

# Marking Tone with Punctuation: Orthography Experimentation and Reform in Eastern Dan (Côte d’Ivoire)

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*Abstract.* Eastern Dan has five level tones, six contours and many monosyllabic words, resulting in an extraordinarily heavy functional load of tone. This led those first involved in orthography development to create a novel system for marking tone that uses punctuation symbols in word-initial and word-final position. This orthography also has considerable segmental over-representation and makes extensive use of umlauts to symbolize vowels. In a quantitative classroom experiment, we tested it against Valentin Vydrin’s recent proposal for radical reform that advocates superscript diacritics for marking tone, biunique correspondence for consonants and vowels, and special characters in place of umlauts. Sixty-eight participants with no previous exposure to written Eastern Dan were taught various combinations of tones and segments in parallel groups and their acquired skills were tested in dictation and oral reading tasks. The results point to an advantage for the experimental orthography that combines the punctuation tone marking strategy with biunique segmental correspondence and spe-

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cial characters for marking vowels. Nevertheless, the language community has recently adopted Vydrin's reform in its entirety.

*Abbreviations.* C: consonant; H: high tone; L: low tone; M: mid tone; T: tone; TBU: tone bearing unit; V: vowel; xH: Extra-high tone; xL: Extra-low tone.

## 1. Background

### 1.1. Orthography Development

Dan<sup>1</sup> is a South Mande Niger-Congo language spoken in the Man, Danané and Biankouma prefectures of the Montagnes district of Côte d'Ivoire, and in Liberia where it is called Gio; there are also some Dan villages in Guinea. Since Dan has over forty dialects in Côte d'Ivoire alone, the decision was made in the 1970s to develop two varieties in this country: Western Dan (based on the Blo dialect) and Eastern Dan (based on the Gweetaa dialect, and including the dialect of Man, the main population centre of the entire Dan population). It is the latter variety that is the subject of the present research. Dan is spoken by about 1,600,000 people in all three countries (Vydrin, 2016a), of whom it is estimated that 650,000 are Eastern Dan speakers (Eberhard, Simons, and Fennig, 2019).

Eastern Dan is an overwhelmingly oral society. The only language of instruction at school is French, the official language, and L1 literacy is consigned to informal adult education. The average Dan speaker cannot read or write his or her own language. Literacy classes were extremely numerous in the 1970s-1980s (Bolli 1980, p. 7; 1983, p. 3; Thomas 1978, pp. 1, 14, 16) but numbers have declined steeply since then.

Eastern Dan is unusual among African languages in that it has five level tones and six contours. This, combined with the fact that it is highly monosyllabic and isolating in its root structures, results in a language with an exceptionally heavy functional load of tone. In the 1970s, SIL researchers were faced with the unenviable challenge of developing a tone orthography for Eastern Dan while working with the limitations of manual typewriters. The solution they came up with was an orthography that marks tone fully<sup>2</sup> using word initial and word final punctuation

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1. ISO 639-3: dnj. Exoglossonym: Yacouba.

2. We use the term *full tone marking* to refer to orthographic representations containing one symbol fewer than the number of contrastive level tones in the language. We reserve the term *exhaustive tone marking* for orthographies that mark each and every tone, a tradition that is virtually unknown in Africa but is not uncommon in Asia and Latin America.

marks:<sup>3</sup> a radical departure from the traditional strategy of using superscript accents (Bolli, 1978). This orthography, first developed in 1974, survived a government imposed segmental reform in 1982 and was still in use when we undertook this research project in 2017. Henceforth, it will be referred to as “The 1982 orthography”.

The punctuation strategy was hailed locally as a breakthrough at the time and was replicated in no fewer than fifteen Mande, Kru and Kwa languages in Côte d’Ivoire as well as being validated at national level by the *Institut de Linguistique Appliquée* (ILA, 1979). Although it has seldom been adopted beyond the borders of Côte d’Ivoire, it has nevertheless received some attention among writing systems researchers (Fricke-Kappers 1991; Kutsch Lojenga 1993, pp. 13–14; Kutsch Lojenga 2014, pp. 57–58; Roberts 2013, p. 91).

