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UPPS-P impulsive personality traits and adolescent cigarette smoking: A meta-analysis

Jason Bos, Melissa J. Hayden, Jarrad A.G. Lum, Petra K. Staiger*

School of Psychology, Deakin University, 225 Burwood Highway, Burwood, Victoria, 3125, Australia

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ABSTRACT

Background: Adolescence is a critical developmental period in the trajectory of nicotine dependence, highlighting the need for a greater understanding of the modifiable risk factors. An extensive body of research has found that trait impulsivity is associated with higher levels of adolescent smoking; however, findings have been mixed. The present study aimed to synthesise existing literature to determine the strength and nature of the relationship between the UPPS-P impulsive traits and both adolescent cigarette consumption and nicotine dependence.

Methods: Fifty-one studies were meta-analysed using a random effects model to determine the association between each UPPS-P impulsive trait and both adolescent cigarette consumption and nicotine dependence. Age, gender, ethnicity and sample type were examined as potential moderators.

Results: Cigarette consumption was positively associated with each UPPS-P impulsive trait (*r*'s ranging from 0.17-0.20). There were an insufficient number of studies to meta-analyse the association between nicotine dependence and the UPPS-P impulsive traits. There were no significant moderation effects of age, gender, ethnicity or sample type.

Conclusions: Findings suggest that each UPPS-P impulsive trait shares similar associations with adolescent cigarette consumption. Additional studies are needed to determine the relationship between adolescent nicotine dependence and impulsivity. As most adult smokers initiate during adolescence, targeting these impulsive traits via novel prevention and intervention strategies may assist in reducing the prevalence of smoking.

1. Introduction

Despite the well-established health risks, cigarette smoking remains one of the leading preventable causes of premature death worldwide (World Health Organisation [WHO], 2015). In 2015, over six million people died globally as a result of smoking and, if current trends persist, this number will exceed eight million by the year 2030 (WHO, 2015). Adolescence is a critical developmental period where increases in risk-taking behaviours and experimentation with a variety of substances, such as cigarette smoking, emerge (Backinger et al., 2003; Ernst et al., 2009; Lantz, 2003). Research has demonstrated that smoking initiation predominantly begins during adolescence (U.S Department of Health and Human Services, 2012), and, longitudinal research has indicated that cigarette consumption (i.e., the quantity and frequency of cigarette use) during adolescence is associated with levels of consumption and dependence in adulthood (Buchmann et al., 2013; Chassin et al., 2000; Jefferis et al., 2003). For instance, a one-year increase in age at initiation among 213 ever-smokers, was associated with smoking 33.5 fewer cigarettes per month at age 22 and a decrease of 0.42 in the Fagerström Test for Nicotine Dependence score (Buchmann et al., 2013). Furthermore, adolescent cigarette smokers are more likely to engage in other addictive behaviours (Kandel and Kandel, 2014; Merline et al., 2004; Moss et al., 2014) and, are at an increased risk of experiencing a range of negative outcomes, such as anxious and depressed mood and poor academic achievement (Leventhal and Zvolensky, 2015; Morin et al., 2012). As such, research into the modifiable risk factors associated with adolescent cigarette smoking is critically important to effectively reduce the global prevalence of smoking. Doing so will enable the identification of adolescents who are at the greatest risk of smoking, and, importantly, allow for the development of tailored prevention and intervention strategies to be directed towards those who would yield the greatest benefits.

* Corresponding author.
E-mail addresses: bojas@deakin.edu.au (J. Bos), m.hayden@deakin.edu.au (M.J. Hayden), jarrad.lum@deakin.edu.au (J.A.G. Lum), petra.staiger@deakin.edu.au (P.K. Staiger).

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1.1. Trait Impulsivity and Adolescent Cigarette Smoking

