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A systematic review on WAIS-III's research with a special focus on clinical studies

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Abstract

This systematic review was performed to explore (1) the main goal of the publications, (2) the inclusion criteria used for the most studied neurological samples, and (3) the main conclusions of the clinical/neurological/psychiatric studies which used the core/whole Wechsler Adult Intelligence Scale third edition (WAIS-III). EBSCO Host database was searched three times (2011, 2013 and 2014) using the keyword "WAIS-III" and the only limiters applied were "full text" and "scholarly (peer reviewed) journals". A total of 226 articles were identified. We classified 23 articles as no WAIS-III focus nor data, 28 as focused on other tests but with WAIS-III data, 28 as theoretical articles, 13 as articles on WAIS-III short-forms, 46 as articles with the technical manual samples, and 88 as articles with various kinds of samples. At the end, we came to the conclusions that (a) most of the articles published on this systematic review have neuropsychological issues as the main target, (b) most TBI samples focus on moderate severity, and in 18 out of 20 articles with the so called "mixed neuropsychiatric samples", there is no selection of brain injury samples according to injury localization, finally (c) it was not found an exclusive profile specific to brain injury.

Keywords

WAIS-III, brain injury, systematic review.

Introduction

Although Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV) is already available in several non-English speaking countries (namely, France, Germany, Spain, Sweden, Danmark, Norway, Netherlands, India and Chile), many others countries (where Portugal is included) still use the WAIS-III, because they don't have the WAIS-IV standardization for their countries and/or because there is the clinical information we have now about WAIS-III make it a better clinical instrument than the WAIS-IV.

The Wechsler Adult Intelligence Scale – Third Edition (WAIS-III) was standardized in the United States of America (1997, *N*=2450), and extended for Australia (1997, *N*=297) and for the United Kingdom (1999, *N*=332). It was also standardized in Spain (1999, *N*=1369), France (2000, *N*=1104), Canada (2001, *N*=1100), China (2002, *N*=888), Mexico (2003, *N*=970), Finland (2005, *N*=446), Germany, Austria and Switzerland (German version, 2006, *N*=1181), and Portugal (2008, *N*=1181). Sweden (2003) and Denmark (2005) only translated the battery. South Africa (2010, *N*=84) published the preliminary studies on the standardization of the WAIS-III.

In 2008, the Portuguese technical manual included the results of the US clinical trial field samples and three national clinical small samples: temporal lobe epilepsy, schizophrenia and depressive states. Although the manual showed the results of the clinical US samples, we decided to look for more. Thus, the main goal of this research was to explore what kind of samples is being studied with the WAIS-III, knowing ahead that we had a special interest on the neurological samples.

In detail, this systematic review was performed to explore (1) the main goal of the publications, (2) the criteria used to select subjects for clinical/neurological studies, and (3) the main conclusions of the clinical/neurological studies which used the core or the whole battery.

Methods

EBSCO Host database (including PsychARTICLES, PsychINFO, Academic Search Complete, Education Source, and Psychology and Behavior Science Collection) was searched using the keyword "WAIS-III" and the limiters applied were "full text" and "Scholarly (peer reviewed) journals". The search took place in 2011-06-08, 2013-01-29 and 2014-01-14, always using the same search strategy: no language or publication date limiters were applied. Based on this process, 226 articles written in English and in Spanish, dated between 1998 and 2013, were identified.

Results and Discussion

(1) Classifying the publications according to main target and to main goal

As shown in Table 1, the three journals that published more articles on WAIS-III were journals focused on Neuropsychology. Table 1, also shows that the years with more publications are almost a decade after the US publication of the battery (1997), the top publication years vary from 2005 to 2010. Analyzing the journals that published more articles at Table 1, it seems that this battery, initially made for intelligence and intellectual disabilities assessment, apparently became a neuropsychological assessment standard.

Table 1. Journals that published more than 4 articles about WAIS-III, according to the year of publication.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	**TOTAL**
The Clinical Neuropsychologist	1	1	4	2	4	4	5	3	3	2	3	4					**36**
Journal Clinical Experimental Neuropsychology			1			1	6	4	4	4	2		3				**25**
Applied Neuropsychology		1	1	1	1		2			4	4	7		2	1		**24**
Psychological Assessment		2	5	1	1	1	3		2	1				1			**17**
Intelligence				1	2	1			4	1		1	1				**11**
International Journal of Neuroscience		1	1	1	2		1	1				2					**9**
Journal of Clinical Psychology			1	1		2		1	1	1							**7**
… others with 4 or less articles	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	**97**
	1	**6**	**15**	**12**	**14**	**13**	**20**	**16**	**22**	**25**	**21**	**20**	**18**	**8**	**10**	**5**	**226**

Next, the reading and rating each item in accordance with its primary objective allowed a finding of 23 articles with word WAIS-III mentioned in the article but with no empirical WAIS-III data, 28 theoretical and/or no sample articles, 13 articles about the short-forms, 46 articles with standardization and/or technical manual samples, 28 articles focused on other tests (e.g., validation of other tests/tasks), and 88 articles with various kinds of samples and empirical data.

From the 23 articles somehow had the word WAIS-III on the text, that made them selected by the database, but the article didn't give any WAIS-III data, 10 focused on other WAIS versions or other Wechsler Scales (Crum, 2000; McPherson et al., 2000; Ryan et al., 2000; McCarthy et al., 2003; Saklofske et al., 2003; Hawkins & Tulsky, 2004; Tulsky, 2004; Lucas et al., 2005; Ryan et al., 2005; Herreras, 2010), 10 focused on other tests (Tishler et al., 2006; Williams & Donovick, 2008; Velassaris et al., 2009; Rabin et al., 2008; García-Molina et al., 2010; Herreras, 2010; Vilaseca et al., 2010, Juncos et al., 2011; Theodore et al., 2012; Tseng et al., 2013), and finally 3 papers had nothing to do with Wechsler Scales nor related tests (Roid et al., 2005; Karson, 2004; Berry, 2008).

The 28 theoretical articles and/or articles with no sample could be subdivided in groups. Three articles were books reviews (Gregory, 2001; Donders, 2004; Larabee, 2004). Some were focused on the revision of the test and corrected norms (Nell, 1999; Okasaki & Sue, 2000; Tulsky & Ledbetter, 2000; Holdnack et al., 2004; Walker et al., 2009; Shuttleworth-Edwards, 2012), Flynn effect (Russell, 2007; Flynn, 2009), and index scores (Longman, 2004, 2005). Eight articles were focused on intellectual disabilities (Charter, 2003; Frumkin, 2006; Crawford et al., 2007; Whitaker, 2008; Suen & Greenspan, 2009a, 2009b; Escobedo & Hollingworth, 2009; Brooks et al., 2009). The rest of the articles focused on neuropsychological assessment (Herrera, 2008; Crawford & Garthwaite, 2009), short-form (Crawford et al., 2008), malingering (Mittenberg et al., 2002), specific subtests (Shuttleworth-Edwards, 2002; van Ommem, 2005), and gender effect (Molenaar et al., 2009).

