd edn.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Congdon, E., & Canli, T. (2008). A neurogenetic approach to impulsivity. *Journal of Personality*, *76*(6), 1447-1484. doi: 10.1111/j.1467-6494.2008.00528.x

Coskunpinar, A., Dir, A. L., & Cyders, M. A. (2013). Multidimensionality in impulsivity and alcohol Use: a meta-analysis using the UPPS model of impulsivity. *Alcoholism: Clinical and Experimental Research*, *37*(9), 1441-1450.

Crane, N. A., Vergés, A., Kamali, M., Bhaumik, R., Ryan, K. A., Marshall, D. F., Saunders, E. F., Kassel, M. T., Weldon, A. L., McInnis, M. G., & Langenecker, S. A. (2020). Developing dimensional, pandiagnostic inhibitory control constructs with self-report and neuropsychological data. *Assessment*, *27*(4), 787-802. doi: 10.1177/1073191118754704

Cuttler, C., & Spradlin, A. (2017). Measuring cannabis consumption: psychometric properties of the daily sessions, frequency, age of onset, and quantity of cannabis use inventory (DFAQ-CU). *PloS One*, *12*(5), e0178194. https://doi.org/10.1371/journal.pone.0178194

Cyders, M. A., & Coskunpinar, A. (2011a). 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. (2011b). Depression, impulsivity and health-related disability: A moderated mediation analysis. *Journal of Research in Personality*, *45*(6), 679-682. doi: 10.1016/j.jrp.2011.08.005

Cyders, M. A., Flory, K., Rainer, S., & Smith, G. T. (2009). The role of personality dispositions to risky behavior in predicting first-year college drinking. *Addiction*, *104*(2), 193-202. doi: 10.1111/j.1360-0443.2008.02434.x

Cyders, M. A., Smith, G. T., Spillane, N. S., Fischer, S., Annus, A. M., & Peterson, C. (2007). Integration of impulsivity and positive mood to predict risky behavior: Development and validation of a measure of positive urgency. *Psychological Assessment*, *19*(1), 107. DOI: 10.1037/1040-3590.19.1.107

Dawe, S., Gullo, M. J., & Loxton, N. J. (2004). Reward drive and rash impulsiveness as dimensions of impulsivity: implications for substance misuse. *Addictive Behaviors*, *29*(7), 1389-1405. DOI: 10.1016/j.addbeh.2004.06.004

Day, M. A., Kahler, W. C., Ahern, C. D., & Clark, S. U. (2015). Executive functioning in alcohol use studies: a brief review of findings and challenges in assessment. *Current drug abuse reviews*, *8*(1), 26-40.

Dolan, S. L., Bechara, A., & Nathan, P. E. (2008). Executive dysfunction as a risk marker for substance abuse: the role of impulsive personality traits. *Behavioral sciences & the law*, *26*(6), 799-822.

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

Egeland, J., & Fallmyr, Ø. (2010). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF): Support for a distinction between emotional and behavioral regulation. *Child Neuropsychology*, *16*(4), 326-337. doi: 10.1080/09297041003601462

Enticott, P. G., Ogloff, J. R., & Bradshaw, J. L. (2006). Associations between laboratory measures of executive inhibitory control and self-reported impulsivity. *Personality and Individual Differences*, *41*(2), 285-294. doi: 10.1016/j.paid.2006.01.011

Gioia, G. A., Guy, S. C., Isquith, P. K., & Kenworthy, L. (1996). *Behavior rating inventory of executive function*. Lutz, FL: Psychological Assessment Resources, Inc.

Glickman, M. E., Rao, S. R., & Schultz, M. R. (2014). False discovery rate control is a recommended alternative to Bonferroni-type adjustments in health studies. *Journal of clinical epidemiology*, *67*(8), 850-857. doi: 10.1016/j.jclinepi.2014.03.012

Goldstein, S., & Naglieri, J. A. (Eds.). (2013). *Handbook of executive functioning*. New York, NY: Springer Science & Business Media.

Grace, J., & Malloy, P. H. (2001). *Frontal systems behavior scale (FrSBe): Professional manual*. Lutz, FL: Psychological Assessment Resources (PAR).

Grant, D. A., & Berg, E. (1948). A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. *Journal of experimental psychology*, *38*(4), 404.

Grant, B. F., Saha, T. D., Ruan, W. J., Goldstein, R. B., Chou, S. P., Jung, J., ... & Hasin, D. S. (2016). Epidemiology of DSM-5 drug use disorder: Results from the National Epidemiologic Survey on Alcohol and Related Conditions–III. *JAMA psychiatry*, *73*(1), 39-47. doi: 10.1001/jamapsychiatry.2015.0584

Hagen E., Erga A., Hagen K., Nesvåg S., McKay J., Lundervold A., & Walderhaug E. (2016). Assessment of executive function in patients with substance use disorder: A comparison of inventory-and performance-based assessment. *Journal of Substance Abuse Treatment*, *66*, 1-8. doi: 10.1016/j.jsat.2016.02.010.

Hamilton, C. M., Strader, L. C., Pratt, J. G., Maiese, D., Hendershot, T., Kwok, R. K., ... & Nettles, D. S. (2011). The PhenX Toolkit: get the most from your measures. *American journal of epidemiology*, *174*(3), 253-260. doi: 10.1093/aje/kwr193.