An increasing amount of attention has been placed on trait impulsivity and its role in the development and maintenance of cigarette smoking (Bloom et al., 2013). Research has generally demonstrated that adolescent smokers are more impulsive than their non-smoking counterparts and, that trait impulsivity is associated with smoking initiation, cigarette consumption, poor cessation outcomes and nicotine dependence (Burris et al., 2017; Fields et al., 2009; Lee et al., 2015; Pang et al., 2014; Reynolds et al., 2007; Spillane et al., 2010; Weckler et al., 2017). Yet, despite this well-examined relationship, no attempt has been made to systematically meta-analyse these studies. One potential reason is that quantifying the overall association between adolescent cigarette smoking and trait impulsivity poses challenges, largely because impulsivity is a multidimensional construct with varying definitions. For example, commonly used trait impulsivity variables such as novelty seeking, fun seeking, disinhibition and boredom susceptibility have all been subsumed under the construct of impulsivity; however, research has shown that these variables are both unique, and related, components of impulsivity (Lynam et al., 2006; Whiteside and Lynam, 2001). Specifically, Whiteside and Lynam (2001) used factor analysis on a number of frequently used trait impulsivity measures and demonstrated that impulsivity comprises five distinct, yet interrelated, impulsive traits, including: 1) *sensation seeking*, defined as the tendency to seek sensory pleasure, excitement and novel experiences; 2) *lack of premeditation*, defined as the tendency to act without forethought; 3) *lack of perseverance*, defined as the tendency to not finish tasks, or heightened susceptibility to boredom; 4) *negative urgency*, defined as the tendency to act rashly in negative emotional states, and; 5) *positive urgency*, defined as the tendency to act rashly in positive emotional states (UPPS-P; Lynam et al., 2006; Whiteside and Lynam, 2001). Studies have shown that the UPPS-P impulsive traits share between 6% and 27% of their variance, with negative and positive urgency sharing the largest proportion of variance (Cyders and Smith, 2007).

In recent years, several meta-analyses have utilised the UPPS-P model when quantifying the association between trait impulsivity and adolescent risky behaviours, including alcohol use (Stautz and Cooper, 2013), marijuana use (VanderVeen et al., 2016) and risky sexual behaviours (Dir et al., 2014). For example, Stautz and Cooper (2013) meta-analysed 87 studies to examine the relationship between impulsivity and adolescent alcohol consumption and found that sensation seeking and positive urgency were most strongly associated with alcohol consumption, whereas positive and negative urgency showed the largest associations with alcohol dependence. Similar meta-analyses have been conducted using adult samples, with results demonstrating that the UPPS-P impulsive traits share distinct associations with nicotine dependence (Kale et al., 2018) and alcohol consumption (Coskunpinar et al., 2013). As such, utilising the UPPS-P model of impulsivity allows for clarification of discrete relationships that might otherwise be hidden when impulsivity constructs are combined (Smith et al., 2003).

Indeed, research has demonstrated that the UPPS-P traits share unique associations with adolescent smoking outcomes. Sensation seeking has been the most widely studied impulsivity-related trait and it has been shown to positively associate with cigarette consumption (Kraft and Rise, 1994; Pokhrel et al., 2010; Urbán and Urbán, 2010), status as a smoker (Tercyak and Audrain-McGovern, 2003; Thrasher et al., 2006) and the initiation of smoking (Spillane et al., 2012; Wellman et al., 2016). There is initial evidence that positive and negative urgency are associated with cigarette consumption (Balevich et al., 2013; Lee et al., 2015) and nicotine dependence (Ryan et al., 2013; Spillane et al., 2010), whereas lack of perseverance has been found to relate to cigarette consumption (Frankenberger, 2004; Pedersen et al., 1989), though with varying degrees of association, as well as smoking status (Balevich et al., 2013; Spillane et al., 2010). Lack of premeditation has been found to be strongly related to cigarette consumption in some studies (Cavalca et al., 2013; Reynolds et al., 2007), but weakly related in others (Leeman et al., 2014; White et al., 2011), and there is mixed evidence regarding its association with the severity of nicotine dependence (Ryan et al., 2013; Spillane et al., 2010). Such variations and inconsistencies in the relationships between impulsivity and adolescent cigarette smoking warrants a more comprehensive systematic review of current literature.

1.2. Present Study

The aim of the present study is to summarise and synthesise existent literature to determine the direction and magnitude of the relationship between each UPPS-P impulsive trait and both adolescent cigarette consumption and nicotine dependence. In addition, this review will investigate whether age, gender, ethnicity, and sample type moderate any relationships. To the best of our knowledge, this is the first meta-analysis to examine the association between the UPPS-P impulsive traits and adolescent cigarette smoking. It is our hope that improved understanding of the modifiable risk factors associated with adolescent cigarette consumption and nicotine dependence may enable the development of tailored prevention and intervention strategies, and ultimately, reduce the prevalence of smoking.

2. Materials and Methods

2.1. Study Design

We followed methods used by previous meta-analyses examining the association between adolescent risky behaviours and UPPS-P impulsive traits (Dir et al., 2014; Stautz and Cooper, 2013; VanderVeen et al., 2016). Relevant articles were identified following searches in PsycINFO, MEDLINE, CINAHL and Embase electronic databases to October 2018. Searches were conducted based on all keyword combinations of terms for *adolescence* (adolesc* OR youth OR teen*), *impulsivity* (impuls* OR disinhibit* OR premedit* OR “sensation seek*” OR “novelty seek*” OR “behavi* approach” OR “behavi* activation” OR BAS OR “reward sensitivity” OR “reward drive” OR “negative urgency” OR “positive urgency” OR perseverance OR (boredom N3 (prone* OR suscept*)) and *smoking-related behaviours* (cigarette* OR tobacco OR smok* OR nicotine). The reference sections of all included articles were also examined to identify further studies that could be included.

