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Validation of the brave hand writing kinder (BHK): a tool for measuring arabic handwriting

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Abstract. Handwriting is a complex skill that has been developing over time. To learn handwriting, children need to combine motor skills, memory, attention, visuomotor integration and other cognitive functions. The readability of writing can affect teachers' assessment of academic achievement and children's self-esteem about their ability to produce texts. Referring to the practice of Tunisian school education we find that there is a lack of scientific references to discern when the difficulties of Handwriting transits from normality to abnormality. So far we have no scale of criteria evaluating this gesture in Arabic writing. The aim of this study is to have a means of evaluating the performance of Handwriting of the Tunisian student in two measurable dimensions namely quality and speed. Thus, we undertake a validation methodology of a measurement tool on a population with varied characteristics and ordinarily representative of the Tunisian child in the six levels of primary school (age: 6.6 - 11.8). In fact, we chose to validate the Brave Handwriting Kinder (BHK) from its French version translated by Charles, Soppelsa&Albaret in (2003). The scale also makes it possible to establish a rapid and early diagnosis of writing disturbances of the child and thus to identify premature disorders related to the functions of Handwriting.

Keywords. Handwriting, BHK, Arabic writing, Validation

Introduction

Handwriting is a skill that school-age children are required to master (Schoemaker, Niemeijer, Reynders, & Smits-Engelsman, 2003). Even with the increased use of computers and tablets, handwriting remains an important skill, because the motor action of creating letters on paper has been found to increase the memory of letters beyond that attainable with keyboarding alone (Longcamp et al., 2008).

In particular, according to a study by (Di Brina, Niels, Overvelde, Levi, & Hulstijn, 2008) in Germany, they were able to show that children still spend between 30 and 60% of their time writing. Indeed, in school, writing is ubiquitous and needs to be faster and faster to meet the demands that increase with grade levels. In this regard, other studies that highlight the effectiveness of the teaching of writing (Berninger et al., 1997; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003; Schoemaker et al., 2003) are numerous.

In addition, the readability of writing can affect teachers' assessment of academic achievement and children's self-esteem about their ability to produce texts. A child's writing skills can also affect the amount of time they need to complete a homework assignment, their note-taking skills, and the speed with which they will write. Screening children with writing difficulties is therefore important. Identifying writing difficulties can be done in different ways (Koziatek & Powell, 2002; Thijs & Verkuyten, 2008). On the one hand, the assessment quality assessment and the speed of manual writing can be subjective with the opinion of the teacher and, on the other hand, objective with the use of standardized tests including criteria allowing to measure the speed and quality of writing.

The readability and fluidity of a text written by weak writers are not as good as those of a group of good writers because an irregularity of the production is perceived as it is at the level of the size of the writing, the spacing between the letters of a word or between words (karlsdottir, 2002; Rosenblum, Dvorkin, & Weiss, 2006) report errors in letter alignment. In addition, weak writing may have sharp angles in letter formation or linkage between letters (karlsdottir, 2002). The production of letters can be changed from the calligraphic standards (Graham, Weintraub, & Berninger, 1998) and describe the frequent presence of additional curves in the formation of letters. (Rosenblum et al., 2006) note the presence of ambiguous letters. In addition, (DEUEL, 1994) notes a larger number of corrected letters among weak writers than among good writers. These letter corrections are probably the consequence of an autocorrection highlighting a control of the spacing between the expected result and the written realization. According to (Graham et al., 1998), the presence of letter corrections would indicate an unstable letter motor program. In addition, since the number of pencil lifters is greater among weak writers than among good writers, and their written writing time is longer (J.P. Wann & J.G. Jones, 1986), weak writers would need longer duration for programming and making consecutive letters, also a consequence of unstable motor programs (Rosenblum et al., 2006) (karlsdottir, 2002) states that the writing of weak writers is characterized by height and a width greater than that of the powerful writers.

