Adaptation and norm determination of the Boston Naming Test for healthy Lebanese adults aged between 50 and 88 years

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Abstract

The Boston Naming Test is a well-known neuropsychological test widely used to evaluate linguistic abilities, encompassing object naming and word retrieval in subjects representing various clinical pathologies. Our study has two main stages: (1) a pilot study aimed at adapting the BNT to the linguistic and cultural particularities of Lebanese society and (2) norm determination for the Lebanese version of the BNT through the analysis of participants' responses. The primary goal of this study is to develop a Lebanese version of the BNT comprising 60 images adapted to the Lebanese language and culture. This version is based on normative data derived from healthy Lebanese adults aged between 50 and 88 years. The study seeks to assess the influence of age, gender, and education level on the naming performance of participants. In the pilot study, 103 Lebanese volunteers participated, while the normative study involved 280 healthy volunteers aged between 50 and 88 years. Three screening tests—Montreal Cognitive Assessment (MOCA), Language Experience and Proficiency Questionnaire (LEAP-Q), and Geriatric Depression Scale 15-item (GDS)—were administered to select participants meeting inclusion criteria. The findings revealed a statistically significant effect of age and education level on the BNT (Lebanese version) total score. The total score decreased with age and increased with education. However, the effect of gender was not significant, a result confirmed by the generalized linear model. This study successfully produced a Lebanese version of the BNT comparable to the original English version. Additionally, it provided normative data crucial for evaluating naming ability, word retrieval, and detecting potential disorders associated with aging.

Keywords: Boston Naming Test (BNT), Adaptation, Norm determination, Neuropsychological tests, Object naming, Word retrieval, Aging

Introduction

The Boston Naming Test (BNT) serves as a widely employed neuropsychological assessment tool specifically designed for evaluating language proficiency, encompassing object naming, and word retrieval capabilities (Kaplan et al., 1983; Soylu & Cangöz, 2018). Its widespread application in clinical settings and scientific investigations is attributed to its simplicity and heightened sensitivity in identifying language impairments across diverse age groups, including children, adults, and the elderly, who present with various clinical

conditions such as communication disorders, aphasia, dementia, and brain lesions (Soylu & Cangöz, 2018; Thomas et al., 2019; Vestito et al., 2021).

The BNT was initially designed for the American English-speaking population (Kaplan et al., 1983). It consists of a set of 60 black and white line drawings of different objects. These objects vary in difficulty, ranging from easily recognizable objects, such as "house", "bed," and "toothbrush", to more complex and less familiar objects, such as "tripod", "protractor," and "abacus" (Kaplan et al., 1983). Then, several adaptations were created in order to be used in different languages and cultures, such as Italian (Vestito et al., 2021); Chinese (Li, Y. et al., 2022; Cheung, Cheung,& Chan, 2004); Spanish in Spain (Peña-Casanova et al., 2009); Spanish in Argentina (Allegri et al., 1997; Serrano et al., 2001); French–Canadian (Roberts & Doucet, 2011); Portuguese (Miotto et al., 2010); Greek (Patricacou, 2007); English in New Zealand (Barker-Collo, 2001); English in Australia (Cruise, Worrall, & Hickson, 2000); Korean (Kim & Na, 1999); and Dutch (Mariën et al., 1998). However, there is currently no version standardized to the Arab world that aligns with the cultural nuances and semantic intricacies specific to the Lebanese population.

Various countries have employed several methods to translate and adapt the BNT for use in their respective linguistic and cultural contexts. Some have implemented minor modifications, such as changing object names to align with the target culture, while others have undergone more significant changes (Roberts & Doucet, 2011; Thomas, 2019). In the Swedish version, for instance, the drawings remained unchanged, but the sequence in which they were presented was modified (Tallberg, 2005). Other adaptations involve replacing original test items with culturally relevant alternatives belonging to the same semantic category; for instance, the substitution of the American-centric "pretzel" with a culturally familiar food in some versions (Patricacou, 2007; Cruise, Worrall, & Hickson, 2000). Notably, the Brazilian adaptation of the BNT involved replacing 20 of the original 60 items with culturally relevant alternatives. These replacements were carefully chosen based on their frequency, ambiguity, familiarity, and similarity to the original picture. For instance, "pretzel" was replaced with "bolo" (cake), a more familiar food, while "rhinoceros" became "elefante" (elephant), a more commonly known animal, and "Pão de Açúcar" (Sugarloaf) replaced the mythical "sphinx" (Miotto et al., 2010). The Greek adaptation of the BNT replaced four items: "pretzel" with "a kind of cake," "door knocker" with "mailbox," "stethoscope" with "blood pressure instrument," and "scroll" with "ancient Greek column" to better reflect the cultural context (Patricacou, 2007). Finally, the Korean adaptation of the BNT by Kim and Na (1999) involved replacing 49 of the 60 pictures, which can again be categorized as a substantial change.

Demographic variables such as age, gender, and education have been investigated due to their potential impact on the performance of the BNT, irrespective of neurological conditions (Neil et al., 1995; Grima & Franklin, 2016). Research on the relationship between age and Boston Naming Test (BNT) scores reveals inconsistent findings; while numerous studies suggest a modest decrease in naming ability with advanced age, particularly in those aged 80 and above, some studies show no significant age effects or even better performance by older adults (Soylu & Cangöz, 2018; Thomas, 2019; Tallberg, 2005). These discrepancies are attributed to variations in research design and sample characteristics (Grima & Franklin, 2016). Similar inconsistent findings exist regarding the effect of gender on naming performance. Some studies suggest that men

perform slightly better than women, while others find no difference between the sexes (Patricacou, 2007; Tallberg, 2005). This discrepancy has been explained in some studies by suggesting that items presented in the BNT are more familiar to men than women (Thomas, 2019; Olabarrieta-Landa et al., 2015). Education has also been shown to affect naming performance (Nour et al., 2021). Many studies have found a positive correlation between naming ability and the number of years of education attained. People with fewer years of education tend to have lower scores, especially those with less than 12 years of education (Hawkins & Bender, 2002; Neils et al., 1995).

Naming disorders are prevalent and extend beyond individuals with brain injuries or advanced age; they manifest in young adults without overt pathological indications. Anomia, characterized by the inability to name objects and the phenomenon of having a "word on the tip of the tongue" represent common facets of these disorders (Burke & Shafto, 2004). This cognitive deficit can instigate frustration and discontent among affected individuals, potentially serving as an early indicator of more severe neurodegenerative conditions, including Alzheimer's disease, aphasia, and dementia (Burke & Shafto, 2004). Therefore, it is imperative to employ a diagnostic test that assesses object-naming proficiency in both normative adults and those with pathological disorders.

Lebanon exhibits high dementia rates among individuals aged 60 and above (Phung et al., 2017). The United Nations projects that the Lebanese population aged 65 and older will constitute 31.2% by 2050 (United Nations, 2017). The prevalence of naming disorders in Lebanon aligns with global patterns, emphasizing the necessity of employing a validated tool like the BNT, commonly used for identifying such disorders. With the cultural and linguistic variations, caution is required in the indiscriminate application of such instruments. Given the absence of standardized scoring norms for the BNT in Lebanon, our focus is on establishing its applicability for the adult Arabic-speaking Lebanese population.

The aims of the current study were (1) to describe the development of an adapted version of the BNT suitable for Lebanese Arabic speakers using a sample of healthy elderly Lebanese individuals and (2) to investigate the effects of age, education, and gender on the scores of the adapted version of the BNT as applied to Lebanese Arabic speakers.

Method

The adaptation and standardization of the BNT for the Lebanese language and culture were carried out through a three-phase approach, utilizing methodologies previously employed in other studies (Grima & Franklin, 2016; Soylu & Cangöz, 2018). It received approval from the Ethical Committee at the Hospital of Notre Dame de Secours in Byblos, Lebanon, on December 10, 2020. It consists of three main phases:

The first phase: translation

The first phase consists of the translation of the 60 items of the original BNT from English to Arabic by using two standard dictionaries (Ba'labakki, 2004; Reverso Dictionary n.d.). This translation allowed us to determine the Modern Standard Arabic (MSA) naming for each item. Based on Classical Arabic, MSA is the official written language used in government affairs, news, broadcast media, books, and education (Ibrahim, 2009; Kwaik et al., 2018). However, Arabic languages are characterized by diglossia: while MSA is

their common means of formal communication, Arabic dialects are the medium of oral communication within each community (Kwaik et al., 2018). MSA shares with Lebanese Arabic a considerable number of lexical, semantic, syntactic, and morphological features, but several differences emerge as well (Boudelaa & Marslen-Wilson, 2013). Therefore, it was essential to check in the second phase that the Lebanese speakers agree on these translations and use them frequently.

