

**Arabic Interference in English
handwriting: Cairene public preparatory
school students with dysgraphia**

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Abstract

Because handwriting is the educational pathway first step, learners' academic achievement might be negatively impacted by learning difficulties such as dysgraphia. This study sought to investigate the extent to which Arabic and English handwritings of adolescents suffering from dysgraphia are correlated and (dis)similar for the sake of determining any traces of language feature transferability. The Arabic and English dysgraphic handwritings of 17 adolescents (collected at three Cairene public Arabic preparatory schools in January 2019) were analysed in terms of quality using criteria borrowed from the Concise Evaluation Scale for Children's Handwriting (BHK). The results came positive regarding trunk size, trunk & non-trunk letter height differences, and letter corrections at letter level; join absences amid letters in words at word level; and word spacing and writing unsteadiness at sentence level. Linguists and teachers of bilingual learners are hoped to benefit from this study as to teaching handwriting to EFL young learners.

المخلص

نظرًا لأن الكتابة اليدوية هي الخطوة الأولى في المسار التعليمي، فقد يتأثر الإنجاز الأكاديمي للمتعلمين سلبيًا بصعوبات التعلم كعسر الكتابة. سعت هذه الدراسة إلى التحقق من مدى ارتباط وتشابه الكتابة اليدوية باللغتين العربية والإنجليزية للمراهقين الذين يعانون من عسر الكتابة من أجل تحديد أي آثار لإمكانية نقل خاصية اللغة. حيث تم

تحليل الخطين المكتوبين بخط اليد باللغتين العربية والإنجليزية لـ 17 مراهقًا (تم جمعهم من ثلاث مدارس حكومية تحضيرية في القاهرة في يناير 2019) من حيث الجودة باستخدام معايير مستعارة من مقياس التقييم الموجز لكتابة يد الأطفال (BHK). جاءت النتائج إيجابية فيما يتعلق باختلاف حجم الجذع، واختلاف ارتفاع الأحرف ذات الجذع وعديته، وتصحيحات الأحرف على مستوى الحرف؛ وغياب الوصل بين الحروف على مستوى الكلمة؛ وتباعد الكلمات والكتابة غير المستقرة على مستوى الجملة. يؤمل استفادة اللغويين ومعلمي ثنائيي اللغة من هذه الدراسة لتعليم الكتابة اليدوية لمتعلمي اللغة الإنجليزية كلغة أجنبية.

1. Introduction

On countless occasions, teachers encounter diligent students whose performance could have been better if not for their script illegibility. Indeed, if technology has made typing prevalent, most exams, assignments and daily in-class activities around the world still require handwriting skills. Thus, script legibility is still of paramount importance.

In Egypt, the bilingual educational system in public schools exposes students sequentially and simultaneously to at least two languages depending on the type of school: Arabic or experimental. The curriculum is taught in Arabic in the former, whereas experimental schools use English as the medium of instruction (Mohamed et al., 2019). It is important to note that learners master first the writing system of Arabic starting at the kindergarten levels (age 4) before they start the English one at

grade 4 (age 9). The drastic differences between the two scripts and the Arabic prevalence over English in terms of learning onset and intensity might suggest some form of Arabic script interference. In fact, cross-linguistic effect has been proven to exist at all levels of second language learners' interlanguage, including vocabulary, pronunciation, syntax, and every other facet of language structure and use (Saville-Troike, 2006). However, little work was done in relation to handwriting ability transfer, especially when it comes to Arabic vs. English and in the presence of students with legibility issues. Thus, the purpose of this study is to investigate Cairene Arabic public (governmental) school preparatory year one students' dysgraphic handwritings in Arabic and English for the sake of determining the extent to which the two scripts are correlated and (dis)similar as outputs at letter, word and sentence levels.

2. Literature review

2.1. (Hand) writing

Ontogenetically, the learning of writing signals the admittance of a child or an illiterate to the world of adults and literacy. This entry is a complex manifestation of ability and thought development requiring a progressive change in brain processes and motor skills. Thus, writing is both an act of lettering and a complex enterprise of text planning, organisation, production and

proofreading (Chung & Patel, 2016). Between these two ends, there lies a continuum of cumulative steps whereby thought is rendered visually on a support (a paper, a screen...).

Along these lines, writing is approached in reference to its graphic signs, production mode and linguistic features (Tolchinsky & Jisa, 2018). Graphic signs have to do with conventional writing alphabetic, syllabic or logographic systems, and are expressed in language particular orthographies, be they transparent or opaque (Tolchinsky & Jisa, 2018). For example and although English and Arabic share many sounds, their alphabets are completely different. Similarly, although English and Spanish use the same alphabet, Spanish has a more transparent (regular) sound–letter correspondence, whereas English has an opaque, i.e., irregular sound–letter correspondence.

The second writing reference is to its production mode that requires tools such as pens and keyboards needed also for the planning, revising and editing features of the written message (Tolchinsky & Jisa, 2018). Thus and unlike spoken language, writing empowers writers with thought command as thoughts could be revisited recurrently.

For their part, linguistic features are present in the final product and characterise writing's discourse mode (Tolchinsky & Jisa,

2018). Indeed, writing allows careful word and structure choice for a particular communicative situation/audience.

Consequently, writing is a multifaceted skill whose intricacy stems from the processes contributing to its fulfilment, such as ‘memory, planning, sequencing, fine motor discrimination and movements, and the use of various eye, hand, and brain integrative systems’ (Hanson, 1976, p. 428), that add to its *prima facie* evolutionary nature. Indeed, as much as writing benefits from other elements of language in their socio–psychological aspects, it also makes the latter grow and expand.

At its basic stages, learning to write is meant to be handwriting which is preceded by the development of ‘prerequisite skills, in language, perception, sequencing, memory, and motor coordination’ (Reynolds & Fletcher–Janzen, 2004, p. 340). On the strength of Sheffield (1996), handwriting is necessary for children and should be taught cautiously for three main reasons: It activates the kinaesthetic memory whereby the formation of alphabet letters becomes automatic; it affords a basis for higher order skills as it sets free learners to focus on content; and finally, it assists both teachers and the world, as per its quality, to issue positive/ negative value judgements about the writer (Sheffield, 1996).

