

Introduction

Aphasia is mainly characterized by language impairments across all modalities, word-finding difficulties, and difficulties in reading and writing (Harley, 2001). Auditory comprehension is often affected in stroke-induced aphasia, especially in cases where the processing of complex grammatical structures is involved.

The Token Test (De Renzi & Vignolo, 1962) has extensively been used in the aphasia literature to discriminate between aphasic patients and healthy individuals and its sensitivity in determining aphasia severity based on auditory comprehension measures.

-> Recently, Bastiaanse et al. (2016) developed a multi-lingual digital version of the shortened version of Token task (De Renzi & Faglioni, 1978), i.e., the *Token Test App*, available for over 35 languages, which was adapted for Greek by Nerantzini et al. (2020).

-> The application is now available for both iOS and Android systems and automatically provides accuracy scoring that can be clinically used to demonstrate performance deterioration in aphasia, while avoiding paper-and-pencil drawbacks that are prone to human error. Additionally, digitized task versions provide procedure standardization with automatic presentation and scoring, time efficiency during assessment, and allow clinicians to access the results remotely in real time (Newton et al., 2013).

Materials

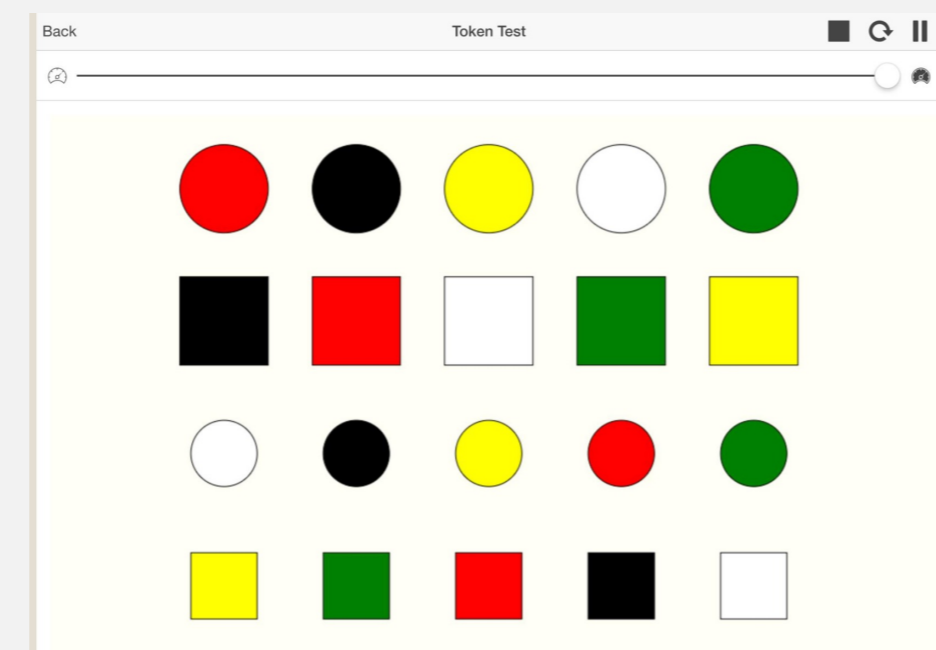
Tokens of different shape, color and size are presented to the participants, who need to follow the instructions in order to accurately determine the correct response.

The fact that the same set of lexical items are used across trials, allows for the control of lexical frequency as a potential factor (lexical diversity is minimized).

The task consists of 36 sentences with increasing levels of structural complexity and working memory load, organized in six blocks, measuring auditory sentence comprehension.

Participants are asked to point to one or two shapes in a particular sequence specified by the examiner.

All instructions were recorded by a Greek native speaker, and the recordings were assessed for articulatory and prosodic accuracy. The materials were presented to the participants by headphones.



Increasing level of complexity
-> **Verbal Complexity** is varied by changing the adjectival content of the object noun phrases in each section.
-Block 1: "Touch a green token"
-Block 5: "Touch the large red circle and the little black square"
More elaborate syntactic structures are used in the last sections: imperative sentences, subordinate clauses, adverbs, and locative prepositional phrases.
-Block 6: " Touch the black circle with the red square"
" Touch all the circles except for the yellow one"
Increasing sentence length
Cognitive processes involved include verbal short-term memory, working memory, and inhibitory control to ignore distracting and competing lexical information.

