NEUROSCIENCE RESEARCH NOTES

OPEN ACCESS | RESEARCH NOTES ISSN: 2576-828X

Validation study of Arizona Battery for Communication Disorders of Dementia in Greek monolingual cognitively impaired patients

Dionysios Tafiadis [1]*, Louiza Voniati [2], Alexandra Prentza [3], Vasiliki Zarokanellou [1], Vassiliki Siafaka [1], Nafsika Ziavra [1] and Spyridon Konitsiotis [4]

[1] Department of Speech & Language Therapy, University of Ioannina, 4th Km Ioannina-Athens Road, Ioannina, Ioanninon, GR455 00, Greece.
[2] Department of Speech and Language Therapy, School of Health Sciences, European University of Cyprus, 6 Diogenous Str, 2404 Engomi, Nicosia, Nicosia District, Cyprus.
[3] Department of Linguistics, School of Philosophy, University of Ioannina, Ioannina, Ioanninon, P.O. box: 1186. PC: GR451 10, Greece.
[4] Department of Medicine, School of Health Sciences, University of Ioannina, Ioannina, Ioanninon, Secretariat Office, 1st floor, Administration Building, PC: GR451 10, Greece.
* Correspondence: tafiadis@uoi.gr; Tel.: +30.6946.433.260

Received: 14 September 2022; **Accepted:** 21 November 2022; **Published:** 2 May 2023
Edited by: Anton Varlamov (Pushkin State Russian Language Institute Akademika, Russia.)
Reviewed by: Sugarmaa Myagmarjav (Mongolian National University of Medical Sciences, Mongolia); Angelo Papadopoulos (General Hospital of Patras Karamandanio, Greece)
https://doi.org/10.31117/neuroscirn.v6i2.182

Abstract: The evaluation of cognitive-communication disorders is performed with several types of assessment methods. These methods include different types of cognitive and language tests such as the Arizona Battery for Communication Disorders of Dementia (ABCD). The present study aimed to validate the ABCD in the Greek language. 132 individuals participated in the study: 60 adults in cognitive health (ACH) and 72 patients [24 Parkinson Disease (PD) patients without cognitive impairment, 24 with Parkinson Disease Dementia (PDD) and 24 with Alzheimer's Disease (AD)]. The cognitive and mental status of all participants was estimated by means of the Mini Mental State Examination (MMSE), the Abbreviated Mental Test Score (AMTS), the Clock Drawing Test (CDT), the Instrumental Activities of Daily Living (IADL), the Neuropsychiatric Inventory (H-NPI) the Geriatric Depression Scale -15 (GDS-15) and the ABCD. Statistically significant differences were found between all tests administered with the PDD and AD patients having the lower scores. The ABCD showed good psychometric properties, internal consistency (Cronbach alpha=0. 901) and discriminatory ability. It was significantly correlated with the AMTS, CDT, IADL, and MMSE.The Greek version of the ABCD demonstrated good validity, sensitivity, and discriminatory ability. The ABCD is a valuable instrument to assess cognitive-communication dis-orders.

Keywords: Alzheimer's disease; Arizona Battery for Communication Disorders of Dementia; cut-off points; diagnostics tools; Parkinson disease; validation.

1.0 INTRODUCTION

Cognitive ability may decline over time (Muslimović et al., 2007; Ryan et al., 2003), with a part of the aging population developing dementia eventually (Klimova et al., 2017; Naylor et al., 2012). Scientists around the world approach this problem from different disciplines and suggest age-related neurodegeneration models (Fossel, 2020), as well as diagnostic criteria (Khachaturian, 2006; Khachaturian et al., 2019) to identify people with cognitive impairment more accurately. A range of medical factors and diseases can lead to the declination of cognitive ability, such as Parkinson disease (PD), Alzheimer disease (AD) or even stroke (Naylor et al., 2012; Khachaturian, 2006; Khachaturian et al., 2019; Khachaturian & Radebaugh, 2019). While cognitive impairment is developing, many quality-of-life problems are arising (Farina et al., 2017) but also language and communication disorders are attested in patients (Azuma et al., 2003; Bayles et al., 1992, 2000, 2004, 2020; Bayles & Tomoeda, 1983).

Particularly, language-communication symptoms due to cognitive impairment can differ depending on the type of dementia and the disease staging (Azuma et al., 2003; Bayles & Tomoeda, 1983; Bayles et al., 2000, 2004). Individuals diagnosed with dementia are experiencing a gradual loss of their daily functions and, eventually, their ability to communicate effectively and independently (Muslimović et al., 2007; Ryan et al., 2003). For example, mild problems in attention, executive functions, language processing and memory result in a slower information process during a discourse (Tomoeda & Bayles, 1993). On the other hand, mediocre problems may result in reduced and less substantive verbal output and a loss of someone's ability to express themselves adequately (Tomoeda & Bayles, 1993).

Furthermore, language disorders due to dementia are characterized by the following: a) less concise discourse with loss of meaningful speech and the ability to maintain a conversation, b) use of fewer words, c) language with perseverations and with grammatical errors, d) difficulties in naming and word finding, e) neologism and f) deficits in comprehension of oral and written language (Klimova & Kuca, 2016).

Based on the above, several screening tests and assessment batteries have been developed, validated, and standardized, which are important for the optimal management of patients with cognitive problems (Hodkinson, 1972; Khachaturian, 2006; Khachaturian et al., 2019; Lawton & Brody, 1969; Tuokko et al., 1992). Furthermore, validation studies (Fountoulakis et al., 1999, 2000; Messinis et al., 2007; Politis et al., 2004; Theotoka et al., 2007) and normative studies (Messinis et al., 2007, 2011; Konstantopoulos et al., 2016; Poptsi et al., 2019) were conducted with Greek speaking populations for several cognitive (Fountoulakis et al., 1999; Fountoulakis et al., 2000; Konstantopoulos et al., 2016; Messinis et al., 2007, 2011; Politis et al., 2004; Poptsi et al., 2019; Tafiadis et al., 2012, 2021, 2022; Theotoka et al., 2007) and language assessment tools (Messinis et al., 2007). To the best of our knowledge, no comprehensive battery for assessing communication disorders due to cognitive impairment, such as ABCD (Bayles & Tomoeda, 1993), has been validated for the Greek language.

Bayles and Tomoeda developed the original ABCD in 1993. The ABCD is a standardized comprehensive assessment for evaluating patients at risk of a neurocognitive disorder (mild to severe). The ABCD assessment was also evaluated in British and Australian English (Armstrong et al., 1996; Moorhouse et al., 1999). Moreover, it was translated into Dutch and Indonesian (Dharmaperwira-Prins, 2004) and into Greek in two pilot studies. However, it has not been validated yet. The test was also used with patients with adolescent TBI (Sandifer et al., 2005) and patients with close head injuries (Speer & Skinner, 1995). This study presents the validation of the ABCD battery test in the Greek language for patients with cognitive-communication disorders due to AD and PD.

