

## SYSTEMATIC REVIEW OF PSYCHOMETRIC PROPERTIES OF BARRATT IMPULSIVENESS SCALE VERSION 11 (BIS-11)

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### Abstract

Impulsivity is an essential dimension of personality and several theories posit that impulsiveness is related to distinct personality traits and to neuropsychological functions. One of the most widely self-report impulsivity measures used on psychiatric research is Barratt Impulsiveness Scale, version 11 (BIS-11). Objective: The aim of present study was to conduct a systematic review on the literature that examines psychometric properties of Barratt Impulsiveness Scale (BIS-11) versions across different cultures. Method: Studies were obtained from MEDLINE, PsycINFO and CAPES periodicals portal. The articles were included if they have investigated at least one psychometric characteristics of BIS-11 with adults or adolescent samples (internal consistence, factor analysis and/or test-retest). Results: Twenty-one studies were included in this review with different methodological characteristics across them. Conclusion: The results indicated BIS-11 has reliability and criterion-related validity across samples. Our findings do not support the hypothesis that BIS-11 assesses the three impulsivity components originally supposed by Barratt. Both numbers and content factors assessed are unstable what configures a problematic issue. It may lead to potential misinterpretations of scores used to characterize impulsivity in clinical and non-clinical groups. To future research, we recommend new efforts to explore BIS items internal organization rather than applying the initial model to calculate scores. Theoretical and empirical items analyses could be a methodological strategy to improve scale validity. It could identify that some items may be better represented in different factors, diverging, this way, from those originally proposed.

**Key words:** BIS-11, psychometric properties, systematic review

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**Declaration of interest:** none

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### Introduction

Impulsivity is a multidimensional construct associated to act quickly without adequate thought or conscious judgment to achieve some goal and without consider future consequences (Moeller et al. 2001). The individual differences in the tendency to restrain impulses has been recognized and different aspects of impulsivity underlie multiple psychological disorders (substance abuse, personality disorders, bipolar disorder, suicide, eating disorders) (American Psychiatric Association (APA), 2004) as well as other potentially risky behavior (overeating, overspend, abuse drugs, get in fight, break the law, gamble, engage in risky sexual behavior) (Krueger et al. 2007).

This construct is considered an essential dimension of personality. Several theories states that impulsiveness is related to distinct psychological traits. However, in spite of the wide use of the term "impulsivity" and the identification of various processes underlying the

construct, its definition remains poor (Eveden 1999). Several instruments have been designed to measure impulsivity including self-report questionnaires and neuropsychological tests (Eveden 1999). The first is a typical assessment used in personality assessment. Our paper will focus on impulsivity as a personality trait.

Self-report inventories present a set of affirmative asking about the frequency of personality manifestations to assess stable patterns of behavior. Their items have been designed to have real-world relevance and they are subjected to psychometric evaluation. Inventories are considered a briefer and less expensive method than neuropsychological tests. However, their results are limited by individuals' motivation and ability to make accurate judgments of themselves (Meyer et al. 2001). One of the most widely used self-report measures of impulsivity in psychiatric research is the Barratt Impulsiveness Scale (BIS; Stanford et al. 2009).

Barratt proposed that impulsiveness and anxiety represent orthogonal personality traits. The author

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selected a pool of items from laboratory research and self-report questionnaires to develop impulsivity scale (Barratt 1965, Patton et al. 1995). Originally, the initial versions had been developed to assess impulsivity as a unidimensional personality trait orthogonal to anxiety measures (Stanford et al. 2009). However, empirical evidences from clinical and laboratory researches had indicated the presence of three subtraits labeled as motor impulsiveness (Im: defined as acting without thinking), cognitive impulsiveness (Ic: associated to making quick cognitive decisions) and nonplanning impulsiveness (Inp: characterized as an orientation to the present or lacking of future) (Barratt 1985, Patton et al. 1995). After an extensive revision of theoretical items, the tenth version of BIS (BIS-10) was available.

BIS-11 is the current scale version and its original validation was developed by Patton et al. (1995). The authors revised BIS-10 to identify the factorial structure of items among undergraduates ( $n=412$ ) and to compare their scores to psychiatric inpatients ( $n=248$ ) and to prison inmates ( $n=164$ ). Four items were dropped from further analyses because they did not find criterion of item-total correlation and did not contribute to differentiate between extreme trait groups. The remaining 30 items were used in subsequent analyses. Principal components analysis with Promax rotation retained six oblique first-order factors and three second-order factors. The factors were: (1) Factor 1- attentional impulsiveness: defined as lack of focus on the ongoing task and comprised of two first-order factors, attention and cognitive instability; (2) Factor 2 - motor impulsiveness: defined as action without inhibition of prepotent or ongoing responses and included two first-order factors, motor, perseverance and representing; (3) Factor 3 - non-planning impulsiveness: defined as orientation towards the present rather than to the future and it included self-control and cognitive complexity first order factors (Patton et al. 1995).

The motor (Factor 2) and non-planning (Factor 3) factors were reproduced similar as originally conceptualized by Barratt (Patton et al. 1995). However, attentional impulsiveness (Factor 1) was not consistent with "cognitive impulsiveness" theoretical factor proposed by this author. According to Patton et al. (1995), his and other studies failed to identify this factor since its items loading in all factors. Their hypothesis was that cognitive impulsiveness is a general process that underlies impulsivity as a whole.

