Personality and Individual Differences 135 (2018) 67–79

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Review

Behavioral measures of state impulsivity and their psychometric properties: A systematic review☆

Rebecca Nguyen[a], Michael Brooks[a], Raimondo Bruno[a,b], Amy Peacock[a,b,*]

[a] National Drug and Alcohol Research Centre, University of New South Wales, Sydney, 22-32 King Street, Randwick 2031, Australia
[b] School of Psychology, University of Tasmania, Private Bag 30, Hobart, Tasmania 7004, Australia

ARTICLE INFO

Keywords:
Impulsivity
Measurement
Instruments
Psychometrics
Systematic review
Response inhibition
Behavioral disinhibition

ABSTRACT

Aims: Various behavioral impulsivity measures have been developed, yet there has been no recent synthesis and evaluation of available tools. Key to consider is the context for assessment, and whether they can be delivered outside of the laboratory. The aim of this review was to identify and appraise behavioral impulsivity measures, with a secondary objective of identifying measures suitable for real-world delivery (independent of researcher administration).

Methods: PsycINFO, Embase, Medline and PsycTESTS databases were searched for articles published from 1997 using a behavioral impulsivity measure suitable for adults (PROSPERO: CRD42017057784). Measures assessing response disinhibition, impulsive response initiation, and/or impulsive decision-making were identified, delivery method assessed, and searches undertaken for psychometric properties of tasks.

Results: Twenty four behavioral impulsivity measures were identified; evidence of adequate reliability and validity was reported for only eight measures. Only six measures did not require computer facilities. Two measures were suitable for pen-and-paper delivery, the Monetary Choice Questionnaire and Probabilistic Discounting Task, both of which index impulsive decision-making.

Conclusions: Further validation of impulsivity measures is necessary to assist researchers in choosing an appropriate measure for their research setting. Development of behavioral impulsivity measures which can be delivered outside of the laboratory context is a key priority.

1. Introduction

In recent decades, there has been growing interest in the construct of impulsivity. Impulsivity has been implicated in several psychiatric disorders including borderline personality disorder, attention-deficit hyperactivity disorder (ADHD), problem gambling (Dougherty, Bjork, Huckabee, Moeller, & Swann, 1999; Epstein et al., 2003; Verdejo-García, Lawrence, & Clark, 2008), and substance use (Field, Christiansen, Cole, & Goudie, 2007; Fillmore & Rush, 2002; Mitchell, 1999; Smith, Mattick, Jamadar, & Iredale, 2014). Despite this, there remains a general lack of consensus in defining impulsivity, which remains broadly understood as a predisposition to act without proper consideration of, or sensitivity to, the possible negative consequences (Reynolds, Ortengren, Richards, & de Wit, 2006). *Trait impulsivity* refers to the enduring personality characteristic of the individual, which remains relatively stable over time, and works in concert with other cognitive patterns to influence day-to-day activities in a relatively consistent manner (DeYoung, 2011). In contrast, *state impulsivity* refers to variable, momentary responses to contextual intrinsic and extrinsic triggers (Bari, Robbins, & Dalley, 2011; de Wit, 2009; Wingrove & Bond, 1997), and comprises the focus of this paper.

State impulsivity is widely considered as a multifaceted construct, including *impulsive decision-making*, denoted by a preference for immediate over delayed rewards, and *behavioral disinhibition*, defined as an inability to inhibit pre-potent responses (Lane, Cherek, Rhoades, Pietras, & Tcheremissine, 2003; Reynolds et al., 2006; Swann, Bjork, Moeller, & Dougherty, 2002). More recently, *impulsive response initiation* (the inability to concentrate exclusively on the task at hand) has also been suggested as a third aspect of behavioral impulsivity (de Wit, 2009). Such categorization is essential, as the different domains are likely influenced by independent neural mechanisms or genetic processes (Meda et al., 2009). Specifically, the interaction between the inferior frontal cortex and pre-supplemental motor area has been suggested to be implicated in response inhibition. In contrast, delay discounting, a component of impulsive decision-making, has been associated with multiple neural networks, including a ventral cortico-

☆ Declarations of interest: None.

* Corresponding author at: National Drug and Alcohol Research Centre, University of New South Wales, Randwick, 2052, New South Wales, Australia.
E-mail address: Amy.Peacock@unsw.edu.au (A. Peacock).

https://doi.org/10.1016/j.paid.2018.06.040
Received 24 April 2018; Received in revised form 20 June 2018; Accepted 21 June 2018

striatal network, a lateral prefrontal-cingulate network, and a medial temporal-hippocampus network (Bari & Robbins, 2013). Indeed, several studies using behavioral measures of impulsivity have similarly shown poor congruence between these domains, suggesting poor construct validity of the measures used, or that these domains are separate components within impulsivity (Lane et al., 2003; Reynolds, Penfold, & Patak, 2008).

State impulsivity is generally assessed via an array of behavioral tasks which induce immediate actions and decisions (Dick et al., 2010). These measures can index changes in state impulsivity over time and in different contexts, and may be adapted for animal research to investigate underlying biochemistry (e.g. Fineberg et al., 2010; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Furthermore, such measures are objective, avoiding issues of social desirability bias and poor reflective insight into one's own actions as faced by self-report questionnaires (Cyders & Coskunpinar, 2011). Despite this, behavioral measures may not necessarily reflect normal day-to-day impulsive actions, as they examine the pure attribute removed from social and emotional contexts.