Second phase: pilot study

Different populations may use more than one word to refer to the same object depending on the particular cultural characteristics. Hence, all the possible Lebanese responses for each item of the BNT were collected even if they differed from the translated ones.

A pilot study was conducted on a sample of volunteers from a Lebanese population to help determine the name agreement for each image from the original BNT and, from that, to elaborate an adapted version that takes into consideration the Lebanese dialect and culture.

Participants of the pilot study

This study was conducted among a sample of Lebanese volunteers of different ages, levels of education, and gender in alignment with previous studies (Patricacou et al., 2007; Miotto et al., 2010; Grima & Franklin, 2016; Soylu & Cangöz, 2018). All participants reside in Lebanon and speak Lebanese Arabic as their native language.

A total of 103 volunteers participated in the study, of which there were 63 women (61.2%) and 40 men (38.8%). The range of age was between 18 and 86 years (mean = 35.54; standard deviation = 1.8). The level of education was divided into four groups: primary level (12.6%) with basic education, supplementary education till grade 9, secondary level (16.5%) with high school education from grade 10 to grade 12, university level (67%) with a bachelor's or master's degree, and doctorate level (3.9%).

Procedure

The pilot study was conducted by asking participants to name each of the 60 pictures of the BNT in Arabic as quickly as possible (with a limit of 20 s) using the word that most spontaneously came to their mind. No semantic or phonemic cues were given in the pilot study as there is no current Lebanese version to base the cueing upon.

Responses for each image of the BNT were entered in Excel to be analyzed. Name agreements, possible alternative synonyms, and lexical variations were determined for each image based on the responses given by the participants (see Table 1).

Development of the Lebanese version of the BNT

In order to analyze and adapt the BNT to Lebanese–Arabic, all responses provided by the participants were subdivided into two categories, and each of these categories was further subdivided into several more subcategories.

The first category contains all the responses that are accepted based on their alignment with the following:

Table 1 Analysis of the frequency rate of responses to the 60 items of the original BNT

Items	No	Correct responses			Incorrect responses						Total correct response	Total errors	Difficulty index (*p*)
		NA	Syn	NAR	Omi	WP	VM	ICE	SOE	*P*			
Bed	103	88	15	0	0	0	0	0	0	0	103	0	100
Tree	103	103	0	0	0	0	0	0	0	0	103	0	100
Pencil	103	103	0	0	0	0	0	0	0	0	103	0	100
House	103	86	8	0	0	0	0	7	2	0	94	9	91.26
Whistle	103	103	0	0	0	0	0	0	0	0	103	0	100
Scissors	103	103	0	0	0	0	0	0	0	0	103	0	100
Comb	103	97	0	0	0	0	0	6	0	0	97	6	94.17
Flower	103	76	26	0	0	0	0	1	0	0	102	1	99.03
Saw	103	103	0	0	0	0	0	0	0	0	103	0	100
Toothbrush	103	103	0	0	0	0	0	0	0	0	103	0	100
Helicopter	103	80	18	80[a]	0	0	0	0	7	0	98	7	95.15
Broom	103	103	0	0	0	0	0	0	0	0	103	0	100
Octopus	103	94	0	5	1	0	1	2	0	0	99	4	96.12
Mushroom	103	88	0	13	2	0	0	0	0	0	101	2	98.06
Hanger	103	101	2	0	0	0	0	0	0	0	103	0	100
Wheelchair	103	41	44	10	0	0	0	7	0	1	95	8	92.23
Camel	103	102	0	1	0	0	0	0	0	0	103	0	100
Mask	103	47	45	47[a]	0	0	1	4	6	0	92	11	89.32
Pretzel**	103	27	8	13	3	0	37	12	3	0	48	55	46.6
Bench	103	71	31	30	0	0	0	1	0	0	102	1	99.03
Racquet	103	64	34	64[a]	0	0	0	2	1	2	98	5	95.15
Snail	103	85	11	7	0	0	0	0	0	0	103	0	100
Volcano	103	85	0	14	0	0	2	1	0	1	99	4	96.12
Sea horse**	103	35	10	1	8	0	6	20	19	4	46	57	44.66
Dart	103	68	19	5	7	0	2	1	0	1	92	11	89.32
Canoe	103	65	15	9	0	0	0	14	0	0	89	14	86.41
Globe	103	97	2	2	0	0	0	2	0	0	101	2	98.06
Wreath**	103	32	0	2	8	0	2	17	37	3	34	69	37.86
Beaver**	103	8	0	14	8	0	0	69	1	3	22	81	21.36
Harmonica**	103	43	0	43[a]	10	0	5	16	20	9	43	60	41.74
Rhinoceros	103	88	0	6	3	0	0	6	0	0	94	9	91.26
Acorn	103	93	0	1	0	0	1	8	0	0	94	9	91.26
Igloo**	103	25	0	17	13	0	15	16	0	18	42	61	40.78
Stilts**	103	8	0	5	15	7	2	58	1	7	13	88	12.62
Dominoes**	103	47	0	47[a]	1	0	0	53	2	0	47	56	45.63
Cactus	103	83	0	14	0	0	0	5	0	1	97	6	94.17
Escalator	103	83	14	4	0	0	1	0	1	0	101	2	98.06
Harp**	103	29	0	20	10	0	1	7	35	1	49	54	47.57
Hammock	103	83	3	15	0	1	0	0	0	1	101	2	98.06
Knocker**	103	26	0	0	5	22	1	42	0	7	26	77	25.24
Pelican	103	56	0	8	4	0	0	20	14	1	64	39	62.14
Stethoscope	103	81	0	6	0	0	0	0	0	16	87	16	84.47
Pyramid	103	97	0	1	0	0	2	2	1	0	98	5	95.15
Muzzle**	103	5	0	6	7	21	0	50	0	14	11	92	10.68
Unicorn**	103	10	0	29	1	0	0	44	19	0	39	64	37.86
Funnel	103	96	0	2	0	0	0	3	0	2	98	5	95.15

Table 1 (continued)

Items	No	Correct responses			Incorrect responses						Total correct response	Total errors	Difficulty index (*p*)
		NA	Syn	NAR	Omi	WP	VM	ICE	SOE	P			
Accordion	103	73	0	73a	5	0	0	4	20	1	73	30	70.87
Noose	103	102	0	0	0	0	1	0	0	0	102	1	99.03
Asparagus	103	75	0	9	4	0	9	4	2	0	84	19	81.55
Compass	103	50	0	40	4	0	1	3	0	5	90	13	87.38
Latch	103	75	21	1	3	0	1	1	0	1	97	6	94.17
Tripod**	103	8	0	20	11	0	12	47	2	3	28	75	27.18
Scroll	103	61	27	6	4	0	0	1	3	1	94	9	91.26
Tongs	103	97	0	1	4	0	0	0	0	1	98	5	95.15
Sphinx	103	56	0	9	1	0	0	22	9	6	65	38	63.11
Yoke**	103	18	0	0	19	2	1	35	0	28	18	85	17.48
Trellis**	103	0	0	0	12	5	1	82	0	3	0	103	0
Palette**	103	15	0	19	1	0	0	47	11	10	34	69	37.86
Protractor**	103	36	7	36a	4	0	0	51	0	5	43	60	41.75
Abacus**	103	4	0	4	19	0	16	41	1	18	8	95	7.77

NO number of responses, *NA* name agreement or target word, *Syn* synonyms, *NAR* non-Arabic responses, *Omi* omission, *WP* wrong part, *VM* visual misperception, *ICE* intra-categorial errors, *SOE* superordinated errors, *P* periphrases, total correct responses, total errors, *p* difficulty index

** next to the items designates the words that have been substituted

a Target word is Arabized

- The name agreement (NA): a picture that prompts a consistent name from the majority of participants is considered to have high NA, whereas a picture that elicits multiple different names is considered to have low NA (Boukadi et al., 2016). For example, more than 80% of the participants agreed on naming « تخت» the image of "bed".
- Synonyms or alternatives are defined as different correct names given to the same image that share the same meaning. For example, the image "bed" received another valid common name, which is "سرير". The latter is the word found in the dictionary when translated in its MSA form.
- Answers that were correct according to the image but were named using their foreign origin (Arabized) can be attributed to the characteristic of bilingualism, which is prevalent in Lebanese society. For example, the word "helicopter" was named "helicopter" by 78% of the participants (80 out of 103).