2.2. Inclusion and Exclusion Criteria

Studies included in the final meta-analysis met the following criteria: 1) published in a peer-review journal reporting on an original piece of research; 2) measured self-report impulsivity and cigarette consumption (and not any other forms of tobacco such as cigars, hookah, e-cigarettes etc.,) and/or severity of nicotine dependence; 3) included a sample of adolescents with a mean age between 10.0 and 19.9 years, a range of adolescence provided by the World Health Organisation (WHO, 2011) and; 4) published in English. Studies were excluded if they: 1) used a composite measure of substance use that combined cigarette and other drug use; 2) used a measure of impulsivity that was unable to be coded onto the UPPS-P model and; 3) were review studies, case studies, commentaries, systematic reviews or meta-analyses. Fig. 1 summarises the studies removed following application of each criterion according to PRISMA guidelines (Moher et al., 2009).

2.3. Study Selection

Following the removal of duplicate entries, one reviewer (JB) assessed all records. Twenty percent of title and abstracts were assessed by PS and 10% of full-text articles were assessed by MH. For 19 out of the 20 full-text articles (Cohen’s-kappa = 0.90), the reviewers

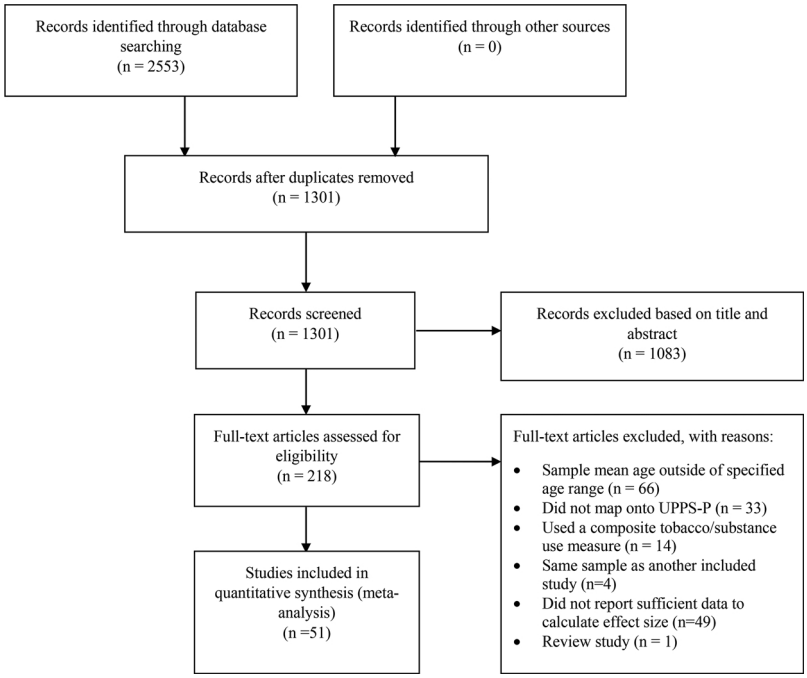

Fig. 1. PRISMA flowchart of articles included in the meta-analytic review.

independently agreed upon the appropriateness of each article for inclusion. Fifty-five studies did not include sufficient data to calculate effect sizes. For studies in the previous ten years, first authors were contacted with a request for data. A total of 35 authors were contacted and six provided the requested data. A total of 51 published studies were included and their data was extracted for the five separate meta-analyses.

2.4. Data Extraction and Effect Size Calculation

All studies were coded by the first author. Five randomly selected studies were coded by a second author (MH) to assess reliability. There was a 97% agreement between coders. The following information was extracted from each of the included studies: Author(s) and year of publication, study design (longitudinal or cross-sectional), sample size, sample type (normative, which included high school, university or community samples and non-normative, which included clinical or incarcerated samples), mean age of the sample (when the age range was reported and not the mean, the median value of the range was extracted), gender (percentage male), ethnicity (percentage Caucasian, as most studies reported samples of Caucasian ethnicity), trait impulsivity scale used and effect sizes reported.