2.0 MATERIALS AND METHODS

2.1 Participants

One hundred and thirty-two (132) monolingual Greek speakers participated in this study. Sixty (60) cognitively healthy adults (ACH) were recruited from the "National Open Care Centre for the Elderly" (KAPI). The "KAPI" are state institutions established in Greece to prevent health, psychological and social problems that the aging populations may face. The remaining seventy-two (72) participants were 24 PD patients without cognitive impairment, 24 patients with PDD and 24 patients with AD. In this study, the ACH and the PD patients were the cognitively healthy group (GCH), while the PDD and the AD patients formed the group with cognitive impairment (GCI).

All patients were recruited from a neurological outpatient clinic of the University Hospital of Ioannina in Epirus, Greece. A specialized neurologist diagnosed patients with AD and PD patients on their medical files, neurological examination, and Magnetic Resonance

Imaging (MRI) (Jack, et al., 2011; Litvan, et al., 2012; Postuma et al., 2015, 2016, 2018; Schmand et al., 2012).

Specifically, for the PD patients, the staging was determined following the Hoehn and Yahr scale (Emre et al., 2007; Goetz et al., 2004; Hoehn &Yahr, 1967). The cognitive status of the PD and PDD patients was determined based on the MDS task force criteria (Goetz et al., 2004; Litvan et al., 2012; Postuma et al., 2015; Schmand et al., 2012) and the clinical diagnostic criteria suggested by Emre et al. (2007). On the other hand, the NIA-AA guidelines were followed to determine AD patients' cognitive impairment levels (Jack et al., 2011; McKhann et al., 2011; Sperling et al., 2011).

All subgroups were matched on age and educational background. The participants with a history of prior cognitive deficits, other neurological impairments and/or psychiatric disorders were excluded from the study. All participants were informed of this study with a consensus letter and signed a written consensus form. The participants with PD and PDD were fully communicative and at the first stages of the PD, as apparent from the Hoehn-Yahr staging. The AD patients were in the first years of staging. However, if there was any doubt about their level of consciousness, the legal caregiver signed the consent form. This research was approved by the Department of Medicine, School of Health Sciences, University of Ioannina Ethical Committee (reference No: 658α).

2.2 Translation of the ABCD

The translation and cultural adaptation of the ABCD (Copyright © 1993 PRO – ED, Inc. Arizona Battery for Communication Disorders of Dementia, translated with the permission of the publisher. All rights reserved) (Bayles & Tomoeda, 1993) were carried out according to the "Minimal Translation Criteria." (Medical Outcomes Trust, 1997). Finally, the Greek version of the ABCD underwent two pilot studies before its validation. The battery test has several subtests that are divided into five constructs: i) Mental Status, ii) Episodic Memory, iii) Language Expression, iv) Language Comprehension and v) Visuospatial Construction. The ABCD test evaluates a person's mental status using questions that pertain to the participant's current condition and questions that target current time and space. For the evaluation of Episodic Memory, a person is asked to retell a story immediately after it is presented to him/her, while after about 20 minutes, the participant is expected to recall and recognize words in a specific manner. To evaluate the Linguistic Expression, a person is asked to describe two objects, respond to several naming tasks, and provide definitions. For the assessment of Linguistic Comprehension, a person is asked to reply to word repetition tasks, follow commands of ascending difficulty, pair words to figures, and respond to comprehension questions on several types of printed tasks. Finally, a participant is evaluated on his/her Visual-Spatial abilities by means of coping figures and generating specific drawings such as a clock (Bayles & Tomoeda, 1993) **(Table 1)**. The ABCD in its original version exhibited very good construct validity when it was correlated with the Global Deterioration Scale (GDS) (Reisberg et al., 1982), the Mini-Mental State Examination (MMSE) (Folstein et al., 1975) and the Block Design of the Wechsler Adult Intelligence Scale – Revised (WAIS-R) (Wechsler, 1981). This robustness was also reported for the Australian and UK versions of the battery (Dharmaperwira-Prins, 2004; Sandifer et al., 2005).

Table 1. The five constructs of ABCD.

Mental Status	Episodic Memory	Linguistic Expression	Linguistic Comprehension	Visuospatial Construction
Mental status	Story Retelling: Immediate	Object description	Following commands	Generative drawing
	Word Learning	Generative naming	Reading comprehension (words; sentences)	Figure coping
	Free recall	Confrontation naming	Comparative Questions	
	Total recall	Concept definition	Repetition	
	Recognition			

2.3 Data Collection

All informants were administered the ABCD battery test (Bayles & Tomoeda, 1993). The ABCD battery test has 17 brief subtests that are divided into five constructs i) Mental Status, ii) Episodic Memory, iii) Language Expression, iv) Language Comprehension and v) Visuospatial Construction (Bayles & Tomoeda, 1993). The ABCD also includes four optional screening tasks that determine whether participants' limitations with vision, reading, and other difficulties will impact their ABCD performance (Bayles & Tomoeda, 1993). Besides the administration of ABCD, all participants were evaluated for their cognitive and mental status on the following scales:

a) Evaluation of Cognitive and Daily Living Abilities

1. The validated Mini-Mental State Examination (MMSE) in the Greek language (Fountoulakis et

al., 2000) is a screener that assesses cognitive abilities. MMSE was introduced in 1975 by Folstein, Folstein, and McHugh (1975), and it is recommended to evaluate AD patients' cognitive status by NIA-AA (McKhann et al., 2011). Likewise, the MDS task force (Schmand et al., 2012) suggests MMSE as a level I instrument for evaluating a PD patient's cognitive ability (Emre et al., 2007; Goetz et al., 2004; Litvan et al., 2012). The study's groups were formed based on the cut-off of<24, as suggested by Fountoulakis et al. (2000).

2. The Abbreviated Mental Test Score (AMTS) is a 10-item screening test for the detection of cognitive impairment (Hodkinson, 1972). The validated in Greek language AMTS was used -as was the MMSE- to categorize patients with or without cognitive impairment using a threshold of<6.5 (Tafiadis et al., 2022).
3. The Greek version of the Clock Drawing Test (CDT) (Tafiadis et al., 2021) can evaluate the participants' visuospatial abilities. The CDT test was shown to differentiate dementia from typical age-related memory changes (Tuokko et al., 1992, Tafiadis et al., 2021). The threshold of the Greek CDT was computed at<4 (Tafiadis et al., 2021) and was used to categorize patients with or without visuospatial difficulties.
4. The Greek version of the Instrumental Activities of Daily Living (IADL) (Theotoka et al., 2007), is a test that can evaluate the functional abilities that are essential in determining participants' cognitive capacity (Lawton & Brody, 1969).

b) *Evaluation of Psychiatric Symptoms*

1. The Greek version of the Geriatric Depression Scale -15 (GDS-15) is a 15-item screening test that assesses depression in geriatric populations (Fountoulakis et al., 1999). A threshold of > 7 was used to include informants in the study (Fountoulakis et al., 1999).
2. The Greek version of the Neuropsychiatric Inventory (H-NPI) (Politis et al., 2004) is a screener designed to detect the occurrence of neuropsychiatric symptoms common in dementia. The H-NPI was used to consider if an informant is to be excluded due to psychiatric disturbances such as deliberative Ideas, hallucinations, and anxiety from the present study.