Further, behavioral measures often require dedicated computer programs, mainly for tasks assessing impulsive response initiation or disinhibition, where response latency is essential to measure. These instruments are therefore more labor and resource intensive (compared to pen-and-paper tasks), and are often confined to use in laboratories, or in the presence of an experimenter. Yet, variations in state impulsivity in response to internal and external stimuli may necessitate in situ measurement (e.g. measuring the effects of alcohol intoxication, recreational drug use, or changes in affect on state impulsivity within real-world environments), and administration via online survey platforms (i.e., independent of direct researcher manipulation).

There has been no recent synthesis and evaluation of measures of behavioral impulsivity. This review was undertaken with the aim of systematically identifying measures of state impulsivity and, in turn, evaluating their psychometric properties (reliability and validity). A secondary aim was to scrutinize their method of delivery to determine tools which may be used in real-world settings (i.e., outside of the laboratory and free of experimenter manipulation).

2. Method

2.1. Search strategy

Systematic searches of Medline, Embase, PsycINFO, and PsycTESTs were conducted using search terms relating to impulsivity and measurement tools combined using the 'AND' function (*see Appendix A*). The search was limited to English-language articles published from January 1997 to March 2017, to identify behavioral measures of impulsivity currently in use. Details of the protocol for the systematic review were registered on PROSPERO (Nguyen, Peacock, Bruno, & Brooks, 2017), and reporting is in accordance with PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman, & Prisma Group, 2009; see Appendix B).

2.2. Inclusion/exclusion criteria

Behavioral measures of impulsivity were included if they were deemed suitable for human adults, and assessed one of the three domains of state impulsivity. *Impulsive response initiation tasks* were defined as those assessing resistance to irrelevant, distractor information to the task; *response disinhibition tasks* were defined as those assessing inability to stop pre-potent responses; and *impulsive decision-making tasks* were defined as those measuring a preference for immediate rewards over larger, delayed rewards.

Measures were excluded if they assessed risk-taking, whereby the individual must weigh up the likelihood of a response with an unknown probability of providing a reinforcing or aversive outcome, as the outcome is dependent on their decision. This contrasts with impulsivity measures, which either assess quick responding or do not allow for careful deliberation (as with impulsive response initiation and response disinhibition tasks), or have a known probability of reinforcing and aversive outcomes (as with impulsive decision-making tasks) (Kreek, Nielsen, Butelman, & LaForge, 2005). Any tasks measuring impulsive inattention with retroactive interference were also excluded, as they are typically used to assess short-term memory (Eakin & Smith, 2012), and thus performance likely reflects memory as opposed to impulsivity.

2.3. Identification of measures

Search results were stored in an Endnote version X8 library and were screened using the Covidence platform (Veritas Health Innovation, 2017). RN screened all studies identified through preliminary searches by their titles and abstracts. All studies potentially using a human, behavioral measure of impulsivity were included in the next stage of screening, where the full-text of included papers were assessed and the names of any behavioral impulsivity measures recorded. The list of measures was then independently reviewed by AP and RB to determine adherence to inclusion criteria for the review. Discrepancies were resolved through discussion with RN.

After the list of included measures was finalized, the studies detailing scale development were obtained, and the names of the measures re-entered into the above databases to identify validation and reliability studies; while some measures have been previously used to assess more than one domain of impulsivity, data were only extracted regarding the predominant domain assessed for each task. Relevant articles were identified and data extracted into Microsoft Excel by RN and checked by AP. Psychometric properties detailed in the original studies for these measures were included in preference to later validation efforts.

2.4. Psychometrics

While there are a number of components of validity and reliability that can be assessed, this paper focused on the following psychometric properties in appraising the impulsivity measures.

2.4.1. Test-retest reliability

The test-retest reliability of a measure represents the consistency of scores between two sessions ideally conducted under similar conditions (Terwee et al., 2007). Test-retest reliability is typically assessed with a coefficient ranging from -1 (perfect negative correlation) to 1 (perfect positive correlation). Measures with high test-retest reliability (correlation ≥ 0.70) are favored, as they are more sensitive to changes in state impulsivity (Terwee et al., 2007).

2.4.2. Construct validity

Construct validity refers to the ability of the instrument to measure the concept of impulsivity, and was assessed via convergent and known groups validity (Cronbach & Meehl, 1955). Convergent validity refers to the degree to which scores on the impulsivity measure correlate with scores of a gold-standard measure of impulsivity, and is also measured by a correlation coefficient ranging from -1 to 1. Ideally, correlations of 0.50 and above are desirable as they are considered strongly correlated; however, correlations of 0.30–0.49 are considered moderate and still acceptable (Cohen, 1992). Known groups validity refers to the ability to differentiate between two groups recognized to differ in impulsivity, such as smokers and non-smokers (Terwee et al., 2007).

3. Results

The initial literature search yielded 3843 unique studies, of which 2955 studies were excluded on the basis of title and abstract screening (Fig. 1). From 888 full-text articles screened, sixty eight unique impulsivity measures were initially identified. Forty three measures were