Two variables were extracted from each study. The first was a measure of trait impulsivity and the second was a measure of cigarette use. The data extracted to measure trait impulsivity was categorised into one of the five relevant UPPS-P traits based on previous categorisation developed by Stautz and Cooper (2013) (see supplementary Table 1)[1]. The data extracted to measure cigarette use was the quantity, frequency or lifetime use of cigarettes consumed (i.e., consumption) and/or nicotine dependence.

The relationship between the UPPS-P impulsive traits and both cigarette consumption and nicotine dependence was Pearson's *r* correlation coefficient. Using this effect size permits our results to be compared with previous meta-analyses on this topic (Coskunpinar et al., 2013; Dir et al., 2014; Kale et al., 2018; Stautz and Cooper, 2013; VanderVeen et al., 2016). For studies that did not report a correlation, *r* was converted from Cohen's *d*, F, odds ratios using Comprehensive Meta-Analysis (CMA; Borenstein et al., 2005). Several studies provided more than one effect size for the association between the UPPS-P impulsive traits and cigarette consumption. In these cases, CMA was used to generate one effect size across all measures, ensuring each study contributed only one effect size to any one meta-analysis. Multiple effect sizes from longitudinal studies were averaged using CMA. Effect sizes were coded such that higher positive values indicated higher levels of trait impulsivity.

2.5. Meta-Analytic Procedure

Study level Pearson's *r* values were pooled, and an average value was computed using a random effects model. This model assumes that variability in effect sizes reflects both random error and true heterogeneity/non-random error (Borenstein et al., 2011). An alpha level of 0.05 was used for all statistical tests. The values of the *r* coefficients were interpreted according to Cohen's (1988) guidelines: Small (r = 0.10), Medium (r = .30) and Large (r = .50). Forrest plots were calculated to illustrate the heterogeneity of included studies in each meta-analysis (see Supplementary Figures 1–5)[1].

For all meta-analyses, the I^2 statistic was computed. The I^2 statistic measures, as a percent, the variability between effect studies that is due to true heterogeneity. I^2 values of 25%, 50% and 75% correspond to low, moderate and high levels of heterogeneity between effect sizes respectively (Higgins et al., 2003). When I^2 values exceeded 50%, meta-regression (Greenland, 1987) was conducted. Meta-regression examined whether participants' age, gender and ethnicity were significant predictors of the effect sizes. Sub-group analysis using CMA examined whether sample type (i.e., normative versus non-normative) moderated effect sizes. Publication bias was assessed by computing fail-safe N (FSN) analyses (presented in Table 2) and funnel plots (see Supplementary Figures 6–10)[1].

[1] Supplementary material can be found by accessing the online version of this paper at https://doi.org/10.1016/j.drugalcdep.2019.01.018.

Table 1
Studies included in the meta-analyses.