2.4 Statistical Analysis

The normality assumption was evaluated using Kolmogorov-Smirnov and Shapiro-Wilk tests (p>0.05). The continuous variables are expressed with means (M) and standard deviations (SD), and the dichotomous ones with absolute and relative frequencies. The chi-square tests were used for the comparison of proportions. The student's t-test was used to compare the ABCD mean total scores and the scores in its five-constructs between the GCH and the GCI groups, along with Cohen's effect sizes. Additionally, to compare the mean scores of the ABCD total score and its 5-constructs between all study groups (ACH, PD patients, PDD patients and AD patients), the One-Way ANOVA test was calculated along with partial eta square effect sizes. The internal consistency of the Greek version of ABCD was computed using Cronbach's alpha coefficient and the split-half reliability coefficient technique. Additionally, Pearson correlation (r) between total scores of the Greek versions of the AMTS, CDT, MMSE, IADL and the total score of ABCD was computed to determine the sensitivity of the latter. A Receivers Operative Characteristic (ROC) analysis using the Youden Index was calculated to determine the ABCD discriminatory ability between the study groups. The statistical significance was set at p<0.05, and all reported p values were two-tailed. The analysis was conducted using SPSS statistical software (version 19.0, Armonk, NY, USA).

3.0 RESULTS

3.1 Demographic Data

The sample of this study was matched on age, years of education and gender. All patient groups were also matched on the duration of their disease. The PD and PDD patients were also matched on the Hoehn-Yahr staging. Relevant information is presented in **Table 2**.

3.2 Comparison of Means Between Subgroups

For comparing the means for the ABCD test and its five constructs, an independent sample t-test analysis was computed. A statistically significant difference was observed in the ABCD total scores between the GCH and the GCI group [t (130)=7.59, p<0.01], with the GCH group scoring significantly higher and with large effect size results (Cohen's d=0.97, 95% CI [0.74, 1.58]) **(Table 3)**.

Likewise, the results of the t-test returned a statistically significant difference in the "Mental Status" construct total scores between the GCH and the GCI group [t (130)=5.731, p<0.01] with the GCH group scoring significantly higher and with large effect size results

(Cohen's d=0.96, 95% CI [0.58, 1.38]). A statistically significant difference was observed in the "Episodic Memory" construct total scores between the GCH and the GCI group [t (130)=6.461, p<0.01], with the GCH group scoring significantly higher and with large effect size results (Cohen's d=0.86, 95% CI [0.71, 1,42]). A statistically significant difference was observed in the "Linguistic Expression" construct total scores between the GCH and the GCI group [t (130)=6.733, p<0.01], with the GCH group scoring significantly higher and with large effect size results (Cohen's d=0.92, 95% CI [0.78, 1.50]). A statistically significant difference was observed in the "Linguistic Comprehension" construct total scores between the GCH and the GCI group [t (130)=7.048, p<0.01], with the GCH group scoring significantly higher and with large effect size results (Cohen's d=0.95, 95% CI [0.82, 1.52]). A statistically significant difference was observed in the "Visuospatial Construction" construct total scores between the GCH and the GCI group [t (130)=5.471, p<0.01], with the GCH group scoring significantly higher and with large effect size results (Cohen's d=0.91, 95% CI [0,60, 1.31]) **(Table 3)**.

Regarding group effects in the tests used, the ANOVA analysis returned a main group effect in the ABCD total scores. Similarly, group main effects were also detected in all the test's constructs. A group main effect was observed in the "Mental Status" construct total scores F (3, 128)=15.003, p<0.01; η^2=0.510. A group main effect was detected in the "Episodic Memory" construct total scores F (3, 128)=17.872, p<0.01; η^2=0.543. A group main effect was observed in the "Linguistic Expression" construct total scores F (3, 128)=16.813, p<0.01; η^2=0.532. A group main effect was found in the "Linguistic Comprehension" construct total scores F (3, 128)=19.640, p<0.01; η^2=0.561. A group main effect was observed in the "Visuospatial Construction" construct total scores F (3, 128)=12.739, p<0.01; η^2=0.478. In ABCD total score and all five constructs total score, PDD and AD had the lower scores. Relevant information is presented in **Table 4**.

3.3 Reliability Measures for the ABCD Test

The overall estimated internal consistency of the ABCD was excellent (Cronbach alpha=0.901). An alternative analysis using the split-half reliability technique also showed that the ABCD was internally consistent (split-half reliability coefficient=0.890). The Internal consistency for the constructs of Mental status (α=0.855), Episodic memory (α=0.828), Linguistic expression (α=0.819), Linguistic comprehension (α=0.824), and Visuospatial construction (α=0.878) were all excellent as well.

3.4 Correlations for the ABCD Test

Pearson correlations were computed between the ABCD Total Score, as well as its five constructs and the Greek versions of the MMSE, AMTS, IADL and Tuoko's CDT for determining the sensitivity of the ABCD test against an external validity criterion.

3.4.1 Correlation between the ABCD and MMSE

A strong positive correlation was detected between the MMSE total score and the ABCD total (r=0.863, p<0.01). Statistically significant positive correlations were detected between the MMSE score and the ABCD five constructs total scores. Specifically:

- MMSE score and ABCD "Mental Status" construct total score: (r=0.787, p<0.01);
- MMSE score and ABCD "Episodic Memory" construct total score: (r=0.774, p<0.01);
- MMSE score and ABCD "Linguistic Expression" construct total score: (r=0.767, p<0.01);
- MMSE score and ABCD "Linguistic Comprehension" construct total score: (r=0.776, p<0.01);
- MMSE score and ABCD "Visuospatial Construction" construct total score: (r=0.720, p<0.01).