There were 13 articles that focused on different ways of short-forms for different kinds of population (Pilgrim et al., 1999; Ryan et al., 1999; Ryan & Ward, 1999; Axelrod & Ryan, 2000; Schopp et al., 2001; Donders & Axelrod, 2002; Kulas & Axelrod, 2002; Clara & Huynh, 2003; Alley et al., 2007; Christensen et al., 2007; Lange et al., 2007; Dura et al., 2010). Among these articles there were several forms to abbreviate the WAIS-III: the most common way was to reduce the number of subtests (we found versions with 9, 7, 4 and 2 subtests), the other way was to reduce the number of items per subtest (we found at least three ways to select items). The only study that compared these two ways to abbreviate the WAIS-III (Kulas & Axelrod, 2002) gave the primacy to the reduced subtest form (SF-7) over the reduced-item form (Staz-Mogel SF).

There were 46 articles based on the standardization or clinical samples described in the technical manual. Out of these 46 studies, we found five that concerned the clinical field trial samples, all with English speaking samples (Hawkins, 1998; Wilde et al., 2004; Schoenberg et al., 2003; Schoenberg et al., 2006; Lange & Chelune, 2007). In fact, only 8 out of these 46 papers were made with non-english speaking samples (Gregoire, 2001; Colom et al., 2002; Juan-Espinosa et al., 2002; Dolan et al., 2006; Renteria et al., 2008; Grieve & van Eeden, 2010; Roivainen, 2010; Golay & Lecerf, 2011).

The remaining of these 46 studies used samples with English-speaking samples from United States of America, Canada, Australia or United Kingdom and were focused on sampling or updating norms (Bowden et al., 2003; Wycherley et al., 2005), demographic variables effects (Kaufman, 2000, 2001; Dori & Chelune, 2004; Lange, Chelune et al., 2006; Saklosfke et al., 2008), factor analysis (Caruso & Cliff, 1999; Saklosfke et al., 2000; Ward et al., 2000; Tulsky & Price, 2003; Taub et al., 2004; Bowden et al., 2006; Bowden et al., 2007;

Lange, 2007), *g* and General Ability Index (Tulsky et al., 2001; Lange et al., 2005; Saklosfke et al., 2005; Gignac, 2006a; 2006b; Kane & Krenzer, 2006; Lange et al., 2006; Lange, Chelune, & Tulsky, 2006), Oklahoma Premorbid Intelligence Estimate, OPIE-3 (Schoenberg et al., 2002; Schoenberg et al., 2004; Schoenberg et al., 2005), focused only on some subtests as Letter Number Sequencing (Tulsky & Zhu, 2000) or Digit Symbol (Joy et al., 2003; Ryan, Kreiner, & Tree, 2008), and finally focused on other theoretical issues (Tulsky et al., 2000; Zhu & Tulsky, 2000; Reddon et al., 2004; Allen & Barchard, 2009).

There were 28 articles focused on other tests or tasks but showing WAIS-III data, these papers could be divided in two: 18 that used the core or the whole battery (Martin et al., 2000; Bell et al., 2001; Devaraju-Backhaus et al., 2001; Lassiter et al., 2001; Titus et al., 2002; Loring et al., 2002; Mathias et al., 2007; Barker-Collo et al., 2008; Ford et al., 2008; Forn et al., 2008; Green et al., 2008; O'Hara et al., 2008; Wilbur et al., 2008; Cioe et al., 2010; Misdraji & Gass, 2010; Barker-Collo et al., 2011; Olivar-Parra et al., 2011; Wieland et al., 2012) *versus* 10 that used only some subtests (Carey et al., 2004; Fisher & Rose, 2005; Kilgore et al., 2005; O'Hora et al., 2005; Scott et al., 2006; Zook et al., 2006; Esperanza, 2007; Barreyro et al., 2009; Haatveit et al., 2010; Cabrera et al., 2011).

Finally, 88 articles had various kinds of samples. We decided to divide them again in two groups: those which used the core or the whole battery (n=47) and those which used only some subtests (n=41), as summarized in Table 2.

Table 2. Articles using the whole WAIS-III or some subtests with various kinds of samples.

	The whole WAIS-III was used	**Only some subtests were used**
Neurological samples	Martin et al. (2002) – Epilepsy Lange & Chelune (2006) – Alzheimer's Disease (AD) Moyle et al. (2007) – Phenilketonuria Ryan et al. (2009) – lateralized lesion Murayama et al. (2010) – Mild Cognitive Impairment Arreguín-González et al. (2011) – Cerebellar tumors Li et al. (2012) – AD and Mild Cognitive Impairment **Only Traumatic Brain Injury (TBI) samples:** Fisher et al. (2000) Axelrod et al. (2001) Axelrod et al. (2002) Van der Heidjen & Donders (2003) Langeluddecke & Lucas (2003) Langeluddecke & Lucas (2004) Strong et al. (2005) Greve et al. (2008) Blake et al. (2009) Walker et al. (2010)	Dugbartey et al. (1999) – Matrix Reasoning Bowler et al. (2001) – PSI+WMI subtests Earnst et al. (2001) – WMI subtests Wilde & Strauss (2002) – Digit Span Costello & Connolly (2005) – Picture Arrangement Stubberud et al. (2007) – Letter Number Sequencing Tranel et al. (2008) – Matrix Reasoning Dean et al. (2009) – Vocabulary and Digit Span Fucetola et al. (2009) – Block Design + Matrix Reasoning + Picture Arrangement Karzmark (2009) – Arithmetic Introzzi et al. (2010) – Matrix Reasoning Blanco-Rojas et al. (2013) – Digit Span **Only TBI samples:** Kennedy et al. (2003) – PSI+WMI subtests Noe et al. (2010) – WMI subtests