The second category contains all responses with errors, where the response was non-concordant or nonspecific to the target name of the image that had been presented. The incorrect responses or the responses with errors were divided into five categories. The five categories were inspired by previous studies, particularly the Swedish, Turkish, and Dutch versions of the test (Mariën et al., 1998; Soylu & Cangöz, 2018; Tallberg, 2005).

1- Omission: no response or "I don't know."

2- Visuo-perspective errors or visual misperception: for example, the picture of a "pretzel" was misperceived as a "rope" (حبلة) or "snake" (حية).

3- Intra-categorial errors or side-ordinated words: for example, giving the answer of "squirrel" (سنجاب) or "rat" (فارا) for the image "Beaver."

4- Superordinated word errors: for example, instead of "harp," they said, "musical instrument" (الة موسيقية), or for "sea horse," they said, "animal" (حيوان).

5- Periphrases: for example, instead of "muzzle," participants described the image using periphrases such as "a thing to prevent the dog from biting" « شي بحطوا للكلب حتى ما يعض».

The analysis was based on the frequency rate of responses given by the 103 participants to each of the 60 original items of the BNT. This was done by calculating the total score of the correct answers for each image (the target word or Name agreement, synonym answers, and responses named using their foreign origin (Arabicized names)) and the total of answers with errors (visual misperception, intra-category errors, superordinated errors, periphrases responses, wrong part, no responses, or "don't know") (see Table 1).

To perform a careful selection of the items to be included in the Arabic version of the BNT, the selection was based on the analyses of the difficulty index (p). The difficulty index (p) is equal to the sum of correct responses divided by the total number of participants. It indicates how much each image was successfully recognized, in other words, correctly named. It varies from 0 to 1; 1 meaning that the image was named correctly in 100% of cases and 0.5 meaning it was correctly named in 50% of cases. If the image took a value smaller than 0.5, it was eliminated and replaced by another image more accessible to the Lebanese population according to previous studies who used the same criterion for screening (Pedraza et al., 2011; Soylu & Cangöz, 2018) (see Table 1).

The image that had the most visual–perceptual error was the image of "pretzel" which is a familiar food in the USA, unlike Lebanon. The participants saw this image as a snake or a rope due to the shape and lack of exposure to this concept. The image that had the most intra-categorical errors was the image of an "abacus". The participants mistook the object for a toy. In addition, the word "abacus" does not have an equivalent in Arabic, so participants had to describe it in order to name it. Also, the "beaver" had a high rate of intra-categorial error, as the participants mistook this object for a "squirrel" or a "mouse". The naming of this item respects the semantic category of the concept presented but remains far from the correct name. The image that had the most periphrastic responses was "yoke". The participants recognized the object and its mode of use, but the majority of them were unable to find its name. As a result, they had to use periphrases in order to name it. The image that had the most superordinated responses was "wreath". Participants had difficulty identifying the exact word, and instead referred to the image with general terms such as "decoration," "زينة", or "a decorative object". Also, for "harp" and "harmonica," the participants gave these images the generic name of "musical instrument." This is probably due to the fact that these two instruments are known in the West

more than in the East where their use is very rare. These two instruments do not have equivalent common names in Arabic.

In total, 18 pictures were eliminated because they did not receive enough name agreement (NA) from the participants, with a very high error rate. In order to replace these words with semantically similar ones with the same level of complexity and frequency, a number of Lebanese words were selected from books, newspapers, and television, a procedure used before (Heaton et al., 2004; MacKay et al., 2005; Storms, Saerens, &De Deyn 2004; Tsang HL & Lee TM, 2003;). Afterwards, the images were replaced by others from the same semantic category ensuring that the word length, number of syllables, and phonemes were as similar as possible to the original item (see Tables 2 and 3). The substitution of images was as follows: pretzel to manouche "منقوشة", sea horse to an alligator "تمساح", wreath to chandelier "تريا", beaver to hedgehog "قنفذ", harmonica to flute "مزمار", igloo to grotto "مغارة", stilts to clown "مهرج", harp to zither "القانون", knocker to kebbe pestle "مدقة الكبة", muzzle to cage "قفص", dominos to chess "شطرنج", unicorn to snowman "رجل ثلج", tripod to binocular "ناضور", yoke to saddle "سرج", trellis to windmill "طاحون", palette to paintbrush "ريشة", protractor to compass "بوصلة", and abacus to pulley «بكرة». To gather lexical and semantic norms for the new items, we enlisted 37 participants aged between 20 and 35 years. The cohort comprised 19 men and 18 women, all possessing a minimum of 13 years of education. Following the methodology outlined by Patricacou et al. (2007), these individuals were selected based on their age and educational background, deemed conducive to proficient task performance. For the familiarity and subjective frequency norms, we followed the same procedure of Chedid et al. (2022) who collected normative Lebanese Arabic data for 380 pictures. In the familiarity task, participants were asked to rate the familiarity of the concept depicted by each picture based on how common an object was in the language speaker's realm of experience (Bonin et al., 2003; Boukadi et al., 2016; Chedid et al., 2018). In the subjective frequency task, participants were asked to estimate the frequency of use of each word in the written or spoken language (Desrochers & Thompson, 2009). The results obtained allowed us to reorganize the items of the original BNT, as well as the newly replaced images. Adhering to the American Standard order and psycholinguistic variables, items were organized from the most familiar, highest-frequency object to the least familiar, lowest-frequency counterpart. This method mirrors the procedure implemented for the Portuguese version of the BNT (Patricacou, 2007). Thus, the Lebanese version of the BNT was created (see Table 4) and was used for the norm determination study to investigate the effects of age, gender, and level of education on naming performance.

Third phase: norm determination of the Lebanese version of the BNT
Participants of this study
The sample of the norm determination study consists of 280 participants, all volunteers, aged between 50 and 88 years (mean age = 68.57; SD = 10.77). They were recruited from different Lebanese villages covering different regions of Lebanon. All participants were informed about the objectives of this study and signed a prior consent form. The sample consists of 138 women (49.3%) and 142 men (50.7%) in total, divided into four age groups (group 1 = 50 to 59 years, group 2 = 60 to 69 years, group 3 = 70 to 79 years, and group 4 = 80 years and over) (Grima & Franklin, 2016; Mariën et al., 1998; Patricacou

Table 2 Normative data for psycholinguistic variables in Lebanese Arabic for the 60 items of the original BNT

	LA intended name	LA model name	Number of letters	Number of syllables	Number of phonemes	Name agreement (%)	Frequency (mean)	Familiarity (mean)
Bed	تخت	تخت	3	1	4	85.43%	6.9	4.77
Tree	شجرة	شجرة	4	3	6	100%	6.8	4.6
Pencil	قلم	قلم رصاص	3	2	5	100%	6.1	4.66
House	بَيْت	بَيْت	3	1	3	83.49%	5.87	4.61
Whistle	صوفيرة	صوفيرة	6	3	6	100%	3.54	3.6
Scissors	مُقَصّ	مُقَصّ	3	2	5	100%	4.9	3.88
Comb	مُشْط	مُشْط	3	1	4	94.17%	5.8	4.34
Flower	وَرْدَة- زهرة-	وَرْدَة	4	2	5	73.68%	5.37	4.6
Saw	منشار	منشار	5	2	6	100%	3.12	3.06
Toothbrush	فرشاة الاسنان	فرشاة الاسنان	12	5	-	100%	6.13	4.66
Helicopter	طائرة عامودية	هيليكوبتر	9	4	10	86.40%	2.72	3.3
Broom	مِكْنْسَة	مِكْنْسَة	5	3	6	100%	5.03	3.68
Octopus	أخطبوط	أخطبوط	6	3	7	91.26%	2.01	2.5
Mushroom	فطر	فطر	3	2	5	85.43%	3.3	3.16
Hanger	تَعْليقَة	تَعْليقَة	6	3	6	99%	6.22	3.92
Wheelchair	كرسي متحرك	كرسي متحرك	9	6	-	39.80%	2.6	3.2
Camel	جَمَل	جَمَل	3	2	5	99%	2.14	2.77
Mask	قناع	ماسك	4	2	5	45.60%	1.2	1.73
Pretzel	كَعْكَة	كَعْكَة	5	2	6	26.20%	-	-
Bench	مَقْعَدْ	مَقْعَدْ	4	2	6	68.90%	5.6	3.86
Racquet	مضرب	راكيت	5	2	6	62.10%	2.78	1.9
Snail	بَزَّيقة	بَزَّيقة	5	3	7	82.50%	3.5	3.88
Volcano	بركان	بركان	5	2	7	82.50%	1.37	1.93
Sea horse	حصان البحر	حصان البحر	9	4	-	33.98%	1.5	1.2
Dart	سَهم	سَهم	3	2	4	66.00%	1.8	3.21
Canoe	قارب- زورق -	شخطورة	4	2	7	63.20%	2.6	3.44
Globe	الكُرَة الأرْضيّة	الكُرَة الأرْضيّة	13	5	-	94.20%	2.5	2.13
Wreath	اكليل	اكليل	5	2	5	31.06%	1.6	1.4
Beaver	قندس	سمور	4	2	6	7.80%	-	-
Harmonica	هارمونيكا	هارمونيكا	9	4	9	41.64%	1.48	2.04
Rhinoceros	وحيد قرن	وحيد قرن	7	4	-	85.40%	1.56	2.66
Acorn	بَلّوط	بَلّوط	4	2	5	90.30%	1.16	3.49
Igloo	بيت ثلج	بيت ثلج	6	3	-	24.30%	1.46	1.27
Stilts	ساق- طويلات	ساق	4	1	3	7.70%	-	-
Dominoes	دومينو	دومينو	6	3	6	45.63%	1.26	1.83
Cactus	صبيّر	صبيّر	4	2	6	80.60%	2.49	2.03
Escalator	درج كهرباني	درج كهرباني	10	-	-	80.60%	3.05	2.51
Harp	قيثارة	قيثارة	6	3	6	28.20%	1.66	2.67
Hammock	مرجوحة	مرجوحة	6	3	7	80.60%	3.24	3.12
Knocker	مطرقة	مقرعة	5	3	7	25.20%	1.44	3.16
Pelican	بجعة	بجعة	3	2	6	54.40%	2.43	2.07
Stethoscope	سماعة حكيم	سماعة حكيم	8	5	-	78.70%	2.26	2.32
Pyramid	هرم	هرم	3	2	5	94.20%	1.01	3.01