Hershberger, A. R., Um, M., & Cyders, M. A. (2017). The relationship between the UPPS-P impulsive personality traits and substance use psychotherapy outcomes: A meta-

analysis. *Drug and alcohol dependence*, *178*, 408-416. doi: 10.1016/j.drugalcdep.2017.05.032.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Kahler, C. W., Hustad, J., Barnett, N. P., Strong, D. R., & Borsari, B. (2008). Validation of the 30-day version of the Brief Young Adult Alcohol Consequences Questionnaire for use in longitudinal studies. *Journal of Studies on Alcohol and Drugs*, *69*(4), 611-615. doi: 10.15288/jsad.2008.69.611

Kahler, C. W., Strong, D. R., & Read, J. P. (2005). Toward efficient and comprehensive measurement of the alcohol problems continuum in college students: The Brief Young Adult Alcohol Consequences Questionnaire. *Alcoholism: Clinical and Experimental Research*, *29*(7), 1180-1189. doi: 10.1097/01.alc.0000171940.95813.a5.

Kesler, S., Hosseini, S. H., Heckler, C., Janelsins, M., Palesh, O., Mustian, K., & Morrow, G. (2013). Cognitive training for improving executive function in chemotherapy-treated breast cancer survivors. *Clinical breast cancer*, *13*(4), 299-306. doi: 10.1016/j.clbc.2013.02.004

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.) Guilford Press. *New York.*

Lipari, R. N., Park-Lee, E., & Van Horn, S. (2016). America's need for and receipt of substance use treatment in 2015. *The CBHSQ report*. Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration, Rockville, MD:

Retrieved from https://www.samhsa.gov/data/sites/default/files/report_2716/ShortReport-2716.html

Littlefield, A.K., Sher, K.J. (2016). Personality and substance use disorders. In K. J. Sher (Ed.), *Oxford Handbook of Substance Use Disorders.* Oxford University Press; New York, NY

Littlefield, A. K., Stevens, A. K., & Sher, K. J. (2014). Impulsivity and alcohol involvement: Multiple, distinct constructs and processes. *Current Addiction Reports*, *1*(1), 33-40. doi: 10.1007/s40429-013-0004-5

Mallinckrodt, B., Abraham, W. T., Wei, M., & Russell, D. W. (2006). Advances in testing the statistical significance of mediation effects. *Journal of Counseling Psychology*, *53*(3), 372. doi: 10.1037/0022-0167.53.3.372

Maloney, K. A., Schmidt, A. T., Hanten, G. R., & Levin, H. S. (2020). Executive dysfunction in children and adolescents with behavior disorders and traumatic brain injury. *Child neuropsychology*, *26*(1), 69-82. doi: 10.1080/09297049.2019.1640868

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function?. *Journal of the International Neuropsychological Society: JINS*, *16*(3), 495. doi: 10.1017/S1355617710000093.

McCoy, D. C. (2019). Measuring young children's executive function and self-regulation in classrooms and other real-world settings. *Clinical child and family psychology review*, *22*(1), 63-74.

Meda, S. A., Stevens, M. C., Potenza, M. N., Pittman, B., Gueorguieva, R., Andrews, M. M., Thomas, A. D., Muska, C., Hylton, J., & Pearlson, G. D. (2009). Investigating the behavioral and self-report constructs of impulsivity domains using principal component

analysis. *Behavioural Pharmacology*, *20*(5-6), 390. DOI: 10.1097/fbp.0b013e32833113a3

Meil, W. M., LaPorte, D. J., Mills, J. A., Sesti, A., Collins, S. M., & Stiver, A. G. (2016). Sensation seeking and executive deficits in relation to alcohol, tobacco, and marijuana use frequency among university students: Value of ecologically based measures. *Addictive behaviors*, *62*, 135-144. https://doi.org/10.1016/j.addbeh.2016.06.014

Miech, R. A., Johnston, L. D., O'Malley, P. M., Bachman, J. G., Schulenberg, J. E., & Patrick, M. E. (2020). Monitoring the Future National Survey Results on Drug Use, 1975-2019. Volume I, Secondary School Students. Ann Arbor, MI: *Institute for Social Research*, University of Michigan.

Miller, D. J., Derefinko, K. J., Lynam, D. R., 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

Miranda, A., Colomer, C., Mercader, J., Fernández, M. I., & Presentación, M. J. (2015). Performance-based tests versus behavioral ratings in the assessment of executive functioning in preschoolers: associations with ADHD symptoms and reading achievement. *Frontiers in Psychology*, *6*. DOI: 10.3389/fpsyg.2015.00545

Muthén, L. K., & Muthén, B. O. (2013). Mplus 7.11. *Los Angeles, CA: Muthén & Muthén*.

Niemeier, J. P., Perrin, P. B., Holcomb, M. G., Nersessova, K. S., & Rolston, C. D. (2013). Factor structure, reliability, and validity of the Frontal Systems Behavior Scale (FrSBe)

in an acute traumatic brain injury population. *Rehabilitation psychology*, *58*(1), 51. doi: 10.1037/a0031612

Niendam, T. A., Horwitz, J., Bearden, C. E., & Cannon, T. D. (2007). Ecological assessment of executive dysfunction in the psychosis prodrome: A pilot study. *Schizophrenia research*, *93*(1-3), 350-354. doi: 10.1016/j.schres.2007.03.009

Piche, J., Kaylegian, J., Smith, D., & Hunter, S. J. (2018). The relationship between self-reported executive functioning and risk-taking behavior in urban homeless youth. *Behavioral Sciences*, *8*(1), 6. doi: 10.3390/bs8010006