This BIS-11 final version assessed attentional (Ia), motor (Im) and nonplanning (Inp) impulsiveness dimensions (Patton et al. 1995). Differences between undergraduate and clinical groups were found ( $F=27.49$ ;  $p<0.001$ ) in BIS-11 total score. There was no significant sex difference on scores. Finally, the second-orders factors were intercorrelated significantly ( $0.46 < r < 0.53$ ) which suggests a measure of general personality trait of impulsiveness.

Evidences have reported that BIS-11 scores correlate with risky behavior and clinical symptoms (Stanford et al. 2009). For example, the number of daily cigarettes smoked by alcohol-dependent subjects correlates with non-planning subscale (Dom et al. 2006). Among male offenders with personality disorders, non-planning impulsiveness was significantly higher than other scales (Dolan and Fullam 2001). Adults with a past

history of suicide attempt(s) tend to score higher than those without attempts on BIS-11 motor (Dougherty et al. 2004) and attentional dimensions (Quednow et al. 2006). In bipolar disorder (BD), Peluso et al. (2007) demonstrated high scores on BIS scales as a stable characteristic of bipolar patients. Swann et al (2008) identified that three subtraits of impulsiveness are differentially related to the affective states of the BD: motor impulsiveness related to manic episodes, non-planning impulsiveness to depressive episodes and attentional impulsiveness related to both manic and depressive episodes. Elevated impulsivity has also been demonstrated in BD patients who attempt suicide (Swann et al. 2005).

BIS-11 American English original version has been translated into at least 11 other languages. The scale is available in Chinese (Yang et al. 2007), Estonian (Paaver et al. 2007), French (Bayle et al. 2000), German (Preuss et al. 2007, Hartmann et al. 2011), Italian (Fossati et al. 2001), Japanese (Someya et al. 2001), Korean (Chung and Lee 1997), Portuguese (von Diemen et al. 2007) and Spanish (Oquendo et al. 2001). A first BIS-11 Brazilian Version has been recently translated for use with adolescents by von Diemen and colleagues (2007). This version showed acceptable internal consistency ( $r=0.62$ ). However, an exploratory factor analysis did not replicate the three second-order factors proposed by Patton et. al (1995). Authors concluded that original scores of BIS-11 have not been validated and recommend not using them with Brazilian adolescents (von Diemen et al. 2007).

Despite the large use of the scale, there is none published systematic review featuring its psychometric properties. Recently, Stanford and colleagues (2009) have published a review about fifty years of BIS-11 offering an updating to the literature about the instrument. They demonstrated the internal consistency ( $\alpha=0.83$ ), test-retest at one month ( $\rho=0.83$ ) for original BIS-11 factors based on a sample of 1577 adults from United States. However, the authors did not investigate the scale's dimensionality in their own sample. They only mentioned evidences about the adequacy of original factor structure supported by other studies. Yet, other published studies did obtain the expected three-order factorial structure (Fossati et al. 2002, Hartmann et al. 2011). For example, in an Italian BIS-11 psychometric study, a model with two second-order factors produced the best fit in a confirmatory analysis (Fossati et al. 2002). An exploratory factor of the German version identified three factors that showed differences from the original model proposed by Patton et al. (1995) (Hartmann et al. 2011).

Our research question is concerned with the number and content of impulsivity dimensions obtained from BIS-11 and instrument's reliability across diverse cultures and samples. Therefore, the central aim of present study was to summarize psychometric proprieties evidences to Barratt Impulsiveness Scale (BIS-11) versions within different samples. Additionally, authors ascertained and identified possible sources of heterogeneity on the psychometrics results across studies. We intended to synthesize empirical evidences about the psychometric legitimacy of BIS-11 original subscales (Ia, Im and Inp) for characterizing and interpreting an individual's level of impulsiveness. Our

results could help researchers to realize areas in which more research is needed.