Psychiatric and neuropsychiatric samples	Ryan et al. (2002) – mixed sample Basso et al. (2002) – mixed sample Miller et al. (2004) – mixed sample Gorlyn et al. (2006) – Major Depression Iverson et al. (2006) – mixed sample Ryan et al. (2006) – mixed sample Ryan et al. (2007) – Substance Abuse Disorders Yao et al. (2007) – Schizophrenia Glass et al. (2009) – mixed sample Lin et al. (2010) – substance abuse Lin et al. (2012) – Schizophrenia Shan et al. (2013) – schizophrenia	Kreiner & Ryan (2001) – Digit Symbol Coding Zakzanis et al. (2003) – Vocabulary O'Bryan & O'Jile (2004) – Vocabulary Ditmann et al. (2007) – Letter Number Sequencing Glass et al. (2007) – Digit Symbol Tokley & Kemps (2007) – Object Assembly Pollice et al. (2010) – Digit Span Bossman et al. (2012) – Digit Span Bouso et al. (2012) – Letter Number Sequencing
Educational samples	Jones et al. (2006) – Low IQ sample Bigler et al. (2007) – Autism Fitzgerald et al. (2007) – Learning Disabilities Graue et al. (2007) – Mental Retardation Hayes et al. (2007) – Intellectual disability in prison Spinks et al. (2007) – School achievement Wierzbicki et al. (2007) – Learning and Attention Spek et al. (2008) – Asperger Syndrome Whitaker & Wood (2008) – Learning Disability Tirri et al. (2009) – Mathematically Gifted Students Copet et al. (2010) – Prader-Willi syndrome Gordon et al. (2010) – Special education students Nunes et al. (2013) – Williams Syndrome	Stearns et al. (2004) – WMI subtests Cheung et al. (2012) – Vocabulary, Similarities, Picture Completion and Block Design
Research samples (i.e., volunteers with no clinical diagnosis and/or students)	Abad et al. (2003) – University students Shuttleworth-Edwards et al. (2004) – South Africa Van der Sluis et al. (2006) – gender groups Greenaway et al. (2009) – MOANS Davis et al. (2011) – university students	Jung et al. (2000) – no Comprehension, Object Assembly and Picture Arrangement Mix & Crews (2002) – Block Design + Digit Symbol Lemay et al. (2004) – Letter Number Sequencing Shuttleworth-Edwards et al. (2004b) – Digit Symbol Hopko et al. (2005) – 5 performance subtests Cannon et al. (2006) – WMI+PSI subtests Etherthon et al. (2006) – PSI subtests Schwarz et al. (2006) – Digit Span + Vocabulary + Digit Symbol Coding + Symbol Search Cottone et al. (2007) – Comprehension + Similarities Ryan & Tree (2007) – 5 performance subtests Rozencwajg & Bertoux (2008) – Similarities Ryan et al. (2008) – supplementary and optional subtests Cannon et al. (2009) – WMI+PSI subtests Hill et al. (2010) – WMI subtests Davis & Pierson (2012) – Digit Symbol Coding Holtzer et al. (2012) – Vocabulary + Digit Symbol

Note: WMI = Working Memory Index, PSI = Processing Speed Index.

In sum, from the big pool of 226 papers on WAIS-III, the two most popular focus were studies with various kinds of samples on WAIS-III (n=88, 39%) and technical/psychometric studies made with the standardization samples (n=46, 20%). We were especially interested in these 88 "sample" studies, and we were surprised that only 15 papers included educational samples; against the 21 university and/or community samples, the 21 psychiatric or neuropsychiatric samples and the 31 neurological samples. We also noticed that slightly more than half of these 88 papers used the whole or the core battery (n=47) and the remaining used only one or a few subtests (n=41). We think this reflects the actual clinical use of the WAIS-III, as we all know that there are several environments where only a few subtests are used.

Last but not the least, looking in some detail to the last column of Table 2, we find out that the most popular subtests studied in these papers seemed to be Processing Speed Index's subtests (Digit Symbol Coding and Symbol Search), Working Memory Index's subtests (Digit Span, Arithmetic and LNS) and Matrix Reasoning (new subtest in this battery). Once again, these issues are very important in the neuropsychological assessment, once they enable levels of analysis focused on more specific neurocognitive functions.

(2) Criteria used for the selection of neurological samples

Next, we wanted to know the criteria used to select the more frequently studied neurological samples. It didn't matter if the study was based (1) on the core/whole WAIS-III, (2) on some subtests from the battery, (3) on WAIS-III short-forms or (4) on the validation/study of other tests. So we went back to the 226 articles and we selected all that had Traumatic Brain Injury (TBI) samples (Table 3) and "mixed neurological" samples (Table 4).

As shown in Table 3, there were 19 articles with TBI samples. A large number of articles had mild TBI subsample, but most the articles focus on moderate, moderate-severe or severe TBI. Near half of the articles didn't have a control group without TBI, 5 articles have a subsample of the standardization sample, and 4 articles had control samples with other clinical etiologies. Although most of the articles described the sample in detail (e.g., loss of consciousness, post-traumatic amnesia, time elapsed since injury), there were still 6 articles that didn't categorize their samples in severity of the TBI.

Table 3. TBI samples: frequency of different severities by samples.

		MTBI	M-MoTBI	MoTBI	Mo-STBI	STBI	ESTBI	Total TBI	Controls with no TBI
1	Fisher et al. (2000)	23			22			**45**	**45 matched from the standardization sample**
	Axelrod et al. (2001)		46					**46**	**n.r.**
	Axelrod et al. (2002)		51					**51**	**n.r.**
	Van der Heidjen & Donders (2003)	78			88			**166**	**n.r.**
	Langeluddecke & Lucas (2003)			35		74	41	**150**	**50 matched from the standardization sample**
	Langeluddecke & Lucas (2004)			35		74	41	**150**	**50 matched from the standardization sample**
	Miller et al. (2004)	15		3		10		**27**	**30 alcohol abuse + 43 polysubstance abuse**
	Strong et al. (2005)	53			47			**100**	**100 matched from the standardization sample**
	Greve et al. (2008)	127			84			**211**	**93 other neurological diagnosis**
	Blake et al. (2009)	18		8		31		**57**	**61 pseudoneurologic controls**
	Walker et al. (2010)							**196**	**n.r.**
2	Kennedy et al. (2003)	26		20		20		**66**	**n.r.**
	Noe et al. (2010)							**239**	**n.r.**
3	Schopp et al. (2001)							**118**	**n.r.**
	Donders & Axelrod (2002)	41			51			**100**	**100 matched from the standardization sample**
	Reid-Arndt et al. (2011)							**176**	**n.r.**
4	Martin & Donders (2000)	29			31			**53**	**n.r.**
	Green et al. (2008)							**24**	**n.r.**
	Wilbur et al. (2008)							**42**	**42 Learning Disabilities + 42 Emotional Diagnosis**

Note: n.r. = not reported; MTBI = Mild Traumatic Brain Injury (TBI); M-MoTBI = Mild to moderate TBI; MoTBI = Moderate TBI; Mo-STBI = Moderate to severe TBI; STBI = Severe TBI, and ESTBI = Extremely severe TBI. 1 = used 11, 13 or 14 subtests to study the TBI sample; 2 = used some subtests to study the TBI sample; 3 = short-form studies, and 4 = focus on other tests.

As it can be seen on Table 4, there were 20 articles that had mixed neurologic and/or neuropsychiatric samples. Only two of these articles described the subjects according to brain injury location: different locations of the prefrontal cortex but only matrix reasoning subtest (Tranel et al., 2008), and right versus left hemisphere injuries in the whole battery performance (Ryan et al., 2009). The remaining of the articles are mainly large series of accumulations of patients with various kinds of etiologies that vary a lot in age and gender.

Table 4. Mixed neurological/neuropsychiatric samples: Frequencies of the main etiologies and *M* and *SD* of demographic variables.