Table 2 (continued)

	LA intended name	LA model name	Number of letters	Number of syllables	Number of phonemes	Name agreement (%)	Frequency (mean)	Familiarity (mean)
Muzzle	لجام- لجم	لجام- لجم	3	1	5	4.90%	1.17	1.07
Unicorn		حصان خرافي	-	-	-	14.60%	-	-
Funnel	قِمع	قِمع	3	2	5	93.20%	4.6	3.98
Accordion	أكورديون	أكورديون	8	4	10	74.11%	1.48	2.23
Noose	حبل المشنقة	حبل المشنقة	10	1	4	99%	2.86	2.35
Asparagus	هَلْيون	هَلْيون	5	2	6	72.80%	3.27	2.37
Compass	بيكار	بيكار	5	2	5	49%	1.85	1.53
Latch	قفل	قفل	3	1	4	72.80%	3.96	4.07
Tripod	-	ثلاثية الارجل	-	-	-	7.76%	-	-
Scroll	فرمان	رسالة	5	3	7	59.20%	1.32	1.96
Tongs	ملقط	ملقط	4	2	6	94.20%	5.6	3.6
Sphinx	أبو الهول	أبو الهول	8	3		54.36%	1.12	1.27
Yoke	نير	نير	3	1	3	17.50%	1.24	1.03
Trellis	تعريشة	سياج	4	2	5	14.60%	2.57	3.34
Palette	لوحة	صحن تلوين	4	2		14.56%	2.9	2.57
Protractor	منقلة	رابورتور	8	3	8	35%	2.38	2.07
Abacus	طبلية تاج	طبلية تاج	-	-	-	3.90%	-	-

LA intended name: Lebanese Arabic intended name from dictionary translation; LA model name: the Lebanese Arabic model is the actual name given by the majority of participants to the item presented in Lebanese Arabic; Name agreement (%) refers to the consistency with which different people agree on the name of an object depicted in an image indicating how often a specific name is chosen for the image compared to all responses

et al., 2007; Roberts & Doucet, 2011; Slegers et al., 2018). They were recruited based on three levels of education (primary, secondary, and university), and all participants had to meet the inclusion criteria established by prior studies (Soylu & Cangöz, 2018; Slegers et al., 2018; Grima & Franklin, 2016; Baerecke, 2013; Miotto et al., 2010; Patricacou et al., 2007; Tallberg, 2005; Mariën et al., 1998; Tombaugh & Hubley, 1997 Welch et al., 1996): (1) born and residing in Lebanon; (2) speak Lebanese Arabic as their native language; (3) have no particular cognitive impairment, nor any visual, auditory, neurological disorder, or other problem that may disrupt naming abilities; (4) no current antidepressant, antiepileptic, or anxiolytic treatment; (5) no excessive alcohol consumption or history of withdrawal; and (6) no drug consumption.

Moreover, three screening tests were applied to determine whether the participants were elderly adults with healthy cognitive functions and fit to participate in the study. The first one was the Language Experience and Proficiency Questionnaire (LEAP-Q) in its standardized Arabic version. It collected data on the knowledge and the degree of mastery of our participants of the Arabic language as well as other languages and allowed us to divide them into groups (Kaushanskaya et al., 2020). Participants who did not report using Arabic for at least 70% of their daily life activities were excluded from our study. The second one is the Montreal Cognitive Assessment (MoCA). This test was to assess mild cognitive dysfunctions: attention, concentration, executive functions, memory, language, visuo-constructive abilities, abstraction skills or conceptual thinking, calculation, and orientation (Nasreddine

Table 3 Normative data for psycholinguistic variables in Lebanese Arabic for the newly replaced items

	LA intended name	LA model name	Number of letters	Number of syllables	Number of phonemes	Frequency (mean)	Familiarity (mean)
Pretzel	كَعْكَة	كَعْكَة	5	2	6	-	-
Manoushe	منقوشة	منقوشة	6	3	7	4.83	3.94
Sea horse	حصان البحر	حصان البحر	-	4	-	1.5	1.2
Alligator	تمساح	تمساح	5	2	7	1.73	1.95
Wreath	اكليل	اكليل	5	2	5	1.6	1.4
Chandelier	تريا	تريا	5	2	6	3.34	2.24
Harmonica	هارمونيكا	هارمونيكا	9	4	9	1.48	2.04
Flute	مزمار	مزمار	5	3	6	1.57	3.06
Igloo	بيت ثلج	بيت ثلج	6	3	-	1.46	1.27
Cave/grotto	مغارة	مغارة	5	3	7	3.32	2.1
Dominos	دومينو	دومينو	5	3	6	1.26	1.83
Chess	شطرنج	شطرنج	5	3	7	2.89	3.05
Stilts	ساق- طويلات	ساق	4	1	3	-	-
Clown	مهرج	مهرج	4	3	6	1.67	2.51
Harp	قيثارة	قيثارة	6	3	6	1.66	1.37
Zither	القانون	القانون- قانون	7	2	6	2.04	1.53
Knocker	مقرعة	مقرعة	5	3	7	-	-
Kebbe pestle	مدقة الكبة	مدقة الكبة				1.75	1.67
Muzzle	لجام- لجم	-	3	1	5	1.17	1.07
Cage	قفص	قفص	3	2	5	2,27	3.26
Unicorn	-	-	-	-	-	-	-
Snowman	رجل ثلج	رجل ثلج	-	-	-	1.91	2.1
Tripod	-	-	-	-	-	-	-
Binocular	ناضور	ناضور	5	2	6	2.02	2.43
Yoke	نير	نير	3	1	3	1.24	1.03
Saddle	سرج	سرج	3	2	4	1.86	1.39
Trellis	تعريشة	-	4	2	5	-	-
Windmill	طاحون	طاحون	5	2	7	2.07	1.75
Palette	لوحة	صحن تلوين	4	2	5	2.9	2.57
Paintbrush	ريشة	ريشة	4	2	5	3.27	2.48
Protractor	منقلة	رابورتور		3	8	2.38	2.07
Compass	بوصلة	بوصلة	5	2	7	2.2	1.4
Abacus	طبلية تاج	-	-	-	-	-	-
Pulley	بكرة	بكرة	4	3	6	1.29	1.7

LA intended name: Lebanese Arabic intended name from dictionary translation; LA model name: the Lebanese Arabic name given by most participants in Lebanese Arabic

et al., 2005). The maximum score is 30 points. Participants who scored below 21 were excluded. The third test was the Geriatrics Depression Scale 15-item (GDS). This scale was designed to screen older adults for depressive feelings and suicidal intentions (Chaaya et al., 2008). Participants who received scores of 14 and above from GDS were not included in the study. The scores of MOCA (27.16 ± 1.34) and GDS (2.70 ± 1.22) varied between 23 and 30, as well as 0 and 5, respectively. Sociodemographic characteristics along with the mean and standard deviation values for the screening test scores have been described in Table 5.