Poythress, N. G., & Hall, J. R. (2011). Psychopathy and impulsivity reconsidered. *Aggression and Violent Behavior*, *16*(2), 120-134. doi: 10.1016/j.avb.2011.02.003

Rabin, L. A., Roth, R. M., Isquith, P. K., Wishart, H. A., Nutter-Upham, K. E., Pare, N., Flashman, L. A., & Saykin, A. J. (2006). Self-and informant reports of executive function on the BRIEF-A in MCI and older adults with cognitive complaints. *Archives of Clinical Neuropsychology*, *21*(7), 721-732. doi:10.1016/j.acn.2006.08.004

Reitan, R. M., & Wolfson, D. (1985). *The Halstead-Reitan neuropsychological test battery: Theory and clinical interpretation* (Vol. 4). Tucson, AZ: Neuropsychology Press.

Reynolds, B. W., Basso, M. R., Miller, A. K., Whiteside, D. M., & Combs, D. (2019). Executive function, impulsivity, and risky behaviors in young adults. *Neuropsychology*, *33*(2), 212.

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *BRIEF-A: Behavior rating inventory of executive function-adult version: Professional manual*. Lutz, FL: Psychological Assessment Resources.

Roth, R. M., Lance, C. E., Isquith, P. K., Fischer, A. S., & Giancola, P. R. (2013). Confirmatory factor analysis of the behavior rating inventory of executive function-adult version in

healthy adults and application to attention-deficit/hyperactivity disorder. *Archives of clinical neuropsychology*, *28*(5), 425-434. doi: 10.1093/arclin/act031

Schmidt, A. T., Li, X., Zhang-Rutledge, K., Hanten, G. R., & Levin, H. S. (2014). A history of low birth weight alters recovery following a future head injury: A case series. *Child Neuropsychology, 20*(5), 495-508. doi: 10.1080/09297049.2013.822059

Schmidt, A. T., Martin, R. B., Ozturk, A., Kates, W. R., Wharam, M., Mahone, E. M., & Horska, A. (2010). Neuroimaging and neuropsychological follow-up study in a pediatric brain tumor patient treated with surgery and radiation. *Neurocase, 16*(1), 74-90. doi: 10.1080/13554790903329133.

Shuster, J., & Toplak, M. E. (2009). Executive and motivational inhibition: Associations with self-report measures related to inhibition. *Consciousness and Cognition*, *18*(2), 471-480. doi: 10.1016/j.concog.2009.01.004

Simblett, S. K., & Bateman, A. (2011). Dimensions of the Dysexecutive Questionnaire (DEX) examined using Rasch analysis. *Neuropsychological rehabilitation*, *21*(1), 1-25. doi: 10.1080/09602011.2010.531216

Simon, H. A. (1975). The functional equivalence of problem solving skills. *Cognitive psychology*, *7*(2), 268-288.

Simons, J. S., Dvorak, R. D., Merrill, J. E., & Read, J. P. (2012). Dimensions and severity of marijuana consequences: Development and validation of the Marijuana Consequences Questionnaire (MACQ). *Addictive Behaviors*, *37*(5), 613-621. doi: 10.1016/j.addbeh.2012.01.008

Slotkin, J., Nowinski, C., Hays, R., Beaumont, J., Griffith, J., Magasi, S., & Gershon, R. (2012b). NIH Toolbox scoring and interpretation guide. *National Institutes of Health, Washington (DC)*, 6-7.

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), 155-170. https://doi.org/10.1177/1073191106295527

Solowij, N., Stephens, R. S., Roffman, R. A., Babor, T., Kadden, R., Miller, M., ... & Vendetti, J. (2002). Cognitive functioning of long-term heavy cannabis users seeking treatment. *Jama*, *287*(9), 1123-1131. DOI: 10.1001/jama.287.9.1123

Soto, E. F., Kofler, M. J., Singh, L. J., Wells, E. L., Irwin, L. N., Groves, N. B., & Miller, C. E. (2020). Executive functioning rating scales: Ecologically valid or construct invalid?. *Neuropsychology*, *34*(6), 605.

Stautz, K., Dinc, L., & Cooper, A. J. (2017). Combining trait models of impulsivity to improve explanation of substance use behaviour. *European Journal of Personality*, *31*(1), 118-132. https://doi.org/10.1002/per.2091

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of experimental psychology*, *18*(6), 643.

Toplak, M. E., Bucciarelli, S. M., Jain, U., & Tannock, R. (2008). Executive functions: performance-based measures and the behavior rating inventory of executive function (BRIEF) in adolescents with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *15*(1), 53-72. doi: 10.1080/09297040802070929.

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*, *54*(2), 131-143. doi: 10.1111/jcpp.12001.

VanderVeen, J. D., Hershberger, A. R., & Cyders, M. A. (2016). UPPS-P model impulsivity and marijuana use behaviors in adolescents: A meta-analysis. *Drug & Alcohol Dependence*, *168*, 181-190.

Verdejo-García, A., del Mar Sánchez-Fernández, M., Alonso-Maroto, L. M., Fernández-Calderón, F., Perales, J. C., Lozano, Ó., & Pérez-García, M. (2010). Impulsivity and executive functions in polysubstance-using rave attenders. *Psychopharmacology*, *210*(3), 377-392.