		N	**Neurologic diagnosis (*n*)**	**Psychiatric Diagnosis (*n*)**	**Unspecified clinical diagnosis or others (*n*)**	**Demographic variables by subsample**
1	Basso et al. (2002) – 3 and 6 months interval	51			51 patients screened for neurological and psychiatric disease	Age: 24.6 Education: 14.4 Gender: reported Ethnicity: reported
	Ryan et al. (2002) – Low versus high scatter groups	40 + 40	2/3 dementia	9/7 nonpsychotic 2/1 psychotic 21/20 substance abuse	5/3 brain injury 1/6 medical disorders	n= 40 / 40 Age: 50.18 SD 14.32 / 50.95 SD 12.92 Education: 13.12 SD 2.0 / 13.02 SD 2.12 Male: 100% / 100% Ethnicity: reported Handedness: reported
	Miller et al. (2004) – TBI versus Alcohol versus Polysubstance	100	27 head trauma	30 alcohol abuse 43 polysusbstance abuse		n= 27 / 30 / 43 Age: 33.44 SD 10.35 / 50.90 SD 11.37 / 42.40 SD 5.85 Education: 12.04 SD 1.7 / 11.93 SD 1.91 / 12.79 SD 1.54 Gender: 15M 12F / 29M 1F / 42M 1F Ethnicity: reported
	Iverson et al. (2006) – neuropsychiatric versus forensic groups	40 + 60		26 schizophrenia spectrum disorder 16 substance abuse 5 bipolar disorder	40 neuropsychiatric patients 13 undiagnosed forensic	n= 40 / 60 Age: 45.5 SD 11.4 / 36.3 SD 13.1 Education: 11.5 SD 2.9/ 10.2 SD 2.4 Male: 62,5%/85% Ethnicity: reported
	Ryan et al. (2006)	174	86 TBI 40 stroke 16 dementia 15 seizure disorders 5 tumor 2 meningitis 2 encephalitis 2 multiple sclerosis 2 encephalopathy			Age: 49.19 SD 15.33 Education: 12.57 SD2.78 Gender: 116M 58F Ethnicity: reported Control group: standardization sample (n=2450)
	Ryan et al. (2009) – left versus right hemisphere injury	36	20 vascular 14 TBI 1 Tumor 1 Tumor+TBI			n= 20 / 16 Age: 46.25 SD 17.42 / 47.86 SD 16.83 Education: 12.17 SD2.87 / 12.27 SD2.46

2	Dugbartey et al. (1999) – study 1	41	8 TBI 6 neurotoxin exposure 2 cerebral neoplasm 2 subarachnoid hemorrhage	5 unipolar depression 4 alcoholism	3 asymptomatic HIV 11 mixed diagnosis	Age: 38.2 SD 12.1 Education: 12.5 SD 2.81 Gender: 22M 19F Ethnicity: reported Handedness: reported
	Dugbartey et al. (1999) – study 2	14	2 seizure disorders 1 cerebrovascular 1 cerebral neoplasm	1 depression 1 schizophrenia	4 short-term memory loss 2 cardiac disease 1 hypertension 1 chronic renal disease	All immigrants Age: 55.56 SD 17.9 Education: 4.5 SD 4.3 Gender: 7M 7F Ethnicity reported
	Wilde & Strauss (2002)	44	35 TBI		9 various etiologies	Age: 37.1 SD 13.9 Education: 12.4 SD 2.0 Gender: 26M 18F
	Costello & Connolly (2005)	400			4x100 archival samples of two laboratories (no diagnosis)	Age: reported Gender: reported Education: n.r. Ethnicity: reported
	Tranel et al. (2008)	160	101 cerebrovascular 56 surgical resection* 3 herpes simplex encephalitis			Demographics reported for each of the four subsamples created.
	Karzmark (2009)	118	23 dementia 18 TBI 15 cerebrovascular 8 developmental 6 anoxia 4 tumor 7 others		25 psychiatric disorder 12 no diagnosis	Age: 47.2 SD 16.1 Education: 15.0 SD 2.9 Gender: 77M 41F Ethnicity: reported
	Bossman et al. (2012)	92	55.4% ischaemic stroke 16.3% haemorragic str. 7.6% Subarachnoid haemorrhage 5.4% post-anoxic 12% TBI 1.1% brain abscess 2.2% brain tumor			Age: 55.6 SD14.6 Education: 38.9% high school Gender: 48M 34F Consecutive inpatients
3	Pilgrim et al. (1999)	111	10.8% seizure disorder 9.9% TBI 9.9% vascular 3.6% subcortical dementia 1.8% hydrocephalus 1.8% encephalitis 2% brain tumor 9% Parkinson's disease		21.6% mental health 18.9% motor vehicle accident 4.5% learning disability 4.5%developmental 1.8% systemic lupus erythematosus 1.8% electrical injury 6.3% unspecified or multiple etiologies	Age: 40.49 SD 18.04 Education: 11.82 SD2.33 Gender: 65M 46F Ethnicity: reported Handedness: 85,6% right

	Axelrod & Ryan (2000)	278			278 patients referred for neuropsychological evaluation	Age: 51.8 SD 15.1 Education: 12.3 SD 2.3 Gender: 270M 8F Handedness: 90% right Ethnicity: reported
	Kulas & Axelrod (2002)	150	3% stroke 8% Alzheimer's disease 7% seizure disorder 3% multi-infart dementia 1% aneurism 10% TBI 1% Parkinson's disease 1% multiple sclerosis	19% substance abuse 14% mood disorder 11% schizophrenia 9% anxiety	6% free from neurologic or psychiatric condition	Age: 53.5 SD 14.2 Education: 12.2 SD 2.3 Gender: 95% male Handedness: 91% right Ethnicity: reported
	Lange et al. (2007)	100		26 schizophrenia spectrum disorder 16 substance abuse 5 bipolar disorder	40 neuropsychiatric patients 13 undiagnosed forensic	See above Iverson et al (2006)
4	Devaru-Backhaus et al. (2001)	85			22 psychiatric disorder 54 neurological disorder 9 no DSM-IV or neurological disorder	Age: 38.73 SD 16.54 Education: 13.07 SD 2.6 Gender: 40M 45F Handedness: 86,3%right Ethnicity: reported
	Fisher & Rose (2005)	32	18 TBI 2 cerebral hemorrhage 2 epilepsy 2 multiple sclerosis 1 cerebral palsy 1 cerebrovascular accident 1 Alzheimer's disease 1 encephalitis 1 hydrocephalus		3 unspecified neurologic problem	Age: 40 SD 13.38 Education: 12 SD 2.17 Gender: 18M 14F There were 2 other groups: 64 healthy volunteers subdivided in 32 controls and 32 simulators of memory impairment.
	Misdraji & Gass (2010)	192			192 consecutive neuropsychological referrals	Age: 59.3 SD 14.5 Education: 13.2 SD 2.2 Gender: 180M 12F

Notes: n.r. = not reported; 1 = used the core subtests; 2 = used some subtests; 3 = short-form studies, and 4 = focus on other tests. * 56 surgical resection = 23 benign tumor, 9 hematoma, 16 anterior temporal lobectomy for pharmacoresistent epilepsy, and 8 arteriovenous malformation.

(3) Is there a specific profile in acquired brain injury?

To answer this final question we focused on the 88 empirical articles with samples summarized in Table 2. From these articles, we first selected the 48 studies that had clinical samples (neurological, psychiatric or mixed neuropsychiatric). We then decided to pay special attention only to the studies that used 11, 13 or 14 subtests from the battery, and that gave us data about IQs, Indexes or subtests (middle column of Table 2). We called these studies, articles that "used the whole battery". We ended up with 29 clinical studies that used the whole/core battery and we sorted these studies by the samples: 6 mixed neurologic/neuropsychiatric (Table 5), 10 TBI (Table 6), 7 other neurologic etiologies (Table 7), and 6 psychiatric samples (Table 8).