Table 4 The Lebanese version of the BNT with the sum of frequency and familiarity for each item

Items		Name in Arabic	S*	Items		Name in Arabic	S*
1	Bed	تخت	11.67	31	Racquet	راكيت	5.02
2	Tree	شجرة	11.4	32	Cage	قفص	5.01
3	Toothbrush	فرشاة الاسنان	10.79	33	Dart	سَهم	5.01
4	Pencil	قلم رصاص	10.76	34	Camel	جَمَل	4.91
5	House	بَيْت	10.48	35	Globe	الكُرَة الأَرْضِيَّة	4.63
6	Hanger	تَعْليقَة	10.14	36	Binocular	ناضور	4.63
7	Comb	مُشْط	10.14	37	Acorn	بَلُّوط	4.62
8	Flower	وَرْدَة	9.97	38	Stethoscope	سماعة حكيم	4.58
9	Bench	مَقْعَدْ	9.46	39	Cactus	صبيّر	4.52
10	Tongs	ملقط	9.2	40	Octopus	أخطبوط	4.51
11	Scissors	مُقَصّ	8.78	41	Pelican	بجعة	4.5
12	Manoushe	منقوشة	8.77	42	Flute	مزمار	4.4
13	Broom	مِكْنَسَة	8.71	43	Rhinoceros	وحيد قرن	4.22
14	Funnel	قِمِع	8.58	44	Noose	حبل المشنقة	4.21
15	Latch	قفل	8.03	45	Clown	مهرج	4.18
16	Snail	بزَّيقة	7.38	46	Pyramid	هرم	4.02
17	Whistle	صوفيرة	7.14	47	Volcano	بركان	4.01
18	Mushroom	فطر	6.46	48	Snowman	رجل ثلج	4.01
19	Hammock	مرجوحة	6.36	49	Kebbe pestle	مدقة الكبة	3.94
20	Saw	منشار	6.18	50	Windmill	طاحون	3.82
21	Helicopter	هيليكوبتر	6.04	51	Accordion	أكورديون	3.71
22	Wheelchair	كرسي متحرك	6.02	52	Hedgehog	قنفذ	3.7
23	Canoe	قارب- شخطورة	6.1	53	Alligator	تمساح	3.68
24	Chess	شطرنج	5.94	54	Compass	بوصلة	3.6
25	Paintbrush	ريشة	5.75	55	Zither	القانون	3.57
26	Asparagus	هَلْيون	5.64	56	Compass	بيكار	3.38
27	Chandelier	تريا	5.58	57	Scroll	رسالة-فرمان	3.28
28	Escalator	درج كهربائي	5.56	58	Saddle	سرج	3.25
29	Cave	مغارة	5.42	59	Pulley	بكرة	2.99
30	Mask	ماسك	5.06	60	Sphinx	أبو الهول	2.39

S sum of frequency and familiarity

Administration procedure

All participants were tested individually and were administered all 60 items of the BNT in order of increasing difficulty. Participants were asked to give the names of all the images presented to them in Lebanese Arabic. Each image was presented for twenty seconds. If an answer is not provided after this time, a semantic cue is given to make it easier to find the name. A semantic cue provides information related to the meaning of the target word, offering hints like superordinate categories ("vegetable" for "asparagus"), actions associated with the word ("you ring it" for "bell"), or definitions and sentence completions ("stethoscope" a medical instrument to listen to the heart and internal sounds) (Python et al., 2021). If, however, the answer is still not found, another phonemic cue was provided to facilitate word retrieval. A phonemic cue assists word retrieval by focusing on its sound, offering hints like the first phoneme(s) (it starts with "c" for "cactus"), the first syllable for longer words, or a rhyming word (it rhymes with "nail" for "snail") (Python et al., 2021). This process was suspended if the participant was in

Table 5 Description of sociodemographic characteristics along with mean and standard deviations of screening test scores of the participants ($N = 280$)

	Mean	Standard deviation
Age (continuous)	68.57	(10.77)
MOCA	27.16	(1.34)
GDS	2.70	(1.22)
	Number of participants	Percentage
Age (categorical)		
50–59	75	26.8%
60–69	72	25.7%
70–79	77	27.5%
80 and above	56	20%
Gender		
Female	138	(49.3)
Male	142	(50.7)
Education		
Primary	90	(32.1)
Secondary	87	(31.1)
University	103	(36.8)

MOCA Montreal Cognitive Assessment, *GDS* Geriatrics Depression Scale

distress or refused to continue. The response for each item was recorded via a digital audio recorder and transcribed. The total score of the test represents the number of correct spontaneous responses and all correct responses obtained only after a semantic cue (Olabarrieta-Landa, 2015).

All accepted responses of the BNT Lebanese version can be found in the Appendix 1. We organized participants' responses using our instruction grid, which covers all possible types of responses (see Appendix 2). This grid was designed based on methods used in previous studies by Slegers et al. (2018) and Nicholas et al. (1989). This process sorted responses into two scores: one from responses given without semantic or phonemic cues and another from those given with cues. The total score combined correct spontaneous responses and correct responses with semantic cues (Cronbach's alpha = 0.754). This score gauges overall performance on the BNT.

Statistical analysis

Data analysis for the norm determination study was conducted using SPSS software version 26. We used the following information in our study:

- The sociodemographic characteristics of the participants
- The total score of the BNT (score of spontaneous responses and after a semantic cue)
- The four sub-scores (the numbers of the semantic and phonological cues given and the numbers of the correct responses following the semantic and phonological cues),
- error scores (no response, visual misperception, intra-categorical errors, superordinate errors, phonological errors, and periphrastic responses)

– The means, standard deviations (m±SD), medians, interquartile deviations (me±IQR), and minimum and maximum were reported for continuous variables, while frequencies (*n*) and percentages (%) were reported for categorical variables. Cronbach's alpha assessed the total score.

The normality of continuous variables was assessed using the Shapiro–Wilk test. Since the distribution of scores was skewed, as well as the variance of these scores not being equal between the groups studied, the generalized linear model (GzLM) was used to quantify the relationship between age (50–59; 60–69; 70–79; and 80 and above), education level (primary, secondary, university, and above), and gender (male; female) with the total Lebanese BNT score. Thus, the β coefficient and the 95% confidence interval (95% CI) were reported. The age × gender × education interaction was tested; in addition to the Akaike information criterion (AIC), the Bayesian information criterion (BIC) and the corrected Akaike information criterion (AICC) were used to choose the best model (the smallest value corresponds to a better model) (Neil et al., 1995). The correlation between BNT sub-scores and the correlation between sociodemographic variables with BNT sub-scores and error scores was tested. The Spearman correlation coefficient was reported when there was a correlation between two continuous variables, the point-biserial correlation coefficient when there was a correlation between a continuous variable and a dichotomous variable, and the Kendall correlation coefficient when a correlation between a continuous variable and an ordinal variable was reported. Finally, a *P*-value below 0.05 was considered statistically significant (Tallberg, 2005; Tombaugh & Hubley., 1997).

Results

Results of the norm determination study for the Lebanese version of the BNT

The mean (standard deviation), median (interquartile deviation), minimum, and maximum of the total score of the BNT (Lebanese version), as well as its sub-scores and the scores of errors made by the participants, were all described in (Table 6).

Table 6 Description of the BNT (Lebanese version) scores/sub scores and errors (*N* = 280)

	Mean	Standard deviation	Median	Interquartile deviations	Min	Max
Total score	51	(6.09)	52	(8)	31	60
Number of semantic cues given	4.00	(5.15)	2	(6)	0	22
Number of the correct responses following the semantic cues	1.53	(1.79)	1	(2)	0	9
Number of phonological cues given	9.16	(6.08)	8	(8)	0	28
Numbers of the correct responses following the phonological cues	7.59	(4.77)	7	(7)	0	26
No response after a given cue	0.56	(1.29)	0	(1)	0	8
Errors						
Visual misperception errors	1.15	(1.70)	0.5	(2)	0	11
Intra-categorical errors	4.16	(3.44)	3	(4)	0	16
Superordinate errors	1.59	(1.55)	1	(2)	0	8
Phonological errors	0.27	(0.60)	0	(0)	0	3
Periphrastic responses	2.18	(1.86)	2	(2)	0	9

The results showed that the total score of the BNT (Lebanese version) varied between 31 and 60, with a mean of 51 ± 6.09 and a median of 52 ± 8. The mean number of phonological cues (phonemic cue) (9.16 ± 6.08) provided was higher than the average number of semantic cues (4 ± 5.15). The intra-categorical errors had the highest mean (4.16 ± 3.44) among all error types, while the phonological errors had the lowest mean (0.27 ± 0.60). A good internal consistency was found for the Lebanese version of the BNT as indicated by Cronbach's alpha at 0.754 (Pedraza et al., 2011; Tombaugh & Hubley, 1997).

