Further evidence of the heterogeneous nature of impulsivity ☆

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A B S T R A C T

'Impulsivity' refers to a range of behaviours including preference for immediate reward (temporal-impulsivity) and the tendency to make premature decisions (reflection-impulsivity) and responses (motor-impulsivity). The current study aimed to examine how different behavioural and self-report measurements of impulsivity can be categorised into distinct subtypes.

Exploratory factor analysis using full information maximum likelihood was conducted on 10 behavioural and 1 self-report measure of impulsivity.

Four factors of impulsivity were indicated, with Factor 1 having a high loading of the Stop Signal Task, which measures motor-impulsivity, factor 2 representing reflection-impulsivity with loadings of the Information Sampling Task and Matching Familiar Figures Task, factor 3 representing the Immediate Memory Task, and finally factor 4 which represents the Delay Discounting Questionnaire and The Monetary Choice Questionnaire, measurements of temporal-impulsivity.

These findings indicated that impulsivity is not a unitary construct, and instead represents a series of independent subtypes. There was evidence of a distinct reflection-impulsivity factor, providing the first factor analysis support for this subtype. There was also support for additional factors of motor- and temporal-impulsivity. The present findings indicated that a number of currently accepted tasks cannot be considered as indexing motor- and temporal-impulsivity suggesting that additional characterisations of impulsivity may be required.

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1. Introduction

Impulsivity encompasses a range of behaviours that include making premature decisions, preferring immediate gratification and having difficulties inhibiting motor responses. Impulsivity functions as a dimension of normal behaviour, and it is thought that it can be adaptive in certain situations (Dalley, Everitt, & Robbins, 2011). However, it is also well established that it is associated with a number of negative outcomes (Aichert et al., 2012; Schweizer, 2002; Vigil-Colet & Morales-Vives, 2005) and is elevated in many clinical populations (e.g. de Wit, 2009; Winstanley, Dalley, Theobald, & Robbins, 2004; Winstanley, Eagle, & Robbins, 2006).

There is growing consensus that impulsivity is heterogeneous and should not be considered a unitary construct and should instead reflect a variety of behaviours and processes (Evenden, 1999). In laboratory-based research, investigators have focused on two subtypes of behavioural impulsivity: 'motor'-impulsivity (MI), as a failure to inhibit a behavioural response (also termed inhibitory control) and the failure to delay gratification (which we will term 'temporal'-impulsivity [TI], also referred to as delay discounting). A third subtype of 'reflection'-impulsivity (RI), i.e. the tendency to make decisions without gathering or evaluating necessary information, has also been suggested although it received comparatively little attention. Multiple tasks have been designed to index each subtype including the Stop Signal Task (SST), Go/NoGo (GNG) and Immediate Memory Task (IMT) for MI, the Matching Familiar Figures (MFF20) and Information Sampling

Task (IST) for RI, and pen-and-paper measures such as the Monetary Choice Questionnaire (MCQ) and experiential tasks including the Single Key Impulsivity (SKIP) and Two Choice Impulsivity Paradigm (TCIP) for TI. Impulsivity can also be indexed using self-report measures (e.g. Kirby & Finch, 2010; Whiteside & Lynam, 2001), including the Barratt Impulsiveness Scale (BIS-11, Patton, Stanford, & Barratt, 1995).

However, despite agreement that impulsivity comprises of multiple subtypes, they are rarely investigated concurrently and multiple tasks are seldom simultaneously administered to the same participants. Researchers typically select a single measure and refer to it as 'impulsivity', disregarding the wide array of processes and subtypes contributing to impulsive behaviour. This practice has led to poor characterisation of the structure of impulsivity, and the relationship of the subtypes to one another.

Of the small number of studies attempting to address this, investigators typically find correlations between dependent variables of a task and have also found relationships between tasks indexing the same subtype (e.g. Broos et al., 2012; Dougherty et al., 2009; Reynolds, Penfold, & Patak, 2008), suggesting that the subtypes may be well-defined. In contrast, relationships between subtypes are not uniformly found (e.g. Broos et al., 2012; de Wit, 2009; Messer, 1976; Reynolds et al., 2008) and investigators employing factor analysis procedures have found that measures of TI and MI load onto different factors of impulsivity, providing evidence that these two subtypes may be distinct (Broos et al., 2012; Lane, Cherek, Rhoades, Pietras, & Tcheremissine, 2003; Reynolds, Ortengren, Richards, & de Wit, 2006).

Collectively these studies provide preliminary evidence that the subtypes of impulsivity may be well-defined and differentiated. However these studies are limited by including too few tasks (e.g. Broos et al., 2012; Lane et al., 2003; Reynolds et al., 2006) despite evidence that more detailed classifications of impulsivity are required.

