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Impulsivity: Four ways five factors are not basic to addiction

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HIGHLIGHTS

- Impulsivity is multifaceted, but debate continues as to the precise number of facets.
- Situation resembles debate between H. J. Eysenck and Costa & McCrae concerning personality structure.
- Strong evidence for unique role of two factors of impulsivity in addictive behavior, weak evidence for five factors
- Two-factor impulsivity models, anchored in biological processes, show remarkable consistency across domains.
- Consideration of biological evidence provides a necessary constraint on theory development.

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ABSTRACT

Several impulsivity-related models have been applied to understanding the vulnerability to addiction. While there is a growing consensus that impulsivity is multifaceted, debate continues as to the precise number of facets and, more critically, which are most relevant to explaining the addiction-risk profile. In many ways, the current debate mirrors that which took place in the personality literature in the early 1990s (e.g., Eysenck's 'Big Three' versus Costa and McCrae's 'Big Five'). Indeed, many elements of this debate are relevant to the current discussion of the role of impulsivity in addictive behavior. Specifically, 1) the use of factor analysis as an atheoretical 'truth-grinding machine'; 2) whether additional facets add explanatory power over fewer; 3) the delineation of specific neurocognitive pathways from each facet to addictive behaviors, and; 4) the relative merit of 'top-down' versus 'bottom-up' approaches to the understanding of impulsivity. Ultimately, the utility of any model of impulsivity and addiction lies in its heuristic value and ability to integrate evidence from different levels of analysis. Here, we make the case that theoretically-driven, bottom-up models proposing two factors deliver the optimal balance of explanatory power, parsimony, and integration of evidence.

1. Introduction

Impulsivity, whether measured by self-report, observer-report, or behavioral performance, is a robust predictor of current and future problems with substance use (Dawe & Loxton, 2004; Jentsch & Taylor, 1999; Moeller et al., 2001; Moffitt et al., 2011; Nigg et al., 2006; Potenza, 2013; Tarter et al., 2003). In children, its association with future substance use remains even after controlling for other markers of risk, including low IQ, socioeconomic status, and parental history of substance dependence (Moffitt et al., 2011; Nigg et al., 2006; Tarter et al., 2003). Not surprisingly, the construct is of great interest to addiction scientists.

In addiction science, there is an emerging consensus that impulsive drug use involves two core processes observable at the neurophysiological, behavioral, cognitive, and trait levels. The first involves a heightened propensity, or impulse, to approach drugs and the second involves a reduced capacity to inhibit this approach behavior. The summary presented in Table 1 highlights the considerable overlap of different theoretical models in the importance placed on these two fundamental processes. Notably, these models have been derived from multiple researchers across diverse methodological investigations.

While a two-factor model is attractive in its parsimony, other researchers have proposed that a more useful way to consider impulsivity is to develop a more nuanced delineation of subtypes. This would have important implications for addiction science. In an attempt to "bring order to the myriad of measures and conceptions of impulsivity", Whiteside and Lynam (2001, p. 684) drew upon the Five Factor Model of human personality (Costa & McCrae, 1992; Goldberg, 1993) as a framework for conceptualizing impulsivity. Employing factor analysis of self-report data, they constructed the four-factor UPPS impulsivity questionnaire consisting of: *U*rgency, (lack of) *P*remeditation, (lack of) *P*erseverance, and *S*ensation seeking. Subsequently, Cyders et al. (2007) argued that the UPPS model was incomplete, in that it did not

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Table 1
Distinct components of impulsive substance use.

Domain	↑ Approach impulse	↓ Inhibitory control
Personality		
Dawe and Loxton (2004)	Reward Sensitivity/Drive	Rash Impulsiveness
Steinberg (2008)	Sensation Seeking	Impulsivity
Woicik, Stewart, Pihl, and Conrod (2009)	Sensation Seeking	Impulsivity
Depue and Collins (1999)	(Agentic) Extraversion	(Low) Constraint
Behavior		
Wiers et al. (2007)	Appetitive Motivation	(Poor) Self-regulation
de Wit and Richards (2004)	Delay Discounting	Motor (Dis)inhibition
Bari and Robbins (2013)	Impulsive Choice	Impulsive Action
Swann, Bjork, Moeller, and Dougherty (2002)	Reward-delay Impulsivity	Rapid-response Impulsivity
Goldstein and Volkow (2002)	(Impaired) Salience Attribution	(Impaired) Response Inhibition
Potenza and Taylor (2009)	Choice Impulsivity	Response Impulsivity
Neurophysiology		
Bechara (2005)	Impulsive System (striatum, amygdala)	Reflective Prefrontal Cortex System (VMPFC, DLPFC, ACC, insula)
Jentsch and Taylor (1999)	Limbic System (NAcc, VTA, amygdala)	Frontal Cortical System
Bickel et al. (2007)	Impulsive System (NAcc, ventral pallidum, amygdala)	Executive System (PFC, VMPFC)

Note. VMPFC = ventromedial prefrontal cortex, DLPFC = dorsolateral prefrontal cortex, ACC = anterior cingulate cortex, NAcc = nucleus accumbens, VTA = ventral tegmental area, PFC = prefrontal cortex.

incorporate impulsive behavior arising from positive mood states. They proposed that individual differences in this tendency were important to consider in understanding risky behavior such as alcohol abuse, and used factor analysis to derive an additional scale to measure the construct. Thus, the Urgency subscale was renamed Negative Urgency and a new scale added, Positive Urgency. We refer to this extended model as the UPPS + P model.