We noticed that the six mixed neurological/neuropsychiatric samples that used the whole battery (Table 5), when characterized by etiology, were mainly addressing head trauma (i.e. TBI) or substance abuse disorders. These samples were all from North America, all reported a majority of Caucasian ethnicity, but only two studies reported handedness (Ryan et al., 2002; Glass et al., 2009). The samples were mainly of men with low-average or average IQ, mean aged from 40 to 50 years old (exception to the head trauma group described by Miller et al., 2004), and all had a mean education level of high school. Only one study had a control group of people with no clinical diagnosis; that group was the 2450 individuals from the US standardization sample (Ryan et al., 2006). Against our expectations, only one of these studies (Ryan et al., 2006) looked for a clinical profile and didn't find any difference in the inter-subtest scatter among brain injured patients compared to normal controls.

In what concerns the TBI samples (Table 6), 4 out of 10 articles selected concluded that the Processing Speed Index (PSI) is lower in all TBI samples with chronic and at least mild-to-moderate severity (Fisher et al., 2000; Axelrod et al., 2001; Axelrod et al., 2002; Langeluddecke et al., 2003). These results support the clinical trials (Hawkins, 1998), where the PSI was particularly sensitive to brain dysfunction; but the same results were obtained with Phenilketonuria patients (Moyle et al., 2007; see Table 7) and Depression samples as well (Gorlyn et al., 2006; see Table 8). So, although a low PSI is a good indicator of a TBI, it is also suggestive of other brain dysfunctions/diseases.

The other six articles with TBI samples were not looking for a clinical profile. One was trying to replicate the four-factor model (van der Heidjen & Donders, 2002), one discusses two methods for estimating premorbid intelligence (Langeluddecke & Lucas, 2004), two were focused on corrected norms (Strong et al., 2005; Blake et al., 2009), one focus on Australian cultural diversity (Walker et al., 2010) and, finally one was focused on malingering (Greve et al., 2008).

Table 5. Descriptive analysis (*M* and *SD*) and main conclusions from the mixed neurological/neuropsychiatric samples.

	Etiology	Age	Education	Gender	VIQ	PIQ	FSIQ	VCI	POI	WMI	PSI	Subtests	Main conclusions
Basso et al. (2002)	51 patients screened for neurological and psychiatric disease: - baseline	n.r.	n.r.	n.r.	111.0 (11.5)	105.4 (12.5)	109.4 (11.6)	111.5 (11.9)	106.1 (14.1)	106.9 (12.4)	109.3 (13.0)	n.r.	All IQs and indexes, except WMI, improved significantly from baseline to 3- or 6-months reevaluation
	- retest	n.r.	n.r.	n.r.	114.8 (11.5)	116.0 (14.4)	115.04 (12.1)	115.8 (12.3)	114.4 (14.1)	108.6 (13.1)	116.4 (14.5)	n.r.	
Ryan et al. (2002)	40 low scatter group*	50.18 (14.32)	13.12 (2.00)	40M	101.15 (10.78)	98.38 (10.56)	99.88 (10.47)	n.r.	n.r.	n.r.	n.r.	11 subtests reported	When differences in IQ are controlled, the intersubtest scatter does not predict memory performance
	40 high scatter group**	50.95 (12.92)	13.02 (2.12)	40M	100.38 (11.83)	99.18 (13.26)	99.78 (10.30)	n.r.	n.r.	n.r.	n.r.	11 subtests reported	
Miller et al. (2004)	30 alcohol abuse	50.90 (11,37)	11.93 (1.91)	29M 1F	93.70 (10.94)	92.17 (10.13)	92.60 (10.03)	n.r.	n.r.	n.r.	n.r.	Vocabulary + Digit Span	Vocabulary – Digit Span score has 99% overall accuracy detecting malingering
	43 polysubstance abuse	42.40 (5.85)	12.79 (1.54)	42M 1F	98.51 (14.11)	97.09 (14.17)	99.40 (14.73)	n.r.	n.r.	n.r.	n.r.	Vocabulary + Digit Span	
	27 head trauma	33.44 (10.35)	12.04 (1.70)	15M 12F	93.37 (11.44)	93.52 (8.17)	93.04 (9.11)	n.r.	n.r.	n.r.	n.r.	Vocabulary + Digit Span	

Iverson et al. (2006)	40 neuropsychiatric + 60 forensic psychiatric: - American norms	n.r.	n.r.	n.r.	84.9 (14.3)	81.4 (14.8)	82.0 (14.6)	86.9 (15.5)	86.1 (15.3)	82.5 (16.2)	76.6 (13.2)	11 subtests reported	Significantly lower scores on all IQs, Indices, and subtest scores will be calculated when using the Canadian versus the American norms
	- Canadian norms	n.r.	n.r.	n.r.	82.0 (12.8)	76.5 (14.9)	78.1 (13.0)	84.3 (13.4)	81.3 (14.6)	79.9 (14.2)	73.8 (14.3)	11 subtests reported	
Ryan et al. (2006)	174 mixed neurologic patients***	49.19 (15.33)	12.57 (2.78)	116M 58F	89.06 (16.36)	86.17 (17.12)	88.45 (17.78)	89.82 (16.54)	89.99 (17.26)	84.84 (16.34)	79.51 (13.45)	13 subtests reported	Inter-subtest scatter among brain-damaged patients is no greater than among normal persons
Glass et al. (2009)	82 polysubstance abuse + 53 alcohol abuse	47.16 (9.19)	12.55 (1.58)	135M 0F	n.r.	n.r.	92.10 (13.73)	94.39 (13.61)	93.51 (14.27)	92.57 (14.30)	86.46 (11.99)	n.r.	GAI and FSIQ were highly correlated

Note: n.r. = not reported; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ; VCI = Verbal Comprehension Index; POI = Perceptual Organization Index; WMI = Working Memory Index; PSI = Processing Speed Index. *9 nonpsychotic psychiatric disorders; 2 psychotic psychiatric disorders; 5 neurological disorders involving brain; 1 medical disorder; 21 substance abuse disorders; 2 dementia. **7 nonpsychotic psychiatric disorders; 1 psychotic psychiatric disorders; 3 neurological disorders involving brain; 6 medical disorder; 20 substance abuse disorders; 3 dementia. ***86 TBI; 40 stroke; 16 dementia; 15 seizure disorders; 5 tumors; 2 meningitis; 2 encephalitis; 2 multiple sclerosis; 2 anoxia; 2 hydrocephalus; 1 each cardiac and hepatic encephalopathy.

Table 6. Descriptive analysis (*M* and *SD*) and main conclusions from the TBI samples.