Correct response = 1, correct response after repetition = 0.5, incorrect response = 0 (max total score = 36)

Validity and Reliability

TEST-RETEST RELIABILITY

20 Healthy non-brain-damaged participants
•Three weeks interval

Stable performance was attested between the initial testing and retesting for the control group, with very little difference in mean scores between the two administrations.

Controls	Session 1	Session2
Mean Token Score	34,7	35,6
SD	1,16487	1,629278

Marginal Pearson test-retest correlations were attested for this group due to the fact that the range of their scores was relatively restricted, compared to the large distribution found among for the PWA group.

However, high test-retest reliability needs to be verified for the PWA group (work in progress).

Discussion

Despite the relatively small sample size, our preliminary results suggest that the Token Test app can indeed be effectively used as an accurate discriminator between aphasic participants of varying severity levels and healthy adults.

- The comprehension scores of other behavioral measures (e.g., NAVS sentence comprehension) was also highly correlated with the token test score suggesting that language comprehension is highly dependent on the syntactic processing skills, as well.
- Correlations with working memory suggest that complex sentence decoding is more costly than the simple maintenance of linguistic information over a short period.
- Test-retest scores suggest that performance does not change over time, but further research is needed to establish test-retest reliability for PWA, as well.

Pilot study

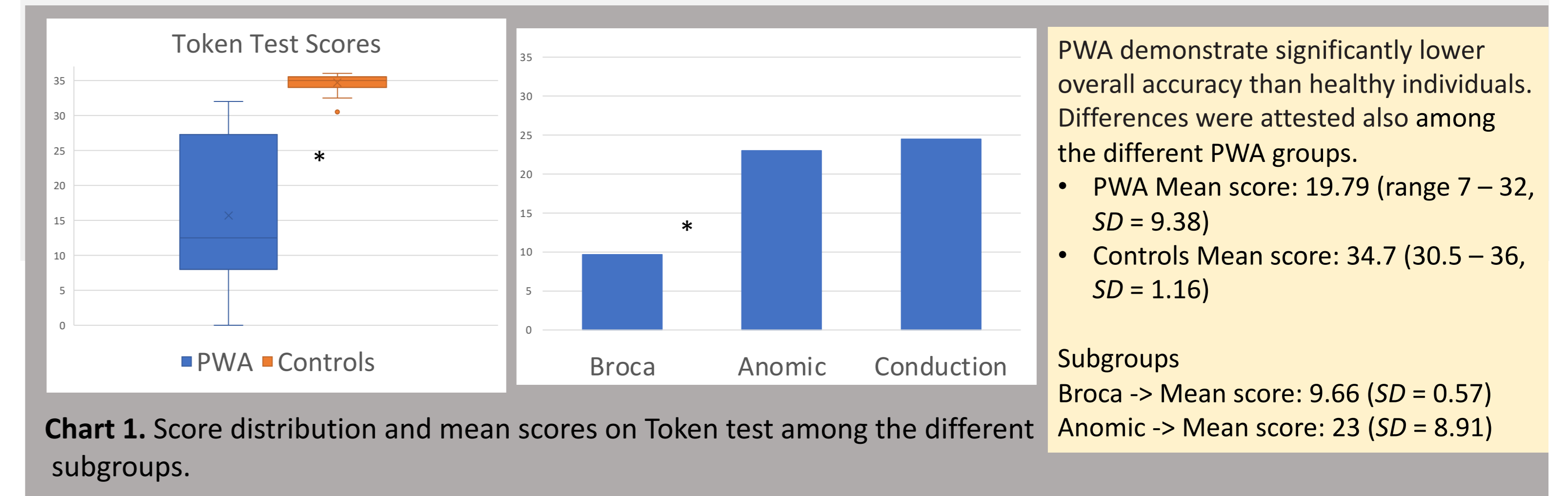
Participants



- 15 Greek-speaking individuals with aphasia (PWA) (mean age: 55.2; SD: 10.1; mean years of education: 11.1, SD: 3.42), with a single left lesion and an average of 6 months post onset were recruited from the ANIMUS Rehabilitation Center in Larisa, Greece.
- 45 healthy non-brain-damaged participants (mean age: 54.3; SD: 8.45; mean years of education: 10.2; SD:4,62) were included in the pilot.