Study	*N*	Mean Age	Gender (% Male)	Ethnicity (%Caucasian)	Sample Type	Study Design	Smoking Measure	Impulsivity Measure	UPPS-P Trait	*r*
Audrain-McGovern et al. (2003)	1071	14.60	48	64.20	School	CS	C^{+}	TPQ-NS	SS	0.28
Baker and Yardley (2002)	420	15.50	46	65	School	CS	C*	SSS-T	SS	0.24
Balevich et al. (2013)	243	19.40	46.50		University	CS	C^{+}	SSS-TAS, BIS-NPMI	SS	0.15
									LPREM	0.17
								SSS-BS, SSS-DIS, BIS-A	LPERS	0.33
									NU	0.17
Capone and Wood (2008)	408	18.80	28.20	87.20	University	CS	C^{*+}	SSS-T	SS	0.15
Cavalca et al. (2013)	39	16.20	51.30		School	CS	C^{+}	BIS-T	LPREM	0.67
De Leo and Wulfert (2013)	498	19.20	46.40	63.20	University	CS	C*	I7-IMP	LPREM	0.22
Dinn et al. (2004)	23	18.60	28.70		University	CS	C^{+}	TPQ-NS, I7-VEN	SS	0.27
								I7-IMP	LPREM	0.27
Doran et al. (2011)	277	15.80	49	58	School	CS	C*	BIS/BAS FS	SS	0.07
Egan et al. (2017)	197	18.96	49.2	90.3	University	CS	C*	UPPS-P	SS	.178
									LPREM	.06
									LPERS	.08
									NU	.14
									PU	.05
Fields et al. (2009)	50	15.37	34		Community	CS	C^{+}	BIS-T	LPREM	0.27
Frankenberger (2004)	217	15.91	52	77	School	CS	C*	SSS-DIS, SSS-BS	SS	0.11
								SSS-TS	LPERS	0.20
Gerra et al. (2005)	210	16.86	57.14	100	School	CS	C*	TPQ-NS	SS	0.26
Hendershot et al. (2011)	124	16.01	55	10.6	Criminal	CS	C^{+}	BSSS	SS	0.30
Hertel and Mermelstein (2012)	1030	15.60	43.40	56.5	Community	CS	ND	TPQ-NS	SS	0.11
Hwang and Park (2015)	915		52	0	School	CS	C*	SSS –DIS, SSS-BS	SS	0.10
								SSS-TS	LPERS	0.15
Janssen et al. (2015)	284	14.80	31.30		Community	L	C^{+}	SURPS-SS	SS	0.21
								SURPS-IMP	LPREM	0.17
Kong et al. (2013)	3068	15.50	39.20	75	School	CS	C*	ZKPQ-IMP	SS	0.05
								ZKPQ-SS	LPREM	0.04
Kraft and Rise (1994)	1841	18	53.80		Community	CS	C*	SSS	SS	0.17
Kuo et al. (2002)	905	14.10	49.40	0	School	CS	C*	TPQ-NS	SS	0.31
Laucht et al. (2005)	53	14.90	47.50		Clinical	CS	C^{*+}	JCTI-NS	SS	0.26
Lee et al. (2015)	500	18.49	48	82.80	University	CS	C*	UPPS-P	SS	0.12
									LPREM	0.22
									LPERS	0.13
									NU	0.22
									PU	0.20
Leeman et al. (2014)	3106	15.86	45.40	76.60	School	CS	C^{+}	ZKPQ-SS	SS	0.03
								ZKPQ-IMP	LPREM	0.04
Lewis et al. (2015)	42	16.32	52	93		CS	C^{+}	BIS-T	LPREM	0.41
Lynskey et al. (1998)	913	16.50			Community	L	C*	TPQ-NS	SS	0.28
Malmberg et al. (2010)	3783	13.01	49.10		School	CS	C*	SURPS-SS	SS	0.18
								SURPS-IMP	LPREM	0.18
Martin et al. (2002)	208	12.80	61.10	71.40	Clinical	CS	C^{+}	SSS-C	SS	0.35
Melanko et al. (2009)	75	15.80	38.60	41	Community	CS	C^{+}	BIS-T	LPREM	0.21
Morean et al. (2015)	64	16.36	46.90	90.60	School	CS	C^{+}	BIS-T	LPREM	0.22
Pang et al. (2014)	57	14.5	48.70	24.10	School	CS	C*	UPPS-P	NU	0.04
Pedersen et al. (1989)	967	17.50	49		Community	CS	C^{+}	SSS-DIS	LPERS	0.31
Peterson and Smith (2017)	1897	10.33		60.9	School	L	C*	UPPS-P-SS	SS	.10
Pokhrel et al. (2014)	821	16.26	60	12.60	School	L	C*	ZKPQ-SS	SS	0.18
								ZKPQ-IMP	LPREM	0.09
Pokhrel et al. (2010)	S1 130	S1 15.70	S1 45%	S1 31 S2 0	School	CS	C*	ZKPQ-SS	SS	0.23
	S2 155	S2 15.10	S2 51%						SS	0.08
Reynolds and Fields (2012)	141	15.37	34	44	Community	CS	C^{+}	BIS-T	LPREM	0.11
Reynolds et al. (2007)	51	15.15	49.01	58.50	Community	CS	C^{+}	BIS-T	LPREM	0.61
Robbins and Bryan (2004)	300	15.30	73	23	Criminal	CS	C^{+}	ZKPQ-IMP	LPREM	0.14
Romer et al. (2009)	387	11.40	49	63	School	CS	C*	SSS	SS	0.10
								I7-IMP	LPREM	0.20
Ryan et al. (2013)	107	18.90	57.90	83	Community	CS	C^{+}	BIS-AI	LPREM	0.05
								BIS-NPMI	NU	0.13
Ryan et al. (2013)	107	18.90	57.90	83	Community	CS	ND	BIS-AI	NU	0.29
								BIS-NPMI	LPREM	0.17
Saletti et al.(2017)	1022	15.19	52.1		School	CS	C*	BSSS	SS	0.12
Schmid et al. (2007)	139	14.90	48.16		Community	CS	C*	JTCI-NS	SS	0.29
Simon et al. (1994)	101	17	46.50	48.50	School	CS	C*	ZKPQ-SS	SS	0.26
Spillane et al. (2010)	226	19	41.22		University	CS	C^{+}	UPPS-P	SS	0.21
									LPREM	0.22
									LPERS	0.16
									NU	0.21
									PU	0.21
Tercyak and Audrain-McGovern (2003)	449	15.60	52	65	School	CS	C^{+}	TCI-NS	SS	0.33