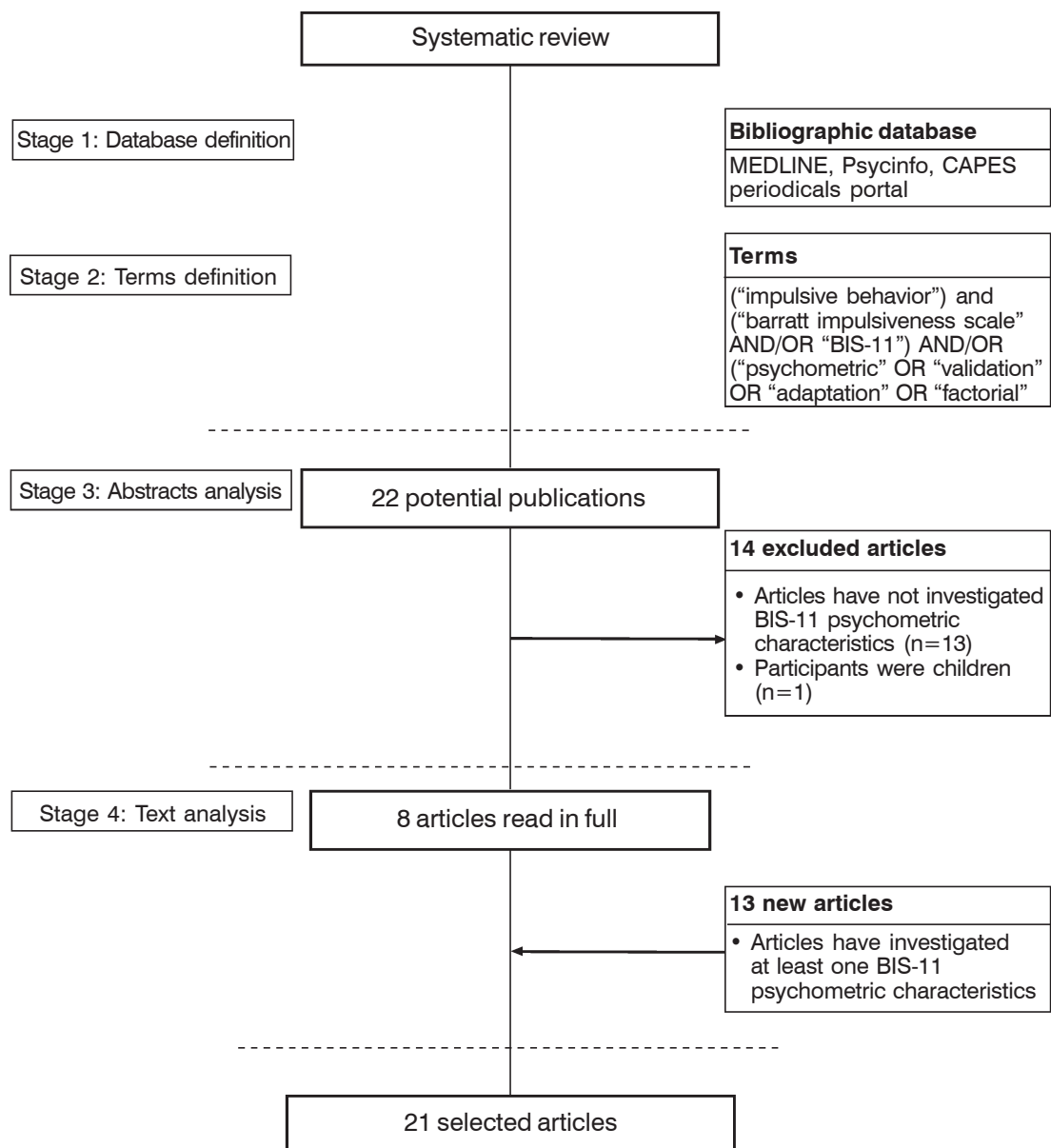
## METHODS

### Search strategy

Studies were identified via a systematic search in bibliographic databases MEDLINE, PsycINFO and CAPES periodicals portal. The combinations of the used terms were (“impulsive behavior”) AND (“barratt impulsiveness scale” AND/OR “BIS-11”) AND/OR (“psychometric” OR “validation” OR “adaptation” OR “factorial”). Reference lists of publications identified by these procedures were hand-searched for additional relevant citations.

### Inclusion/exclusion criteria

The articles would be included if they have investigated at least one of the psychometric characteristics of BIS-11 versions with adults or adolescent samples (internal consistency, factor analysis and/or test-retest). We did not limit time period or language of publications. Only exception was articles in Korean and Japanese. Two independent reviewers (AGV, LFMD) excluded articles from the initial search yield on the basis of title and abstract. Full text articles were sourced if the title and abstract did not provide enough information about the criteria fulfillment. Any disagreements about which papers should be included or excluded were discussed with a third reviewer (HC) until a consensus was reached.



**Figure 1.** Representation of producers for selecting articles

## Data extraction and analysis

Two reviewers (AGV, LFMD) performed data extraction: one reviewer extracted the data, which was checked by the second reviewer for information's accuracy. We extracted data on: year of publication, study country, sampling (number and clinical status), reliability (the extent the measure can be assured over time and internal consistency), validity (criterion-related validity and internal structure), type of factor analysis and dimensions' number and content obtained from each sample.

## Results

### Selected articles

Search has yielded 22 potential publications to achieve our aim. One of these articles has presented the original three-dimensional structure proposed to BIS-11. This was used as a benchmark of internal structure comparisons (Patton et al. 1995). From reading the title and abstract of the selected publications, 14 articles were excluded because they did not attend the inclusion criteria (14/22). Thirteen new studies were included by consulting the references on previously selected articles. Therefore, the review was based on the total of 21 publications and the articles were full read. It is important to note that there is a difference between the number of studies and samples available. One of the selected studies evaluates BIS-11 internal structure in seven prisoners' samples (Ireland & Archer 2008). Because of it, we have summarized BIS-11 factor structured evidences from 27 samples that have been reported in 21 studies (**Figure 1**).

The selected studies included a broad range of different size and nature samples (e.g., healthy volunteers, urban or rural groups, high-risk groups, representative population-based samples), socio-demographics composition (e.g., college and undergraduate students, exclusively male or female samples) and medical characteristics (e.g., healthy subjects, alcohol dependence, psychiatric disorders).