## 1.2. Previous Experimentation

In 2015, Roberts and Vydrin collaborated with a remote team of researchers working in five African countries to run a cross-linguistic classroom experiment the aim of which was to test the contribution of full tone marking to reading and writing fluency in the orthographies of ten Niger-Congo languages, including Eastern Dan.<sup>4</sup>

Across the ten languages, a total of 308 readers were recorded orally reading four previously unseen texts with and without tone marks. The results were measured for reading speed, accuracy and comprehension. The participants also added tone marks to the unmarked versions of the texts using pencil and paper, and we used these data to measure tone writing accuracy.

Analysis of the reading results indicates that, among the 57 Eastern Dan participants, the presence of punctuation marks to indicate tone does not contribute to gains in oral reading speed. Neither does it have a measurable impact on comprehension, contrary to some of the other languages. Granted, the punctuation marks do slightly reduce the number of errors in oral reading, but their average number is much higher in Eastern Dan than in any of the other languages, irrespective of whether tone is marked. As for the writing results, the average success rate in adding punctuation marks to unmarked texts was just over 60%, and only 3.5% of the participants scored over 90%. All this suggests not only that the 1982 tone orthography may not be doing its job effectively, but

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3. In fact, as we will see, the 1982 orthography contains a mixture of punctuation and mathematical symbols, but in this paper, for the sake of brevity, we will refer to all of them as punctuation symbols.

4. The other languages were Elip, Mmala, Yangben (Bantu A62), Yoruba, Idaasha, Ife (Ede), Nateni, Mbelime and Tem (Gur).

also that other orthographic elements, such as the lack of segmental adherence to the phonemic principle may also be contributing to lack of fluency (Roberts, submitted).

The results are not altogether surprising given that we had already identified Eastern Dan as being an outlier on four accounts. First, it has a far heavier functional load of tone than any of the other nine languages. Second, the Eastern Dan orthography is the only one of the ten in which tone is represented by punctuation marks. Third, the literacy primer (Tiémoko, Déli Tiémoko, Bolli, and Flik, 1994) contains no dedicated tone lessons. Fourth, the literacy program was decimated by two civil wars in 2002–2007 and 2010–2011.

## 2. Comparing the 1982 and 2014 Orthographies

### 2.1. Introduction

All orthography stakeholders—literacy personnel, Bible translators, linguists, and writers among others—agree that Eastern Dan must mark tone fully because the functional load of tone is so exceptionally heavy. If the 1982 orthography was to be reformed, then, the question was not largely<sup>5</sup> one of diacritic density;<sup>6</sup> it was rather to do with the choice of symbols, and their position with relation to the orthographic word. An alternative orthography, developed by Valentin Vydrin in 2014, marks tone fully with superscript diacritics, eliminates consonant and vowel over-representation, and replaces unlauded vowels with special characters. Henceforth, it will be referred to as “The 2014 orthography”. It was introduced to Eastern Dan orthography stakeholders at two meetings in Man in September 2014 and January 2017.

The development of the 2014 orthography presented an ideal opportunity for a second experiment following on from the worrying results of the first that would specifically investigate the choice of symbol and position for tone marks in the 1982 orthography more closely. Such an experiment would also add novel perspective to the tone orthography literature, which tends to be dominated by experiments testing the parameters of diacritic density (Bernard, Mbeh, and Handwerker 2002;

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5. We state ‘largely’ because the 2014 orthography marks tone on word medial feet whereas the 1982 orthography was incapable of this. As a result, it has a higher diacritic density, but only slightly so because most words have only one foot. See Section 2.4 for details.

6. In this study, we use the term “diacritic” to refer to both superscript accents and word-initial and word-final punctuation. Diacritic density is precisely measurable by calculating the number of diacritics as a percentage of the total number of orthographic TBUs in a natural text (Bird, 1999, p. 89).