Missing such a basic skill might have consequences in the hereafter. For example, if it is not automatic enough at the stage where it should be, it might hinder spelling acquisition, content processing and thought expression as these aspects are consumed by the time and effort devoted to the physical movements required by handwriting. With time, the problem that should have been resolved at the beginning develops. Eventually, handwriting difficulties will reach adolescence and adulthood at the expense of other facets of writing such as ideation (Gregg & Nelson, 2018). In addition to the self-assurance it constructs in a child, writing also paves the way for success in school (Sassoon, 1990). Undeniably, the complications encountered by certain children to learn writing were found to have repercussions on the whole of their schooling, especially in relation to their school tasks, motivation, frustration, tiredness and hand pain, auto-evaluation and self-esteem as well as their teachers' assessments of their written production (Soppelsa et al., 2016).

Generally, handwriting is judged by its fluency– that is to say, celerity of accurate letter formation, and its legibility, i.e., letter formation accuracy (Feng, Lindner, Ji, & Joshi, 2017). Both aspects are important as a higher speed while writing frees more space in the writer's mind for higher order thinking and text generation, and thanks to legibility, the production might positively

influence the readers' judgments about the writer's competence (Feng, Lindner, Ji, & Joshi, 2017).

1.2. Handwriting impairments

In the DMS 5 (American Psychiatric Association, 2013), writing was mentioned as 'written expression' and associated with difficulties that occur as part of criterion A in the specific learning disorder classification. The person affected was described as: 'makes multiple grammatical or punctuation errors within sentences; employs poor paragraph organization; written expression of ideas lacks clarity' (p. 66). In addition, handwriting difficulty was cited as an example of impairments described in diagnostic criterion A of developmental coordination disorder. The manual explained further that competence in handwriting is often impacted and is impacting legibility (emphasis is put on written output skills), speed of outcome and academic accomplishment.

Yet, teachers also regularly reported handwriting difficulties in the absence of motor or cognitive impairment and referred to them as 'dysgraphia' (Prunty & Barnett, 2017). Etymologically, the Merriam-Webster Online (2020) traced the Greek origins of 'dysgraphia' back to the prefix "dys" meaning 'abnormal', 'impaired', 'bad' and 'difficult'; and the stem 'graphia' meaning writing. According to Chung & Patel (2016), dysgraphia may take place as a writing trouble happening at any stage in connection

with illegibility, slow pace of writing, spelling, syntax and composition difficulties. Thus, its stretching nature comprehends all the facets of written language, namely, clarity, accuracy and spelling (Westwood, 2004). It was also depicted in terms of low writing achievement of average intelligence children who show no abnormalities with reference to their neurological and perceptual-motor capacities (Ajuriaguerra, 1974; Hamstra-Bletz & Blote, 1993).

However and as pointed by Chung & Patel (2016), it might occur, jointly with other learning disorders like dyslexia (reading difficulties). In this case, it points to errors made in writing and which accompany those made in reading, as well as errors made with respect to handwriting command issues (Nicolson & Fawcett, 2011; McCloskey & Rapp, 2017). Thus, individuals with dysgraphia might encounter problems with their handwriting alone, their spelling alone –without reading issues–, or both of their handwriting and spelling (International Dyslexia Association, 2020).

Dysgraphia is said to be developmental regarding the learning of writing by children and adolescents or acquired as a result of a pathological condition or a trauma that induced a partial loss in the writing capacity (Danna, Velay & Albaret, 2016). In other words, if it happens while the child / adolescent is in the process

of learning and because of reasons other than accidental or medical conditions (such as the loss of some brain functions because of a trauma or an aging situation like Alzheimer), it is a developmental dysgraphia. If the opposite happens, then, it is acquired dysgraphia. Developmental dysgraphia can be primary–isolated and specific to the learning of writing, or secondary, i.e., as a result of another developmental issue such as autism (Danna, Velay & Albaret, 2016).

Motor dysgraphia happens when the handwriting is illegible, but the letters are decipherable and it is due to problems in motor skills and muscle toning (Brown, 2019). In this case, the learner finds it difficult to control the hand movements that are necessary to join letters for the sake of making words and sentences. The final result is a piece of writing that is not readable. On the strength of Westwood (2003), illegible handwriting can be traced back to problems with muscle command and weak eye–hand harmonisation, neurological causes (in relation to ADHD learners in particular), and erroneous teaching situations. In other words, it is not solely confined to the physical features of the handwriting activity but might also be a teaching induced result because children– and at early stages, imitate their teachers. So, if the teacher’s writing is not clear, the consequence might be detected in his/her learners’ productions.

For its part, spatial dysgraphia is depicted as a sum of anomalies in relation to remaining within the paper lines and margins as well as letter, letter size and word on– line inconsistencies (Brown, 2019). Dun, Vanderborre, & Mariën (2015) portrayed it as a product of visual and proprioceptive disorders whereby one receives erroneous feedback via senses about the environment and one’s own body orientation. Thus, the learner is neither able to maintain his/her words on a straight line within the margins, nor is s/he capable of making his/her letters and words regular.

Dysgraphia might be attributed to endogenous and exogenous factors (Danna, Velay & Albaret, 2016). Endogenous factors include deficits in sensorimotor and visual–motor skills whereby the learner has trouble controlling finger inter–segmental movements and synchronisation, as well as visual perception and finger movement coordination (Danna, Velay & Albaret, 2016). For their part, exogenous factors comprise situations that impose certain behaviours on learners such as using electronic writing via smartphones and tablets with, as a result, a serious reduction in time devoted for handwriting (Danna, Velay & Albaret, 2016).

Dysgraphia might become a sufficient motive for exclusion from the schooling system at college since handwriting is still the main support for evaluation (Soppelsa & Albaret, 2014). Actually, most

tests and in different subjects are conducted through handwriting. Thus, if the latter is impaired, the written production becomes illegible. The result might be a punitive judgement of the paper and its author as failure to decode the messages inevitably leads to failure to evaluate accurately the content.