The generalized linear model (GzLM) was applied to investigate the effect of age, gender, and education on BNT (Lebanese version) performance (Peña-Casanova et al., 2009; Tsapkini et al., 2011). The results show that the total score of the BNT (Lebanese version) decreases with age and increases with education. It has been observed that the BNT score decreases by 2.3 in people aged between 60 and 69 years $(p = 0.001)$, by 7.2 in those aged between 70 and 79 years $(p < 0.001)$, and by 11.4 in those aged over 80 years $(p < 0.001)$ when compared to those aged between 50 and 59 years.

On the other hand, the BNT score increases by 2.12 in people with secondary education $(p = 0.001)$ and by 3.50 in those with a university education $(p < 0.001)$ when compared to those with primary education.

There were no significant differences found between men and women $(p = 0.07)$. It is worth noting that the interaction between age $\times$ gender $\times$ education was tested and found to be non-significant. Additionally, the model not including interaction (Table 7) has the lowest indices of AIC, BIC, and AICC (1615 vs. 1595; 1621 vs. 1595; and 1706 vs. 1624 respectively) when compared to the model with interaction.

The norms for sub-scores and errors of the BNT (Lebanese version) by age, gender, and education were also analyzed. The results are presented in Tables 8 and 9.

The study found that the number of semantic and phonological cues provided, as well as the number of errors, increase with age and decrease with education. The results showed that there are significant positive correlations between age and

Table 7 The results of the generalized linear model (GzLM) for the total score of the BNT (Lebanese version)

Total score of BNT 60	β	(95% IC)	*P*-value
Age			
50–59	1		
60–69	− 2.30	(− 3.62; − 0.99)	0.001
70–79	− 7.26	(− 8.55; − 5.97)	< 0.001
80 and above	− 11.43	(− 12.84; − 10.02)	< 0.001
Gender			
Male	1		
Female	0.88	(− 0.07; 1.83)	0.070
Education			
Primary	1		
Secondary	2.12	(0.92; 3.32)	0.001
University	3.50	(2.35; 4.65)	< 0.001

β the estimated effect size of age, gender, and education on the BNT performance, *IC* the range of values

Table 8 Norms for the sub-scores of the BNT (Lebanese version) by age, gender, and education (*N* = 280)

The sub-scores of the BNT (Lebanese version)	Age	Female			Male		
		Primary	Secondary	University and more	Primary	Secondary	University and more
Number of semantic cues given	50–59	0.69 (0.75)	1.33 (0.87)	1.43 (2.87)	0.58 (0.90)	1.18 (1.40)	0.63 (1.54)
	60–69	7.29 (3.93)	2.92 (3.29)	1.23 (2.98)	5.20 (2.62)	1.70 (2.71)	0.46 (0.66)
	70–79	14.58 (5.63)	3.50 (2.42)	2.64 (2.76)	15.08 (4.39)	5.54 (6.57)	1.93 (2.43)
	80 and over	10.88 (6.51)	5.27 (2.57)	1.88 (1.64)	5.13 (3.40)	4.00 (2.49)	3.20 (3.26)
Number of the correct responses following the semantic cues	50–59	0.62 (0.77)	1.11 (0.60)	1.14 (1.88)	0.50 (0.80)	0.82 (1.08)	0.56 (1.31)
	60–69	3.29 (1.94)	1.67 (1.61)	0.62 (1.94)	1.40 (0.70)	0.80 (1.32)	0.23 (0.44)
	70–79	2.50 (1.88)	1.60 (1.96)	1.36 (1.45)	4.15 (1.63)	2.08 (2.72)	0.87 (1.19)
	80 and over	3.13 (2.47)	2.36 (1.63)	1.13 (0.99)	1.75 (1.28)	2.18 (1.54)	1.40 (1.58)
Number of phonological cues given	50–59	6.00 (3.08)	5.00 (1.22)	4.79 (2.39)	3.83 (1.19)	2.82 (1.47)	3.31 (2.27)
	60–69	8.93 (3.89)	7.50 (2.97)	4.85 (2.70)	7.60 (2.59)	6.30 (3.89)	4.85 (3.13)
	70–79	14.75 (6.31)	11.30 (4.50)	9.57 (5.17)	13.46 (3.82)	11.46 (4.94)	9.40 (4.55)
	80 and over	18.25 (4.40)	15.82 (5.29)	13.63 (3.66)	19.38 (6.72)	15.00 (6.75)	12.80 (6.71)
Numbers of the correct responses following the phonological cues	50–59	5.31 (2.93)	4.44 (1.24)	4.43 (2.31)	3.50 (0.80)	2.45 (1.57)	3.13 (2.39)
	60–69	6.86 (3.48)	6.25 (2.49)	4.54 (2.67)	5.90 (2.23)	5.70 (3.68)	4.62 (3.04)
	70–79	10.58 (4.46)	8.70 (2.45)	8.86 (4.88)	10.23 (3.30)	9.54 (2.82)	8.40 (4.01)
	80 and over	11.38 (1.60)	12.82 (4.29)	12.25 (3.37)	13.63 (6.12)	13.55 (5.87)	12.00 (6.18)

Table 9 Norms for the error scores of the BNT (Lebanese version) by age, gender, and education (N = 280)

Error scores of the BNT (Lebanese version)	Age	Female			Male		
	Education	Primary	Secondary	University and more	Primary	Secondary	University and more
No response	50–59	0.00 (0.00)	0.00 (0.00)	0.07 (0.27)	0.08 (0.29)	0.00 (0.00)	0.00 (0.00)
	60–69	0.71 (1.07)	0.25 (0.45)	0.08 (0.28)	0.90 (1.29)	0.00 (0.00)	0.00 (0.00)
	70–79	2.17 (2.33)	1.20 (1.99)	0.36 (0.63)	1.62 (1.61)	0.92 (1.66)	0.27 (0.46)
	80 and over	3.13 (3.09)	0.73 (1.79)	0.63 (1.06)	0.88 (0.83)	0.27 (0.47)	0.40 (0.70)
Visual misperception	50–59	0.31 (0.63)	0.22 (0.44)	0.14 (0.53)	0.08 (0.29)	0.09 (0.30)	0.19 (0.54)
	60–69	1.21 (1.05)	0.92 (1.31)	0.38 (0.65)	0.10 (0.32)	1.10 (2.02)	0.46 (0.66)
	70–79	1.33 (1.50)	2.50 (2.01)	1.36 (1.45)	2.08 (1.55)	2.00 (2.20)	1.07 (1.16)
	80 and over	2.13 (1.25)	2.00 (2.32)	1.63 (1.77)	4.50 (3.55)	2.00 (2.24)	1.80 (1.87)
Intra-categorical errors	50–59	1.69 (1.60)	2.44 (1.94)	1.64 (1.82)	1.50 (0.90)	1.09 (1.04)	1.38 (1.67)
	60–69	5.43 (3.13)	3.83 (2.66)	2.46 (1.56)	2.90 (1.66)	2.60 (2.55)	2.38 (1.71)
	70–79	5.00 (2.17)	4.50 (3.10)	4.93 (3.60)	6.08 (1.98)	4.38 (3.80)	4.40 (2.44)
	80 and over	6.75 (2.92)	8.36 (3.85)	6.88 (1.73)	8.63 (4.07)	8.27 (4.61)	6.90 (4.38)
Superordinate errors	50–59	1.38 (1.33)	1.33 (0.71)	0.93 (1.38)	0.42 (0.51)	0.82 (0.75)	0.38 (0.62)
	60–69	2.36 (1.22)	1.08 (1.08)	0.69 (1.44)	2.20 (1.48)	0.70 (0.95)	0.15 (0.38)
	70–79	2.75 (1.96)	1.50 (1.35)	1.07 (1.33)	2.92 (1.55)	2.08 (1.26)	0.93 (1.10)
	80 and over	4.63 (1.77)	2.64 (1.03)	1.88 (0.99)	2.63 (1.51)	2.73 (1.10)	2.10 (1.79)
Phonological errors	50–59	0.08 (0.28)	0.11 (0.33)	0.00 (0.00)	0.17 (0.39)	0.00 (0.00)	0.06 (0.25)
	60–69	0.29 (0.47)	0.25 (0.45)	0.00 (0.00)	0.20 (0.42)	0.20 (0.42)	0.00 (0.00)
	70–79	0.75 (0.97)	0.00 (0.00)	0.43 (0.65)	0.77 (0.93)	0.15 (0.55)	0.47 (0.74)
	80 and over	0.75 (0.89)	0.73 (1.01)	0.50 (0.76)	0.00 (0.00)	0.55 (0.93)	0.10 (0.32)
Periphrastic responses	50–59	1.38 (1.45)	1.22 (0.97)	1.14 (1.29)	0.58 (0.79)	0.73 (1.19)	0.63 (0.81)
	60–69	2.71 (1.64)	1.83 (1.90)	1.08 (1.32)	2.20 (1.40)	2.10 (1.79)	1.00 (1.15)
	70–79	2.92 (1.62)	3.20 (2.10)	3.14 (2.11)	3.00 (1.53)	2.62 (1.26)	3.33 (2.72)
	80 and over	3.63 (1.51)	3.64 (1.21)	3.38 (2.56)	2.88 (2.42)	2.45 (1.29)	3.00 (1.76)