Bird 1999) and orthographic depth (Mfonyam 1989; Roberts, Snider, and Walter 2016).<sup>7</sup> In the following sections, we summarize the differences between the 1982 and 2014 orthographies.

## 2.2. Consonants

Table 2 compares the consonantal grapheme-phoneme correspondences in the 1982 orthography (Vydrin and Kességbeu, 2008) and the 2014 orthography (Vydrin, Zeh, and Gué, 2019).

TABLE 1. Consonantal grapheme-phoneme correspondences in the 1982 and 2014 Eastern Dan orthographies

	Phoneme	1982	2014
Voiceless stops	/p/		<p>
	/t/		<t>
	/k/		<k>
	/kp, kw/		<kp, kw>
Voiced stops	/b/		<b>
	/d/		<d>
	/g/		<g>
	/gb, gw/		<gb, gw>
Voiceless fricatives	/f/		<f>
	/s/		<s>
Voiced fricatives	/v/		<v>
	/z/		<z>
Implosives	/ɓ/	<bh, m>	<bh>
	/ɗ/	<dh, n>	<dh>
Continuants	/l/	<l, r>	<l>
	/y/		<y>
	/w/		<w>

The 1982 orthography contains three cases of allophonic over-representation where spelling represents the surface form. First, the phoneme /ɓ/ is pronounced [m] preceding a nasal vowel and [ɓ] elsewhere; these sounds are spelled <m, bh> respectively. Second, the phoneme /ɗ/ is pronounced [n] preceding a nasal vowel and [ɗ] elsewhere; these sounds are spelled <n, dh> respectively. Third, the

7. To our knowledge, Duitsman (1986) is the only other researcher to have tested the Ivoirian punctuation system for marking tone. However, his intervention in Western Krahn lasted only 90 minutes, and some of the participants had prior knowledge of one of the alternatives being tested. Variables were not controlled for and no reference is made to statistical significance. All in all, the experiment design and reporting have such serious flaws that the results can tell us very little.

phoneme /l/ is pronounced [ɾ] following a coronal consonant and [l] elsewhere; these sounds are spelled <r, l> respectively, however, many writers spontaneously abandon <r> in favor of <l>. The 2014 orthography eliminates the graphemes <r, m>, and maintains the grapheme <n> only for the purpose of representing nasal vowels; in this way it maintains a biunique phoneme-grapheme correspondence.

### 2.3. Vowels

Table 2 compares the vocalic grapheme-phoneme correspondences in the 1982 orthography (Vydrin and Kességbeu, 2008) and the 2014 orthography (Vydrin, Zeh, and Gué, 2019).

TABLE 2. Vocalic grapheme-phoneme correspondences in the 1982 and 2014 orthographies

	Phoneme	1982	2014
Front unrounded oral	/i/		<i>
	/e/	<e, ɛ>	<e>
	/ɛ/		<ɛ>
	/æ/	<ɛa>	<æ>
Back unrounded oral	/u/	<ü>	<u>
	/ɤ/	<ö, ü>	<ɤ>
	/ʌ/	<ë>	<ʌ>
	/a/		<a>
Back rounded oral	/u/		<u>
	/o/	<o, v>	<o>
	/ɔ/		<ɔ>
	/ɒ/	<aɔ>	<œ>
Front unrounded nasal	/ĩ/		<in>
	/ẽ/		<ɛn>
	/æ̃/	<ɛan>	<æ̃n>
Back unrounded nasal	/ũ/	<ün>	<un/
	/ʌ̃/	<ɛ̃n>	<ʌ̃n>
	/ã/		<an>
Back rounded nasal	/ũ/	<un>	<un>
	/õ/	<ɔn>	<ɔn>
	/õ̃/	<aɔn>	<œ̃n>
Velar nasal	/ŋ/	<ng>	<ŋ>

The velar nasal /ŋ/ is best analyzed as being a vowel with a restricted distribution (Vydrin and Kességbeu, 2008).<sup>8</sup> The 1982 orthography writes it as <ng>, and the 2014 orthography as <ŋ>.