Regarding production speed, there is no significant difference between a group of weak writers and a control group (Hamstra-Bletz & Blöte, 1993; J.P. Wann & J.G. Jones, 1986). One of the few studies to show a significant difference between these two groups is that of (Volman, Laroy, & Jongmans, 2006). In addition, several studies (Graham et al., 1998; karlsdottir, 2002) highlight that the speed and quality of writing are not correlated. These authors believe that speed assessment and writing quality assessment are almost independent measures. In the case of a clinical alteration of the writing we will evoke on this subject a learning disorder of the schooled child known under the name of dysgraphia, its diagnosis is possible only after the age of 7 years and defined by (Ajuriaguerra, J., Auzias, M., Coumes, F., Denner, A., Lavondes-Monod, V., Perron, R. & Stambak, 1964) as an alteration of writing quality without this deficiency being explained by a neurological or intellectual deficiency. It therefore affects individuals with normal intelligence and people with no neurological disorder. In fact, according to several authors like (Kushki, Chau, & Anagnostou, 2011; Rosenblum, Aloni, & Josman, 2010), we will list the different characteristics of dysgraphic writing which generally includes:

- A bad spatial organization of the page with a non-respect of the spaces between the letters and the words as well as chaotic lines.
- Errors in form and proportion of letters.
- A slow and tiring writing (presence of longer breaks in writing).
- An instability of writing through a direction and size of changing letters.
- A production of neglected and unreadable appearance.

By this very involved aspect, a scientific evaluation articulating the functional components corresponding to the way in which manual writing is organized, is therefore of crucial importance for the Tunisian student.

Referring to the practice of Tunisian educational system, which is bilingual we find that we lack scientific references to discern when the difficulties of writing transition from normality to abnormality especially with writing in Arabic.

A study in Lebanon highlights that the availability of a standardized assessment tool of handwriting for the Lebanese population is crucial to delineating patterns in the development of handwriting in a bilingual and bigraphic context and therefore to be able to identify the first signs of dysgraphia MATTA-ABIZEID, C (2016) . So far we have no scale of criteria evaluating this gesture in Arabic. In fact, in examining this complex process we have noted a striking resemblance in the forms of letters between the Arabic alphabet and basic Latin. This resemblance is situated at the level of the four primitive forms quoted in the works of (Edelman & Flash, 1987).

Consequently, in the field of manual writing, the hypothesis of the similarity of the traces produced during writing in French and in Arabic needs to be investigated in the perspective of the validation of a measuring tool appropriate to Arabic handwriting.

Calligraphic comparison between the two traces in French and Arabic:

(Edelman & Flash, 1987) are based on the observation that all movements are based on the minimization of acceleration variations (the jerk principle) and postulate that writing is composed of four primitive forms:

- The shape of the cup that is found in the letter "u"
- The oval present in the letter "o"
- The hook as in the "t" or the "i" lowercase
- The vertical line.

They mention the planning of an intermediate point between the initial departure of the line and the targeted point. For this purpose and comparing in terms of trace production writing in Arabic and writing in French we note a striking resemblance yet not apparent at first. We will expose this resemblance through a calligraphic reading at the level of the classification of Latin alphabet writing according to the four basic forms (primitive forms).

- The shape of the cup is found in:

ب ت ث د ذ ر ز س ش ص ض ك ل ن

- The oval shape is found in:

ط ظ ع غ ف ق م

ه و ي

- The shape of the hook is found in:

ح خ ع ج

- The vertical line from top to bottom is found:

أ ط ظ ل

However, when producing these forms, we note only one difference in relation to the meaning of writing. In fact, Arabic is written from right to left and French is written from left to right.

We also point out other similarities in calligraphic standards when writing on the lines of the school notebook, namely:- A classification of the letters trunk and non-trunk letters found for the two writings, while noting that the trunk is formed of the space between the two lines, the first in bold and the second upwards.

- All the letters, which are written in a vertical line also called a stick or in a loop at the top, do not exceed 3 lines and all the letters written down with a stick or also in a loop do not exceed 2 lines.