Wallace, G. L., Kenworthy, L., Pugliese, C. E., Popal, H. S., White, E. I., Brodsky, E., & Martin, A. (2016). Real-world executive functions in adults with autism spectrum disorder: Profiles of impairment and associations with adaptive functioning and co-morbid anxiety and depression. *Journal of autism and developmental disorders*, *46*(3), 1071-1083. doi: 10.1007/s10803-015-2655-7

Waxman, S. E. (2009). A systematic review of impulsivity in eating disorders. *European Eating Disorders Review: The Professional Journal of the Eating Disorders Association*, *17*(6), 408-425. doi: 10.1002/erv.952

Wilson, B. A., Alderman, N., Burgess, P. W., Emslie, H., & Evans, J. J. (1996). Behavioural assessment of the dysexecutive syndrome: Test manual. *England: Thames Valley Test Company*.

Wu, L. T., Pilowsky, D. J., Schlenger, W. E., & Hasin, D. (2007). Alcohol use disorders and the use of treatment services among college-age young adults. *Psychiatric Services*, *58*(2), 192-200.

Zapolski, T. C., Settles, R. E., Cyders, M. A., & Smith, G. T. (2010). Borderline personality disorder, bulimia nervosa, antisocial personality disorder, ADHD, substance use: Common threads, common treatment needs, and the nature of impulsivity. *Independent Practitioner (Lutterworth, England)*, *30*(1), 20.

Table 1. Demographics information across sample and substance-related subgroups.

Demographic Variable	Total *N* = 339	Alcohol *n* = 210	Cannabis *n* = 163	Combined *n* = 123
Age				
	19.35 (1.96)	19.47 (2.13)	19.50 (2.10)	19.59 (2.24)
SES				
	50,000-74,999	75,000-99,999; 100,000-124,999	100,000-124,999	100,000-124,999
Gender				
Male	97	62	47	41
Female	215	128	110	76
No Response	27	20	6	6
Race				
White	226	139	116	86
Native American	10	5	6	3
Asian	16	9	5	3
Black	32	20	15	13
Pacific Islander	0	0	0	0
Other	19	10	11	8
No Response	36	27	10	10
Ethnicity				
Non-Hispanic	209	129	103	77
Hispanic	89	47	48	35
No Response	41	34	12	11

Note: Parentheticals display standard deviations; SES = Socioeconomic Status; SES row displays the modal endorsed annual income category; the alcohol participant group equally endorsed two SES income categories and both are displayed; the column labeled "combined" displays participants who endorsed both lifetime alcohol and cannabis use.

Table 2. Zero-order correlations across all self-report factors and performance-based executive function tasks.

		Urgency	Deficits in Conscientiousness	Sensation Seeking	BRI	MI		
UPPS-P	Urgency							
	Def. in Conscientiousness	0.76***						
	Sensation Seeking	0.15*	-0.19*					
BRIEF-A	BRI	0.82***	0.73***	0.03				
	MI	0.71***	0.87***	-0.02	0.90***			
		Positive Urgency	Negative Urgency	Lack of Planning	Lack of Perseverance	Sensation Seeking	Inhibit	Shift
UPPS-P	Positive Urgency							
	Negative Urgency	0.75***						
	Lack of Planning	0.42***	0.40***					
	Lack of Perseverance	0.38***	0.58***	0.40***				
	Sensation Seeking	0.26***	0.07	0.14*	-0.24***			
BRIEF-A	Inhibit	0.52***	0.67***	0.51***	0.52***	0.23***		
	Shift	0.50***	0.65***	0.08	0.50***	-0.14*	0.61***	
	Emotional Control	0.39***	0.63***	0.17**	0.39***	-0.13*	0.60***	0.73***
	Self-Monitor	0.69***	0.77***	0.57***	0.46***	0.16*	0.86***	0.70***
	Initiate	0.52***	0.67***	0.25***	0.72***	-0.06	0.75***	0.80***
	Working Memory	0.41***	0.60***	0.25***	0.61***	-0.10	0.91***	0.79***
	Task Monitor	0.52***	0.69***	0.30**	0.67***	-0.04	0.74***	0.72***
	Plan/Organize	0.57***	0.64***	0.40***	0.70***	0.02	0.76***	0.70***
	Organization of Materials	0.46***	0.51***	0.41***	0.55***	0.06	0.67***	0.41***

Note. * < .05; ** < .01; *** < .001; Def. in Conscientiousness = Deficits in Conscientiousness; EF = Executive Function; BRI = Behavior Regulation Index; MI = Metacognition Index; DCCS = Dimensional Change Card Sort Task; all correlations reported in the metric of *r*.

Table 2 (cont.). Zero-order correlations across all self-report factors and performance-based executive function tasks.

		Emotional Control	Self-Monitor	Initiate	Working Memory	Task Monitor	Plan / Organize	Organization Of Materials
BRIEF-A	Emotional Control							
	Self-Monitor	0.61***						
	Initiate	0.53***	0.71***					
	Working Memory	0.60***	0.75***	0.85***				
	Task Monitor	0.46***	0.74***	0.94***	0.78***			
	Plan/Organize	0.51***	0.78***	0.91***	0.80***	0.86***		
	Organization of Materials	0.39***	0.64***	0.65***	0.58***	0.68***	0.77***	

Note. * < .05; ** < .01; *** < .001; EF = Executive Function; DCCS = Dimensional Change Card Sort Task; all correlations reported in the metric of *r*.

Table 3. Zero-order correlations across all self-report factors and substance-related outcomes.