3.4.2 Correlation between the ABCD and AMTS

A strong positive correlation was detected between the AMTS and the ABCD total scores (r=0.835, p<0.01). Statistically significant positive correlations were found between the AMTS score and the ABCD five construct total scores. Specifically:

- AMTS score and ABCD "Mental Status" construct total score: (r=0.833, p<0.01);
- AMTS score and ABCD "Episodic Memory" construct total score: (r=0.747, p<0.01);
- AMTS score and ABCD "Linguistic Expression" construct total score: (r=0.759, p<0.01);
- AMTS score and ABCD "Linguistic Comprehension" construct total score: (r=0.737, p<0.01);
- AMTS score and ABCD "Visuospatial Construction" construct total score: (r=0.704, p<0.01).

Table 2. Demographics of the samples.

	ACH Group	PD Patients	PDD Patients	AD Patients	*p*
Participants	60	24	24	24	
	M (SD)	M (SD)	M (SD)	M (SD)	
Years of Age	67.77 (7.51)	69.00 (5.81)	71.54 (9.15)	67.58 (7.11)	.446
Gender, N (%)					
Male	30 (50%)	12 (50%)	13 (54%)	13 (54%)	
Female	30 (50%)	12 (50%)	11 (46%)	11 (46%)	.575
Years of Education	8.07 (3.86)	9.23 (4.89)	8.35 (3.55)	9.54 (3.68)	.222
Duration of Disease	------	2-3 years	2-3 years	2-3 years	
H-Y Staging	------	1. 64 (0.056)	1.59 (0.038)	------	.741

Abbreviations: *ACH, Adults in Cognitive Health; PD, Parkinson's Disease; PDD, Parkinson's Disease Dementia; AD, Alzheimer's Disease; H-Y Staging, Hoehn – Yahr Staging; *p<0.05.*

Table 3. ACH and GCI group comparisons on ABCD total score and its five construct total scores.

	GCH Group (N=84)	GCI Group (N=48)		
	M (SD)	**M (SD)**	**t (130)**	***d***
Mental Status	4.07 (0.73)	3.07 (1.28)	5.731**	0.96
Episodic Memory	3.96 (0.58)	3.11 (0.93)	6.461**	0.86
Linguistic Expression	3.92 (0.62)	3.04 (0.86)	6.733**	0.92
Linguistic Comprehension	4.06 (0.68)	3.04 (0.96)	7.048**	0.95
Visuospatial Construction	4.39 (0.94)	3.21 (1.40)	5.471**	0.91
ABCD Total Score	21.81 (2.93)	15.95 (4.54)	7.847**	0.97

Abbreviations: *ACH, Adults in Cognitive Health; GCI, Group with Cognitive Impairment; Arizona Battery for Communication Disorders of Dementia; *p<0.05; **p<0.01.*

Table 4. Group effects (ACH, PD, PDD, AD) in the ABCD total score and its five construct total scores.

	ACH Group (N=60)	PD Group (N=24)	PDD Group (N=24)	AD Group (N=24)		
	M (SD)	**M (SD)**	**M (SD)**	**M (SD)**	**F (3, 128)**	**η^2**
Mental Status	4.80 (0.40)	4.46 (1.17)	4.08 (0.93)	3.33 (1.46)	15.003**	0.510
Episodic Memory	4.05 (0.41)	3.96 (0.85)	3.37 (0.69)	2.85 (1.07)	17.872**	0.543
Linguistic Expression	4.09 (0.37)	4.04 (1.02)	3.15 (0.46)	2.84 (1.09)	16.813**	0.532
Linguistic Comprehension	4.20 (0.51)	4.03 (0.92)	3.16 (0.61)	2.92 (1.21)	19.640**	0.561
Visuospatial Construction	4.54 (0.48)	4.12 (1.25)	3.17 (1.14)	3.35 (1.62)	12.638**	0.478
ABCD Total Score	21.53 (1.35)	22.10 (1.70)	16.18 (4.54)	16.67 (2.76)	22.893**	0.669

Abbreviations: ACH, Adults in Cognitive Health; PD, Parkinson's Disease; PDD, Parkinson's Disease Dementia; AD, Alzheimer's Disease; Arizona Battery for Communication Disorders of Dementia; *p<0.05; **p<0.01.

3.4.3 Correlation between the ABCD and Tuokko CDT

A strong positive correlation was detected between the Tuokko CDT score and the ABCD total score (r=0.770, p<0.01). Statistically significant positive correlations were detected between the Tuokko CDT score and the ABCD five construct total scores. Specifically:

- Tuokko CDT score and ABCD "Mental Status" construct total score: (r=0.601, p<0.01);
- Tuokko CDT score and ABCD "Episodic Memory" construct total score: (r=0.604, p<0.01);
- Tuokko CDT score and ABCD "Linguistic Expression" construct total score: (r=0.619, p<0.01);
- Tuokko CDT score and ABCD "Linguistic Comprehension" construct total score: (r=0.616, p<0.01);
- Tuokko CDT score and ABCD "Visuospatial Construction" construct total score: (r=0.880, p<0.01).

3.4.4 Correlation between the ABCD and IADL

A strong positive correlation was found between the IADL score and the ABCD total score (r=0.702, p<0.01). Statistically significant positive correlations were detected between the IADL score and the ABCD five construct total scores. Specifically,

- IADL's score and ABCD "Mental Status" construct total score: (r=0.851, p<0.01);
- IADL's score and ABCD "Episodic Memory" construct total score: (r=0.636, p<0.01);

- IADL's score and ABCD "Linguistic Expression" construct total score: (r=0.578, p<0.01);
- IADL's score and ABCD "Linguistic Comprehension" total construct score: (r=0.614, p<0.01);
- IADL's score and ABCD "Visuospatial Construction" total construct score: (r=0.587, p<0.01).

3.5 Receiver Operating Characteristics Analysis

A ROC analysis was used to determine the ability of the Greek ABCD test, its total score and its five construct scores to discriminate between the GCH and GCI groups. The analysis returned a statistically significant positive discrimination for the ABCD total score, with the cut-off point calculated at 19.40 (AUC 0.892, p<0.01) **(Figure 1a; Table 5**).

Likewise, the analysis showed the discriminatory ability of all the test's constructs. Specifically, statistically significant positive discrimination was shown for the "Mental Status" construct (AUC 0.740, p<0.01) with a cut-off point estimated at 3.50 was shown for the score, for the "Episodic Memory" construct (AUC 0.790, p<0.01) with the cut-off calculated at 3.50; for the "Linguistic Expression" construct (AUC 0.825, p<0.01) with the cut-off estimated at 3.70; for the "Linguistic Comprehension" construct (AUC 0.818, p<0.01) with the cut-off calculated at 3.60 and for the "Visuospatial Construction" construct (AUC 0.753, p<0.01) with the cut-off estimated at 3.70 **(Figure 1b; Table 6)**.

