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An Exploratory Factor Analysis of a Brief Self-Report Scale to Detect Neurocognitive Impairment Among Participants Enrolled in Methadone Maintenance Therapy

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ABSTRACT

The present study examines the factor structure of the existing Neuropsychological Impairment Scale (NIS) through the use of exploratory factor analysis (EFA). The NIS is a brief, self-report measure originally designed to assess neurocognitive impairment (NCI) by having patients rate a range of items that may influence cognitive functioning. Stabilized patients on methadone maintenance therapy (MMT; $N = 339$) in New Haven, CT who reported drug- or sex-related HIV risk behaviors in the past 6 months were administered the full 95-item NIS. An EFA was then conducted using principal axis factoring and orthogonal varimax rotation. The EFA resulted in retaining 57 items, with a 9-factor solution that explained 54.8% of the overall variance. The revised 9-factor measure - now referred to as the Brief Inventory of Neuro-cognitive Impairment (BINI) - showed a diverse set of factors with excellent to good reliability (i.e., F1 $\alpha = 0.97$ to F9 $\alpha = 0.73$). This EFA suggests the potential utility of using the BINI in the context of addiction treatment. Further research should examine the utility of this tool within other clinical care settings.

1. Introduction

Illicit drug use is a significant public health problem in the United States and elsewhere. In 2013, there were over 24.6 million current illicit drug users, representing over an 8% increase in the number of drug users since 2002 (Substance Abuse and Mental Health Services Administration, 2014). Studies on the neurocognitive effects of drug use have shown that chronic drug use is strongly correlated with a host of neurocognitive impairments (NCI). For example, individuals with opioid use disorders (OUDs) have documented deficits in executive function, attention, working memory, and episodic memory (Anand, Springer, Copenhaver, & Altice, 2010; Baldacchino, Balfour, Passetti, Humphris, & Matthews, 2012; Rapeli et al., 2006; Schiltenwolf et al., 2014; Verdejo-García, López-Torrecillas, Giménez, & Pérez-García, 2004). Cocaine and methamphetamine use is also correlated with lasting changes in brain structure and neurological functions, resulting in impaired executive function, memory, attention, new learning, information-processing speed, and visual–spatial perception (Anand et al., 2010; Nordahl, Salo, & Leamon, 2003; Norman, Basso, Kumar, & Malow, 2009; Shrestha, Huedo-Medina, & Copenhaver, 2015; Spronk, van Wel, Ramaekers, & Verkes, 2013; Vonmoos et al., 2014). Likewise, lifetime alcohol dependence has been found to impair attention, memory, and learning (Anand et al., 2010; Loeber et al., 2009; Solfrizzi et al., 2007; Stampfer, Kang, Chen, Cherry, & Grodstein, 2005). Within HIV clinical care settings, NCI can be compounded when patients use alcohol or drugs (Anand et al., 2010) and this can greatly impact treatment outcomes like linkage and retention in care and antiretroviral therapy (ART) adherence (Altice, Kamarulzaman, Soriano, Schechter, & Friedland, 2010; Kamarulzaman & Altice, 2015).

Neurocognitive deficits have been found to affect multiple behavioral predictors of intervention efficacy, including motivation and behavioral skills (Anand et al., 2010; Bates, Pawlak, Tonigan, & Buckman, 2006; Blume, Davis, & Schmaling, 1999; Morgenstern & Bates, 1999; Nakagami, Hoe, & Brekke, 2010), which must be accounted for during behavioral intervention development and adaptation (Ezeabogu, Copenhaver, & Potrepka, 2012). Moreover, impaired neurocognitive abilities including executive function, memory, attention, new learning, and information processing observed in persons with substance use

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disorders may prevent appropriate acquisition and retention of behavioral content conveyed in customary risk-reduction programs (Anand et al., 2010). Thus, deficits in neurocognitive abilities among people who use drugs (PWUD) are important predictors of overall risk-reduction program participation and outcomes. For example, Ezeabogu et al. found differential treatment outcomes (i.e., ART adherence and drug risk reduction) following an HIV prevention intervention: PWUD with a lower degree of NCI demonstrated better treatment outcomes. Similarly, an earlier study observing PWUD with comorbid psychiatric conditions demonstrated that lower executive, memory, and intellectual function corresponded closely with lower motivation to change substance use behaviors (Blume et al., 1999). Given the persistence of NCI among PWUD, there is a growing need to improve screening for NCI, and when detected, to more effectively accommodate NCI in the delivery of interventions.

Despite the need to identify and address NCI when providing addiction treatment and related services, training of clinical staff does not typically include the requisite knowledge and skills to rapidly and accurately assess clients' neurocognitive status in order to make appropriate modifications, if needed, to treatment approaches (Copenhaver, Avants, Warburton, & Margolin, 2003; Fals-Stewart, 1997; Weinstein & Shaffer, 1993). Furthermore, cognitively impaired individuals often develop adaptive mechanisms to socially disguise their impairment, making casual observation of cognitive problems quite challenging (Copenhaver et al., 2003; Fals-Stewart, 1997). Therefore, despite the availability of a number of diagnostic instruments designed to measure NCI, many of which are complex and time-consuming, recent studies have stressed the importance of rapid self-report screening tools for this purpose (Schouten, Cinque, Gisslen, Reiss, & Portegies, 2011; Shrestha et al., 2015).