		NIAAA Quantity-Frequency	B - YAACQ	DFAQ - CU Quantity-Frequency	B - MACQ
UPPS-P	Positive Urgency	0.28***	0.39***	0.08	0.31***
	Negative Urgency	0.35***	0.44***	0.26**	0.35***
	Planning	0.29***	0.22***	0.09	0.10
	Perseverance	0.19**	0.30***	0.06	0.12
	Sensation Seeking	0.16*	0.20**	0.26**	0.19
	Urgency	0.37***	0.47***	0.12	0.28**
	Deficits in Conscientiousness	0.34***	0.40***	0.14	0.12
BRIEF-A	Inhibit	0.38***	0.34***	0.08	0.28**
	Shift	0.19**	0.25***	0.10	0.23*
	Emotional Control	0.23***	0.25***	0.07	0.20*
	Self-Monitor	0.29***	0.35***	0.28	0.40***
	Initiate	0.24***	0.28***	0.08	0.20*
	Working Memory	0.21***	0.24***	-0.09	0.17
	Task Monitor	0.24***	0.32***	0.07	0.25**
	Plan/Organize	0.28***	0.35***	0.08	0.27**
	Organization of Materials	0.28***	0.33***	0.08	0.13
	BRI	0.34***	0.37***	0.22	0.32***
	MI	0.28***	0.34***	0.15	0.23**

Note. * < .05; ** < .01; *** < .001; Statistical significance was adjusted for using the Benjamini and Hochberg (1995) procedure; EF = Executive Function; BRI = Behavior Regulation Index; MI = Metacognition Index; B-YAACQ = Brief – Young Adult Alcohol Consequences Questionnaire; B-MACQ = Brief Marijuana Consequences Questionnaire; all correlations reported in the metric of *r*.

Table 4. Hierarchical regression of alcohol and cannabis use outcomes on lower-order UPPS-P and BRIEF-A measures.

	NIAAA Quantity-Frequency	B - YAACQ	DFAQ - CU Quantity-Frequency	B - MACQ
Step One (Overall R2)	0.17***	0.25***	0.10*	0.16***
	β	β	β	β
Negative Urgency	0.34***	0.35***	0.30*	0.30
(lack of) Planning	0.11	-0.08	-0.09	-0.10
(lack of) Perseverance	0.05	0.14	0.09	-0.04
Sensation Seeking	0.18**	0.21**`	0.25**	0.14
Positive Urgency	-0.09	0.09	-0.09	0.14
Step Two (Overall R2 / ΔR2)	0.20*** / Δ 0.03	0.29*** / Δ 0.04	0.20* / Δ 0.10	0.24*** / Δ 0.08
Negative Urgency	0.29**	0.35***	0.20	0.16
(lack of) Planning	0.07	-0.11	-0.22	-0.21
(lack of) Perseverance	-0.01	0.07	0.29	-0.03
Sensation Seeking	0.13	0.20**	0.27	0.08
Positive Urgency	-0.09	0.08	-0.15	0.04
Inhibit	0.16	-0.09	0.12	0.10
Shift	-0.02	-0.02	0.15	0.03
Emotional Control	0.05	0.06	0.03	0.03
Self-Monitor	-0.06	-0.03	0.31	0.33
Initiate	-0.04	-0.17	-0.23	-0.13
Working Memory	-0.06	0.01	-0.36	-0.26
Plan / Organize	0.00	0.11	0.03	0.21
Task Monitor	0.09	0.08	-0.05	0.08
Organization of Materials	0.12	0.18	0.06	-0.06

Note. * < .05; ** < .01; *** < .001; Statistical significance was adjusted for using the Benjamini and Hochberg (1995) procedure; β = standardized regression coefficient; S.E. = Standard Error; Δ = delta/change; R2 = overall model r-squared; B-YAACQ = Brief – Young Adult Alcohol Consequences Questionnaire; B-MACQ = Brief Marijuana Consequences Questionnaire.

Table 5. Hierarchical regression of alcohol and cannabis use outcomes on higher-order UPPS-P and BRIEF-A measures.

	NIAAA Quantity-Frequency	B - YAACQ	DFAQ - CU Quantity-Frequency	B - MACQ
Step One (Overall R2)	0.14***	0.24***	0.06*	0.13***
	β	β	β	β
Urgency	0.21	0.36*	0.13	0.60**
Deficits in Conscientiousness	0.14	0.11	0.07	-0.31
Sensation Seeking	0.17	0.17*	0.17	-0.00
Step Two (Overall R2 / ΔR2)	0.15*** / Δ 0.01	0.25*** / Δ 0.01	0.08* / Δ 0.02	0.15*** / Δ 0.02
Urgency	0.20	0.40	-0.02	0.49
Deficits in Conscientiousness	0.03	0.00	0.25	-0.34
Sensation Seeking	0.15	0.14	0.23	0.01
BRI	0.04	-0.05	0.18	0.18
MI	0.13	0.13	-0.21	0.01

Note. * < .05; ** < .01; *** < .001; Statistical significance was adjusted for using the Benjamini and Hochberg (1995) procedure; β = standardized regression coefficient; S.E. = Standard Error; Δ = delta/change; R2 = overall model r-squared; BRI = Behavior Regulation Index; MI = Metacognition Index; B-YAACQ = Brief – Young Adult Alcohol Consequences Questionnaire; B-MACQ = Brief Marijuana Consequences Questionnaire.