	TBI severity	Age	Education	Gender	Time elapsed	VIQ	PIQ	FSIQ	VCI	POI	WMI	PSI	Subtests	Main Conclusions
Fisher et al. (2000)	45 controls from standardization sample	32.53 (9.93)	12.96 (1.94)	n.r.	n.a.	100.0 (13.8)	101.7 (14.6)	100.8 (14.0)	99.2 (14.6)	102.4 (14.3)	100.6 (16.4)	99.6 (14.0)	n.r.	No IQ or index score will help discriminate mild TBI patients from normal controls. IQ and index scores were lower for moderate-severe TBI, even when controlling for education level; PSI was particularly low
	23 mild TBI	35.73 (11.33)	12.87 (2.53)	12M 11F	431 days (367.9)	96.3 (12.7)	100.0 (13.8)	98.0 (13.1)	95.8 (16.0)	104.6 (15.4)	96.1 (11.2)	95.3 (12.2)	n.r.	
	22 moderate-severe TBI	26.9 (5.9)	13.32 (1.67)	14M 8F	n.r.	89.6 (12.4)	84.5 (13.8)	86.5 (10.9)	89.6 (12.7)	92.1 (15.0)	89.8 (13.1)	73.4 (10.7)	n.r.	
Axelrod et al. (2001)	46 at least mild-moderate TBI	33.5 (13.3)	12.6 (2.3)	32M 13F	4.9 months (5.8)	88.5 (14.7)	85.1 (16.0)	85.6 (15.4)	88.2 (15.0)	88.1 (16.0)	90.4 (11.9)	79.6 (11.7)	n.r.	PSI was more sensitive (but not specific) to brain injury than other WAIS-III composites
	22 controls from standardization sample	n.r.	n.r.	n.r.	n.a.	89.6 (12.4)	84.5 (13.8)	86.5 (10.9)	89.6 (12.7)	92.1 (15.0)	89.8 (13.1)	73.4 (10.7)	n.r.	
Axelrod et al. (2002)	51 at least mild-moderate TBI	33.9 (13.5)	12.5 (2.3)	35M 16F	4.2 months (5.0)	90.5 (15.5)	86.4 (15.8)	87.9 (15.8)	90.4 (16.0)	89.8 (16.1)	90.8 (12.7)	81.0 (1.9)	n.r.	PSI was significantly lower than other indexes. Tables of frequencies differences
van der Heidjen & Donders (2003)	78 mild TBI + 88 moderate-severe TBI	33.14 (14.84)	12.64 (1.93)	105M 61F	92.14 days (69.38)	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	A four-factor model, similar to the technical manual, provided the best fit to the clinical data

Langeluddecke & Lucas (2003)	50 controls from standardization sample	38.3 (20.8)	12.7 (2.9)	24M 26F	n.a.	104.9 (16.0)	104.08 (15.3)	105.4 (16.3)	105.7 (15.7)	104.7 (15.3)	102.8 (15.5)	102.4 (16.6)	13 subtests reported	Subtests scores are discussed.
	35 moderate TBI	35.6 (13.8)	11.9 (2.5)	24M 12F	32.1 months (19.7)	102.1 (14.7)	100.9 (14.4)	101.7 (14.4)	103.0 (15.5)	104.07 (15.4)	101.9 (14.4)	93.1 (12.6)	13 subtests reported	PSI scores were lower by an average of 9 points.
	74 severe-very severe TBI	31.5 (11.3)	11.6 (2.4)	53M 22F	34.1 months (24.6)	94.5 (14.6)	91.7 (13.6)	92.7 (14.3)	95.2 (15.0)	95.6 (14.4)	94.4 (14.1)	88.1 (12.9)	13 subtests reported	PSI scores were lower by an average of 14 points, and FSIQ an average approximately 9 points.
	41 extremely severe TBI	36.6 (13.2)	11.3 (2.6)	29M 15F	33.9 months (23.1)	89.7 (15.1)	86.4 (12.5)	87.3 (14.3)	90.5 (14.5)	91.2 (12.7)	90.1 (16.9)	80.1 (13.0)	13 subtests reported	PSI scores were lower by an average of 22 points, and FSIQ an average approximately 16 points.
Langeluddecke & Lucas (2004)	same as Langeluddecke & Lucas (2003)	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	n.r.	Discusses two methods for estimating premorbid intelligence
Strong et al. (2005)	53 mild + 47 moderate-severe TBI	33.92 (15.43)	12.60 (2.08)	66M 34F	102.43 days (76.67)	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	Demographically corrected norms are not clearly better or worse than the conventional age-corrected norms
	100 controls from standardization sample	34.29 (15.94)	12.53 (2.181)	66M 34F	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	

Greve et al. (2008)	93 general clinical (other diagnosis)	57.0 (16.1)	14.1 (2.6)	48M 45F	n.r.	95.0 (15.5)	90.4 (14.8)	92.4 (14.7)	n.r.	n.r.	n.r.	n.r.	n.r.	VIQ accurately differentiated malingering from non-malingering patients regardless of injury severity PIQ was only accurate in mild TBI and did not add increment validity to the VIQ
	127 mild TBI + 84 moderate-severe TBI	38.3 (13.6)	12.1 (3.1)	151M 60F	22.1 months (26.0)	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	
	87 TBI not-malingering	n.r.	n.r.	n.r.	n.r.	95.8 (15.5)	94.3 (17.2)	94.8 (16.5)	n.r.	n.r.	n.r.	n.r.	n.r.	
	68 TBI indeterminate malingering	n.r.	n.r.	n.r.	n.r.	87.9 (14.1)	88.1 (14.6)	87.2 (14.6)	n.r.	n.r.	n.r.	n.r.	n.r.	
	56 TBI malingering	n.r.	n.r.	n.r.	n.r.	75.6 (12.6)	77.9 (13.7)	74.5 (13.4)	n.r.	n.r.	n.r.	n.r.	n.r.	
Blake et al. (2009)	18 mild + 8 moderate + 31 severe TBI	40.70 (16.90)	13.00 (1.94)	36M 21F	8.51 months (25.65)	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	11 subtests reported	The corrected norms are no more or less beneficial than traditional age-corrected norms for neurodiagnostic purposes
	61 controls (pseudoneurologic group)	45.46 (13.13)	13.23 (2.62)	17M 44F	16.92 months (18.57)	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	11 subtests reported	

Walker et al. (2010)	130 moderate-severe TBI - english-australian	30.7 (12.0)	11.0 (2.2)	98M 32F	28.2 weeks (21.8)	93.3 (13.8)	90.9 (13.7)	n.r.	92.9 (14.3)	94.3 (14.0)	93.9 (14.1)	85.6 (12.2)	11 subtests reported	The English-educated culturally and linguistically diverse group performed lower than the English-speaking background group on some verbal WAIS-III measures
	33 moderate-severe TBI - "english country"	27.2 (10.6)	11.0 (1.8)	27M 6F	25.3 weeks (20.4)	87.2 (13.0)	88.3 (13.0)	n.r.	87.5 (12.7)	92.3 (13.3)	88.1 (15.2)	82.9 (12.3)	11 subtests reported	
	33 moderate-severe TBI - "non english country"	43.9 (13.1)	10.8 (3.2)	27M 6F	25.7 weeks (17.9)	n.r.	79.0 (11.2)	n.r.	n.r.	81.8 (11.7)	n.r.	78.9 (11.8)	11 subtests reported	The non-English-educated diverse group performed lower than both groups on several WAIS-III measures

Note: n.r. = not reported; n.a. = not applicable; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ; VCI = Verbal Comprehension Index; POI = Perceptual Organization Index; WMI = Working Memory Index; PSI = Processing Speed Index.