sub-scores, as well as error scores, on the Lebanese version of the BNT. However, a negative correlation was found between education and these scores, as shown in Table 10.

Additionally, it is worth noting that there was a strong linear correlation between the number of semantic cues given and the number of correct responses following the semantic cues ($r = 0.834$; $p < 0.001$), as well as between the number of phonological cues and the number of correct responses following the phonological cues ($r = 0.962$; $p < 0.001$), as evidenced by the statistically significant correlations (Fig. 1).

Discussion

This research facilitated the development of a Lebanese iteration of the Boston Naming Test (BNT) that aligns comparably with the original American version. Additionally, normative data were collected based on a cohort of healthy Lebanese adults, stratified according to age, gender, and educational level.

The response analysis results guided the selection of an optimal Lebanese translation aligning with the typical naming tendencies of the Lebanese population. A noteworthy distinction lies in the fact that the American version of the BNT suggests a single correct name for each image, while Lebanon exhibits linguistic and cultural diversity, allowing for multiple correct names for the same image due to regional and cultural variations. For instance, the Arabic term for "dart" ("sahem"; "سهم") can be denoted by diverse names such as "nablat," "nashabat," and "sanka" ("سنكة", "نشابة", "نبلة"). To ensure precision, a comprehensive list of accurate responses has been compiled, encompassing the target word and all its synonyms.

An examination of correct responses within our sample of participants revealed a mean score and standard deviation of correct responses (51 ± 6.09), closely aligned with international norms observed in various studies: 52.76 in Worrall et al. (1995); 49.6 in Mariën et al., 1998; 53.0 in Neils et al. (1995); 53.04 in Tallberg (2005); and 54.5

Table 10 Correlation between sub-scores and errors of the BNT (Lebanese version) with age, gender, and education

	Gender	Age	Education
	(dichotomous)	(continuous)	(ordinal)
Number of semantic cues given	− 0.068	0.471**	− 0.382**
Number of the correct responses following the semantic cues	− 0.088	0.332**	− 0.284**
Number of phonological cues given	− 0.066	0.741**	− 0.184**
Numbers of the correct responses following the phonological cues	− 0.033	0.734**	− 0.101*
No response after a given cue	− 0.103	0.388**	− 0.266**
Errors			
Visual misperception errors	0.022	0.536**	− 0.105*
Intra-categorical errors	− 0.045	0.647**	− 0.106*
Superordinate errors	− 0.107	0.461**	− 0.325**
Phonological errors	− 0.061	0.243**	− 0126*
Periphrastic responses	− 0.097	0.456**	− 0.107*

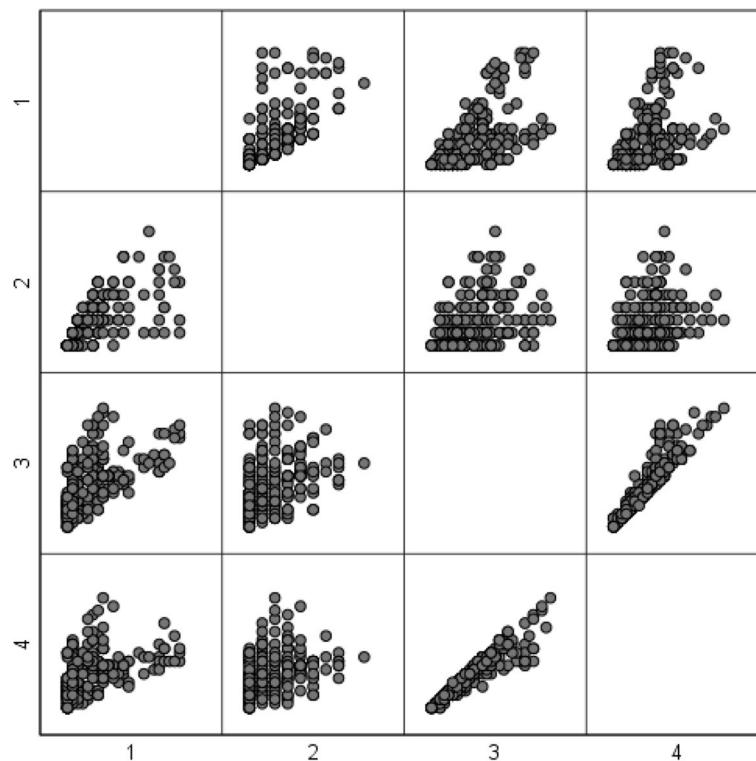* $p < 0.05$; ** $p < 0.001$

Fig. 1 Correlation matrix between the given cues and the generated correct responses. 1 semantic cue given, 2 number of the correct responses following the semantic cues, 3 phonological cue given, 4 numbers of the correct responses following the phonological cues

in Nicholas et al. (1989). Furthermore, the reliability of the Lebanese Boston Naming Test (BNT) demonstrated acceptability and comparability to the original version. The internal consistency, as measured by Cronbach's alpha, was determined to be 0.75 in our study, closely resembling the reported value of 0.78 in healthy individuals for the original BNT (Tombaugh & Hubley, 1997).

While it is true that the average age of participants differed between the pilot study and the normative study, it is important to note that the primary reason for this variation stems from the distinct objectives of each study. The pilot study aimed to assess initial feasibility and gather preliminary data; hence, participants were recruited with a focus on diversity rather than homogeneity in age (Patricacou et al., 2007; Miotto et al., 2010; Grima & Franklin, 2016; Soylu & Cangöz, 2018). In contrast, the normative study aimed to establish standardized benchmarks for elderly individuals by recruiting participants aged between 50 and 88 years, thereby ensuring representation of the target population. Therefore, the difference in participant age reflects the deliberate divergence in study objectives rather than a flaw in methodology (Li et al., 2022; Mariën et al., 1998; Roberts & Doucet, 2011). The pilot study not only served to devise scoring and administration rules but also provided guidelines tailored to the psycholinguistic and cultural variables inherent in the Lebanese population for the BNT's Lebanese version. Accordingly, we restructured the item list maintaining conformity with the original version's order. Consequently, certain items underwent repositioning in the Lebanese version

compared to the American version. Notably, "tongs" was elevated from its original position at number 55 to number 10 due to its heightened frequency in Lebanon, as affirmed by our pilot study. Conversely, "octopus" was relocated from number 23 in the American version to number 47 in our version. The reordering also allowed us to demonstrate that the difficulty of the new items was similar to those they replaced.

The derived Lebanese version of the Boston Naming Test (BNT) enabled an examination of the impact of age, gender, and educational attainment on the cognitive performance of healthy adult participants within our cohort. Our investigation revealed significant influences of age and educational level on accurate response rates, aligning with existing literature (Neils et al., 1995; Tombaugh & Hubley, 1997; Welch et al., 1996). Specifically, older adults exhibited diminished naming performance compared to their younger counterparts. Higher error rates among older individuals correlated with an increased reliance on semantic or phonemic cues to compensate for cognitive deficits. Conversely, participants with elevated education levels demonstrated superior BNT scores, reduced dependence on cues, and fewer errors than those with lower educational levels. Notably, adults aged over 70 with more than 12 years of education outperformed peers with primary education, indicating a clear association between age, education, and declining performance. However, variations in performance decline were evident among those aged over 70, with individuals possessing higher education levels exhibiting better naming proficiency. Importantly, all healthy elderly participants aged over 70, regardless of education, retained lexical–semantic knowledge and naming ability with aid cues. Retrieval following phonemic cues yielded notably high correct response rates. Participants with higher education levels exhibited shorter response times after receiving aid cues compared to those with lower education levels.