Interestingly, some BIS-11 items have been developed to measure adult behaviours. In adolescents version, some authors have used modified items to obtain a better correspondence to adolescents' experiences and to avoid content bias (e.g., item 16 was reworded to "I change my mind about what I will do when I grow up" from "I change jobs"; BIS-11 item 21 was reworded to "I change friends" from "I change residences" (Fossati et al. 2002, Hartmann et al. 2011). However, these modifications did not influence the construct representation.

### Demographic influences

The contributions of demographic characteristics to BIS scores were investigated. Sex differences in total BIS score were investigated in nine samples (9/27). Six studies (6/9) did not find differences between male and female in total score (Someya et al. 2001, Fossati et al. 2001, Li and Chen 2007, Ireland and Archer 2008, Singh

et al. 2008, Stanford et al. 2009). Two studies (2/9) reported higher scores in male samples (Fossati et al. 2002, Spinella 2007). However, one study (1/9) found the inverse result (Yao et al. 2007). Ireland and Archer (2008) found different factor structures for men and women samples. A confirmatory analysis showed that, although the three factor solution was a good fit for men, a two factor solution was better for women.

Three studies (3/21) investigate age effect in BIS-11 scores (Someya et al. 2001, Haden and Shiva 2008, Spinella 2007) and they identified significantly correlations. Older patients reported less impulsivity as measured on the nonplanning score (Haden and Shiva 2008, Spinella 2007) and total score (Someya et al. 2001). Hade and Shiva (2008) also showed significantly differences in attentional score between younger and older individuals.

Only two studies (2/21) investigated whether education could also contribute to differences in BIS-11 total score (Someya et al. 2001, Spinella 2007). The results were different from each study. One study found significant correlation between educational level and total score (Someya et al. 2001) while another reported a non-significance between variables (Spinella 2007).

## Psychometric proprieties

### Reliability

#### Internal consistency

Sixteen studies (16/27) investigated the internal consistency of BIS-11 total score via Cronbach's alpha (Patton et al. 1995, Someya et al. 2001, Fossati et al. 2001, Fossati et al. 2002, Spinella 2007, von Diemen et al. 2007, Li and Chen 2007, Yao et al. 2007, Yang et al. 2007, Paaver et al. 2007, Preuss et al. 2007, Haden and Shiva 2008, Guleç et al. 2008, Ireland and Archer 2008, Stanford et al. 2009, Hartmann et al. 2011). The coefficients had ranged from 0.69 to 0.83 and indicated satisfactory scale homogeneity. The exception was a coefficient from von Diemen et al. (2007) whose coefficient was 0.62.

#### Retest reliability

Five studies investigated test-retest reliability of the BIS-11 total score (Yao et al. 2007, Yang et al. 2007, Stanford et al. 2009, Fossati et al. 2002, Guleç et al. 2008, Hartmann et al. 2011, Orozco-Cabal 2010). The samples were retested on different time intervals after first administration: two weeks (Orozco-Cabal 2010), one month (Yao 2007, Yang 2007, Stanford, 2009), two months (Fossati 2002, Guleç et al. 2008) and six months (Hartmann et al. 2011). The authors reported a test-retest correlation coefficient range from 0.66 to 0.83 for the total score in samples composed by adults and adolescents.

### Validity

#### Criterion-related validity

One of the goals of using a personality instruments

**Table 1.** Summarizes the internal consistency and test-retest reliability of BIS-II total score

Studies / Country	Participants	Male (%)	Cronbachs' Alfa	Test-retest (time interval)	Differences between groups
Patton (1995) United States	412 undergraduates, 248 psychiatric inpatients, 73 male inmates	48.2	$\alpha_t=0.82$	nc	Clinical status differences
Baylé (2000) France	208 adults from general population (18 to 79 years)	np	np	np	np
Someya (2001) Japan	450 adults	28	$\alpha_t=0.79$	nc	nc
Oquendo (2001) Caribbean	29 dominant Spanish-speaking psychiatric outpatients	nc	nc	nc	nc
Fossati (2001) Italy	763 college undergraduates	35.8	$\alpha_t=0.79$	0.81 (2 months)	Risk behaviors status differences. No sex differences.
Fossati (2002) Italy	563 adolescents (13 to 19 years)	37.1	$\alpha_t=0.78$	nc	Sex differences
Recio (2004) Spain	600 adolescents (9 to 17 years)	np	nc	nc	nc
Spinella (2007) United States	700 adults (15 to 89 years)	40.29	$\alpha_t=0.82$	nc	Sex differences