The BHK metric qualities and presentation

The BHK in its French version has good metric qualities. It is sensitive to changes in age and school level as well as the presence or absence of dysgraphia. The validation study by (Charles M, 2003) confirms that the concurrent validity with the De(Ajuriaguerra, J., Auzias, M., Coumes, F., Denner, A., Lavondes-Monod, V., Perron, R. & Stambak, 1964) dysgraphia scale, shows a significant correlation ($r = .68, p < 0.01$).

It also has a good construct validity because the dysgraphic subjects present notes in the 8.6% of the highest scores of the calibration and are significantly different from those of the control subjects. . Intercorrector reliability was .90 ($p < .001$) between the authors of the validation and .68 ($p < .001$) with professionals unfamiliar with the tool. These results show that a period of training is really necessary to master the correction.

Tasks and instructions

The text to be copied is presented to the students face down. The students' first and last names, sex, date of birth, age, laterality, class and the date and time of the examination are noted on the correction grid. Before the test, it is important to find out if a student has visual problems or wears glasses to make sure it does not affect their performance. After the test, you must ask students if they have cramps or painful phenomena. After 5 minutes, stop the timer and check that the students have written at least the first five lines. If not, mark where the student stopped then let him finish just the first five lines. The test was made with the whole class, two experimenters controlled the smooth running of the test.

Scoring

The correction criteria for points 1 and 2 apply to the entire text. As for criteria 3 to 13, they take into account only the first five lines. One score is placed per line for each of these criteria. One dot per line is assigned for one or more errors, 0 if there are none. When hesitating, you must score 0 except for item 9 (incorrect relative height of letters,) where you will score 1 if you are hesitant. When there are doubts as to the criterion for which the letter is defective (for example between criterion 10 corresponding to letter distortion, and the criterion 11 corresponding to ambiguous letter forms), it is necessary to note one point in one or the other criteria but especially not in both.

The integral score is calculated by performing the total score of the criteria from 1 to 13. It is a degradation score. For the correction we used the transparency of the BHK correction aid in its French version (rapid assessment scale of writing in children) designed by (Charles M, 2003) in Psychological Publishing and Application (EaP). On the other hand we adapted the help to the correction for the pupils' writing evaluation the in Arabic.

The correction criteria of the BHK:

Before presenting the correction criteria related to BHK items, it is important for us to classify letters in Arabic as in French according to two main categories:

- Trunk letters written in the first space just after the line of writing.
- Non trunk letters: written at the top or bottom of the line of writing and different spaces according to the calligraphic standards of each letter. (**Table1**)

Table 1: Letters truncated and not truncated in French and Arabic.

languages	Letters trunks	Non-trunk letters
Arabic	ء ص ذ ض ع و غ غ خ ج ح د ذ س ش ب ت ث ف ق م ن ه ب	ظ ع غ ق ك ل م ن ه ة ي أ ج ح خ ر ز س ش ص ض ط
French	a, c, e, i, m, n, o, r, s, u, v, w,x	b, d, f, g, h, j, k, l, p, q, t, y,z

The French version of the BHK (Charles M, 2003) measures the quality and the speed of handwriting. In this test, the child was asked to copy a text in 5 minutes. The first five lines are considered in the assessment process, which is based on 13 criteria: (1) letter size, (2) left margin widening, (3) poor word alignment, (4) insufficient word spacing, (5) acute turns in connecting letters or too long joining (chaotic writing), (6) irregularities in joining strokes, (7) collision of letters, (8) inconsistent letter size, (9) incorrect relative height of letters, (10) letter distortion, (11) ambiguous letter forms, (12) correction of letter forms, and (13) unsteady writing trace. For overall quality of handwriting, the minimum score in this test is zero and the maximum score is 65. A score of less than 20 means "no difficulty," between 21 to 28 means "poor handwriting," and a score at or above 29 means "very poor handwriting" (Hamstra-Bletz & Blöte, 1993). The inter-rater reliability for this assessment is .90, and the concurrent validity with a teacher's judgment is 0.68 ($p < .01$; Charles et al., 2003). Speed is measured by counting the number of letters written in five minutes.