1.3. Diagnosis

As explained earlier, the evaluation of handwriting leans on its legibility and speed. To analyse the quality of handwriting as a final product, three different levels should be considered: the letter, the word and the sentence. At letter level, the impairment is identified regarding the anomaly in the relative size of the letters' strokes, their incorrect number, their bad orientation or their spatial error situated at their beginning (Danna, Velay & Albaret, 2016). At word level, what is scrutinised is the inter-letter spacing– i.e., the letters are either distant or superposed– and a relatively inappropriate inter-letter height especially between trunk letters such as a, c, and e and non-trunk letters (ascenders and descenders) like b, f, g and p (Danna, Velay & Albaret, 2016). At sentence level, the inter-word spacing, the horizontality and the margin are the three variables to be investigated (Danna, Velay & Albaret, 2016).

Informal techniques of evaluation are simple to apply as most psychologists, instructors, and special education teachers employ

them (Jena, 2013). However, various formal instruments for handwriting analysis were developed and tested. One of them is the Evaluation Tool of Children's Handwriting (ETCH) (Amundson, 1995) which targets the domains of alphabet, numbers, near point and far point copying, dictation, composition, and speed, as well as, areas of form, spacing, and size. A second instance is the Children's Handwriting Evaluation Scale (CHES) developed by Phelps and Stempel (1987) and which deals with speed and quality (letter form, spacing, rhythm, and appearance). A third example is the Minnesota Handwriting Test (MHT) by Reisman (1993) which is a norm referenced test that targets legibility, form, alignment, size and spacing. A fourth example of tests is the Concise Evaluation Scale for Children's Handwriting (BHK) that was developed by Hamstra-Bletz & Blote (1993) to measure legibility and speed (from which this study shall borrow the criteria). In addition to diagnosing dysgraphia, the BHK might also be used as a rehabilitation outcome assessment (Matta Abizeid, Tabsh Nakib, Younes, Ghantous Faddoul, & Albaret, 2017). It was validated in several studies in countries with a number of languages and was proved to be cross-culturally reliable (Matta Abizeid, Tabsh Nakib, Younes, Ghantous Faddoul, & Albaret, 2017). It was also psychometrically validated for the E

language by Brossard–Racine et al. (2012) and for the A language by Ben Chikha et al. (2020).

The BHK and regarding the legibility, requires that the informant writes for five minutes a text which is, then, evaluated according to 13 criteria on a scale from 0 to 5:

- *(1) Writing is too large: The trunk letter sizes are comprised between 3mm and 9 mm. The smaller the size, the more 0 is approached.*
- *(2) Widening of left-hand margin: It should be the least possible inclined towards the right in relation to the first line.*
- *(3) Word alignment: Letter bottoms should rest on the line.*
- *(4) Insufficient word spacing: Word spacing is correct when it is equivalent to a trunk letter.*
- *(5) Severe turns in connecting joins to letters which disturb writing fluidity.*
- *(6) Absence of joins amid letters in words.*
- *(7) Letter collision: Letters are too close and sometimes superposed.*
- *(8) Inconsistency in letter size: The smallest letter size is established, and the rest of the trunk letters should not be excessively higher.*

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- (9) *Relative height of different types of letters: Trunk and non-trunk (ascenders and descenders) letters should not be of the same height.*
 - (10) *Letter distortion: Letter forms do not correspond to the standard form of the alphabet.*
 - (11) *Ambiguous letter forms: Letters are ill-formed and confused with other ones.*
 - (12) *Letter form correction: The pen goes on letters many times to modify letter appearance.*
 - (13) *Writing trace unsteadiness: The writing is hesitant leaving bad traces.*

These thirteen criteria can be grouped into three main levels: letter (1, 8, 9, 10, 11 and 12), word (3, 5, 6, and 7) and sentence (2, 4 and 13).

2.4. Arabic versus English scripts

Arabic is a Semitic language belonging to the Afro-Asiatic family of languages (Ryding, 2005), whereas English is a Germanic language belonging to the Indo-European family (Crystal, 2010).

Arabic (A) handwriting is characterised by:

- Right to left writing direction and letter looping
- Use of the Arabic alphabetic system
- Use of a transparent orthography

- Semi-cursive style (letters are systematically joined for the majority)
- Absence of capitalisation
- Word initial, medial and final shapes of letters
- Presence of diacritic signs (*Ryding, 2005; Matta Abizeid, Tabsh Nakib, Younes, Ghantous Faddoul, & Albaret, 2017*).

In A, short vowels are represented by diacritics (long vowels are signalled by consonantal letters) and these diacritics may not be used at advanced levels when the users are apt to deduce them from the contexts surrounding them.

For its part, English (E) handwriting is characterised by:

- Left to right writing direction and letter looping
- Use of the Latin alphabetic system
- Use of an opaque orthography
- Cursive and print styles
- Capitalisation
- Absence of diacritic signs (Crystal, 2010).

3. The study

3.1. Research questions and null hypotheses

Borrowing from the BHK (but disregarding its scoring scheme) its 13 criteria and grouping them into three levels, namely, letter,

word and sentence levels, the following questions and null hypotheses were probed (same sample).

At letter level and in terms of trunk letter size, letter collision, letter size inconsistency, trunk and non-trunk letter relative height, letter distortion, letter ambiguity and letter correction:

– To what extent are A and E dysgraphic handwritings correlated at letter level?

–To what extent are there differences between A and E dysgraphic handwritings?

Ha₀: *There is no correlation between E and A handwritings at a significance level of .05 ($H_0: \mu d = 0$ where $d =$ trunk letter size E – trunk letter size A/ number of letter collisions E – number of letter collisions A/ letter size inconsistencies E – letter size inconsistencies A/ height differences between trunk and non-trunk letters E – height differences between trunk and non-trunk letters A/ number of distorted letters E – number of distorted letters A/ number of ambiguous letters E – number of ambiguous letters A/ number of corrected letters E – number of corrected letters A).*

Hb₀: *There is no difference, on average, between E and A handwritings at a significance level of .05 ($H_0: \mu d = 0$ where $d =$ trunk letter size E – trunk letter size A/ number of letter collisions E – number of letter collisions A/ letter size inconsistencies E –*

letter size inconsistencies A/ height differences between trunk and non-trunk letters E – height differences between trunk and non-trunk letters A/ number of distorted letters E – number of distorted letters A/ number of ambiguous letters E – number of ambiguous letters A/ number of corrected letters E – number of corrected letters A).