Table 7. Descriptive analysis (*M* and *SD*) and main conclusions from the other neurological samples.

	Etiology	Age	Education	Gender	VIQ	PIQ	FSIQ	VCI	POI	WMI	PSI	Subtests	Main Conclusions
Martin et al. (2002)	42 unoperated-on adult patients with complex partial seizures	34.8 (11.3)	13.2 (2.6)	13M 29F	86.6 (16.1)	86.4 (14.6)	85.5 (15.9)	87.0 (14.6)	88.0 (15.1)	89.1 (17.6)	n.r.	11 subtests reported	Individual subtests for the WAIS-III were less reliable than the Index scores but still within very acceptable reliability ranges
	42 same sample, mean 7-month retesting interval	same	same	same	86.4 (16.4)	89.5 (14.6)	86.9 (16.1)	87.6 (15.4)	90.8 (14.3)	87.6 (16.2)	n.r.	11 subtests reported	
Lange et al. (2006)	34 patients with Alzheimer's type dementia	73.0 (7.2)	14.5 (2.9)	19M 15F	n.r.	n.r.	n.r.	93.2 (12.1)	85.1 (12.4)	n.r.	n.r.	n.r.	GAI-memory discrepancy differentiate patients with DAT from healthy participants, however failed to provide unique interpretive information beyond that which is gained from memory indexes alone
	34 controls matched from the standardization sample	72.9 (7.1)	14.2 (2.7)	19M 15F	n.r.	n.r.	n.r.	109.8 (15.4)	105.7 (12.4)	n.r.	n.r.	n.r.	
Moyle et al. (2007)	12 Phenylketonuria (PKU) treated with a low-phenylalanine diet from birth	28.5 (3.3)	11.8 (0.5)	2M 10F	n.r.	n.r.	n.r.	105 (n.r.)	101 (n.r.)	103 (n.r.)	92 (n.r.)	n.r.	POI and PSI were significantly lower in the PKU group. Taken together with WMS-III and TMT scores, these results supported a profile of reduced information-processing speed
	12 controls (friends of PKU group)	29.2 (3.2)	12.2 (0.5)	Matched	n.r.	n.r.	n.r.	106 (n.r.)	115 (n.r.)	101 (n.r.)	106 (n.r.)	n.r.	

Ryan et al. (2009)	20 left brain lesion (mixed etiology)	46.25 (17.42)	12.17 (2.87)	n.r.	86.70 (17.78)	87.45 (15.65)	n.r.	87.10 (17.04)	94.25 (15.84)	n.r.	n.r.	n.r.	Neither VIQ-PIQ nor VCI-POI discrepancy scores were effective in identifying lateralized brain damage.
	16 right brain lesion (mixed etiology)	47.86 (16.83)	12.27 (2.46)	n.r.	92.56 (16.48)	82.56 (15.58)	n.r.	90.95 (14.50)	86.06 (15.26)	n.r.	n.r.	n.r.	
Murayama et al. (2010)	8 early Mild Cognitive Impairment (MCI)	70.5 (3.1)	14.6 (2.1)	5M 3F	127.1 (8.0)	120.3 (8.4)	126.5 (7.1)	121.1 (8.1)	n.r.	n.r.	n.r.	n.r.	The discrepancy between intelligence and memory scores combined with F-FDG PET findings would make it possible to diagnose early-stage amnestic MCI.
	10 MCI	68.8 (5.5)	13.8 (2.2)	3M 7F	113.9 (11.4)	105.8 (8.7)	111.4 (10.5)	107.6 (12.2)	n.r.	n.r.	n.r.	n.r.	
	6 controls	68.3 (4.7)	14.0 (1.8)	2M 4F	113.3 (10.2)	107.7 (9.5)	112.2 (10.5)	107.3 (7.6)	n.r.	n.r.	n.r.	n.r.	
Arreguín -González et al. (2011)	12 untreated cerebellar tumor	45 (1.3)	n.r.	8M 3F	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	A tumor in the cerebellum may cause substantially lower mean IQ.
Li et al. (2012)	30 patients = = 18 Alzheimer's Disease + +12 Mild Cognitive Impairment	73.80 (8.26)	n.r.	8M 22F	82.74 (18.60)	78.04 (19.12)	79.00 (19.85)	n.r.	n.r.	n.r.	n.r.	14 subtests reposted	Z-scores of VSRAD were revealed to have close relation with many neuropsychological tests, especially ADAS-cog and subtest Information

Note: n.r. = not reported; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ; VCI = Verbal Comprehension Index; POI = Perceptual Organization Index; WMI = Working Memory Index, and PSI = Processing Speed Index and VSRAD = voxel-based specific regional analysis system for Alzheimer's disease.

Table 8. Descriptive analysis (*M* and *SD*) and main conclusions from the psychiatric samples

	Etiology	Age	Education	Gender	VIQ	PIQ	FSIQ	VCI	POI	WMI	PSI	subtests	main conclusions
Gorlyn et al. (2006)	41 non-patients controls	33.80 (11.9)	16.49 (2.5)	20M 21F	118.3 (18.0)	115.1 (18.4)	118.4 (17.9)	120.5 (17.3)	113.4 (17.1)	109.8 (17.3)	110.0 (13.8)	11 subtests reported	Results suggest general intellectual performance in depression is best characterized by deficits in processing speed.
	81 major depression + 40 bipolar disorders	38.40 (12.0)	15.86 (2.4)	50M 71F	114.3 (14.2)	108.4 (17.0)	112.9 (15.2)	117.1 (14.0)	109.5 (16.5)	106.8 (14.8)	101.9 (15.5)	11 subtests reported	
Ryan et al. (2007)	131 substance abuse disorders	47.16 (9.14)	12.59 (1.58)	132M 2F	n.r.	n.r.	92.37 (14.14)	n.r.	n.r.	n.r.	n.r.	n.r.	Case-by-case analyses demonstrated concordance rates of 99% for the IMI-GMI and IMI-DMI comparisons and 94% for the FSIQ-GMI and FSIQ-DMI contrasts
Yao et al. (2007)	114 schizophrenia	32.5 (10.2)	10.5 (2.9)	60M 54F	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	The results of the present study with two Chinese mainland samples provide further support for the WAIS-III Chinese version four factor structure.
	114 controls from standardization sample	32.8 (10.3)	10.6 (3.2)	53M 61F	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	
Lin et al. (2010)	34 methamphetamine-induced psychosis	28.7 (6.1)	10.4 (1.8)	28M 6F	84.3 (11.9)	81.9 (12.1)	82.3 (10.8)	85.5 (11.9)	84.7 (12.5)	85.4 (13.6)	78.5 (12.7)	13 subtests reported	Although methamphetamine-induced psychosis patients were younger, with shorter duration of substance misuse than alcoholic patients, their mentality had more severe deterioration.
	34 alcohol dependent	40.7 (7.3)	11.1 (2.8)	32M 2F	95.2 (11.3)	86.0 (13.8)	90.5 (12.0)	95.5 (11.0)	87.1 (14.5)	96.2 (13.1)	84.5 (15.0)	13 subtests reported	