In examining the impact of gender on naming performance, our study found no statistically significant difference between men and women, aligning with findings from previous studies (LaBarge et al., 1986; Ross et al., 1995). However, our results contradict studies suggesting significant gender effects on naming (Mariën et al., 1998; Welch et al., 1996). A possible explanation for this inconsistency is proposed by certain studies, positing that men and women have divergent interests, particularly concerning images exclusively associated with men. Such images represent specific points of interest for men but are less engaging for women, given that they fall outside their spheres of occupation or interest. The lack of statistical significance in the gender effect within the Lebanese version may be attributed to nearly equal familiarity with the replaced images among men and women in our study.

These findings underscore the significance of conducting normative studies tailored to specific cultural and linguistic contexts, employing extensive samples that encompass individuals of diverse ages and educational backgrounds. The present outcomes imply that the adapted BNT may exhibit enhanced suitability for clinical utilization within the Lebanese Arabic-speaking population. However, the clinical validity of this adapted version awaits confirmation through future investigations across diverse patient cohorts.

This study aimed to standardize the Boston Naming Test (BNT), a widely utilized neuropsychological assessment for evaluating linguistic capabilities in naming and word retrieval, especially applicable to various clinical pathologies such as communication disorders, aphasia, and language impairments resulting from conditions like stroke,

Alzheimer's disease, or brain injury. The standardization focused on a diverse, healthy population across different age groups, providing health professionals with a culturally adapted Lebanese instrument. The standardized BNT allows clinicians to effectively test, evaluate, and compare naming performance in individuals with linguistic disorders against well-defined standards, aiding in the identification and severity assessment of such disorders and facilitating targeted interventions.

Conclusion

It is important to acknowledge the impact of the ongoing technological revolution at all levels, which is leading to a significant gap between generations. This gap affects not only the way people think and live but also the social and interpersonal relations, and cultural and sentimental aspects of our society. Therefore, it is necessary to revise the norms regularly, not only just for the original BNT but also for all the adapted versions, including the one that we have implemented in this study.

Open practice statement

The raw data supporting the conclusions of this manuscript will be made available upon request to the corresponding author. The study research design, methods, and analyses were pre-specified in the study protocol, which is available upon request. Experimental materials and data collection instruments used in this study will be made available upon request.

Appendix 1

Table 11 All correct responses accepted for the Lebanese version of the BNT

		Target word	Synonym	
1	Bed	تخت	سرير	
2	Tree	شجرة		
3	Toothbrush	فرشاة الاسنان		
4	Pencil	قلم رصاص	قلم	
5	House	بَيْت	منزل	
6	Hanger	تَعْليقَة	شنغل	
7	Comb	مُشْط		
8	Flower	وَرْدَة	زهرة	
9	Bench	مَقْعَدْ	بانك	
10	Tongs	ملقط		
11	Scissors	مُقَصّ		
12	Manoushe	منقوشة		
13	Broom	مِكْنْسَة		
14	Funnel	قِمع		
15	Latch	قفل	ساقوطة	مزلاج
16	Snail	بزّيقة	حلزونة	
17	Whistle	صوفيرة		
18	Mushroom	فطر		
19	Hammock	مرجوحة	عنزوقة	

		Target word	**Synonym**				
20	Saw	منشار					
21	Helicopter	هيليكوبتر	طائرة عمودية	طائرة مروحية			
22	Wheelchair	كرسي متحرك	كرسي للمقعدين	كرسي للمعوق	كرسي نقال	كرسي للمكرسح	كرسي لزوي الاحتياجات الخاصة
23	Canoe	قارب- شخطورة	زورق				
24	Chess	شطرنج					
25	Paintbrush	ريشة					
26	Asparagus	هُلْيون					
27	Chandelier	تريا					
28	Escalator	درج كهربائي	درج متحرك				
29	Cave	مغارة					
30	Mask	ماسك	قناع				
31	Raquet	راكيت	مضرب				
32	Cage	قفص					
33	Dart	سَهم	نبلة	نشابة, سنكة			
34	Camel	جَمَل					
35	Globe	الكُرَة الأرضيَّة					
36	Binoculor	ناضور					
37	Acorn	بَلُّوط					
38	Stethoscope	سماعة حكيم					
39	Cactus	صبيَّر					
40	Octopus	أخطبوط					
41	Pelican	بجعة					
42	Flute	مزمار					
43	Rhinoceros	وحيد قرن					
44	Noose	حبل المشنقة	حبل او مشنقة				
45	Clown	مهرج	بهلواني	كلون			
46	Pyramid	هرم					
47	Volcano	بركان					
48	Snowman	رجل ثلج					
49	Kebbe pestle	مدقة الكبة					
50	Windmill	طاحون					
51	Accordion	أكورديون					
52	Hedgehog	قنفذ					
53	Alligator	تمساح					
54	Compass	بوصلة					
55	Zither	القانون					
56	Compass	بيكار					
57	Scroll	فرمان	رسالة	منشور			
58	Saddle	سرج					
59	Pulley	بكرة					
60	Sphnix	أبو الهول					

All alternative responses were validated by cross-checking using a dictionary. Images with poor recognition that were unfamiliar to the study population were replaced by alternative images from the same semantic category but that was more relevant to Lebanese culture

These answers helped to evaluate the degree of compatibility of the names attributed to each of the images from the BNT with the Lebanese Arabic language. In this way, the BNT was adapted to be more compatible with Lebanese culture and language

Appendix 2

Table 12 The instruction grid of the Lebanese version of the BNT

Possible responses of participants and coding	Examiner response and scoring
Spontaneous response (SR): name agreement or synonym of the target word such as سرير– تخت If the participant adds an adjective to the target word: "It's a big house" (بيت كبير.)	Accept and move on to the next image by scoring (+) The answer is also accepted with a score (+)
No response or do not know (NR)	Ask them to give it a try by helping them with a semantic[1] or phonemic cue[2]*
Wrong part (WP) of the image named	Indicate the exact part of the object to be named
Visual misperception (VM) i.e., "fez" (طربوش) for "acorn" (بلوط)	Give them a semantic cue[1]. If the response is correct after the cueing we score (+) if not, give them a phonemic cue[2]* (the first syllable of the target word)
Intra-categorial errors (ICE). i.e., "bull" (ثور) for "rhinoceros" (وحيد القرن)	Tell them that this is not the name we are looking for and we give the them opportunity to self-correct. If they did not find the exact name, we give them a phonemic cue[2]*
Superordinated word errors (SOE): I.e., "musical instrument" (الة موسيقية) for "flute" (مزمار)	Tell them the answer is true but general, and ask them to specify. If they cannot find the exact name, give them a phonemic cue[2]*
Phonological error (PHE) i.e., "glove" for "globe or bursa بورصة for بوصلة busla	The response is considered correct and we score (+)
Periphrase response (P)	We give them a phonemic cue[2]* to help them retrieve the target name

* Note: if a phonemic cue is given, always encode the answer as (-), even if it is correct. This will not count toward the total score

Total score = sum of SR (spontaneous responses) + sum of correct responses after receiving a semantic cue

Semantic cue[1]: a semantic cue provides information related to the meaning of the target word. offering hints like superordinate categories ("vegetable" for "asparagus"), actions associated with the word ("you ring it" for "bell"), or definitions and sentence completions ("stethoscope" a medical instrument to listen to the heart and internal sounds) (Python et al., 2021)

Phonemic cue[2]: a phonemic cue assists word retrieval by focusing on its sound, offering hints like the first phoneme(s) (it starts with "c" for "cactus"), the first syllable for longer words, or a rhyming word (it rhymes with "nail" for "snail") (Python et al., 2021)

Abbreviations
BNT   Boston Naming Test
LEAP-Q   Language Experience and Proficiency Questionnaire
MOCA   Montreal Cognitive Assessment
GDS   Geriatric Depression Scale 15-item
NA   Name agreement
MSA   Modern Standard Arabic
(p)   Difficulty index
LA   Lebanese Arabic
GzLM   Generalized linear model

Availability of data and materials
All relevant data and materials are presented within the tables and appendix of this article. Additionally, they are available upon request from the authors.

Declarations

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