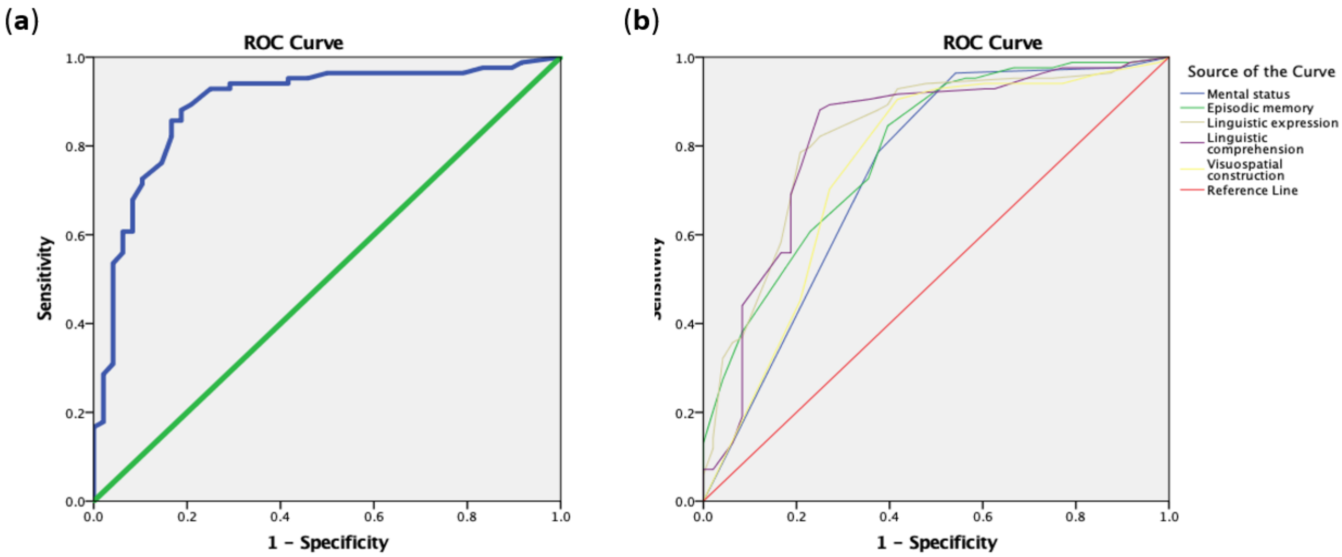

Figure 1. Receiver Operating Characteristics (ROC) curve for the **(a)** ABCD total between GCH and the GCI groups; **(b)** ABCD five constructs total scores between GCH and the GCI groups.

Similarly, a ROC analysis was used to determine the ability of the Greek version of the ABCD total score to discriminate between all study groups. The analysis returned a statistically significant positive discrimination between the GCH and AD groups (AUC 0.873, p<0.01), with the cut-off point calculated at 19.70. Likewise, statistically significant positive discrimination was detected between the GCH and PDD groups (AUC 0.911, p<0.01), with the cut-off estimated at 19.10 **(Table 5)**.

Also, statistically significant positive discrimination was estimated between the ACH and GCI groups (AUC 0.930, p<0.01) with the cut-off point estimated at 19.40. A statistically significant positive discrimination was found also between the ACH and AD groups (AUC 0.907, p<0.01). At the same time, the cut-off point was calculated at 19.30, as well as between the ACH and the PDD groups (AUC 0.953, p<0.01) with the cut-off set at 18.90 **(Table 5)**.

Moreover, the same discriminatory ability was observed between the PD and PDD groups (AUC 0.810, p<0.01), while the cut-off point was calculated at 19.10. Finally, the ROC analysis revealed statistically a significant positive discriminatory ability for the ABCD total score between the PD and the AD groups [cut-off=19.60; (AUC 0.800, p<0.01)]. Non-statistically significant results were returned for the ABCD total score between the ACH and the PD groups as well as between the PDD and AD groups. Statistically significant results are presented in **Table 5**.

4.0 DISCUSSION

This study presents a psychometric evaluation of the Greek version of ABCD, a line of investigation never pursued before. The ABCD was shown to have high reliability and validity (Bayles & Tomoeda, 1993). Furthermore, the validation results agree with other adaptations of the ABCD for a number of languages (Dharmaperwira-Prins, 2004). Moreover, this study provides evidence for the ability of the test to assess the level of cognitive impairment caused by different medical conditions.

Table 5: ROC data on the discrimination between subgroups of the ABCD total score.

	Cut-off (Out of 25)	AUC	(95% *CI*)	*p*
GCH Vs. GCI	19.40	0.892	(0.831-0.935)	<0.01
GCH Vs. AD	19.70	0.873	(0.790-0.956)	<0.01
GCH Vs. PDD	19.10	0.911	(0.840-0.892)	<0.01
ACH Vs. GCI	19.40	0.930	(0.877-0.983)	<0.01
ACH Vs. AD	19.30	0.907	(0.826-0.989)	<0.01
ACH Vs. PDD	18.90	0.953	(0.888-1.00)	<0.01
PD Vs. PDD	19.10	0.810	(0.673-0.947)	<0.01
PD Vs. AD	19.60	0.800	(0.670-0.927)	<0.01

Abbreviations: *ACH, Adults in Cognitive Health; GCH, Group with Cognitive Health; GCI, Group with Cognitive Impairment; PD, Parkinson's Disease; PDD, Parkinson's Disease Dementia; AD, Alzheimer's Disease; Arizona Battery for Communication Disorders of Dementia.*

Table 6: ROC data on the discriminatory ability of the ABCD five constructs between GCH and GCI groups.

	Cut-off (Out of 5)	AUC	(95% *CI*)	*p*
Mental Status	3.50	0.740	(0.644-0.835)	<0.01
Episodic Memory	3.50	0.790	(0.709-0.871)	<0.01
Linguistic Expression	3.70	0.825	(0.748-0.902)	<0.01
Linguistic Comprehension	3.60	0.818	(0.736-0.901)	<0.01
Visuospatial Construction	3.70	0.753	(0.659-0.847)	<0.01

Abbreviations*: AUC, Area Under Curve; CI, Confidence Interval; Arizona Battery for Communication Disorders of Dementia.*

4.1 Discriminatory ability of ABCD

The ABCD total score and its five constructs revealed significant differences between all study groups, with the AD and PDD patients showing the lowest scores (Sandifer et al., 2005; Tafiadis et al., 2015). Specifically, previous research has proven that the ABCD test successfully assessed the level of cognitive communication impairment in AD patients (Bayles & Tomoeda, 1993) and in PD and PDD patients (Tafiadis et al., 2015). Moreover, previous relevant studies that focus on the ABCD battery test also support its discriminatory ability for cognitive-communication disorders due to different types of medical conditions (Sandifer et al., 2005; Speer & Skinner, 1995). Sandifer et al. (2005) administered the ABCD battery in adolescents with traumatic brain injury (TBI) and found significant differences between Caucasians and African Americans, with the latter scoring significantly lower. They also concluded that clinicians should use this battery test to assess language functions in populations with race differences and TBI (Sandifer et al., 2005). Additionally, Speer and Skinner in 1995 assessed young adults having Closed Head Injury (CHI) against a control group using the ABCD battery test. They found statistically significant differences between the two groups in all the subtests of ABCD (Speer & Skinner, 1995). Furthermore, the researchers re-administrated the ABCD to the CHI group after a period of rehabilitation, and it was evident that the CHI subjects did not show improvement over time in the mental status or episodic memory constructs of the ABCD (Speer & Skinner, 1995). This finding proves the post-therapy validity of this battery test. The above results are in line with the findings of this study since, in our case, the ABCD was administered to Greek-speaking patients experiencing cognitive impairment due to different medical etiology, with the analysis supporting it proving the discriminatory ability of the ABCD.