(*continued on next page*)

Table 1 (*continued*)

Study	*N*	Mean Age	Gender (% Male)	Ethnicity (%Caucasian)	Sample Type	Study Design	Smoking Measure	Impulsivity Measure	UPPS-P Trait	*r*
Urban (2010)	2565	15.3	48.77		School	CS	C^{+}	BSSS	SS	0.51
van de Venne et al. (2006)	113	14	41.50	75.20	Community	CS	C*	SSS-C	SS	0.31
Von Knorring and Oreland (1985)	1129	18.50	100		Community	CS	C*	SSS, KPI-SS	SS	0.16
								KPI-IMP	LPREM	0.23
Weckler et al. (2017)	199	16.27	39.70		School	CS	C^{+}	BIS-T	LPREM	0.11
White et al. (2011)	47	19.44	53.03	85.60	University	CS	C^{+}	BIS-T	LPREM	0.01
Williams (1973)	105		52.10		School	CS	C*	JPRF	LPREM	0.24
Wills et al. (2015)	1373	14.6	47	17	School	CS	C*	BSSS	SS	0.15
Wood et al. (1995)	1179	17.2	45		School	CS	C*	SSS	SS	0.27
								CPI	LPREM	0.28

Notes. N = sample size; C = consumption; ND = nicotine dependence; Q = ; F = frequency of cigarette use; LU = lifetime use; CS = cross sectional; r = r value prior to transformation; L = longitudinal; SS = sensation seeking; LPREM = lack of premeditation; LPERS = lack of perseverance; NU = negative urgency; PU = positive urgency; BIS-NPMI = Barratt Impulsivity Scale – Nonplanning and Motor Impulsivity; BIS-A = Barratt Impulsivity Scale –Attentional; BIS-T = Barratt Impulsivity Scale –Total score; I7-IMP = I-7 Impulsiveness; I7-VEN = I-7 Venturesomeness; UPPS-P-SS = UPPS-P – Sensation Seeking Scale; JPRF = Jackson Personality Research Form; ZKPQ-Imp = Zuckerman-Kuhlman Personality Questionnaire; ZKPQ-SS = Zuckerman-Kuhlman Personality Questionnaire; CPI = California Psychological Inventory; TPQ-NS = TPQ–Novelty Seeking; BSSS = brief sensation seeking scale; SSS-T = Sensation Seeking Scale – Total score; SSS-BS = Sensation Seeking Scale – Boredom Susceptibility; SSS-DIS = Sensation Seeking Scale – Disinhibition; SSS-TAS = Sensation Seeking Scale – Thrill and Adventure Seeking; SSS-S = Sensation Seeking Scale – Children; BIS/BAS FS = BIS/BAS Scales–Fun Seeking; SURPS-SS = Substance Use Risk Profile Scale– Sensation seeking; SURPS-IMP = Substance Use Risk Profile Scale– Impulsivity; ZKPQ-IMP = Zuckerman – Kuhlman Personality Questionnaire – Impulsivity ; ZKPQ-SS = Zuckerman – Kuhlman Personality Questionnaire – Sensation Seeking; JCTI-NS = JCTI-Novelty Seeking; KPI-SS = Karolinska Scales of Personality – Sensation Seeking; KPI-IMP = Karolinska Scales of Personality – Impulsivity; $^{+}$ = quantity of cigarette use; * = frequency of cigarette use; $^{+*}$ quantity and frequency combined.

3. Results

3.1. Study Characteristics

A total of 51 studies, published between 1973 and 2017, were eligible for inclusion (see Table 1). The mean sample size was 645 (*SD* = 866.03; range 23–3783), and the mean age was 16.05 (*SD* = 2.00; range 10.30–19.44). On average, samples were 48.59% male (*SD* = 11.04, range 28.20–100), and 55.70% Caucasian (*SD* = 29.75; range 0–100). The majority of samples were from high school (*n* = 25, 49%), followed by community (*n* = 14, 28%), university (*n* = 8, 16%), clinical (*n* = 2, 4%) and incarcerated (*n* = 2, 4%), and most studies used a cross-sectional design (*n* = 48, 94%).