At word level and in terms of word alignment, severe turns amidst joins and letters, and join absences amidst letters:

–To what extent are A and E dysgraphic handwritings correlated?

–To what extent are there differences between A and E dysgraphic handwritings?

H_{a0}: *There is no correlation between E and A handwritings at a significance level of .05 ($H_0: \mu d = 0$ where $d =$ word alignment E – word alignment size A/ severe turns amidst joins and letters E – severe turns amidst joins and letters A/ join absences amidst letters E – join absences amidst letters A).*

H_{b0}: *There is no difference, on average, between E and A handwritings at a significance level of .05 ($H_0: \mu d = 0$ where $d =$ word alignment E – word alignment size A/ severe turns amidst joins and letters E – severe turns amidst joins and letters A/ join absence amidst letters E – join absence amidst letters A).*

At sentence level and in terms of margin width, word spacing and writing trace unsteadiness:

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- To what extent are A and E dysgraphic handwritings correlated?
 - To what extent are there differences between A and E dysgraphic handwritings?

Ha₀: *In terms of margin width, word spacing and writing trace unsteadiness, there is no correlation between E and A handwritings at a significance level of .05 ($H_0: \mu d = 0$ where $d = \text{margin width E} - \text{margin width A} / \text{word spacing E} - \text{word spacing A} / \text{writing trace unsteadiness E} - \text{writing trace unsteadiness A}$).*

Hb₀: *There is no difference, on average, between E and A dysgraphic handwritings in terms of margin width, word spacing and writing trace unsteadiness, at a significance level of .05 ($H_0: \mu d = 0$ where $d = \text{margin width E} - \text{margin width A} / \text{word spacing E} - \text{word spacing A} / \text{writing trace unsteadiness E} - \text{writing trace unsteadiness A}$).*

3.2. Context and participants

Seventy-three students (12–13 years old) at three Arabic preparatory public schools in Cairo were conveniently selected by volunteering E teachers who were asked to rely on their experience and judgement to identify them as having handwriting difficulties. All of them were year 1 preparatory (grade 7) with a 9-year contact with A (counting the two kindergarten years) and a 3-year contact with E (it starts at grade 4 and it is around 20 hours per week). The choice of the preparatory level is to make

English as an interlanguage fall approximately within Saville–Troike’s (2006) intermediate state as per a 3–year instructional contact with E. As to the dysgraphia element, it emphasises this temporal location of the interlanguage since ‘good writers’ go down the intermediate state and approach the final one. The test (dictation) was administered to them in January 2019. Only 17 (9 males and 8 females) respondents’ copies were retained: 21 were incomplete (missing parts in one or both of the texts), 5 lacked the E version, and 30 did not satisfy at least 3 BHK criteria (1 for each level: Letter, word and sentence in E texts).

3.3. Instrument

The instrument used is a one paragraph text about technology authored by the researcher in E (66 words: 40 were monosyllabic, 14 were disyllabic, 10 had 3 syllables and 2 had 4 syllables) and translated in A (52 words: 8 were monosyllabic, 7 were disyllabic, 23 had 3 syllables, 6 had 4 syllables and 8 had 5 syllables). The students were dictated the two texts.

3.4. Data Analysis

The BHK 13 legibility criteria (without their scoring scheme) were borrowed in this study, and a Pearson correlation coefficient was computed and interpreted (Dancey & Reidy, 2007) to assess the relationship between E and A handwritings as to the following

averages of representative samples of letters, words, and spaces in the first sentence:

Letter level:

– Size of ‘a, e, o, s, v’ and ‘هـ /h/, ك /k/, ث /θ/, ح /ħ/, ع /ʕ/’

– Number of letter collisions in ‘internet’ and ‘الإنترنت’

(/internet/)

– Letter size inconsistencies (in millimeters) as per differences between ‘a’ vs. ‘e’ in ‘faster’ and between ‘م’ vs. ‘هـ’ in ‘يمكنه’

(/jumkinuhu/: He can)

– Height differences between trunk and non-trunk letters (in millimetres) ‘a’ & ‘f’ in ‘faster’ and ‘هـ’ (/h/) & ‘و’ (/w/) in ‘هو’

(/huwa/: he)

– Number of distorted letters in the first sentence

– Number of ambiguous letters in the first sentence

– Number of corrected letters in the first sentence

Word level:

– Word alignment in ‘instance’ and ‘مثال’ (/miθ₃:l/)

– Severe turns amidst joins and letters in ‘some technologies’ and ‘بعض التقنيات’ (/baʕd eteqeniet /)

– Join absences amid letters in ‘some technologies’ and ‘بعض التقنيات’ (/baʕd eteqeniet/)

Sentence level:

– Widest margin point

- Word spacing between the second and the third words
- Writing trace unsteadiness in terms of number of bad traces in the first sentence

The aforementioned average numbers were also studied through a paired t-test to determine whether, on average, there was a difference between them in relation to E and A handwritings. The practical significance was also computed to support conclusions based on the statistical significance because the sample is small.

4. Findings

4.1. Letter level

M	SD	
A 3.97	1.42	Pearson correlation $r = .66$ Coefficient of determination $r^2 = .4356/ 43.56\%$
E 2.91	.76	Difference= -1.060 Standard error= $.391$ 95% CI= -1.8557 to $-.2643$ t-statistic= -2.714 df = 32 Statistical significance $p = .0106$ Practical significance ES= $.98$

Table 1

Size of trunk letters (millimetres) in A (ح /h/, ك /k/, ث /θ/, ه /h/ & ع /ʕ/) and E (a, e, o, s, & v)

As per table 1, the results indicated a statistically and practically significant moderate positive relationship between the sizes of five E trunk letters (a, e, o, s, and v) and five A letters (ح /h/, ك /k/, ث /θ/, ه /h/, and ع /ʕ/), $r(17) = .69$, $p = .007$ (increases in E trunk letter sizes were correlated with increases in A trunk letter sizes).