Table 1. *continued*

Studies / Country	Participants	Male (%)	Cronbachs' Alfa	Test-retest (time interval)	Differences between groups
von Diemen (2007) Brazil	464 adolescents (15 to 20 years)	100	$\alpha_t=0.62$	nc	nc
Li (2007) China	682 high school students (age mean: 16.8±1.3 years)	49.02	$\alpha_t=0.83$	nc	Sex differences
Yao (2007) China	396 secondary school students	np	$\alpha_t=0.80$	0.70 (one month)	Sex differences
Yang (2007) China	209 undergraduate students	np	$\alpha_t=0.80$	0.83 (one month)	np
Paaver (2007) Estonia	683 adolescents and adults (14 to 66 years)	np	$\alpha_t=0.80$	nc	nc
Preuss (2007) Germany	810 healthy individuals and psychiatric patients	47.01	$\alpha_t=0.69$	nc	Clinical status differences
Haden (2008) United States	436 forensic inpatient (18 to 64 years)	100	$\alpha_t=0.71$	nc	Age differences
Güleç et al. (2008) Turkey	237 college undergraduates and psychiatric patients	51.56	$\alpha_t=0.78$	0.83 (2 months)	Clinical status differences
Ireland (2008)	Sample 1: 383 adults prisoners	100	nc	nc	nc
United Kingdom	Sample 2: 383 adults prisoners	100	nc	nc	nc
	Sample 3: 250 adults prisoners	0	nc	nc	nc



Table 1. *continued*

Studies / Country	Participants	Male (%)	Cronbachs' Alfa	Test-retest (time interval)	Differences between groups
Ireland (2008)	Sample 4: 250 adults prisoners	0	nc	nc	nc
	Sample 5: 633 adults prisoners	60.51	nc	nc	No sex differences
United Kingdom	Sample 6: 250 adults prisoners	100	nc	nc	nc
	Sample 7: 220 adults prisoners	0	nc	nc	No sex differences
Singh (2008) India	120 e 50 adolescents from urban and rural zone	nc	nc	nc	No group and sex differences
	120 e 50 adolescents from urban and rural zone rural, respectively	nc	nc	nc	No group and sex differences
Stanford (2009) United States	1577 adults (18 to 45 years)	np	$\alpha_t=0.83$	0.83 (one month)	No sex differences
	164 clinical, 283 undergraduate and graduate students	np	$\alpha_t=0.79$	0.80	No clinical status differences
Orozco-Cabal (2010) Colombia	164 clinical, 283 undergraduate and graduate students	np	$\alpha_t=0.79$	0.80	No clinical status differences
	659 adolescents (10 to 20 years)	np	$\alpha_t=0.74$	0.66 (6 months)	Clinical status differences
Hartmann (2011) Germany	659 adolescents (10 to 20 years)	np	$\alpha_t=0.74$	0.66 (6 months)	Clinical status differences
	659 adolescents (10 to 20 years)	np	$\alpha_t=0.74$	0.66 (6 months)	Clinical status differences

is to enhance a practitioner to separate individuals into groups. In case of BIS-11, these groups comprise those who manifested high and low impulsivity scores. Nine studies (9/21) did not comprise subsamples of risk behavior or psychiatric conditions so the criterion-related validity could not be reported (Someya et al. 2001, Recio et al. 2004, Stanford et al. 2009, Ireland and Archer 2008, Bayle et al. 2000, Paarver et al. 2007, Spinella 2007, Oquendo et al. 2001, Singh et al. 2008). Twelve studies (12/21) investigated BIS-11 criterion-related validity. It was observed significantly association between BIS scores and a wide variety of risk behaviors. Seven studies (7/21) found BIS-11 total score has been positively associated with frequency of binge eating symptoms, getting drunk to cope with emotional problems, gambling, academic misconduct, alcohol consumption, cigarette smoking, aggression, presence of suicide ideation/attempting and inmate status (Fossati et al. 2001, Fossati et al. 2002, Hartmann and Rief 2011, Patton et al. 1995, Haden and Shiva 2008, Yao et al. 2007, Yang et al. 2007). The instrument also demonstrated good criterion-related validity to differentiate clinical and non-clinical. Nine studies (9/21) reported higher BIS-total scores in the presence of psychiatric conditions as ADHD, obsessive-compulsive, substance abuse, borderline and bipolar disorders (Patton et al. 1995, Preuss et al. 2007, Guleç et al. 2008, Orozco-Cabral et al. 2010; Haden and Shiva 2008, Fossati et al. 2001, Fossati et al. 2002, von Diemen et al. 2007, Li and Chen 2007).

### Factor structure

We also examined BIS-11 factor structure across samples. The results are shown on **table 2**.

Factor analyses of BIS-11 have been reported in twenty three samples (23/27) which included a range of participants with different ages, culture groups and psychiatric diagnoses. Factor analyzes results could be separated in 4 groups (see **table 2**): (1) studies that did not investigate BIS-11 internal structure, (2) samples that replicated the original BIS-11 three second-order factors, (3) samples that showed a different numbers and content factors than the original Barratt's proposal and (4) samples that tested only the unidimensionality of the instrument.

On the first group, four studies (4/27) did not investigate the items structure on their own data and used the original components proposed by Barratt to compute on BIS-11 scores (Oquendo et al. 2001, Paarver et al. 2007, Singh et al. 2008, Stanford et al. 2009). The second group of studies included three samples (3/27) that showed the three second-order factors were adequately replicated (Someya et al. 2001, Yao et al. 2007, Orozco-Cabal et al. 2010). According to these studies, motor, attentional and non-planning impulsiveness partial scores could be used to characterize impulsivity dimensions.