3.2. Meta-Analysis

3.2.1. The Relationship between UPPS-P Impulsive Traits and Adolescent Cigarette Consumption

Five meta-analyses examined the association between the UPPS-P impulsive traits and adolescent cigarette consumption (see Table 2). Results from all meta-analyses showed impulsive traits to be significantly correlated with adolescent cigarette consumption. In each, the magnitude of the correlation can be considered small according to Cohen's (1988) guidelines. All five meta-analyses showed similar weighted correlations, ranging between $r = 0.17$ and $r = 0.20$. FSN analyses revealed that the significant results observed in each meta-analysis is unlikely to be due to missed publications. The smallest number of missed studies was 23 and this was more than seven times the number studies found (i.e., for positive urgency). Funnel plots indicated that publication bias is unlikely to have influenced the results (see Supplementary Figures 6–10)[1]. Calculation of the I^2 statistic indicated that the percentage of true heterogeneity between effect sizes was high for sensation seeking and lack of premeditation. For lack of perseverance and positive urgency the I^2 value was moderate (see Table 2).

3.2.2. The Relationship between UPPS-P Impulsive Traits and Adolescent Nicotine Dependence

Only two studies provided effect sizes for the association between the UPPS-P impulsive traits and adolescent nicotine dependence and therefore, meta-analyses could not be conducted. Bivariate correlations are presented in Table 1.

3.2.3. Moderator Analysis

Moderator analyses examined systematic influences for the association between cigarette consumption, and sensation seeking, lack of

Table 2
Meta-analyses for each UPPS-P impulsive trait and adolescent cigarette consumption.

	k	N	*r*	CI	Z	I^2 (%)	Q	FSN
Lack of premeditation	25	16,364	0.18	0.14-0.23	8.37**	92.39	314.52**	2570
Lack of perseverance	7	2619	0.19	0.12-0.25	5.57**	63.87	16.61*	150
Sensation seeking	37	30,746	0.20	0.16-0.24	9.63**	96.30	973.58**	1345
Negative urgency	6	1330	0.19[a]	0.14-0.24	7.87**	0.00	3.12	59
Positive urgency	3	923	0.17	0.08-0.25	3.73**	49.17	3.94	23

Notes. k = number of studies; N = aggregate sample size; r = weighted correlation; CI = 95% confidence interval; I^2 = percentage of true heterogeneity; Q = heterogeneity statistic; FSN = fail-safe-N; [a]Since I^2 was 0% for this meta-analysis, a fixed effects model will yield the same weighted average as a random effects model.

* = $p < .05$.

** = $p < .001$.

premeditation and lack of perseverance.

Meta-regression was used to assess the potential moderating effects of the continuous variables of age, gender and ethnicity (%Caucasian). No significant moderating effects were found for any of the continuous variables on the relationship between each UPPS-P impulsive trait and adolescent cigarette consumption. Following, sample type (i.e., normative vs non-normative) was considered as a potential categorical moderating variable. Similarly, no significant moderating effects were found for sample type on the relationship between each UPPS-P impulsive trait and adolescent cigarette consumption.

4. Discussion

A systematic review of relevant research literature was conducted to determine the strength and nature of the relationship between the UPPS-P impulsive traits and both adolescent cigarette consumption and nicotine dependence. Results from a review of 51 studies, comprising over 50,000 participants, found that adolescent cigarette consumption was positively related to impulsivity. Specifically, five separate meta-analyses demonstrated that each UPPS-P impulsive trait shared a small, positive association with cigarette consumption. Meta-analyses for the association between adolescent nicotine dependence and the UPPS-P impulsive traits could not be conducted as there were an insufficient number of studies.

The vast majority of included studies analysed the association between sensation seeking and lack of premeditation with cigarette consumption, whereas far less studies examined the lack of perseverance and urgency traits. Although sensation seeking yielded the largest association with cigarette consumption, and positive urgency the smallest, all associations were in the small range, with little variation between them (*r's* ranging from .17 to .20), indicating that each UPPS-P impulsive trait plays an important role in adolescent cigarette consumption. Unfortunately, only two studies fulfilled criteria in relation to the association between adolescent nicotine dependence and the UPPS-P impulsive traits and hence, meta-analyses could not be conducted. This is surprising given the large number of adult smoking studies which measure nicotine dependence. For instance, a recent meta-analysis of over 50 studies using adult samples found that positive and negative urgency yielded stronger associations with nicotine dependence compared to other UPPS-P impulsive traits (Kale et al., 2018). Findings from the present review highlight the need for future research to incorporate measures of nicotine dependence when examining the relationship between impulsivity and adolescent smoking. This will clarify the nature of the relationship between impulsivity and adolescent nicotine dependence, and also, highlight whether distinct impulsive traits contribute to the transition from casual cigarette consumption towards more problematic tobacco-use disorders. Lastly, moderator analyses were conducted to determine if any methodological characteristics moderated study level effect sizes. Consistent with previous meta-analyses that have examined the relationship between the UPPS-P impulsive traits and risky health behaviours (Kale et al., 2018; VanderVeen et al., 2016), age, gender, ethnicity or sample type were not found to moderate the association between impulsive traits and cigarette consumption.