The aim of this study is to have a means of evaluating the performance of Tunisian students' writing gesture in the in two measurable dimensions namely quality and speed. Thus, we are called to undertake a validation methodology of a measurement tool for this manual scriptural skill. In fact, we chose to validate the "Brave Handwriting Kinder" from its French version translated by (Charles M, 2003)

Our objectives in this study also include other important areas such as validation in themselves, namely:

- To determine, for a Tunisian student population, the plurifactoriality of handwriting since it is about a composite process and comprising according to (Sage, Zesiger, & Garitte, 2009) four factors (forms and constancies of the letters, motor realization of letters, spatial organization in the word and spatial organization in the sheet).

- To have scientific evaluation of handwriting is also to evaluate other functions that are mobilized during the execution of the gesture of writing such as balance, posture, dexterity, visuomotor integration, attention...

To have a detailed evaluation by the handwriting we return with exactitude to the deficiency or the difficulty that the child finds during the written production (motor, psychomotor, representational and structural difficulties of the space ...).

To establish a rapid and early diagnosis of the disturbances of handwriting in the child and thus to identify possible disorders such as dysgraphia.

Method

Subjects

The students who make up our entire population are educated in two public and private schools. The first consists of mixed social classes determined by the profession of the

parents and the second comprising well-to-do social classes also determined by the profession of the parents. We collected data from each school in the 6 classes with an average age of 6.6 to 11.8 years.

Our study was spread over three subpopulations defined as follows:

Population 1: Students of the public primary school.

We point out that this is a primary school attended by students with very varied socio-cultural and socio-economic characteristics determined by the parents' profession.

Population 2: Students of the private primary school.

We note that for this population belonging to a private primary school, the choice was dependent on certain criteria of homogeneity in order to guarantee the reliability of the results namely:

All students attended a common pre-school education at the same school (three years, four years and five years in the preparatory class). Students are enrolled in the first year of primary school following a test of aptitude for schooling. The students have followed a curriculum consistent with French programs for learning the French language. All classes have a closed list of 22 students.

Population 3: Dysgraphia pupils of the public primary school dismissed from the beginning of the sample of our study.

Procedure

Our validation methodology is based on the following validation media:

- A factorial analysis
- Sensitivity to age (age validity) (carried out on 132 students in Arabic of the populations 1 and 2 merged, at the rate of 66 pupils of each establishment by respecting a sampling through which all the classes are similarly represented).
- Gender sensitivity (gender validity) (carried out on 132 pupils in Arabic of the population 1 and 2 merged, with an average of 33 female students and 33 male pupils of each establishment, respecting a sampling through which all classes are similarly represented).
- The concurrent validity or convergent validity achieved by comparing the results of the two theoretically similar constructs of the BHK in its French version and its Arabic version (carried out on 132 pupils of population 2).
- The construct validity performed by comparing control subjects with dysgraphic subjects (performed on 20 normal controls of population 1 and 8 dysgraphic of population 3).
- Reproducibility (carried out on 51 pupils of population 1).
- Inter-rater reliability (made between two correctors that each side has 132 texts), with a double coding of 13% or 16 texts made by the second.

Results:

Factorial analysis:

Factor analysis consists in trying to simplify the variables of the study (the 13 criteria of the BHK) measuring the same one-dimensional construct (performance at writing)

According to a multifactorial process. Therefore, it is necessary to assess the child's level of writing to take into account the explanatory factors of his overall score and not just this grade in question. Thus we will use this analysis to group the variables that seem to measure "the same thing" and thus be able to calculate a synthetic score for each factor of the study.

It is from this perspective that we have undertaken two factorial analyzes specific to our research (in French and in Arabic) in the light of the study carried out in the work of (Zesiger, 2003) and which has already identified four factors. :

Factor 1: forms and constancy of letters

Criteria: 8, 10 and 11

Factor 2: Motor realization of the letters

Criteria: 1, 5 and 13

Factor 3: spatial organization of letters in the word

Criteria: 4, 7 and 9

Factor 4: spatial organization of writing in the sheet

Criteria: 2, 3, 6 and 12

We selected the distribution that proposed the highest saturation in each factor. The results of the two factorial analyses, with varimax rotation, are presented in the following tables (2, 3)

Factor Analysis in french

Table 2: KMO index and Bartlett test.