	Gender	Classification	Age in years	Education (years)	Total BDAE auditory comprehension	Total BDAE oral expression	BDAE Word Repetition	BDAE Sentence repetition	Total BNT	Digit span Forward	Digit span Backward
P1	M	Broca	56	12	49/99	48/140	9/10	9/16	16/45	3/16	4/14
P2	M	Broca	53	16	80/99	54/140	5/10	2/16	23/45	2/16	2/14
P3	M	Broca	59	9	92/99	43/140	7/10	6/16	9/45	4/16	3/14
P4	M	Anomic	70	6	91/99	119/140	10/10	14/16	41/45	7/16	3/14
P5	M	Anomic	63	16	83/99	110/140	10/10	8/16	40/45	7/16	6/14
P6	M	Anomic	58	16	79/99	61/140	9/10	7/16	23/45	12/16	3/14
P7	F	Anomic	37	12	91/99	100/140	9/10	7/16	17/45	7/16	5/14
P8	M	Anomic	54	12	84/99	136/140	10/10	16/16	45/45	8/16	6/14
P9	F	Anomic	42	6	56/99	83/140	10/10	4/16	14/45	10/16	2/14
P10	M	Anomic	73	12	75/99	106/140	10/10	10/16	26/45	7/16	5/14
P11	M	Anomic	43	6	91/99	132/140	10/10	16/16	23/45	6/16	4/14
P12	M	Anomic	50	12	89/99	112/140	10/10	16/16	23/45	3/16	0/14
P13	M	Anomic	65	12	73/99	97/140	10/10	16/16	23/45	6/16	3/14
P14	M	Anomic	56	12	68/99	133/140	10/10	16/16	36/45	9/16	2/14
P15	M	Conduction	49	9	99/99	117/140	7/10	1/16	26/45	5/16	2/14

Table 1. Demographic information and accuracy scores on BDAE subtests, Boston Naming Test and working memory capacity.



PWA presented higher variance in terms of Token Test scores

		MMSE	Digit span forward	Digit span backwards	Age	Education
token	Pearson Correlation	.596 [*]	0,505	0,190	-0,307	-0,183
	Sig. (2-tailed)	0,019	0,055	0,498	0,266	0,514
	N	15	15	15	15	15

Correlations

		BDAE auditory comprehension	BDAE oral expression	BDAE word repetition	BDAE sentence repetition	NAVS verb comprehension	NAVS sentence comprehension
token	Pearson Correlation	0,280	0,458	0,426	0,220	0,436	,544 [*]
	Sig. (2-tailed)	0,312	0,086	0,114	0,432	0,104	0,036
	N	15	15	15	15	15	15

Table 2. Pearson Correlations for the PWA group

A bivariate correlation was conducted to investigate how the Token Test scores relate to the raw scores of other cognitive (e.g., MMSE, Folstein et al., 1975) and language measures (BDAE, for Greek: Papanthanasidou et al., 2008 and the comprehension subtests of the Northwestern Assessment of Verbs and Sentences, NAVS, for Greek: Nerantzini et al., 2016).

Significant correlations were attested between the token test score and the **MMSE scores** ($r(15)=.596, p=.019$), and with the **sentence comprehension subtest of NAVS** ($r(15)=.544, p=.036$), while marginally with the **Forward Digit span** ($r(15)=.505, p=.055$).

No significant correlations were attested with **age** or **education** level (in line with Akinina et al., 2019 for Russian).

		Age	Education	Digit Span Forward	Digit Span Backwards	Number Ordering	Word Repetition	Sentence Repetition
token	Pearson Correlation	-0,095	.311 [*]	0,287	.484	0,213	.440	0,060
	Sig. (2-tailed)	0,533	0,038	0,056	0,001	0,160	0,002	0,696
	Sum of Squares and Cross-products	-41,300	73,700	24,400	43,300	32,200	37,300	3,000
Covariance		-0,939	1,675	0,555	0,984	0,732	0,848	0,068
N		45	45	45	45	45	45	45

Table 3. Pearson Correlations for the Control group

Significant correlations were attested between the token test score and the years of **education** ($r(45)=.311, p=.038$), with the **Backwards Digit Span** ($r(45)=.484, p=.001$) and with the **word repetition scores** ($r(45)=.440, p=.002$), while marginally with the **Forward Digit span** ($r(45)=.287, p=.056$).

References

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- Nerantzini, M., Olioumtevs, K., Varlokosta, S., Akinina, Yu., Satoer, D., de Kok, D., & Bastiaanse, R. (2020). *The Token Test App, Second Edition: Greek version*. Groningen (NL): The University of Groningen.