4.1. Implications

Historically, impulsivity has been perceived as a stable trait characteristic not amenable to change; however, over the past decade, it has become increasingly clear that impulsive characteristics can be modified in treatment (Hershberger et al., 2017; Staiger et al., 2007). As such, findings from the present meta-analysis highlight the need to focus research efforts on the development of novel prevention and intervention strategies that target the UPPS-P impulsive traits in adolescents. Indeed, several studies have demonstrated that interventions which specifically target sensation seeking have resulted in significant reductions in adolescent alcohol consumption and binge drinking (Conrod et al., 2011, 2006) and have even delayed the onset of alcohol consumption by up to six-months (Conrod et al., 2008). Such interventions are sorely needed for adolescent smokers given that nicotine dependence can develop rapidly and at low levels of cigarette consumption (DiFranza et al., 2000; Rose et al., 2010) and we suggest that school-based intervention programs provide an ideal window of opportunity to implement and examine such strategies. Additionally, public media campaigns that have been tailored towards high sensation seeking individuals have been shown to be effective at reducing cannabis use (Palmgreen et al., 2001) and similar personality targeted communications that focus on adolescent cigarette use may be an effective public health strategy.

Importantly, this review proposes that prevention and intervention strategies should strive to incorporate all of the UPPS-P impulsive traits as they appear to share similar, positive associations with adolescent cigarette consumption. This multidimensional approach may result in enhanced treatment outcomes and reduce the economic and health burden related to adolescent cigarette consumption. For instance, the urgency traits, which are more affect driven, may benefit from interventions such as mindfulness (Robinson et al., 2014) or emotion regulation skills (Sloan et al., 2018), whereas lack of premeditation, which is more automatic, may benefit from computerised cognitive training tasks such as cognitive bias modification (see Wiers et al., 2013) and impulse control training. Indeed, in recent years, impulse control training has emerged as a potentially efficacious intervention to reduce unhealthy behaviours such as risky alcohol consumption (e.g., Houben et al., 2011; Jones and Field, 2013) and the consumption of unhealthy foods (e.g., Houben and Jansen, 2015; Lawrence et al., 2015). This computer-based training program involves repeatedly pairing target stimuli (i.e., alcohol or unhealthy food) with the requirement to exercise impulse control. At present, the efficacy of smoking-related impulse control training is being evaluated (Staiger et al., 2018), and, if found to be effective, could be offered as a standalone treatment, or as an adjunct to existing treatments for impulsive adolescents. Such interventions could feasibility be incorporated into school substance misuse prevention programs and/or delivered to at-risk adolescents.

4.2. Limitations and Future Research

Although this is the first study to examine the association between the UPPS-P impulsive traits and adolescent cigarette consumption and nicotine dependence, it has several limitations that are typically experienced with meta-analyses. First, it is recognised that data that could not be obtained from authors could have produced different results than that reported; however, we also see this as a limitation of the literature in general. There is a trend towards the online publication of data (Costello, 2009; Lawrence et al., 2011) and, future research should aim to provide correlation matrices of all variables analysed. Second, there was substantial heterogeneity across studies, and, although a random effects model was used, and demographic and methodological variables were examined as potential moderators, it is likely that there are other sources of unexplained variance. Third, most of the included studies were from non-clinical populations which limits the generalisability of these findings to clinical populations. Additionally, all data pertaining to cigarette consumption was self-reported, and while generally considered reliable, a lack of biochemical verification may have limited the accuracy of data (Gorber et al., 2009). Lastly, only three studies were included in the meta-analysis for positive urgency which limits our ability to draw conclusions regarding this impulsive trait. Future research may consider utilising the UPPS-P model when assessing impulsivity and adolescent cigarette use.

4.3. Conclusion

This study was the first to synthesise existing research to examine

the relationship between the UPPS-P impulsive traits and both adolescent cigarette consumption and nicotine dependence. Results from a review of 51 studies demonstrated that each of the five UPPS-P impulsive traits are positively associated with adolescent cigarette consumption; however, additional research is needed to determine the association between the UPPS-P impulsive traits and adolescent nicotine dependence. Findings may help to inform novel prevention and intervention strategies that target these impulsive traits.

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Contributors

JB and PS conceptualised and designed the study. JB, MH and PS completed data acquisition and JL supervised data analysis. All authors contributed to and have approved the final manuscript. Contribution is indicated by order of authors except for the last author who was the senior author.

Conflicts of interest

No conflict declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2019.01.018.

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