Supplemental Materials 1

In addition to reviewing the empirical relations between impulsigenic traits as measured by the Urgency, Planning, Perseverance, Sensation Seeking – Positive Urgency (UPPS-P) scale and executive functions (EF) as measured by the Behavior Regulation Inventory of Executive Functions – Adults (BRIEF-A), we also explored these relations to performance-based measures of EF. Consistent with our study's primary aims, we similarly used these performance-based measures to explore their associations with our external substance use criterions (i.e., cannabis and alcohol quantity-frequency [QF] and consequence outcomes) alongside the hierarchical regression models. These performance-based tools originate from the National Institutes of Health Toolbox (NIH Toolbox; Slotkin et al., 2012), which is a compilation of EF measures administered via electronic tablet and provides assessment of neurological, behavioral, and cognitive function (Gershon et al., 2013). The NIH Toolbox produces several composite scores, such as the Fluid Cognition Composite (FCC). The EF tests within the FCC measure several domains, such as attention, inhibitory control, reversal learning, episodic memory, working memory, and processing speed. Each of the mentioned domains have long-standing associations to alcohol misuse in the literature (see La Berre, 2017; Kopera et al., 2012; Stavro et al., 2013), but appear to have less consistent deficits in cannabis involved populations (see Broyd et al., 2016, for a meta-analysis of 105 studies reviewing cannabis use with neuropsychological task performance). However, the most consistent findings with cannabis using groups were related to verbal learning, memory, attention, and psychomotor function. While the BRIEF-A can tap many of the above noted EF components alone, the NIH Toolbox offered a concise, bounded set of measures to assess these same EFs. Accordingly, in the interest of employing a multi-method approach, the assorted tasks compiled within the NIH Toolbox were used. The below three tables

parallel the tables presented in our primary work, but also include the above noted NIH Toolbox. There were no notable relations between any performance-based tasks and the UPPS-P, BRIEF-A, nor our substance use outcomes that rose above chance-level findings. Table 1 displays the zero-order correlations between each of the UPPS-P, BRIEF-A, and NIH Toolbox measures, while Table 2 presents the individual correlations between each impulsivity and EF measure on each substance use outcome. Tables 3 and 4 display the results of our hierarchical analyses at the lower- and higher-order levels respectively, using each of the four substance use measures as our outcome.

References:

Broyd, S. J., van Hell, H. H., Beale, C., Yuecel, M., & Solowij, N. (2016). Acute and chronic effects of cannabinoids on human cognition—a systematic review. *Biological psychiatry*, *79*(7), 557-567. doi: 10.1016/j.biopsych.2015.12.002

Gershon, R. C., Wagster, M. V., Hendrie, H. C., Fox, N. A., Cook, K. F., & Nowinski, C. J. (2013). NIH toolbox for assessment of neurological and behavioral function. *Neurology*, *80*(11 Supplement 3), S2-S6. doi: 10.1212/WNL.0b013e3182872e5f

Kopera, M., Wojnar, M., Brower, K., Glass, J., Nowosad, I., Gmaj, B., & Szelenberger, W. (2012). Cognitive functions in abstinent alcohol-dependent patients. *Alcohol*, *46*(7), 665-671. doi: 10.1016/j.alcohol.2012.04.005

Le Berre, A. P., Fama, R., & Sullivan, E. V. (2017). Executive functions, memory, and social cognitive deficits and recovery in chronic alcoholism: a critical review to inform future research. *Alcoholism: Clinical and Experimental Research*, *41*(8), 1432-1443. doi: 10.1111/acer.13431

Slotkin, J., Nowinski, C., Hays, R., Beaumont, J., Griffith, J., Magasi, S., & Gershon, R. (2012b). NIH Toolbox scoring and interpretation guide. *National Institutes of Health, Washington (DC)*, 6-7.

Stavro, K., Pelletier, J., & Potvin, S. (2013). Widespread and sustained cognitive deficits in alcoholism: a meta-analysis. *Addiction biology*, *18*(2), 203-213. doi: 10.1111/j.1369-1600.2011.00418.

Table 1. Zero-order correlations across all self-report factors and performance-based executive function tasks.

		Urgency	Deficits in Conscientiousness	Sensation Seeking	BRI	MI	Fluid Cognition Composite
UPPS-P	Urgency						
	Def. in Conscientiousness	0.76***					
	Sensation Seeking	0.15*	-0.19*				
BRIEF-A	BRI	0.82***	0.73***	0.03			
	MI	0.71***	0.87***	-0.02	0.90***		
Performance EF	Fluid Cognition Composite	-0.02	-0.02	0.10	-0.01	0.02	

		Positive Urgency	Negative Urgency	Lack of Planning	Lack of Perseverance	Sensation Seeking	Inhibit	Shift
UPPS-P	Positive Urgency							
	Negative Urgency	0.75***						
	Lack of Planning	0.42***	0.40***					
	Lack of Perseverance	0.38***	0.58***	0.40***				
	Sensation Seeking	0.26***	0.07	0.14*	-0.24***			
BRIEF-A	Inhibit	0.52***	0.67***	0.51***	0.52***	0.23***		
	Shift	0.50***	0.65***	0.08	0.50***	-0.14*	0.61***	
	Emotional Control	0.39***	0.63***	0.17**	0.39***	-0.13*	0.60***	0.73***
	Self-Monitor	0.69***	0.77***	0.57***	0.46***	0.16*	0.86***	0.70***
	Initiate	0.52***	0.67***	0.25***	0.72***	-0.06	0.75***	0.80***
	Working Memory	0.41***	0.60***	0.25***	0.61***	-0.10	0.91***	0.79***
	Task Monitor	0.52***	0.69***	0.30**	0.67***	-0.04	0.74***	0.72***
	Plan/Organize	0.57***	0.64***	0.40***	0.70***	0.02	0.76***	0.70***
	Organization of Materials	0.46***	0.51***	0.41***	0.55***	0.06	0.67***	0.41***
Performance EF	Flanker	0.06	-0.13	0.04	0.00	0.07	-0.10	-0.12
	DCCS	-0.08	-0.04	-0.07	-0.08	-0.02	-0.10	-0.07
	Picture Sequence	-0.04	-0.03	0.02	0.01	0.08	0.08	0.02
	List Sorting	0.05	0.11	0.01	0.01	0.01	-0.07	0.05
	Pattern Comparison	0.06	0.04	0.02	0.02	0.08	0.05	0.02