Indice KMO et test de Bartlett

Mesure de précision de l'échantillonnage de Kaiser-Meyer-Olkin.		,705
Test de sphéricité de Bartlett	Khi-deux approximé	602,370
	ddl	78
	Signification de Bartlett	,000

Factors	N° Items	Designation	Factor 1	Factor 2	Factor 3	Factor 4	Alpha Cronbach
Motor realization of the letters	Item05	Chaotic writing	,774				0,738
	Item01	Large writing	,715				
	Item13	Hesitations and trembling	,689				
Spatial organization in the sheet	Item06	Links between letters		,832			0,773
	Item03	Non-planar lines		,817			
	Item02	Margin tilt		,794			
Forms and consistency of letters	Item12	Letters retouched			,864		0,761
	Item08	Variation height letters trunks			,752		
	Item11	Ambiguous form of letters			,731		

	Item10	Distortion of letters				,724	
Spatial organization in the word	Item04	Tight words					,865
	Item07	Telescoping					,807
	Item09	Relative height of letters					,771
							0,774

Table 3: Matrix of components after Varimax rotation (in French)

The first remark to make and which is most relevant to the case of our study lies in the fact that the grouping of criteria according to the four factors is almost according to the literature and precisely that of the work done by Sage, (Sage et al., 2009) with the exception of criterion 12 (retouched letters) which has moved from the factor "spatial organization of writing in sheet space" to the factor "form and constancy of letters" Moreover, this new regrouping seems to us much more logical because we judge that the editing of the letters acts rather on their constancy and their regularity.

In particular we note that the internal consistency of the composition of each factor is statistically proven according to an acceptable Cronbach alpha coefficient

Factor Analysis in Arabic

Indice KMO et test de Bartlett

Mesure de précision de l'échantillonnage de Kaiser-Meyer-Olkin.		,748
Test de sphéricité de Bartlett	Khi-deux approximé	612,039
	ddl	78
	Signification de Bartlett	,000

Table 4: KMO Index and Bartlett Test

Factors	N° Items	Designation	Factor 1	Factor 2	Factor 3	Factor 4	Alpha Cronbach
Forms and consistency of letters	Item12	Letters retouched	,817				0,79
	Item10	Distortion of letters	,782				
	Item11	Ambiguous form of letters	,730				
	Item08	Variation height letters trunks	,720				
Spatial organization	Item09	Relative height of letters		,846			0,81
	Item04	Tight words		,833			

in the word	Item07	Telescoping			,820		
Spatial organization in the sheet	Item06	Links between letters				,874	0,798
	Item03	Non-planar lines				,839	
	Item02	Margin tilt				,795	
Motor realization of the letters	Item05	Chaotic writing					,773
	Item13	Hesitation and trembling					,757
	Item01	Big writing					,628
							0,682

Table 5: Matrix of components after Varimax rotation (in Arabic).

We also note that for this factorial analysis, the internal consistency of the composition of each factor is statistically proven according to a very acceptable Cronbach's alpha coefficient (with the exception of the factor "Motor Achievement of Letters" which displays a value slightly lower than 0.7.)

We proceed as well as according to this factorial analysis in Arabic, we witness exactly the same grouping of factors as that found during the factor analysis in French. This confirms that the logical readjustment of criterion 12 is statistically certified (**Table 4, 5**).

Sensitivity of Arab BHK to age:

Table 6: Sensitivity of BHK (Arabic version) to age

Settings	Class 1 (N =22)	Class2 (N =22)	Class3 (N =22)	Class4 (N =22)	Class5 (N =22)	Class6 (N =22)	ANOVA
Motor realization of the letters	5,09±1,97	4,77±1,82	4,36±2,11	3,77±1,8	3,64±1,33	3,45±1,3	F(5 ; 126) = 3,17 ; p =0,10
Forms and consistency of letters	5,95±2,15	5,14±2,31	5,23±2,1	5±1,87	4,41±1,5	4,45±0,84	F(5 ; 126) = 1,68 ; p =0,145
Spatial organization in the word	4,64±2,71	3,68±2,19	4,14±2,02	3,5±1,65	3,14±1,38	2,64±1,09	F(5 ; 126) = 2,67 ; p =0,025
Spatial organization in the sheet	6±2,56	4,45±2,45	2,14±1,36	2±1,09	1,59±1,1	1,32±1,42	F(5 ; 126) = 28,24 ; p <0,001
Global mark	21,68±2,5	18,05±1,89	15,86±1,41	14,27±1,92	12,77±1,39	11,86±2,86	F(5 ; 126) = 95,90 ; p <0,001
Speed	106,9±40,9	163,5±37,8	212,9±37,7	246,5±46,8	268,5±47,1	328,4±79,1	F(5 ; 126) = 92,62 ; p <0,001

As shown in (Table 6) above, overall BHK score and speed are significantly age-sensitive at $p < 0.001$. Regarding BHK factors, only spatial organization in the leaf and spatial organization in the word appear to be significantly age sensitive.

Nevertheless, at the level of the two factors “Motor realization of the letters” and “form and constancy of the letters” the sensitivity of BHK is not significant. These findings are confirmed by the empirical study by (Phelps, Stempel, Speck, & Phelps, 1985) that children between 8-9 and 12 years old (infantile calligraphic phase) write much faster but with a loss of precision.

Sensitivity of Arab BHK to gender

Table 7: BHK sensitivity (Arabic version) to gender

Settings	Male (N =66)	Female (N =66)	t Student	p
Motor realization of the letters	3,71 ± 2,18	4,65 ± 1,22	3,059	0,003
Forms and consistency of letters	5,95 ± 2,49	4,11 ± 0,93	5,650	<0,001
Spatial organization in the word	4,09 ± 2,64	3,15 ± 1,23	2,624	0,01
Spatial organization in the sheet	2,26 ± 1,99	3,58 ± 2,54	3,319	< 0,001
Global mark	16,02 ± 3,97	15,48 ± 3,54	0,809	0,420
Speed	209,2 ± 72,0	233,1 ± 88,3	1,705	0,091

It is clear from this table that it is essential to analyze writing performance according to a multi-factorial approach because the overall performance could be non-significant as demonstrated by the present case relating to gender sensitivity. The results in this table (table 7) are corroborated in the work of Phelps et al. (1985), which indicates that girls aged 8 to 14 write faster than boys, and among children who are above average in writing 70% are girls.

Concurrent validity of the BHK (Arabic version):

We studied the two theoretically similar constructs (BHK in its French and Arabic version, and by statistically examining the correlation between the two we obtained the following results. (Table 8)

Table 8: Correlations between the BHK in French and Arabic in the parameters of the study.

Settings	R	P
Motor realization of the letters	0,961	<0,001
Forms and consistency of letters	0,958	<0,001
Spatial organization in the word	0,968	<0,001
Spatial organization in the sheet	0,949	<0,001
Global mark	0,967	<0,001

Speed 0,994 <0,001

The results obtained from the calculation of the correlations between the results of the two tests by the same subjects lead us to confirm that the concurrent validity is significantly confirmed and this at the level of all the parameters of the study without any restriction.

Construction validity

We compared the results of the Arab BHK between two distinct populations formed on the one hand of normal subjects and on the other hand of dysgraphic subjects.

Table9: Difference between normal subject and dysgraphic subject in BHK (Arabic version)

Settings	Dysgraphi c	Normal (N = 20)	t Student	P
Motor realization of the letters	9,25 ±1,49	5 ± 2,34	4,739	<0,001
Forms and consistency of letters	9,38 ±1,41	6,1 ± 2,67	3,263	0,003
Spatial organization in the word	5 ±1,6	5,1 ± 2,94	3,269	0,003
Spatial organization in the sheet	9,13 ±0,64	6,55 ±2,16	3,275	0,003
Global mark	32,75 ±1,98	22,75 ±2,45	10,25	<0,001
Speed	93 ±11,56	100,9 ±24,5	0,867	0,394