No previous studies on linguistic and cultural adaptations of the ABCD battery test estimated cut-off points for the test's overall scores or construct scores with demented populations using a ROC analysis. The present study, which presents such data for the Greek version of the test, is the first one. Specifically, to date, only one study in Greek-speaking populations has presented results on the mediocre discriminatory power of the ABCD total score between cognitively healthy adults and PD patients (AUC 0.675, $p<0.05$) as well as on a high discriminatory ability of the ABCD total score between PD and PDD patients (AUC 0.950, $p<0.01$) without providing cut-off points (Tafiadis et al., 2015). Furthermore, the use of ABCD in the Australian and UK context reported its cultural robustness (Dharmaperwira-Prins, 2004; Sandifer et al., 2005). Armstrong et al., in 1996, reported that ABCD can be used in the UK context and that cultural effects in the stimuli are limited, hence not influencing test performance (Dharmaperwira-Prins, 2004). Similar results were reported by Moorhouse et al. (1999) for the Australian-English language context, although the elderly sample of their study achieved significantly lower scores than those of the participants in the original US study (Sandifer et al., 2005). The above data suggest that the ABCD can sustain its properties and serve its purpose across different languages, as it did in this study.

4.2 Psychometric properties of the ABCD

In this study, the psychometric properties of the Greek version of ABCD were examined, with our results showing similar psychometric properties to those reported in the original study (Bayles, & Tomoeda, 1993). The Greek version of ABCD presents very good internal consistency in line with the data reported in other studies (Armstrong et al., 1996; Bayles & Tomoeda, 1993; Moorhouse et al., 1999). The intra-class correlation coefficient of the Greek version of ABCD was excellent, a result also reported by previous relevant literature, showing that the ABCD is a reliable and valid tool cross-linguistically (Bayles & Tomoeda, 1993).

4.3 Strengths and Limitations

The sample size was a limitation of this study, which could weaken the ability to generalize its results, albeit not substantially. This is because the sample was robustly and strictly characterized, which is one of the study's strengths. Another limitation is that the patients were recruited from one clinic in a specific region. Crucially, the study constitutes the first attempt to psychometrically validate the ABCD in the Greek language, which adds to the novelty of the presented research.

5.0 CONCLUSIONS

This study presented the validation of the ABCD in a Greek-speaking population facing cognitive problems. The ABCD is a battery test that can be used to assess patients with cognitive-communications disorders. The findings of the present study point in the same direction and corroborate relevant previous research since it was found that the Greek version of the ABCD can discriminate between demented and non-demented groups. The Greek version of the ABCD demonstrates good validity, which agrees with previous results in different language versions of the test. As the ABCD is a battery test, it could easily be employed by specialists in outpatient clinics as a reliable assessment tool. It is suggested that it is employed alongside other tools that assess an individual's cognitive abilities.

Acknowledgements: We thank PRO-ED incorporation for permitting us to translate for research purposes ABCD with no charge (Copyright © 1993 PRO – ED, Inc. Arizona Battery for Communication Disorders of Dementia, translated with the permission of the publisher. All rights reserved).

Author Contributions: Conceptualization, DT and SK; methodology, DT, SK, VS and NZ; validation, DT, LV, VS, AP, VZ, NZ and SK; formal analysis, DT; investigation, DT, VZ; resources, DT, LV, VZ, AP; data curation, DT, AP, VS; writing—original draft preparation, DT; writing—review and editing, DT, LV, VS, AP, VZ, NZ and SK; supervision, SK; project administration, DT, NV and SK. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: "The authors declare no conflict of interest".

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.

References

Armstrong, L., Borthwick, S. E., Bayles, K. A., & Tomoeda, C. K. (1996). Use of the Arizona battery for communication disorders of dementia in the UK. *International Journal of Language & Communication Disorders*, *31*(2), 171-180. https://doi.org/10.3109/13682829609042219

Azuma, T., Cruz, R. F., Bayles, K. A., Tomoeda, C. K., & Montgomery Jr, E. B. (2003). A longitudinal study of neuropsychological change in individuals with Parkinson's disease. *International Journal of Geriatric Psychiatry*, *18*(11), 1043-1049. https://doi.org/10.1002/gps.1015

Bayles, K. A., & Tomoeda, C. K. (1983). Confrontation naming impairment in dementia. *Brain and Language*, *19*(1), 98-114. https://doi.org/10.1016/0093-934X(83)90057-3

Bayles, K. A., & Tomoeda, C. K. (1993). *Arizona battery for communication disorders of dementia*. Pro-Ed Publishing, Austin, USA.

Bayles, K. A., Tomoeda, C. K., & Trosset, M. W. (1992). Relation of linguistic communication abilities of Alzheimer's patients to stage of disease. *Brain and Language*, *42*(4), 454-472. https://doi.org/10.1016/0093-934X(92)90079-T

Bayles, K. A., Tomoeda, C. K., Cruz, R. F., & Mahendra, N. (2000). Communication abilities of individuals with late-stage Alzheimer disease. *Alzheimer Disease & Associated Disorders*, *14*(3), 176-181. https://doi.org/10.1097/00002093-200007000-00009

Bayles, K. A., Tomoeda, C. K., McKnight, P. E., Helm-Estabrooks, N., & Hawley, J. N. (2004, November). Verbal perseveration in individuals with Alzheimer's disease. *Seminars in Speech And Language*, *26*(4), 335-347. https://doi.org/10.1055/s-2004-837246

Bayles, K. A., Tomoeda, C. K., Montgomery, E. B., Cruz, R. F., & Azuma, T. (2000). The relation of mental status to performance on lexical-semantic tasks in Parkinson's disease. *Advances in Speech Language Pathology*, *2*(2), 67-75. https://doi.org/10.3109/14417040008996792

Bayles, K., McCullough, K., & Tomoeda, C. K. (2020). *Cognitive-communication disorders of MCI and dementia: Definition, assessment, and clinical management*. Plural Publishing.

