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Are impulsivity and intelligence truly related constructs? Evidence based on the fixed-links model

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ABSTRACT

Based on the statistical decomposition of the variance in the Raven's Advanced Progressive Matrices (APM), the present study attempted to examine whether impulsivity relates to a purified measure of intelligence or is more related to systematic method variance associated with the item-position effect in the measurement of intelligence. A sample of 232 undergraduates was administered the APM, the UPPS-P Impulsive Behavior Scale, and the Barratt Impulsiveness Scale-11 (BIS-11). The results showed that impulsivity, measured by either the UPPS-P or the BIS-11, was significantly related only to the position-specific component of the APM. These results suggest that the relationship between impulsivity and intelligence is a spurious relationship due to the use of similar items in the assessment of intelligence.

1. Introduction

Many studies have shown that impulsivity is negatively and significantly related to performance on intelligence tests (Lozano, Redondo, & Pérez, 2014; Russo, De Pascalis, Varriale, & Barratt, 2008; Schweizer, 2002). However, the question arises whether impulsivity is truly related to intelligence or only prevents individuals from performing on intelligence tests according to their true intelligence. In order to address this issue, it should not be overlooked that scores on intelligence tests not only reflect intelligence, but also method variance that may distort the estimation of the relationship between theoretical constructs (Carlstedt, Gustafsson, & Ullstadius, 2000; Kubinger, Formann, & Farkas, 1991).

1.1. Method variance in the measurement of intelligence

Method variance refers to the part of the variance of a psychological measure that does not represent the construct of interest but systematic error associated with the measurement method (Podsakoff, MacKenzie, & Podsakoff, 2012). Correlations between variables may be either inflated or attenuated by the presence of method variance, leading to erroneous inferences regarding the corresponding constructs. One particular source of method variance is the item-position effect (Schweizer, Troche, & Rammsayer, 2011), which refers to the dependence of the response to a given item on the responses to preceding items. The position effect seems to be intrinsically linked to instruments based on series of similar items (Hartig, Hözel, & Moosbrugger, 2007).

Recent research based on intelligence test performance has modeled the position effect by means of confirmatory factor analysis (CFA). A particular fixed-links model developed on the basis of the essentially tau-equivalent model enables the statistical decomposition of the true-score variance of intelligence into two independent parts: the ability-specific and position-specific components (Schweizer, 2012; Schweizer, Schreiner, & Gold, 2009). The ability-specific component represents a purified measure of intelligence, whereas the position-specific component reflects systematic variance associated with the position effect. Schweizer et al. (2011) demonstrated that the ability-specific component of a measure of fluid intelligence correlated almost perfectly with general intelligence (g). The position-specific component, by contrast, showed a correlation with g considerably smaller.

1.2. Impulsivity and intelligence test performance

Impulsivity is a heterogeneous construct that includes a variety of traits, all of them involving behavior characterized by little or inadequate forethought (Depue & Collins, 1999). Impulsivity exerts a detrimental influence on performance on complex cognitive tasks such as intelligence tests (Lozano et al., 2014; Russo et al., 2008; Schweizer, 2002). This effect may be explained by the

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association between impulsive behavior and executive function (Whitney, Jameson, & Hinson, 2004). In this regard, impulsive individuals seem to lack the attentional resources needed to control and focus their attention on relevant information and inhibit irrelevant information. The link between impulsivity, executive attention, and abstract reasoning is also manifest at the biological level, with the three constructs sharing their biological substrates in the prefrontal cortex (Shamosh et al., 2008).

Studies based on the fixed-links model have revealed that the position-specific component of the Raven's Advanced Progressive Matrices (APM; Raven, 1962), but not the ability-specific component, is related to executive attention (Ren, Goldhammer, Moosbrugger, & Schweizer, 2012) and complex learning (Ren, Wang, Altmeyer, & Schweizer, 2014). As it is known, the solution of APM items depends on a few rules that must be induced (Carpenter, Just, & Shell, 1990). Moreover, research has demonstrated that individuals learn to apply these rules more fluently throughout the test (Carlstedt et al., 2000; Kubinger et al., 1991; Verguts & De Boek, 2000). During this process, executive attention plays a significant role in focusing on the abstract relationships while ignoring concrete irrelevant information (Primi, 2002). Therefore, the position-specific component of the APM may well be representing systematic method variance associated with rule learning processes that occur while responding to a series of similar items and that are ultimately supported by executive functions. The relationship between executive function and complex learning is indeed well-established (Ropovik, 2014), which may also help to explain the low performance of impulsive individuals in a variety of learning contexts (Lozano, Hernández, & Santacreu, 2015; Lozano & Pérez, 2012; Lozano et al., 2014). Accordingly, since executive attention and complex learning are only related to the position-specific component of the APM, there are reasons to suspect that impulsivity is mainly related to method variance associated with the position effect in the measurement of intelligence.