Note. * < .05; ** < .01; *** < .001; Def. in Conscientiousness = Deficits in Conscientiousness; EF = Executive Function; BRI = Behavior Regulation Index; MI = Metacognition Index; DCCS = Dimensional Change Card Sort Task; all correlations reported in the metric of *r*.

Table 1 (cont.). Zero-order correlations across all self-report factors and performance-based executive function tasks.

		Emotional Control	Self-Monitor	Initiate	Working Memory	Task Monitor	Plan / Organize	Organization Of Materials
BRIEF-A	Emotional Control							
	Self-Monitor	0.61***						
	Initiate	0.53***	0.71***					
	Working Memory	0.60***	0.75***	0.85***				
	Task Monitor	0.46***	0.74***	0.94***	0.78***			
	Plan/Organize	0.51***	0.78***	0.91***	0.80***	0.86***		
	Organization of Materials	0.39***	0.64***	0.65***	0.58***	0.68***	0.77***	
Performance EF	Flanker	-0.14	-0.06	-0.01	-0.05	0.02	0.02	0.02
	DCCS	-0.11	-0.06	-0.05	-0.06	0.01	-0.02	-0.03
	Picture Sequence	0.03	0.05	0.03	0.00	-0.13	-0.04	-0.12
	List Sorting	-0.03	0.00	0.02	0.04	0.07	0.06	-0.03
	Pattern Comparison	-0.03	0.04	0.02	0.01	0.05	0.02	-0.01

Note. * < .05; ** < .01; *** < .001; EF = Executive Function; DCCS = Dimensional Change Card Sort Task; all correlations reported in the metric of *r*.

Table 1 (cont.). Zero-order correlations across all self-report factors and performance-based executive function tasks.

		Flanker	DCCS	Picture Sequence	List Sorting	Pattern Comparison
Performance EF	Flanker					
	DCCS	0.79***				
	Picture Sequence	-0.09	-0.14*			
	List Sorting	0.61***	0.59***	-0.07		
	Pattern Comparison	0.56***	0.51***	-0.01	0.36***	

Note. * < .05; ** < .01; *** < .001; EF = Executive Function; DCCS = Dimensional Change Card Sort Task; all correlations reported in the metric of *r*.

Table 2. Zero-order correlations across all self-report factors and substance-related outcomes.

		NIAAA Quantity-Frequency	B - YAACQ	DFAQ - CU Quantity-Frequency	B - MACQ
UPPS-P	Positive Urgency	0.28***	0.39***	0.08	0.31***
	Negative Urgency	0.35***	0.44***	0.26**	0.35***
	Planning	0.29***	0.22***	0.09	0.10
	Perseverance	0.19**	0.30***	0.06	0.12
	Sensation Seeking	0.16*	0.20**	0.26**	0.19
	Urgency	0.37***	0.47***	0.12	0.28**
	Deficits in Conscientiousness	0.34***	0.40***	0.14	0.12
BRIEF-A	Inhibit	0.38***	0.34***	0.08	0.28**
	Shift	0.19**	0.25***	0.10	0.23*
	Emotional Control	0.23***	0.25***	0.07	0.20*
	Self-Monitor	0.29***	0.35***	0.28	0.40***
	Initiate	0.24***	0.28***	0.08	0.20*
	Working Memory	0.21***	0.24***	-0.09	0.17
	Task Monitor	0.24***	0.32***	0.07	0.25**
	Plan/Organize	0.28***	0.35***	0.08	0.27**
	Organization of Materials	0.28***	0.33***	0.08	0.13
	BRI	0.34***	0.37***	0.22	0.32***
	MI	0.28***	0.34***	0.15	0.23**
Performance EF	Flanker	0.08	0.11	-0.35**	-0.10
	Dimensional Change Card Sort	-0.10	-0.12	-0.19	-0.05
	Picture Sequence	-0.03	-0.02	-0.20	-0.03
	List Sorting	-0.01	-0.05	0.28**	-0.06
	Pattern Comparison	-0.02	-0.02	-0.11	0.12
	Fluid Cognition Composite	-0.02	-0.06	-0.08	-0.09

Note. * < .05; ** < .01; *** < .001; Statistical significance was adjusted for using the Benjamini and Hochberg (1995) procedure; EF = Executive Function; BRI = Behavior Regulation Index; MI = Metacognition Index; B-YAACQ = Brief – Young Adult Alcohol Consequences Questionnaire; B-MACQ = Brief Marijuana Consequences Questionnaire; all correlations reported in the metric of *r*.

Table 3. Hierarchical regression of alcohol and cannabis use outcomes on lower-order UPPS-P, BRIEF-A, and Performance-based executive functioning tasks.