The results obtained from the third group of studies were that seventeen samples (17/27) did not identify three factors: (a) Five samples (5/17) did not replicated BIS-11 original structure and they did not show or discuss the factors composition (Bayle et al. 2000, Preuss et al. 2007, Ireland and Archer 2008, samples 2, 4 and 5),

(b) In six samples (6/17), three factors were identified, but the items organization differed from that found by Patton et al. (1995). The nature of the factors was different to those originally proposed for BIS-11 so the factors names were not maintained (Fossati et al. 2001, von Diemen et al. 2007, Li and Chen 2007, Hartmann and Rief 2011, Spinella 2007, Guleç et al. 2008). Some authors suggested new labels to the factors, e.g., general impulsiveness (Fossati et al. 2001), deficit in planning and looking ahead, lack of perseverance and self-control and propensity toward novelty-seeking and acting without thinking (Li and Chen 2007), distractibility, behavioral impulsivity and cognitive planning (Ireland and Archer, sample 5). (c) Finally, in six samples (6/17), authors reported only two factors (Fossati et al. 2002, Recio et al. 2004, Yang et al. 2007, Haden and Shiva 2008, Ireland and Archer 2008, samples 6 and 7). Frequently, these factors were labelled as nonplanning and general impulsivity factors (Recio et al. 2004, Yao et al. 2007, Fossati et al. 2002), behaviour or planning skills (Ireland and Archer 2008).

Moreover, Ireland and Archer (2008) used a confirmatory approach in 2 samples of men and women groups. The results indicated that BIS-11 was not a single-factor instrument (Ireland and Archer 2008, samples 1 and 3).

We could observe that non-planning impulsiveness dimension tends to be identified in most of studies more frequently than motor and attentional components (8/17). Specifically, attentional impulsiveness is the most unstable factor. Its items frequently load in other dimensions (Fossati et al. 2001, Fossati et al. 2002, Recio et al. 2004, von Diemen et al. 2007, Yao et al. 2007, Guleç et al. 2008, Ireland and Archer 2008, Spinella 2007, Hartmann et al. 2011).

We also compared BIS-11 factor organizations among samples from countries with similar primary language and cultural influences. Two studies reported results from United State samples (Spinella 2007, Haden and Rief 2008), two other samples were from Italy (Fossati et al. 2001, 2002) and two samples from Germany (Preuss et al. 2007, Hartmann et al. 2011). Results did not clarify the BIS-11 internal structure. There were differences in number of BIS-11 dimensions despite culture homogeneity within the samples.

Analyzing the internal structure of the items on BIS-11 construct validity studies, we found a use of two statistical methods to describe the variability among items in terms of reduced latent variables: exploratory and confirmatory factor approaches. In thirteen samples (13/23), BIS-11 factor structured was evaluated using an exploratory approach (Patton et al. 1995, Orozco-Cabal et al. 2010, Baylé et al. 2000, Fossati et al. 2001, Recio et al. 2004, von Diemen et al. 2007, Li and Chen 2007, Spinella 2007, Guleç et al. 2008, Ireland and Archer 2008, Preuss et al. 2007, Haden and Shiva 2008, Hartmann et al. 2011). In ten samples (10/23), the confirmatory approach was employed (Someya et al. 2001, Fossati et al. 2002, Yang et al. 2007, Yao et al. 2007, Ireland and Archer 2008). There was no pattern on the number of factors obtained according to the method applied. The models adjusted by confirmatory approach indicated consistently low probability of items organization adequacy as proposed by Patton et al. (1995). The correlations observed between dimensions ranged from



**Table 2.** Main results regarding BIS-II factorial analyses

Number of factors	Studies	Factorial Method / Rotation	Original items distribution on observed factors		
			Factor 1	Factor 2	Factor 3
3 factors identical to original proposed	Patton (1995)	EFA / Promax	A	M	NP
	Someya (2001)	CFA	M	A	NP
	Yang (2007)	CFA	M	A	NP
3 factors different to original proposed	Orozco-Cabal (2010)	EFA / Varimax	M	A	NP
	Fossati (2001)	EFA / Promax	M + A	M	NP
	von Diemen (2007)	EFA / Varimax	NP + A	M + NP	NP
	Li (2007)	EFA / Varimax	A+M +NP	A+M	A+M +NP
	Spinella (2007)	EFA / Varimax	NP	M	A
	Güleç et al. (2008)	EFA / Promax	A+M +NP	M + NP	A+M +NP
	Ireland (2008) Sample 5	EFA / Varimax	A + NP	M +NP	M + A
	Ireland (2008) Sample 6	CFA	NP + A	M +NP	M + A
	Hartmann (2011)	EFA / Promax	M +A	NP	M

Table 2. continued

Number of factors	Studies	Factorial Method / Rotation	Original items distribution on observed factors		
			Factor 1	Factor 2	Factor 3
3 factors different to original proposed	Baylé (2000)	EFA / NP	***	***	***
	Preuss (2007)	EFA / NP	***	***	***
	Ireland (2008) Sample 2	CFA	***	***	***
	Ireland (2008) Sample 4	CFA	***	***	***
	Ireland (2008) Sample 1	CFA	***	***	***
	Ireland (2008) Sample 3	CFA	***	***	***
	Recio (2004)	EFA	M + A	NP + A	-
2 factors	Haden (2008)	EFA / Varimax	M + A	NP + A	-
	Yao (2007)	CFA	M + A	NP	-
	Fossati (2002)	CFA	M + A	NP	-
	Ireland (2008) Sample 7	CFA	NP + A	M + NP	-
Studies did not investigate the scale dimensionality	Oquendo (2001)	NC	NC	NC	NC
	Paaver (2007)	NC	NC	NC	NC
	Singh (2008)	NC	NC	NC	NC
	Stanford (2009)	NC	NC	NC	NC

Legend: NC: Value did not calculate; EFA: Exploratory Factor Analysis; CFA: Confirmatory Factor analysis; M: motor impulsiveness; A: attention impulsiveness; NP: non-planning; impulsiveness; \*\*\* Items organization was not showed on the publication;

0.06 to 0.59. Associations between factors suggested the dimensions tend to be associated but independent.