In addition, 43.56% of variation in E might be explained by the one in A, $r^2 = .4356$. The results also indicated that there was a statistically and practically significant difference in terms of trunk letter size between E ($M = 2.85$, $SD = .75$) and A ($M = 3.97$, $SD = 1.42$) handwritings; $t(32) = 2.71$, $p = .007$, $ES = .98$, 95% CI: $(-1.85, -.26)$. In addition, A trunk letters exceeded E ones by 1.06 millimetres.

	M	SD				
A	.59	.62	Pearson correlation $r = 0$	Coefficient of determination $r^2 = 0/0\%$		
E	1	.79	Difference = .41	Standard error = .672	95% CI = .0861 to .9061	t-statistic = 1.683
			df = 32 Statistical significance $p = .1020$ Practical significance $ES = .4$			

Table 2

Letter collision in 'internet' in E and 'الإنترنت' in A

As per table 2, the results indicated a statistically non-significant (but slightly practically significant) zero relationship between the average number of letter collisions in 'internet' in the E handwritings and the one of letter collisions in 'الإنترنت' (/el internet/) in the A handwritings $r(17) = 0$, $p = .102$ (increases in the number of letter collisions in the E handwritings did not correlate with increases of the one in the A handwritings). In addition, 0% of variation in E might be explained by the one in A, $r^2 = 0$. The results also indicated that there was a statistically non-significant (but slightly practically significant) difference in

terms of letter collisions in E (M=1, SD=.79) and A (M=.59, SD=.62) handwritings; $t(32) = 1.683$, $p=.102$, $ES= .4$, 95% CI: (-.0851, .9061). E letter collisions exceeded A ones by .41.

Table 3

Inconsistency in letter size (in millimetres) in A (‘م’ vs. ‘ه’ in ‘يمكنه’) & E (‘a’ vs. ‘e’ in ‘faster’)

	M	SD	
A	1.76	1.57	Pearson correlation $r=-.04$ Coefficient of determination $r^2 = .0016/ 1.6\%$
E	1.35	1.1	Difference= $-.410$ Standard error= $.465$ 95% CI= $-.5371$ to 1.357 t-statistic= $-.882$ df= 32 Statistical significance $p = .3844$ Practical significance $ES=.182$

As per table 3, the results indicated a statistically and practically non-significant weak negative relationship between the average letter size inconsistencies as per differences between ‘a’ vs. ‘e’ in the word ‘faster’ in the E handwritings and the one of letter size inconsistencies as per differences between ‘م’(/m/) vs. ‘ه’(/h/) in the word ‘يمكنه’ in the A handwritings, $r(17)= -.04$, $p=.3844$ (increases in E letter size inconsistencies were correlated with increases in A letter size inconsistencies). In addition, only 1.6% of variation in E might be explained by the one in A, $r^2 = .0016$. The results also indicated that there was a statistically and practically non-significant difference in terms of letter size inconsistency between E (M=1.35, SD=1.1) and A (M= 1.76, SD=1.57) handwritings; $t(32) = .882$, $p=.3844$, $ES= .182$,

95% CI: (-.5371 to 1.357). A letter size inconsistencies exceeded E ones by .41 millimetres.

Table 4

Height difference of trunk & non-trunk letters (in millimetres) in A ('ه' & 'و' in 'هو') & E ('a' & 'f' in 'faster')

	M	SD	
A	1.21	1.73	Pearson correlation $r = .05$
E	3.94	.41	Coefficient of determination $r^2 = .0025/ 2.5\%$ Difference= 2.73 Standard error= .431 95% CI= -3.6083 to -1.8517 t-statistic= 6.331 df= 32 Statistical significance $p < 0.0001$ Practical significance ES=1.533

As per table 4, the results indicated a statistically and practically significant weak positive relationship between the average trunk & non-trunk letter height difference between 'a' vs. 'f' in the word 'faster' in the E handwritings and the one of trunk & non-trunk letter height difference between 'ه' (/h/) & 'و' (/w/) in the word 'هو' (/huwa/) in the A handwritings, $r(17) = .05$, $p < 0.0001$ (increases in trunk & non-trunk letter height differences in E were fairly correlated with increases in trunk & non-trunk letter height differences in A). In addition, only 2.5% of variation in E might be explained by the one in A, $r^2 = -.0025$. The results also indicated that there was a statistically and practically significant difference in terms of trunk & non-trunk

letter height difference between E (M = 3.94, SD= .41) and A (M= 1.21, SD=1.73) handwritings; $t(32) = -6.33$, $p < 0.0001$, $ES = 1.533$ 95% CI: (-3.6083 to -1.8517). E trunk & non-trunk letter height differences exceeded A ones by 2.73 millimetres.

Table 5

Letter distortion (No. of distorted letters in the first sentence) in A and in E

	M	SD	
A	.35	.7	Pearson correlation $r = .56$
E	.41	.87	Coefficient of determination $r^2 = -.3136/ 3.136\%$ Difference= .06 Standard error= .271 95% CI= -.4917 to .6117 t-statistic=.222 df= 32 Statistical significance $p = .826$ Practical significance $ES=.08$

As per table 5, the results indicated a statistically and practically non-significant moderate positive relationship between the average number of letter distortions in the first sentence of the E handwritings and the one of letter distortions in the first sentence of the A handwritings $r(17) = .56$, $p = .826$ (increases in letter distortions in the E handwritings were correlated with increases in the ones in the A handwritings). In addition, only 3.130% of variation in E might be explained by the one in A, $r^2 = -.3136$. The results also indicated that there was a statistically and practically non-significant difference in terms of letter distortions in E (M =0.41, SD=.87) and A (M =.35, SD=.7) handwritings; t

(32) = .222, $p = .8261$, ES= .08, 95% CI: (-0.4917, .6117). E letter distortions exceeded A ones by .06.