Dharmaperwira-Prins, R. I. (2004). Dutch and Indonesian versions of the Arizona Battery for Communication Disorders of Dementia (ABCD): does the test cross boundaries of language and culture? *Asia Pacific Journal of Speech, Language and Hearing*, *9*(1), 62-69. https://doi.org/10.1179/136132804805575976

Emre, M., Aarsland, D., Brown, R., Burn, D. J., Duyckaerts, C., Mizuno, Y., ... & Dubois, B. (2007). Clinical diagnostic criteria for dementia associated with Parkinson's disease. *Movement disorders*, *22*(12), 1689-1707. https://doi.org/10.1002/mds.21507

Farina, N., Page, T. E., Daley, S., Brown, A., Bowling, A., Basset, T., ... & Banerjee, S. (2017). Factors associated with the quality of life of family carers of people with dementia: A systematic review. *Alzheimer's & Dementia*, *13*(5), 572-581. https://doi.org/10.1016/j.jalz.2016.12.010

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*(3), 189-198. https://doi.org/10.1016/0022-3956(75)90026-6

Fossel, M. (2020). A unified model of dementias and age-related neurodegeneration. *Alzheimer's & Dementia*, *16*(2), 365-383. https://doi.org/10.1002/alz.12012

Fountoulakis, K. N., Tsolaki, M., Chantzi, H., & Kazis, A. (2000). Mini mental state examination (MMSE): a validation study in Greece. *American Journal of Alzheimer's Disease & Other Dementias®*, *15*(6), 342-345. . https://doi.org/10.1177/153331750001500604

Fountoulakis, K. N., Tsolaki, M., Iacovides, A., Yesavage, J., O'hara, R., Kazis, A., & Ierodiakonou, C. (1999). The validation of the short form of the Geriatric Depression Scale (GDS) in Greece. *Aging Clinical and Experimental Research*, *11*(6), 367-372. https://doi.org/10.1007/BF03339814

Goetz, C. G., Poewe, W., Rascol, O., Sampaio, C., Stebbins, G. T., Counsell, C., ... & Seidl, L. (2004). Movement Disorder Society Task Force report on the Hoehn and Yahr staging scale: status and recommendations the Movement Disorder Society Task Force on rating scales for Parkinson's disease. *Movement Disorders*, *19*(9), 1020-1028. https://doi.org/10.1002/mds.20213

Hodkinson, H. M. (1972). Evaluation of a mental test score for assessment of mental impairment in the elderly. *Age and Ageing*, *1*(4), 233-238. https://doi.org/10.1093/ageing/1.4.23

Hoehn, M. M., & Yahr, M. D. (1967). Parkinsonism: onset, progression, and mortality. *Neurology*, *50*(2), 318-318. https://doi.org/10.1212/WNL.17.5.427

Jack Jr, C. R., Albert, M., Knopman, D. S., McKhann, G. M., Sperling, R. A., Carillo, M., ... & Phelps, C. H. (2011). Introduction to revised criteria for the diagnosis of Alzheimer's disease: National Institute on Aging and the Alzheimer Association Workgroups. *Alzheimer's & dementia*, *7*(3), 257. https://doi.org/10.1016/j.jalz.2011.03.004

Khachaturian, Z. S. (2006). Diagnosis of Alzheimer's disease: two-decades of progress. *Journal of Alzheimer's disease*, *9*(s3), 409-415. https://doi.org/10.3233/JAD-2006-9S346

Khachaturian, Z. S., & Radebaugh, T. S. (Eds.). (2019). *Alzheimer's disease: cause (s), diagnosis, treatment, and care*. CRC Press.

Khachaturian, Z. S., Kuller, L. H., & Khachaturian, A. S. (2019). Strategic goals and roadmap for dementia prevention by stroke prevention. *Alzheimer's & Dementia*, *15*(7), 865-869. https://doi.org/10.1016/j.jalz.2019.06.001

Klimova, B., & Kuca, K. (2016). Speech and language impairments in dementia. *Journal of Applied Biomedicine*, *14*(2), 97-103. https://doi.org/10.1016/j.jab.2016.02.002

Klimova, B., Valis, M., & Kuca, K. (2017). Cognitive decline in normal aging and its prevention: a review on non-pharmacological lifestyle strategies. *Clinical Interventions in Aging*, *12*, 903. https://doi.org/10.3928/02793695-20100331-03

Konstantopoulos, K., Vogazianos, P., & Doskas, T. (2016). Normative data of the Montreal Cognitive Assessment in the Greek population and parkinsonian dementia. *Archives of Clinical Neuropsychology*, *31*(3), 246-253. https://doi.org/10.1093/arclin/acw002

Lawton, M. P., & Brody, E. M. (1969). Assessment of older people: self-maintaining and instrumental activities of daily living. *The Gerontologist*, *9*(3), 179-186.

Litvan, I., Aarsland, D., Adler, C. H., Goldman, J. G., Kulisevsky, J., Mollenhauer, B., ... & Weintraub, D. (2011). Diagnostic criteria for mild cognitive impairment in Parkinson's disease: Movement Disorder Society Task Force guidelines. *Movement Disorders*, *27*(3), 349-356. https://doi.org/10.1002/mds.24893

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack Jr, C. R., Kawas, C. H., ... & Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, *7*(3), 263-269. https://doi.org/10.1016/j.jalz.2011.03.005

Medical Outcomes Trust (1997). Trust introduces new translation criteria. *Trust Bulletin*, 5, 1-4.

Messinis, L., Malegiannaki, A. C., Christodoulou, T., Panagiotopoulos, V., & Papathanasopoulos, P. (2011). Color Trails Test: Normative data and criterion validity for the Greek adult population. *Archives of Clinical Neuropsychology*, *26*(4), 322-330. https://doi.org/10.1093/arclin/acr027

Messinis, L., Tsakona, I., Malefaki, S., & Papathanasopoulos, P. (2007). Normative data and discriminant validity of Rey's Verbal Learning Test for the Greek adult population. *Archives of Clinical Neuropsychology*, *22*(6), 739-752. https://doi.org/10.1016/j.acn.2007.06.002

Moorhouse, B., Douglas, J. M., Panaccio, J., & Steel, G. (1999). Use of the Arizona Battery for Communication Disorders of Dementia in an Australian context. *Asia Pacific Journal of Speech, Language and Hearing*, *4*(2), 93-107. https://doi.org/10.1179/136132899805577097

Muslimović, D., Schmand, B., Speelman, J. D., & De Haan, R. J. (2007). Course of cognitive decline in Parkinson's disease: a meta-analysis. *Journal of the International Neuropsychological Society*, *13*(6), 920-932. https://doi.org/10.1017/S1355617707071160