Lin et al. (2012)	120 schizophrenia	37.96 (9.86)	13.08 (2.84)	58M 62F	94.53 (17.08)	90.61 (16.84)	92.52 (15.63)	n.r.	n.r.	92.10 (17.57)	n.r.	5 subtests reported	Mismatch negativity deficits were found in Han Chinese schizophrenia patients. The multivariate approach combining biomarkers from different modalities such as electrophysiology and neuropsychology had a better diagnostic utility.
	76 healthy controls	36.25 (1.12)	15.73 (3.52)	30M 46F	112.67 (16.22)	113.06 (16.56)	112.25 (18.88)	n.r.	n.r.	112.14 (15.30)	n.r.	5 subtests reported	
Shan et al. (2013)	106 schizophrenia	37.2 (10.0)	13.8 (2.7)	52M 54F	95.74 (16.76)	90.58 (18.05)	93.21 (16.15)	n.r.	n.r.	93.14 (17.66)	n.r.	5 subtests reported	The first diagnostic model for schizophrenia in subjects of Chinese ethnicity, using P50 sensory gating along with neuropsychological tests
	74 controls	36.2 (11.5)	15.3 (3.6)	31M 43F	113.0 (16.28)	113.5 (16.53)	114.1 (19.04)	n.r.	n.r.	112.5 (15.34)	n.r.	5 subtests reported	

Note: n.r. = not reported; VIQ = Verbal IQ; PIQ = Performance IQ; FSIQ = Full Scale IQ; VCI = Verbal Comprehension Index; POI = Perceptual Organization Index; WMI = Working Memory Index; PSI = Processing Speed Index; DMI = Delayed Memory Index, and GMI = General Memory Index.

Comparing the TBI samples (Table 6) with other mixed neuropsychiatric samples (Table 5), we noticed that TBI samples are a decade younger (TBI mean age is most of the times between 30 and 40); education level is apparently the same as other neurologic samples (high-school), but the disproportion of male versus female is higher in TBI samples. Although there were some studies in a post-acute phase for TBI samples (van der Heidjen & Donders, 2003; Strong et al., 2005; Walker et al., 2010), the majority of TBI studies focused on chronic patients. For the mixed neuropsychiatric samples, there is no report about the time elapsed since diagnosis/injury.

In sum, from the 29 "clinical samples" papers selected, only 9 had a goal equal or similar to looking for a clinical profile in the WAIS-III (Fisher et al., 2000; Axelrod et al., 2001; Axelrod et al., 2002; Langeluddecke et al., 2003; Gorlyn et al., 2006; Ryan et al., 2006; Ryan et al., 2009; Moyle et al., 2007; Arreguín-González et al., 2011). Further, based on these studies, the most robust conclusion we came to was that the PSI is sensitive to many clinical groups, including the Traumatic Brain Injury (TBI). Although the WAIS-III is sensitive to acquired brain injury, there is nothing exclusive to acquired brain injury or no such thing a specific neuropsychological profile for WAIS-III, identified in this systematic review.

Conclusions

Answering three main questions of this systematic review, the first finding was that the journals which published more articles on WAIS-III have neuropsychologists for main target. These numbers reflect the acknowledgment of the importance of the Wechsler Intelligence Scales in neuropsychological assessment and the growing hegemony of neuropsychological assessment in the evaluation practices.

It is worth noting that only 8 out of 46 (17%) of what we called "technical manual" papers focused on non-English speaking samples. We believe this percentage is very low, considering the worldwide importance of the WAIS.

From the total pool of articles the two most popular neurological samples were selected to analyze how these samples were recruited. There were 19 articles focused on TBI samples and 20 on mixed neuropsychiatric samples. Most of these studies had big samples (sample size varied from 24 up to 400). Around two thirds of the 19 TBI articles describe the participants in detail according to the severity of the injury. But, the so called "mixed neuropsychiatric samples" are most of the times a heterogeneous accumulation of various kinds of diseases. Moreover only 2 out of 20 "mixed clinical" articles in this review selected the participants according to the injury localization (Tranel et al., 2008; Ryan et al., 2009).

Finally, from the pool of 88 "sample" papers, all studies that used the whole battery and neurologic and/or psychiatric samples (n=29) were selected. The results of these studies lead to the conclusion that although the WAIS-III PSI is sensible to TBI and to other clinical groups (e.g., depression), there is nothing specific to brain injury only, and it was not found such thing as an exclusive neuropsychological profile for the WAIS-III in this review.

The important effect of brain injury localization in the performance of multiples cognitive tests is widely recognized among neuropsychologists; however its potential effect on the WAIS-III performance is apparently neglected by the majority of the studies in this review. We believe that most papers fail to find a more specific profile in acquired brain injury samples, because they give primacy to the etiology over brain injury location. Therefore, we would like to suggest that authors should be strongly encouraged to organize their case material, taking in consideration lesion location.

We wouldn’t like to finish without pointing out at least two major limitations of this study. We believe our biggest limitation is that we only used one database: EBSCO Host. We preferred it over PubMed, because we thought we would find a more general overview in psychological research. Although EBSCO Host includes many American Psychological Association (APA) databases, the PubMed could have been a better research tool, when clinical aspects are concerned. A second limitation is that we only read the papers “full text pdf” and sometimes other important research is not in open access. Albeit the open access papers from this database can give us a restricted access to the important WAIS-III research, this review introduced us to a new reality: WAIS-III is becoming more and more a neuropsychological instrument, and progressively less a counseling/vocational instrument, but there is still work to be done in what concerns the effect of different brain injury locations on the WAIS-III performance.

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Revisão sistemática sobre a WAIS-III com especial interesse nos estudos clínicos

Resumo

Nesta revisão sistemática, pretendeu-se explorar como tem sido estudada a Escala de Inteligência de Wechsler para Adultos 3ª versão (WAIS-III): (1) quais os principais temas de publicados, (2) quais os critérios de inclusão utilizados nos estudos com amostras neurológicas e (3) as principais conclusões dos estudos clínicos/neurológicos/psiquiátricos que utilizaram entre 11 e 14 subtestes da bateria. A pesquisa foi feita através da EBSCO-Host por três vezes (2011, 2013 e 2014), utilizando a palavra-chave "WAIS-III" e limitando a pesquisa a "full text" e "scholarly (peer reviewed) journals". Foram identificados 226 artigos: 23 dos quais foram classificados como não tendo o foco ou resultados centrados na WAIS-III, 28 artigos com foco noutro teste ou tarefa, mas utilizando a WAIS-III, 28 artigos teóricos, 13 artigos sobre formas abreviadas, 46 artigos com amostras de estandardização e 88 artigos com amostras de vários tipos. Como principais conclusões apontamos que (1) o maior número das artigos está publicado em revistas especializadas em neuropsicologia, (2) a maioria das amostras com traumatizados cranioencefálicos são de gravidade moderada-grave e nas amostras chamadas "mistas" não há seleção dos sujeitos respeitando ao local da lesão e finalmente (3) não foram encontrados perfis de resposta exclusivas para os doentes com lesão cerebral.

Palavras-chave

WAIS-III, lesão cerebral, revisão sistemática.

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