Table 6

Letter ambiguity (No. of ambiguous letters in the first sentence) in A and in E

As per table 6, the results indicated a statistically and practically non-significant zero relationship between the average number of

	M	SD	
A	.64	1.11	Pearson correlation $r = 0$ Coefficient of determination $r^2 = 0/0\%$
E	.64	1.05	Difference= 0 Standard error= .431 95% CI= -.7548 to .7548 t-statistic= 0 df= 32 <i>Statistical</i> significance $p = 1$ Practical significance ES= 0

letter ambiguities in the first sentence of the E handwritings and the one of letter ambiguities in the first sentence of the A handwritings $r(17) = 0$, $p = 1$ (increases in letter ambiguities in E handwritings did not correlate with increases in the ones in A handwritings). In addition, 0% of variation in E might be explained by the one in A, $r^2 = 0$. The results also indicated that there was a statistically and practically non-significant zero difference in terms of letter ambiguities between A (M =.64, SD=1.11) and E (M =.64, SD=1.05) handwritings; $t(32) = 0$, $p = 1$, ES= 0, 95% CI: (-.7548, .7548). E letter ambiguities were equal to A ones.

Table 7

Letter correction (No. of corrected letters in the first sentence) in A and in E

As per table 7, the results indicated a statistically and practically significant weak negative relationship between the average

	M	SD	
A	.17	.52	Pearson correlation $r = -.15$ Coefficient of determination $r^2 = .0225/ 2.25\%$
E	1.23	1.37	Difference= 1.06 Standard error=.355 95% CI= .3361 to 1.7839 t-statistic=2.983 df= 32 Statistical significance $p = .0054$ Practical significance $ES=.69$

number of letter corrections in E handwritings and the one of letter corrections in A handwritings $r(17) = -.15$, $p = .0054$ (increases in letter corrections in the E handwritings were weakly correlated with decreases in the ones in the A handwritings). In addition, 2.25% of variation in E might be explained by the one in A, $r^2 = .0225$. The results also indicated that there was a statistically and practically significant difference in terms of letter corrections between A (M =.17, SD=.52) and E (M =.23, SD=1.37) handwritings; $t(32) = 2.983$, $p = .0054$, $ES = .69$, 95% CI: (-.7548, .7548). E letter corrections were 1.06 superior to A ones.

4.2. Word level

Table 8

Word alignment (in millimetres) for the words ‘instance’ in E and ‘مثال’ in A

	M	SD	
A	1.91	1.28	Pearson correlation $r = .42$ Coefficient of determination $r^2 = .1764/ 17.64\%$
E	1.67	1.22	Difference = $-.24$ Standard error = $.429$ 95% CI = -1.1136 to 0.6336 t-statistic = $-.56$ df = 32 Statistical significance $p = .5796$ Practical significance $ES = .17$

As per table 8, the results indicated a statistically and practically non-significant moderate positive relationship between the E and A handwritings in terms of word alignment, $r(17) = .42$, $p = .5796$, $ES = .17$ (increases in E word alignment were moderately correlated with increases in A word alignment). In addition, 17.64% of variation in E might be explained by the one in A, $r^2 = .1764$. The results also indicated that there was a statistically and practically non-significant difference in terms of margin width between E ($M = 1.67$, $SD = 1.22$) and A ($M = 1.91$, $SD = 1.28$) handwritings; $t(32) = -.56$, $p = .5796$, $ES = .17$, 95% CI: (-1.1136 , $.6336$). A word alignments exceeded E ones by .24 millimetres.

Table 9

Severe turns amidst joins and letters in ‘ بعض التقنيات ’ in A and ‘some technologies’ in E

	M	SD	
A	.23	.56	Pearson correlation $r = .19$ Coefficient of determination $r^2 = .0361/ 3.61\%$
E	.29	.47	Difference= .06 Standard error=.177 95% CI=-.4212 to .3012 t-statistic= .338 df= 32 Statistical significance $p = .7373$ Practical significance ES=.91

As per table 9, the results indicated a statistically and practically non-significant weak positive relationship between the average number of severe turns amidst joins and letters in the phrase ‘some technologies’ in the E handwritings and the one of severe turns amidst joins and letters in the phrase ‘ بعض التقنيات ’ (/baʕd eteqeniet/) in the A handwritings, $r(17) = .19$, $p = .7373$ (increases in severe turns amidst joins and letters in the E handwritings were correlated with increases of the ones in the A handwritings). In addition, only 3.61% of variation in E might be explained by the one in A, $r^2 = .0361$. The results also indicated that there was a statistically and practically non-significant difference in terms of number of severe turns amidst joins and letters in E ($M = .29$, $SD = .47$) and A ($M = .23$, $SD = .56$) handwritings; $t(32) = .338$, $p = .07373$, $ES = .91$, 95% CI: (-.4212, .3012). E severe turns amidst joins and letters exceeded A ones by .06.

Table 10

Join absences amid letters in 'بعض التقنيات' in A and 'some technologies' in E

M	SD	
A .06	.24	Pearson correlation $r = -.2$ Coefficient of determination $r^2 = .04/ 4\%$
E 5.17	2.46	Difference= 5.11 Standard error= .672 95% CI= -6.4787 to -3.7413 t-statistic= 7.605 df= 32 Statistical significance $p < 0.001$ Practical significance ES= 1.813

As per table 10, the results indicated a statistically and practically significant weak negative relationship between join absences amid letters in the phrase 'some technologies' in the E handwritings and the ones in the phrase 'بعض التقنيات' in the A handwritings, $r(17) = -.2$, $p < 0.001$ (increases in join absences amid letters in words in E handwritings were correlated with decreases of the ones in A handwritings). In addition, only 4% of variation in E might be explained by the one in A, $r^2 = .04$. The results also indicated that there was a statistically and practically significant difference in terms of join absences amidst letters in E ($M=5.17$, $SD=2.76$) and A ($M= .06$, $SD= .24$) handwritings; $t(32) = 7.605$, $p < 0.001$, $ES= 1.813$, 95% CI: (-6.4787, -3.7413). E join absences amidst letters exceeded A ones by 5.11.