Notably, UPPS Sensation Seeking and (lack of) Premeditation align somewhat with the core processes previously implicated in impulsive substance use, and impulsivity theories more generally (Table 1). However, as the authors themselves note, "(lack of) perseverance, like urgency, is not well represented in other measures of impulsivity" (Whiteside & Lynam, 2001, p. 685C). The same could be said of Positive Urgency (Cyders et al., 2007). In debating the importance of these newly constructed impulsivity traits, the field finds itself in a situation strikingly similar to that which took place in the personality literature, in particular, the debate between Costa and McCrae (1992) and Eysenck (1992). In a paper entitled "*Four ways five factors are basic*", Costa and McCrae outlined four lines of evidence to support the five-factor model of personality. This was followed by Eysenck's reply entitled, "*Four ways five factors are not basic*", in which he argued against each of the proposed lines of evidence. Eysenck concluded with a strong call for a science of personality based on theoretical predictions firmly rooted in biological processes.

Many of the issues raised during the personality debate are relevant for addiction researchers studying impulsivity. Specifically, 1) the use of factor analysis as an atheoretical 'truth-grinding' machine; 2) whether additional facets of a construct add explanatory power over fewer; 3) the delineation of specific neurocognitive pathways from each facet to addictive behavior, and; 4) the relative merit of 'top-down' versus 'bottom-up' approaches to the understanding of impulsivity and the integration of experimental evidence. Each of these issues will be discussed, in turn, with reference to current research into impulsivity and substance abuse. While the proceeding discussion focuses on the UPPS + P model, the issues raised apply equally to any top-down theory of impulsivity driven largely by self-report questionnaire data. It is hoped that this critical review of the literature will stimulate further refinements to the understanding of impulsivity and highlight the importance of theoretical integration across fields.

2. Factor analysis is not a 'truth-grinding' machine

The UPPS and UPPS + P are models of impulsivity borne of factor analysis. Using this statistical technique, Whiteside and Lynam (2001) set out to distil the numerous conceptualizations of impulsivity into core facets common across measures. The Five Factor Model of personality, itself a product of factor analysis, was used as the framework within which to 'anchor' these facets within personality more broadly. It should be noted, however, that only three of the Big Five were included as anchors, those considered by the authors as most relevant to impulsivity (Extraversion, Neuroticism, and Conscientiousness). While factor analysis is an extraordinarily useful method of data reduction, it possesses significant shortcomings that limit its value in theory construction (Block, 1995; Eysenck, 1992).

One important limitation to factor analysis is its vulnerability to 'prestructuring' (Block, 1995). That is, that the number and nature of the factors derived depend on the variables included in the factor analysis. This can occur regardless of whether the selection was guided by theory or practical constraints. There is clear evidence of prestructuring in the construction of the UPPS and UPPS + P. After developing the UPPS scales, Whiteside and Lynam (2001, Table 7, p. 684) conducted another factor analysis and found that the new UPPS Urgency scale loaded with all NEO-PI-R Neuroticism subscales, the UPPS Sensation Seeking scale loaded with all NEO-PI-R Extraversion subscales, and both UPPS (Lack of) Premeditation and UPPS (Lack of) Perseverance scales loaded together with all NEO-PI-R Conscientiousness subscales. That is, the four new UPPS scales loaded onto the three factors initially taken from the Big Five and used as anchors. This same three-factor structure was later replicated by Smith et al. (2007). Thus, the inclusion of the three Big Five 'anchor' traits might have prestructured the UPPS. This could explain why the UPPS factor structure differed from previous factor analytic studies of impulsivity that typically found a two-factor structure (for a review, see Dawe & Loxton, 2004), and why Positive Urgency was 'missed' (Cyders et al., 2007).

A further shortcoming of the factor analytic approach is that there is no unequivocal basis for deciding on the number of factors to extract from the data or on the best approach to rotating them for interpretation (Block, 1995). The history of personality psychology provides a clear example of this. Costa and McCrae (1992) argued for their Big Five traits of Extraversion, Neuroticism, Openness to Experience, Conscientiousness, and Agreeableness as forming the basic structure of personality. By contrast, Eysenck argued the case for his Big Three traits of Extraversion, Neuroticism, and Psychoticism. The first two traits in each model are closely aligned. However, Eysenck (1992) argued that Agreeableness and Conscientiousness were too closely related to be considered distinct, and considered them to be subcomponents of his higher-order Psychoticism trait. However, he made the point that the subjectivity of factor analysis is such that there was no psychometric reason for preferring his conceptualization of these traits to any other. How high a correlation is too high for a given pair of variables to be