## Discussion

BIS-11 is a self-report questionnaire developed to assess three impulsiveness components of impulsivity construct: attentional, motor and nonplanning (Patton et al. 1995). The aim of our study was to synthesized evidences from BIS-11 psychometric proprieties within different samples. Evidences about instrument reliability and internal organization are important to assess impulsivity psychological trait (American Educational Research Association [AERA], American Psychological Association [APA] and National Council on Measurement in Education [NCME] 1999). We could observed items homogeneity and that total score tend to be stable across time. However, most of these studies have failed to uphold the three-factor original model proposed by Patton et al. (1995). These results indicate that scale is reliability across diverse cultures and samples, despite that, there is no consensus about the impulsivity dimensions evaluated by the instrument.

In sum, Cronbach's alphas reported ranged from 0.69 to 0.80 which suggests that the set of items has a satisfactory homogeneous quality. To assess the retest stability, the studies calculated the correlation between BIS-11 total scores. Moderate to large magnitude of retest-reliability coefficients indicated that instrument tend to produce similar scores patterns at least one month after the first evaluation. The fact that BIS-11 total score significantly discriminated between "high frequency" and "low-frequency" subjects in terms of alcohol intake, frequency of loss eating control and presence of psychopathology disorders (Hartmann et al. 2011) indicated evidences of criterion-related validity. The instrument could be considered a helpful screening tool to identify impulsivity personality tendencies in clinical and nonclinical individual likewise to risk behaviors samples.

Impulsivity has been invoked as one explanatory variable of sociodemographic differences in maladaptive behaviours. In recent meta-analysis, Cross et al. (2011) showed that men drive more recklessly and have higher death rate from no vehicle accidents than women. They also tend to suffer from a range of externalizing psychopathologies. Higher levels of motor impulsivity in men were associated to sex differences in risk for alcohol problems (Stoltenberg et al. 2008). Moreover, there were evidences that impulsivity has been correlated negatively and significantly with academic and work performances. Hair et al. (2006) found high total scores in BIS-11 from female students were associated with low academic performance assessed at two points in the first year. In our review, different from Patton et al. (1995) and Stanford et al. (2009) postulate, sex differences in BIS-11 total score and internal structure were identified in selected samples (Fossati et al. 2002, Yao et al. 2007, Ireland and Archer 2008, Spinella 2007).

In a work situation, Shiffrin et al. (2011) pointed out college students with ADHD exhibited more on-the-job difficulties than their non-ADHD peers. Frequently work related symptoms were "I am easily distracted", "difficulty sustaining attention" and "fidgets or squirms

in seat." All these symptoms are associated with impulsivity traits. Moreover, younger adult are at relatively high probability for risk behavior (e.g.: alcohol and gambling problems) because of brain maturation events relevant to behavioral control (Chambers and Potenza 2003). In our review, different from Patton et al. (1995) and Stanford et al. (2009) postulate, the influence of other demographic variables also indicated that education and age could contribute to BIS-11 scores (Someya et al. 2001, Haden and Shiva 2008, Spinella 2007, Preuss et al. 2007). The evidences about sex, age and education differences in BIS scores emphasize the importance to investigate the influence of demographic variables on the interpretation of scale scores.

We noted some inconsistencies in the number and in the content of dimensions assessed by BIS-11 across the samples. The results indicated that there is no consensus about which components could be observed in face of the instrument's original validated study (Fossati et al. 2001, von Diemen et al. 2007, Li and Chen 2007, Hartmann and Rief 2011, Spinella 2007, Guleç et al. 2008, Fossati et al. 2002, Recio et al. 2004, Yang et al. 2007, Haden and Shiva 2008, Ireland and Archer 2008, samples 6 and 7). Non-planning impulsiveness tends to be identified in most of the studies and attentional impulsiveness is the most unstable factor. (Fossati 2001, Fossati 2002, Recio 2004, von Diemen 2007, Yao et al. 2007, Guleç et al. 2008, Ireland and Archer 2008, Haden and Shiva 2008, Hartmann et al. 2011). This instability of attentional items is convergent evidence for Patton's who proposed that cognitive impulsivity aspects is a general process underlies personality trait of impulsiveness as a whole (Patton et al. 1995, Hartmann et al. 2011). Sonuga-Barker also hypothesized that problems with the attentional system may result in general impulsive behaviour (Sonuga-Barker 2002). Due to different content configuration, authors from the selected articles suggested a modification of the original factors' names in order to better represent the content measured by each one (e.g.: Fossati et al. 2002, Hartmann et al. 2011).