4.3. Sentence level

Table 11

Margin width (millimetres) in A and E

M	SD	
A 4.64	6.61	Pearson correlation $r=-.15$ Coefficient of determination $r^2 = .0225/ 2.25\%$
E 4.06	4.6	Difference= $-.58$ Standard error= 1.953 95% CI= -4.5585 to 3.3985 t-statistic= $-.297$ df= 32 Statistical significance $p = .7684$ Practical significance ES= $.58$

As per table 11, the results indicated a statistically non-significant and moderately significant weak negative relationship between E and A handwritings in terms of margin width, $r(17) = -.15$, $p = .7684$ (decreases in E margin width were weakly correlated with increases in A margin width). In addition, only 2.25% of variation in E might be explained by the one in A, $r^2 = .0225$. The results also indicated that there was a statistically non-significant and moderately significant difference in terms of margin width between E (M =4.06, SD= 4.60) and A (M= 4.64, SD=6.61) handwritings; $t(32) = -.297$, $p = .7684$, ES=.58, 95% CI: (-4.5585, 3.3985). A margin widths exceeded the E ones accidentally by .58 millimetres.

Table 12

Word spacing (millimetres) in A (A3) & E (E3)

	M	SD	
A	.23	1.82	Pearson correlation $r = .19$ Coefficient of determination $r^2 = .0361/ 3.61\%$
E	1.73	1.84	Difference= 1.5 Standard error= $.628$ 95% CI= -2.7786 to 0.2214 t-statistic= 2.39 df= 32 Statistical significance $p = .0229$ Practical significance $ES=1.5$

As per table 12, the results indicated a statistically and practically significant weak positive relationship between word spacing in E and the one in A, $r(17) = .19$, $p = .00229$ (increases in E word spacing were correlated with increases in A word spacing). In addition, 3.61% of variation in E might be explained by the one in A, $r^2 = .0361$. The results also indicated that there was a statistically and practically significant difference in terms of word spacing between E ($M=1.73$, $SD= 1.84$) and A ($M= .23$, $SD=1.82$) handwritings; $t(32) = 2.39$, $p = .0229$, $ES=1.5$, 95% CI: $(-2.7786, .2214)$. A word spacing was surpassed by the E one by 1.5 millimetre.

Table 13

Writing unsteadiness (No. of bad traces in the first sentence) in A and in E

	M	SD	
A	1	1.17	Pearson correlation $r = .38$ Coefficient of determination $r^2 = .1444/ 14.44\%$
E	2.29	1.83	Difference=1.29 Standard error=.527 95% CI=.2169 to 2.3631 t-statistic=2.449 df=32 Statistical significance $p = .02$ Practical significance ES=1.29

As per table 13, the results indicated a statistically and practically significant weak positive relationship between the writing unsteadiness cases (bad traces in the first sentence) of the E handwritings and the ones of the A handwritings $r(17) = .38$, $p = .02$ (increases in the writing unsteadiness cases in the E handwritings were weakly correlated with increases in the ones in the A handwritings). In addition, 14.44% of variation in E might be explained by the one in A, $r^2 = .1444$. The results also indicated that there was a statistically and practically significant difference in terms of letter corrections between A ($M=1$, $SD=1.17$) and E ($M=2.29$, $SD=1.83$) handwritings; $t(32) = 2.449$, $p = .02$, $ES = 1.29$, 95% (CI: 0.2169, 2.3631). E writing unsteadiness was superior to the A one by 1.29.

4.4. Validation of null-hypotheses

In summary, the results revealed that dysgraphic handwritings in E might be traced back to A with respect to 6 criteria out of 13.

Table 14

Letter null-hypotheses (confirmed/ rejected)

	B	Stat. sig.	Pract. Sig.	r	Diff.	Null-hypotheses
Letter Level	H	<i>p</i> value/ α	Effect Size:			
	K	Type I error	ES			
			Type II error			
Trunk letter size	1	.007 Significant	.98 Large	.69 Moderate +	-1.06 A>E	Ha0 = rejected Hb0 = rejected
Letter collision	7	0 Non-significant	.408 Small	0 Nil	.41 E>A	Ha0 =confirmed Hb0 = confirmed
Inconsistency in letter size	8	.38 Non-significant	.182 Little/ No	-.04 Weak -	-.41 A>E	Ha0 = confirmed Hb0 = confirmed
Height diff. of trunk & non-trunk letters	9	< .0001 Significant	1.533 Large	.05 Weak +	2.73 E>A	Ha0 = rejected Hb0 = rejected
Letter distortion	10	.826 Non-significant	.08 Little/No	.56 Moderate -	.06 E>A	Ha0 = confirmed Hb0 = confirmed
Letter ambiguity	11	1 Non-significant	0 Little/No	0 Nil	0 A=E	Ha0 = confirmed Hb0 = confirmed
Letter correction	12	.0054 Significant	0.69 Medium	-.15 Weak -	1.06 E>A	Ha0 = rejected Hb0 = rejected

As per table 14 (letter), the null–hypotheses have been rejected in 3 out of 7 (42.87%) criteria. Indeed, E and A handwritings are moderately and positively correlated regarding trunk letter size (A exceeding E), feebly and positively correlated as to height difference of trunk and non–trunk letters (E exceeding A), and feebly and negatively correlated concerning letter correction (A exceeding E). As to letter collision, inconsistency in letter size, letter distortion and letter correction criteria (57.13%), the null hypotheses have been confirmed.

Table 15

Word null–hypotheses (confirmed/ rejected)

	B	Stat. sig.	Pract. sig.	r	Diff.	Null-
Word Level	H	p value/ α	Effect Size: ES			hypotheses
	K	Type I error	Type II error			
Word alignment	3	.57 Non-significant	.17 Little/ No	.42 Moderate +	.24 A>E	Ha0= confirmed Hb0= confirmed
Severe turns amidst joins & letters	5	.73 Non-significant	.091 Little/ No	.19 weak +	.06 E>A	Ha0= confirmed Hb0= confirmed
Join absences amid letters	6	$p < .0001$ Significant	1.813 Large	-.2 Weak -	5.11 E > A	Ha0= rejected Hb0= rejected

As per table 15 (word), the null–hypotheses have been rejected in 1 out of 3 (33.33%) criteria. Indeed, E and A handwritings are feebly and negatively correlated as to join absences amid letters in words (E exceeding A). Concerning word alignment and severe turns amidst joins & letters (66.66%), the null hypotheses have been confirmed.