The Neuropsychological Impairment Scale (NIS), a self-report measure, was originally developed as a quick and convenient way to help elicit diagnostically relevant information about NCI (O'Donnell, DeSoto, & Desoto, 1994). The structured, easily administered NIS inventory addresses both general neurocognitive impairment and specific symptoms areas (i.e., attention, memory, linguistic functioning, etc.) generating inherent advantages over lengthy and formal clinical interviews. The NIS was designed to assess NCI by having patients rate a range of items that may influence cognitive functioning. The scale has been primarily used as a screening tool in HIV-negative, psychiatric treatment settings in order to identify patients who may be experiencing significant signs of cognitive impairment relative to normative scores from a non-clinical population.

In the original validation of the 95-item NIS, the psychometric structure was evaluated through two principal components analyses (PCA), which yielded initial solutions of 22 and 24 factors for the nonclinical and clinical samples, respectively (O'Donnell et al., 1994). Despite the large number of factors for both PCAs, a visual inspection of the scree plot was used to justify a 5-factor solution for both the clinical and non-clinical samples. This procedure placed an *a priori* restriction on the number of factors—or in this case, components—that may be empirically observed, violating the established rule of retaining factors with eigenvalues greater than 1, especially in the initial analyses (Bryant & Yarnold, 1995). Upon review of the 5-factor solutions, O'Donnell and colleagues divided individual factors into multiple factors, based on different item content. This procedure was done most evidently with the Attention and Memory subscales of the NIS (see page 51 of NIS manual) (O'Donnell et al., 1994). Furthermore, other subscales of the NIS were composed of items from multiple factors, as was done with the Learning-Verbal and Academic Skills subscales which, again, appears to have been done "by hand" based on visual inspection of item content rather than by statistically relevant factor loadings.

Because of these limitations and because we implemented the NIS with drug-involved participants stabilized on methadone maintenance therapy (MMT), in contrast to the clinical (i.e., a sample of 534 neuropsychiatric patients) and non-clinical (i.e., a sample of 1,000 healthy adults) samples with which the scale was originally developed, our objective was to conduct an exploratory factor analysis (EFA) of the NIS with a new sample (O'Donnell et al., 1994). In the present study, we examined the factor structure of the NIS using data from participants enrolled in MMT and, based on the analysis, have recommended revisions to the original scale for optimal use with this population.

2. Methods

The present EFA of the NIS was embedded within a larger randomized clinical trial (RCT) of the Community-friendly Health Recovery Program (CHRP) (see: https://clinicaltrials.gov/ct2/show/NCT01741350), a behavioral HIV-risk reduction intervention that is designed to reduce HIV transmission risk behavior (Copenhaver, Lee, & Baldwin, 2013). CHRP is an abbreviated, manual-guided intervention strategy composed of four group sessions that address sex- and drug-related HIV risk behaviors among individuals with opioid use disorders (OUDs) and enrolled in MMT (http://www.nrepp.samhsa.gov/ProgramProfile.aspx?id=11). Because of the higher degree of NCI reported among drug-involved persons on MMT (Ezeabogu et al., 2012; Shrestha et al., 2015), we were interested in examining NCI within our study sample. The study protocol was approved by the Investigational Review Board (IRB) at the University of Connecticut, the Human Investigation Committee at Yale University, and received board approval from the APT Foundation MMP, Inc.

2.1. Participants

Participants were recruited from a MMT program in New Haven, Connecticut, if they were: 18 years or older, met *DSM-V* criteria for OUDs and newly enrolled in MMT, reported drug- or sex-related HIV risk behaviors in the past 6 months, able to read and understand the questionnaires, could provide informed consent form, available for the duration of the study, and not actively suicidal, homicidal, or psychotic. All subjects were reimbursed for the time required to participate.

2.2. Neurocognitive impairment measure

Following informed consent and enrollment, the structured baseline survey, including the NIS, was self-administered to participants using Audio Computer-Assisted Self-Interview (ACASI) (Copenhaver et al., 2013; Macalino, Celentano, Latkin, Strathdee, & Vlahov, 2002) battery of questionnaires. The original NIS is composed of 95 items rated on a 5-point scale, ranging from 0 (not at all) to 4 (extremely). As recommended by the NIS manual (O'Donnell et al., 1994), the interviews were conducted in a private room. Individuals were asked to read each statement and indicate the degree to which it applied to them during the last 30 days. Some items referred to experiences during the past few days or weeks, and others referred to experiences at any time in the past (O'Donnell et al., 1994). There was no time limit to complete the NIS, although respondents required an average of 10–12 minutes.

2.3. Procedures and analyses

Prior to our EFA, we evaluated the peer-reviewed literature on the development and validation of the original (O'Donnell, de Soto, & Reynolds, 1984; O'Donnell, Reynolds, & de Soto, 1983, 1984) and revised (O'Donnell, de Soto, & de Soto, 1993) versions of the NIS (O'Donnell et al., 1983; O'Donnell, de Soto, et al., 1984; O'Donnell et al., 1993) as well as the NIS user manual. We noted that 15 of the 95 NIS items are designed to function as "validity checks" to distinguish a participant's potential response set or psychological symptoms that are unrelated to neurocognitive impairment, yet may cloud the ability to detect it, including: defensiveness (e.g., "I am always happy" and "I always tell the truth") and affective disturbance (e.g., "I tend to worry all the time" and "I feel quite discouraged about my future"). We elected to retain these items in the factor analysis.