1.3. The present study

The present study was aimed to analyze the relationship of impulsivity to the ability-specific and position-specific components of the APM. Specifically, impulsivity was hypothesized to relate only with the position-specific component. The APM was chosen as a measure of intelligence since it is considered one of the purest measures of fluid/general intelligence. Regarding impulsivity, two questionnaires were selected for the study: the UPPS-P Impulsive Behavior Scale (Lynam, Smith, Whiteside, & Cyders, 2006) and the Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995). The UPPS-P was selected in that its comprehensiveness and construct validity makes it the most appropriate instrument for the purpose of the study. The BIS-11, on the other hand, was chosen since most studies reporting significant correlations between impulsivity and *g* used the BIS-11 as a measure of impulsivity (Lozano et al., 2014; Russo et al., 2008). Additionally, measures of working memory and processing speed were used in order to obtain evidence of validity for the components of ability and position. Since working memory and processing speed are well-established constituents of *g* (Deary, 2012), they were expected to converge only with the ability-specific component of the APM.

2. Method

2.1. Participants

The sample was comprised of 232 undergraduate university students, 64 males (27.6%) and 168 females (72.4%), with a mean age of 21.8 years (*SD* = 4.2). Participants received a course credit in exchange for participation in the study.

2.2. Materials

Raven's Advanced Progressive Matrices set II (Raven, Court, & Raven, 2001). The test consists of 36 items presented in ascending order of difficulty. Each item consists of a 3 × 3 matrix with the lower right entry missing. Participants are instructed to complete each matrix choosing one of eight response alternatives according to logical rules. The test was administered without time limit, with an average completion time of 41 min.

UPPS-P Impulsive Behavior Scale (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010). Spanish adaptation of the UPPS-P Impulsive Behavior Scale (Lynam et al., 2006). The scale comprises 59 items designed to measure five aspects of impulsive behavior: Negative Urgency, (Lack of) Perseverance, (Lack of) Premeditation, Sensation Seeking, and Positive Urgency. Each item is rated on a 4-point scale ranging from 1 (strongly agree) to 4 (strongly disagree).

Barratt Impulsiveness Scale-11 (*BIS-11*; Oquendo et al., 2001). Spanish adaptation of the Barratt Impulsiveness Scale (Patton et al., 1995). The scale comprises 30 items designed to measure three different components of impulsiveness: Motor Impulsiveness, Cognitive Impulsiveness, and Non-Planning Impulsiveness. Each item is rated on a 4-point scale (rarely/never, occasionally, often, almost always/always).

Working memory was measured by the dot matrix task (Colom, Escorial, Shih, & Privado, 2007). This task requires verifying a matrix equation while simultaneously remembering a dot location in a 5 × 5 grid. Each trial contains a set of matrix equations followed by a 5 × 5 grid containing one dot. Each matrix equation consists of adding or subtracting simple line drawings. Participants are given a maximum of 4.5 s to verify each equation by responding 'True' or 'False'. Immediately after the verification, the grid is displayed for 1.5 ms. After a set of equation-grid pairs, participants must recall, in any order, which grid spaces contained dots. The task comprises 12 trials of between two and five equation-grid pairs (three trials of each size). The score is the number of hits in the verification and recalling tasks.

Processing speed was measured by a simple recognition speed task (Colom et al., 2007). In this task, arrows with one of seven orientations are displayed on the screen for 800 ms. After each arrow, a fixation point appears for 500 ms. Then, a probe item is presented and the participant must decide, as quickly and accurately as possible, if it has the same orientation of the arrow displayed before. The task comprises 30 trials. The score is the mean reaction time for the correct answers.

2.3. Procedure

The tests were administered in groups of approximately 30 participants. The assessment took place in two sessions. The APM was administered in the first session, whereas the dot matrix task, the simple recognition task, the UPPS-P, and the BIS-11 (in that order) were administered in the second session.

2.4. Statistical analyses

Based on previous studies aimed at decomposing the APM variance into ability-specific and position-specific components (Ren et al., 2012, 2014), scores of three adjacent items were added to form composites. Thereby, 12 composites of APM items were used as manifest variables. Four measurement models of the APM were estimated for comparison: the congeneric model (Jöreskog, 1971) and three variants of the fixed-links model (Schweizer, 2012;