It could be hypothesized that structures difference were influenced by culture interpretation and comprehension of affirmatives. Byrne (2008) has emphasized how important is to take account into cultural issues in instruments adaptation. Cultural differences could influence in items distribution on factors. The author suggests structural equation modelling approach to test instruments factorial structure equivalences for the cross-group invariance. Chahin et al. (2010) compared the factorial congruence between Spanish and Colombian BIS-11 versions for children samples even these cultures share the same language. The results confirmed that both adaptations have the same dimensionality. In this review, the comparison of BIS-11 factor structures among samples that share both language and culture indicated differences in numbers factors. It could mean that cultural and linguistic backgrounds can influence BIS-11 responses, but we cannot simply assume that they are the major cause to explain the structure variability among samples. We recommend future studies to test whether the instrument measure same constructs in different samples using empirical approach proposed by Byrne (2008).

Two types of factor analyses have been used to

investigate the second-order structural validity of BIS-11 across twenty-three samples: exploratory factorial analysis (EFA) and confirmatory factor analysis (CFA) (Byrne 2009). EFA seeks to identify the smallest number of factors which can explain the observed correlations among a set of items while CFA is based on available theoretical knowledge or empirical research, and investigators must specify a prior exact factor model they would intend to test (Byrne 2009). CFA could be considered a more powerful and direct method of testing a hypothesized BIS-11 structure. In our review, the authors used these two approaches to analyze the variability among items responses. We could not found a consistence solution (two or three-factor solutions) among selected studies using the same statistical approach. Groups of exploratory and confirmatory studies did not converge to similar number and content factors.

The main point to justify the interest about BIS-11 psychometric proprieties is that this instrument has been influencing the conceptualization of impulsiveness construct on the last decade (Hartmann et al. 2011, Evenden 1999). It is important to identify which dimensions BIS-11 really evaluate given that impulsivity is a complex construct and the instrument is one of the most used impulsivity self-report measure in clinical and research contexts. Although Patton et al. (1995) indicated an internal organization of BIS-11, not all researches have supported this structure. One practical consequence from factors inconsistencies is that impulsivity BIS-11 components could be wrongly scored due to the inexistence of a stable structure across samples (AERA, APA, NCME 1999). Inasmuch as impulsiveness is a complex construct, identifying its components and understanding the relative contribution of each one is critical for characterizing an individual's general level of impulsiveness and the underlying dimensions of his behavior (Eveden 1999). It is strongly recommend a theoretical review of Barratt proposals.

Noteworthy evidences were summarized from studies conducted in different social and cultural environments. They were identified from different bibliographic databases without limit time period and from hand-searched for relevant citations. Finally, we have examined a great number of BIS-11 studies with a systematic approach to extract data. In the presence of this review, our results could be considered meaningful about BIS-11 psychometrics proprieties. In summary, the review suggests BIS-11 as a useful research and clinical tool since it allows differentiating extreme impulsivity groups and assessing impulsivity as stable pattern of behavior across medium time intervals. However, despite widely used, our outcomes demonstrate that a critical question remain open about which are the real dimensions assessed by BIS-11. Our findings must be interpreted in view of limitations. The large range of age and clinical of samples' clinical characteristics could be pointed out as an influence to understand items and behaviour control variation throughout life span. Second, the different samples characteristics and statistical approaches used to investigate instrument's internal structure could influence the conclusions about BIS-11 scores. Moreover, we did not control the translations and adaption processes from original English version. The quality of these

processes could improve scale's reliability and validity (Stanford et al. 2009).

Accumulating evidences from this review must be considered. This systematic review is helpful in identifying a new research question about which are the impulsivity dimensions evaluated by BIS-11. The results illustrate the importance of new efforts to explore BIS-11 empirical and theoretical structure rather than applying the initial model to calculate partial and total scores (Spinella 2007, Ireland and Archer 2008). Factorial analysis conducted by Patton et al. (1995) was very important to design the items into partial scores. This factorial approach is large used in personality psychology and contains some limitations for being a result of empirical research. To consolidate Patton's empirical findings and BIS-11 scores interpretation, a theoretical impulsivity model must have been developed.

Advances in model proposed by Barratt could be obtained by updating the theoretical and the empirical framework with the purpose to understand these dimensions and their relations with each other and with external criteria. The instability on the numbers and on assessed factor's content is a problematic issue. It could lead to clinical and research implications due to potential misinterpretation of scores used to characterize clinical and non-clinical groups with distinguished impulsivity profiles and to associate self-report scores with performance in neuropsychological tests and also with genetic polymorphism (Stanford et al. 2009).

To future research, we recommend the investigation of differences in the structural fits and in the scores between adolescents and adults in order to provide age-specific norms. It will be also important to use confirmatory procedures to analyze BIS-11 factor structure comparing the fitness between two- and three-factor models and to investigate associations between dimensions. Theoretical and empirical items analyses are an interesting strategy to identify evidences about items relevance to measure impulsivity and if some items could be better represented in different original factor. A quantitative analysis based on parameters of Item Response Theory could be conduct to verify BIS-11 items psychometric characteristics. Items could be investigated using a qualitative strategy which focused on item content that was not related to impulsivity components previously described.

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