The SST, GNG and IMT are used interchangeably as measures of MI in spite of evidence that the tasks index distinct processes: '*action cancellation*', i.e. the inhibition of a response *during* its execution, on the SST (Dalley et al., 2011; Winstanley, 2011) and '*action restraint*', i.e. the inhibition of a response *before* it has started, on the GNG and perhaps the IMT (Dalley et al., 2011, 2009; Eagle, Bari, & Robbins, 2008; Reynolds et al., 2008; Winstanley, 2011; Winstanley, Olausson, Taylor, & Jentsch, 2010). There is evidence that different neurotransmitters may contribute to the two processes (Eagle et al., 2008; Winstanley et al., 2010) and factor analysis has indicated two distinct factors of MI (Dougherty et al., 2009; Reynolds et al., 2008).

With regards to TI, participants respond differently to experiential versus pen-and-paper measures (Winstanley, 2011), hypothetical versus real rewards (Hinvest & Anderson, 2009; Madden, Bickel, & Jacobs, 1999), monetary versus point rewards (Frederick, Loewenstein, & O'Donoghue, 2002) and also to short versus longer delays (Odum, 2011). However, these paradigms are used interchangeably despite there being no evidence to validate the assumption that they all index the same underlying process.

Research suggests that self-report measures of impulsivity are not analogous with behavioural tasks (Dick et al., 2010). The BIS-11 has been found not to correlate with measures of MI or TI (Lane et al., 2003; Lansbergen, Schutter, & Kenemans, 2007; Reynolds et al., 2006) and investigators predominantly find distinct factors of self-report and behavioural impulsivity (Broos et al., 2012; Havik et al., 2012; Lane et al., 2003; Malle & Neubauer, 1991; Meda et al., 2009). However, there is some evidence that self-report impulsiveness is related to GNG performance (Aichert et al., 2012; Reynolds et al., 2006).

Importantly, no factor analysis studies have included measures of RI despite evidence that it is clinically significant and distinct from other subtypes (e.g. Caswell, Morgan, & Duka, 2013a, 2013b; Morgan, Impallomeni, Pirona, & Rogers, 2006; Morgan, McFie, Fleetwood, & Robinson, 2002). The IST was designed to minimise some of the potential shortcomings of the MFF20 that include confounding by other cognitive processes (Clark, Robbins, Ersche, & Sahakian, 2006; Messer, 1976; Zelniker & Jeffrey, 1976) but although both tasks have been proposed to be analogous measures of RI, there are no factor analysis studies to validate this.

As such, current literature discusses three subtypes of behavioural impulsivity, RI, MI and TI. There is evidence that MI and TI are distinct, although available literature is hampered by limited selection of tasks. This limited selection of tasks is a cause for concern as there is evidence of task differences within proposed subtypes that may have implications for their factor loadings and call into question their validity as indexes of the subtypes. Previous studies have also failed to incorporate RI into factor analysis models of impulsivity, despite evidence of its importance (e.g. Caswell et al., 2013a, 2013b; Morgan et al., 2006; Morgan et al., 2002).

The current study aims to address these issues by investigating the structure of impulsivity using exploratory factor analysis, including measures of RI, to confirm whether impulsivity can be categorised into distinct subtypes. We will include a greater number of putative measures of different subtypes of impulsivity than has been attempted previously, encompassing the three proposed behavioural subtypes of MI, TI and RI (the previously unexplored subtype). The tasks will also include the BIS-11 as a self-report index of impulsivity although it is expected that separate facets of self-report and behavioural impulsivity will be identified.

2. Method

2.1. Participants

160 (80 m, 80f) student participants at the University of Sussex were recruited, providing informed consent. They were required to be 18–45 years of age, not suffering from any mental illness, not be a heavy smoker (<20 per day), not taking any medication (excluding the contraceptive pill).

Participants were instructed to abstain from the use of illicit recreational drugs for at least 1 week prior to the experiment and from the use of alcohol for at least 12 h prior to the experiments.

2.2. Procedure

Participants completed the BIS-11 and the National Adult Reading Task, Alcohol Use Questionnaire and Drug Use Questionnaire followed by a battery of behavioural impulsivity tasks. Tasks were computerised and completed in a random order.

2.3. Materials

2.3.1. Self-report and demographic measures
National Adult Reading Task (NART; Nelson & O'Connell, 1978): The NART gives an estimate measure of verbal IQ. Participants did not complete the NART if they were dyslexic or second language English (*n* = 23).

Alcohol Use Questionnaire (AUQ; Townshend & Duka, 2002): Participants estimate the number of alcohol units they consume per week.

Drug Use Questionnaire (see Townshend & Duka, 2005): Participants give details of use for main drug categories. Participants were given a score where 0 = no use; 1 = use of cannabis/hash/marijuana; 3 = use of ecstasy/other drugs.