	NIAAA Quantity-Frequency	B - YAACQ	DFAQ - CU Quantity-Frequency	B - MACQ
Step One (Overall R2)	0.17***	0.25***	0.10*	0.16***
	β	β	β	β
Negative Urgency	0.34***	0.35***	0.30*	0.30
(lack of) Planning	0.11	-0.08	-0.09	-0.10
(lack of) Perseverance	0.05	0.14	0.09	-0.04
Sensation Seeking	0.18**	0.21**`	0.25**	0.14
Positive Urgency	-0.09	0.09	-0.09	0.14
Step Two (Overall R2 / ΔR2)	0.20*** / Δ 0.03	0.29*** / Δ 0.04	0.20* / Δ 0.10	0.24*** / Δ 0.08
Negative Urgency	0.29**	0.35***	0.20	0.16
(lack of) Planning	0.07	-0.11	-0.22	-0.21
(lack of) Perseverance	-0.01	0.07	0.29	-0.03
Sensation Seeking	0.13	0.20**	0.27	0.08
Positive Urgency	-0.09	0.08	-0.15	0.04
Inhibit	0.16	-0.09	0.12	0.10
Shift	-0.02	-0.02	0.15	0.03
Emotional Control	0.05	0.06	0.03	0.03
Self-Monitor	-0.06	-0.03	0.31	0.33
Initiate	-0.04	-0.17	-0.23	-0.13
Working Memory	-0.06	0.01	-0.36	-0.26
Plan / Organize	0.00	0.11	0.03	0.21
Task Monitor	0.09	0.08	-0.05	0.08
Organization of Materials	0.12	0.18	0.06	-0.06
Step Three (Overall R2 / ΔR2)	0.20*** / Δ 0.01	0.30*** / Δ 0.01	0.22* / Δ 0.02	0.25*** / Δ 0.02
Negative Urgency	0.29	0.33***	0.18	0.19
(lack of) Planning	0.08	-0.10	-0.24	-0.21
(lack of) Perseverance	-0.03	0.07	0.28	-0.04
Sensation Seeking	0.14	0.22**	0.28	0.08
Positive Urgency	-0.09	0.10	-0.15	0.03
Inhibit	0.17	-0.10	0.12	0.05
Shift	0.00	-0.01	0.14	0.02
Emotional Control	0.04	0.04	0.04	-0.00
Self-Monitor	-0.08	-0.04	0.29	0.33

Initiate	-0.03	-0.13	-0.25	-0.08
Working Memory	-0.05	0.02	-0.36	-0.25
Plan / Organize	0.00	0.11	0.05	0.22
Task Monitor	0.08	0.07	-0.04	0.07
Organization of Materials	0.11	0.19	0.08	-0.05
List Sort	-0.00	-0.05	0.12	-0.05
Pattern Comparison	-0.03	-0.07	0.03	0.07
Picture Sequence	-0.07	0.02	-0.01	0.06
Flanker	0.03	-0.05	-0.18	-0.13
Dimensional Change Card Sort	-0.01	0.02	0.12	-0.05

Note. * < .05; ** < .01; *** < .001; Statistical significance was adjusted for using the Benjamini and Hochberg (1995) procedure; β = standardized regression coefficient; S.E. = Standard Error; Δ = delta/change; R2 = overall model r-squared; B-YAACQ = Brief – Young Adult Alcohol Consequences Questionnaire; B-MACQ = Brief Marijuana Consequences Questionnaire.

Table 4. Hierarchical regression of alcohol and cannabis use outcomes on higher-order UPPS-P, BRIEF-A, and Performance-based executive functioning tasks.

	NIAAA Quantity-Frequency	B - YAACQ	DFAQ - CU Quantity-Frequency	B - MACQ
Step One (Overall R2)	0.14***	0.24***	0.06*	0.13***
	β	β	β	β
Urgency	0.21	0.36*	0.13	0.60**
Deficits in Conscientiousness	0.14	0.11	0.07	-0.31
Sensation Seeking	0.17	0.17*	0.17	-0.00
Step Two (Overall R2 / ΔR2)	0.15*** / Δ 0.01	0.25*** / Δ 0.01	0.08* / Δ 0.02	0.15*** / Δ 0.02
Urgency	0.20	0.40	-0.02	0.49
Deficits in Conscientiousness	0.03	0.00	0.25	-0.34
Sensation Seeking	0.15	0.14	0.23	0.01
BRI	0.04	-0.05	0.18	0.18
MI	0.13	0.13	-0.21	0.01
Step Three (Overall R2 / ΔR2)	0.15*** / Δ 0.00	0.26*** / Δ 0.01	0.08* / Δ 0.00	0.17*** / Δ 0.07
Urgency	0.19	0.40	-0.02	0.54
Deficits in Conscientiousness	0.03	0.01	0.25	-0.39
Sensation Seeking	0.15	0.15	0.23	-0.00
BRI	0.04	-0.06	0.18	0.17
MI	0.13	0.14	-0.21	0.01
Fluid Cognition Composite	-0.02	-0.10	0.01	-0.15

Note. * < .05; ** < .01; *** < .001; Statistical significance was adjusted for using the Benjamini and Hochberg (1995) procedure; β = standardized regression coefficient; S.E. = Standard Error; Δ = delta/change; R2 = overall model r-squared; BRI = Behavior Regulation Index; MI = Metacognition Index; B-YAACQ = Brief – Young Adult Alcohol Consequences Questionnaire; B-MACQ = Brief Marijuana Consequences Questionnaire.