Table 16

Sentence null–hypotheses (confirmed/ rejected)

Sentence Level	B	Stat. sig. H <i>p</i> value/ α	Pract. sig. Effect Size: ES	r	Diff.	Null hypotheses
		K <i>Type I error</i>	<i>Type II error</i>			
Margin width	2	.76 Non-significant	.58 Medium	-.15 Weak +	-.58 A>E	Ha0 = confirmed Hb0 = confirmed
Word spacing	4	.002 Significant	1.5 Large	.19 Weak +	1.5 E>A	Ha0 = rejected Hb0 = rejected
Writing unsteadiness	13	.02 Significant	1.29 Large	.38 Moderate +	1.29 E>A	Ha0 = rejected Hb0 = rejected

As per table 16 (sentence), the null hypotheses have been rejected in 2 out of 3 (66.66%) criteria. Indeed, E and A handwritings are feebly and positively correlated regarding word spacing (E exceeding A), and moderately and positively correlated concerning writing unsteadiness (E exceeding A). As to margin width criterion (33.33%), the null hypothesis has been confirmed.

5. Discussion

This study set out to confirm/reject the letter, word and sentence level null-hypotheses stated in relation to E and A handwritings regarding correlation and differences. The results revealed that the null-hypotheses were rejected in 6 out of 13 criteria (trunk size, trunk & non-trunk letter height differences and letter corrections at letter level; join absences amid letters in words at word level; and word spacing and writing unsteadiness at sentence level) and confirmed in 7 out of 13 criteria (letter

collision, letter size inconsistency, letter distortion and letter ambiguity at letter level; word alignment and severe turns amidst joins and letters at word level; and margin width at sentence level).

25 out of 28 (89.29%) letters in A are trunk letters (they change into non-trunk in word initial and final positions) and in E, 13 out of 26 (50%) are trunk letters (all letters become non-trunk with capitalization). This might explain the results in relation to trunk letters and trunk/ non-trunk letters. Indeed, the correlation that is moderately positive in the former and weakly positive in the latter is supported by A exceeding E in the former and E exceeding A in the latter.

Letter corrections in E were 1.06 times superior to A ones and a weak negative relationship between E and A handwritings was found. As shown in appendix 2, all the handwritings are in print mode for E and semi-cursive mode in A. In a study by Asselborn et al. (2021) wherein a sample of 6–11 year native speakers of Kazakh, were investigated in terms of transferability of different handwriting aspects (static, kinematic, pressure and tilt) while using Cyrillic and Latin alphabets, the informants were found transferring specificities of one alphabet to the other. If it is challenging to use the two modes in one language, let alone two languages. In the present study, the basic differences between E

and A handwritings such as direction and mode might be part of these limitations. In A, the wrist is frequently flexed backwards to allow for text exposure and rapid movement along the line; however, in English, this position quickly becomes uncomfortable (Sassoon, 2006). Letter corrections might also be explained by working memory limitations (Westwood, 2004). Indeed, working memory is torn between low-level (transcription) and high-level (planning and evaluation) processes as children may lose ideas if they focus on how to form letters, for instance, or if their writing is too slow (MacArthur & Graham, 2016).

At word level, only join absences amid letters null-hypotheses were rejected. The former were 5.11 times superior to A ones in E and were weakly negatively correlated. Perhaps, the most plausible explanation has to do with the fact that E is in print (not cursive) mode in the sample.

At sentence level, word spacing and writing unsteadiness in E were found positively correlated with A ones with a precedence of E on A in terms of differences. This precedence might be explained by the fact that words in E being in print mode presupposes the existence of spaces inside the words themselves. Thus, bigger spaces are needed to discern words in E.

All these correlations between E and A and in relation to 6 BHK items corroborate the conclusions of a research made by Buckwalter and Lo (2002) wherein they followed a developing 5 year old bilingual child in Chinese and English and reached the inference that literacy comprehension in one language serves as a basis for further literacies in other languages. Indeed, writing skills across scripts share an essential congruency that affects different aspects of writing like awareness of fine detail, space, force and density (Asselborn et al., 2021). However, this optimistic view of transferability is defied by Matta Abizeid et al. (2017) by virtue of a comparative study of Lebanese (bilingual: Arabic/ French) and French children's dysgraphia. Indeed, the Lebanese grade1 BHK scores got importantly lower at grades 2–5 in comparison to the French ones. This drop was explicated by the competition between the two graphic systems.

The 7 confirmed null hypotheses might be explicated mainly by the small size of the sample. Indeed, to represent a target population, a much larger and random sampling should have been used. In addition, the units of analysis were sometimes restricted to single words and sentences. A third explanation might have to do with the participants' greater proficiency in Arabic than English by virtue of onset and exposure.

6. Conclusions

This study has demonstrated the possibility of handwriting feature transfer from a first language to a second one using the BHK tool wherein 6 criteria showed a correlation between E and A dysgraphic handwritings. Although this number does not constitute a majority, it is still important as dysgraphic writing is not supposed to fulfil all the criteria especially that the sample size lacks statistical power.

Writing didactics is hoped to benefit from the implications of this study. Indeed, the focus being on understanding the student's linguistic background, writing curricular and remedial syllabi could be implemented by the concerned authorities taking into account the first language distance from the second one instead of relying only on the latter. Students themselves could be made aware of the possible reasons behind their handwriting drawbacks in the second language.

Limitations include the small size sample, and the segmented analysis (using single words and sentences). Besides, the cross-sectional procedure failed demonstrating the dysgraphic feature transformation. Further research is needed to highlight dysgraphia aspects in bilinguals like gender, concrete to abstract knowledge development, left handers and generation z tactile specificities.

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Appendix 1: Dictation Transcripts

English

There have been some technologies that have changed our lives recently. For instance, the plane has made international travel faster and easier. Another example is the computer which can store a lot of information contained in libraries. A third case in

point is the internet which has made human communication instant. All these inventions have greatly improved our everyday use. However, many people do not notice their benefits.

Arabic

حديثاً، وجدت بعض التقنيات التي غيرت حياتنا. فعلى سبيل المثال، جعلت الطائرة السفر الدولي أسرع و أسهل. و المثال الآخر هو الكمبيوتر الذي يمكنه تخزين الكثير من المعلومات الموجودة في المكتبات. و ثالث مثال على ذلك هو الإنترنت الذي جعل الإتصال البشري فورياً. و مع ذلك الكثير من الناس لا يلحظون فوائدها.