The above table shows a very significant correlation at the level of the overall score between normal subject and dysgraphic subjects. There are also favourable results for the validation of the construct of the Arabic BHK at the level of the four factors of the test especially concerning "The motor realization of the letters", "Forms and constancy of the letters" and "Spatial organization in the sheet". This is not the case for the speed of writing, which displays a non-significant sensitivity which is consistent with the work of (Hamstra-Bletz & Blöte, 1993; J.P. Wann & J.G. Jones, 1986)

The test makes it possible to identify the disorders of writing and their natures thanks to its pathological sensitivity. (Table 9)

Reproducibility:

In order to verify the reproducibility of the BHK (test-retest) we used the Student's test of the paired series.

This tests the stability of the average value of the scores. This process has been tested on 52 subjects of the population of students belonging to the public school. The interval between the two measurements is set at 07 days.

Table 10: Reliability of BHK (Arabic version)

Settings	Test	Re-test	t Studen	P
Motor realization of the letters	4,39 ±1,78	4,41 ±1,76	0,444	0,659
Forms and consistency of letters	4,65 ±1,47	4,61 ± 1,4	0,340	0,735

Spatial organization in the word	3,49 ±1,87	3,59 ±1,73	1,400	0,168
Spatial organization in the sheet	2,9 ± 2,1	2,86 ±2,07	1,000	0,322
Global mark	15,43 ±2,99	15,47 ±2,82	0,405	0,687
Speed	223,1 ±70,2	223,1 ±70,5	0,000	1,000

We note after reading this table (**Table 10**) and referring to the statistical table of the Student test that the averages of measurements of the Test and Re-test are not significantly different and thus reproducible. We can immediately conclude that the BHK in its Arabic version is rigorously reliable.

Intercorrector fidelity:

The BHK in Arabic and French has been rated by two correctors, the first has 132 texts in Arabic and the second also 132 in French. A double coding was carried out by the second corrector on 16 texts of the first (or 13% of the texts in Arabic). The correlator correlation is $r(N = 264) = .81$ (Pearson correlations, $p < .001$). The BHK manual reports intercorrector correlations between .68 and .90, so the inter-corrective correlation of this study is considered high.

Discussion:

In this study, we have undertaken a methodological investigation in order to validate the Brave Handwriting Kinder (BHK) from its French version and adapt it to the Tunisian children population in an Arabic version. Our validation procedure is based on eight appropriate supports:

- The normative calligraphic comparison between the two writings.
- Factor analysis.
- The sensitivity of Arab BHK to age.
- The sensitivity of Arab BHK to gender.
- The concurrent validity of the BHK (Arabic version).
- The validity of construction.
- Reproducibility.
- Intercorrector fidelity

From the statistical results obtained in each axis studied, we can confirm that our BHK rapid assessment tool is validated for a population with varied characteristics and ordinarily representative of the Tunisian child enrolled. This test also has very good metrics qualities it allows both a rapid assessment of the performance of the writing of students in Arabic and to specifically diagnose early disorders related to the functions writing. These results do not agree with the study conducted by MATTA-ABIZEID, C. (2016) which raises the difficulty of using the BHK criteria as is with a bilingual population.

Certainly at the school level, dysgraphia is the most common problem, it would be an obstacle when writing is slow, unreadable or of poor quality. According, (Cornhill, 1996) in addition to the risk of school failure, dysgraphia has an impact on emotional well-being and social functioning.

According to a study on the negative consequences of writing difficulties in school, determine the existence of an influence on teachers' perceptions (Graham et al., 2008). Teachers

would tend to write down well-written copies rather than less readable ones. Moreover, the bad writers would be perceived by their teachers as less competent even for written expression.

Conclusion

In summary, the present study provides preliminary evidence of good psychometric properties of the BHK for the Arabic handwriting. However this research has been carried out among a group of children (N = 264) whose mean age was between (6.6-11.8). The number is not enough to generalize our results on all Tunisian children. Consequently a study using a greater number of participants is needed to assess the validity of this scale and to calibrate rigorously this tool.

Declaration of conflicting interests

No potential of interest conflict has been reported by the authors.

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