Naylor, M. D., Karlawish, J. H., Arnold, S. E., Khachaturian, A. S., Khachaturian, Z. S., Lee, V. M. Y., ... & Trojanowski, J. Q. (2012). Advancing Alzheimer's disease diagnosis, treatment, and care: Recommendations from the Ware Invitational Summit. *Alzheimer's & Dementia*, *8*(5), 445-452. https://doi.org/10.1016/j.jalz.2012.08.001

Politis, A. M., Mayer, L. S., Passa, M., Maillis, A., & Lyketsos, C. G. (2004). Validity and reliability of the newly translated Hellenic Neuropsychiatric Inventory (H-NPI) applied to Greek outpatients with Alzheimer's disease: a study of disturbing behaviors among referrals to a memory clinic. *International Journal of Geriatric Psychiatry*, *19*(3), 203-208. https://doi.org/10.1002/gps.1045

Poptsi, E., Moraitou, D., Eleftheriou, M., Kounti-Zafeiropoulou, F., Papasozomenou, C., Agogiatou, C., ... & Tsolaki, M. (2019). Normative data for the Montreal Cognitive Assessment in Greek older adults with subjective cognitive decline, mild cognitive impairment and dementia. *Journal of Geriatric Psychiatry and Neurology*, *32*(5), 265-274. https://doi.org/10.1177/0891988719853046

Postuma, R. B., Berg, D., Adler, C. H., Bloem, B. R., Chan, P., Deuschl, G., ... & Stern, M. (2016). The new definition and diagnostic criteria of Parkinson's disease. *The Lancet Neurology*, *15*(6), 546-548. https://doi.org/10.1002/mds.27362

Postuma, R. B., Berg, D., Stern, M., Poewe, W., Olanow, C. W., Oertel, W., ... & Deuschl, G. (2015). MDS clinical diagnostic criteria for Parkinson's disease. *Movement Disorders*, *30*(12), 1591-1601. https://doi.org/10.1002/mds.26424

Postuma, R. B., Poewe, W., Litvan, I., Lewis, S., Lang, A. E., Halliday, G., ... & Berg, D. (2018). Validation of the MDS clinical diagnostic criteria for Parkinson's disease. *Movement Disorders*, *33*(10), 1601-1608. https://doi.org/10.1016/S1474-4422(16)00116-2

Reisberg, B., Ferris, S. H., De Leon, M. J., & Crook, T. (1988). Global deterioration scale (GDS). *Psychopharmacol Bulletin*, *24*(4), 661-3.

Ryan, C. M., Geckle, M. O., & Orchard, T. J. (2003). Cognitive efficiency declines over time in adults with Type 1 diabetes: effects of micro-and macrovascular complications. *Diabetologia*, *46*(7), 940-948. https://doi.org/10.1007/s00125-003-1128-2

Sandifer, H., Frank, E., Montgomery, A., Nichols, M., & Cooper, W. (2005). Arizona Battery for Communication Disorders of Dementia test performance: can this test be used with Caucasian and African American adolescents with traumatic brain injury? *Journal of Medical Speech-Language Pathology*, *13*(1), 1-6. https://doi.org/10.1111/j.1460-6984.1995.tb01716.x

Speer, A., & Skinner, C. (1995). Is the Arizona Battery for Communication Disorders of Dementia an appropriate tool in the assessment of language impairment in closed head injury. *International Journal of Language & Communication Disorders*, *30*(S1), 394-403. https://doi.org/10.1111/j.1460-6984.1995.tb01716.x

Sperling, R. A., Aisen, P. S., Beckett, L. A., Bennett, D. A., Craft, S., Fagan, A. M., ... & Phelps, C. H. (2011). Toward defining the preclinical stages of Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, *7*(3), 280-292. https://doi.org/10.1016/j.jalz.2011.03.003

Tafiadis, D., Konitsiotis, S., & Nasios, G. (2011 November 12 – 17). *Language Disturbances of Greek Alzheimer's population* [Poster session]. 20th World Neurology Congress, Marrakesh, Morocco. https://wfneurology.org/private/downloads/c3pAHy0MljJ5Zbl8eq9neQ/WCN_2011_Final-Abstract-book.pdf

Tafiadis, D., Konitsiotis, S., Nasios, G. (2012). Validation and reliability of instrumental activities of daily living (IADL) in Greek patients with Alzheimer's disease and related dementias with language deficits. *European Journal of Neurology*, *19*(P2060), 479.

Tafiadis, D., Messinis, L., Chrondrogianni, M., Konitsiotis, S., & Nasios, G. (2015). Arizona Battery of Communication Disorders of Dementia for Evaluation of Cognitive Impairment in PD and Early Diagnosis of PDD. *Hellenic Journal of Nuclear Medicine*, *18*(Suppl), 222-230. http://dx.doi.org/10.6084/m9.figshare.5260198.v1

Tafiadis, D., Ziavra, N., Prentza, A., Siafaka, V., Zarokanellou, V., Voniati, L., & Konitsiotis, S. (2022). Validation of the Greek version of the Abbreviated Mental Test Score: Preliminary findings for cognitively impaired patients of different etiology. *Applied Neuropsychology: Adult*, *29*(5), 1003-1014. https://doi.org/10.1080/23279095.2020.1835915

Tafiadis, D., Ziavra, N., Prentza, A., Siafaka, V., Zarokanelou, V., Voniati, L., & Konitsiotis, S. (2021). The Tuokko version of the Clock Drawing Test: A validation study in the Greek population. *Journal of Clinical and Experimental Neuropsychology*, *43*(10), 967-979. https://doi.org/10.1080/13803395.2022.2036706

Theotoka, I., Kapaki, E., Vagenas, V., Ilias, I., Paraskevas, G. P., & Liappas, I. (2007). Preliminary report of a validation study of Instrumental Activities of Daily Living in a Greek sample. *Perceptual and Motor Skills*, *104*(3), 958-960. https://doi.org/10.2466%2Fpms.104.3.958-960

Tomoeda, C. K., & Bayles, K. A. (1993). Longitudinal effects of Alzheimer disease on discourse production. *Alzheimer Disease and Associated Disorders*, *7*(4), 223-236.

Tuokko, H., Hadjistavropoulos, T., Miller, J. A., & Beattie, B. L. (1992). The Clock Test: a sensitive measure to differentiate normal elderly from those with Alzheimer disease. *Journal of the American Geriatrics Society*, *40*(6), 579-584. https://doi.org/10.1111/j.1532-5415.1992.tb02106.x

Wechsler, D. (1981) *Wechsler Adult Intelligence Scale-Revised*. Psychological Corporation, New York.