8. Alternatively, it can be interpreted as a syllabic nasal, occupying an intermediate position between a vowel and a consonant. It cannot be interpreted as a consonant

The 1982 orthography contains three cases of vowel over-representation for speakers of the Gweetaa dialect, though each of these pairs of allophones appear to be contrastive in other dialects, including that of Man. First, the phoneme /e/ is pronounced [ɪ] on a xH tone syllable and [e] elsewhere; these sounds are spelled <ɪ, e>, respectively. Second, the phoneme /ɤ/ is pronounced [ɥ]<sup>9</sup> on a xH tone syllable and [ɤ] elsewhere; these sounds are spelled <ü, ö>, respectively. Third, the phoneme /o/ is pronounced [ɔ] on a xH tone syllable and [o] elsewhere; these sounds are spelled <v, o>, respectively. The 2014 orthography eliminates <ɪ, ü, v> from the alphabet in order to maintain a biunique grapheme-phoneme correspondence, although it is intended that these vowels could still be distinguished as /ɪ, ɥ, v/ in certain dialects where /ɪ, ɥ, ɔ/ have phonological status.

In addition, the 1982 orthography writes three other back unrounded vowels with umlauts, the graphemes <ü, ö, ë> representing the phonemes /ɯ, ɤ, ʌ/, respectively. Since superscript tone diacritics are not easily combinable with the umlauts, the 2014 orthography spells these three vowels with the characters <ɯ, ɤ, ʌ> respectively.

Two long open front vowels /ææ, ɒɒ/ also occur. However, it has only recently been discovered that their short counterparts /æ, ɒ/ also exist, albeit seldom (Vydrin, 2016b, p. 472). The 1982 orthography under-represents this length contrast, writing both the short and long vowels as <εa, aɔ>, respectively. The 2014 orthography represents the short vowels as <æ, œ>, and the long vowels as <ææ, œœ>, respectively.<sup>10</sup>

## 2.4. Tones

Eastern Dan has five phonemic level tones, extra high (xH), high (H), mid (M), low (L), extra-low (xL).<sup>11</sup> These can be combined in four falling contour tones and two rising contour tones. All falling tones finish at the xL level; both rising tones begin at the M level (Flik 1977; Vydrin and Kességbeu 2008, pp. 10–11).

The 1982 orthography uses punctuation symbols placed word initially and word finally to signal tone. Level tones are marked preceding

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because /ɲV/ is unattested, no consonants bear tone, and no other nasal consonants are attested with which it might form a series.

9. Following Vydrin and Kességbeu (2008, p. 7), we use this symbol to indicate a near-close near-back unrounded vowel.

10. In addition, many words have free variation between /ææ ~ εε/ and /ɒɒ ~ ɔɔ/. The 1982 and 2014 orthographies both permit both spellings for these.

11. In Eastern Dan literacy classes, the two outermost tones are referred to as “very high” and “very low”.

the word. As for contour tones, the first element is marked word initially and the second word finally, but only on one-foot words (Kutsch Lojenga, 1993, ms 1989). The 2014 orthography, on the other hand, marks tones with superscript diacritics (Table 3).

TABLE 3. Grapheme-toneme correspondences in the 1982 and 2014 orthographies

Level tones	1982	2014	Contour tones	1982	2014	
xH	/ǒ/	<"o>	xH – xL	/ǒǒ/	<"oo->	<ǒǒ>
H	/ó/	<'o>	H – xL	/óǒ/	<'oo->	<óǒ>
M	/ō/	<o>	M – xL	/ōǒ/	<oo->	<ōǒ>
L	/ò/	<=o>	L – xL	/òǒ/	<=oo->	<òǒ>
xL <sup>12</sup>	/ḡ/	<-o>	M – H	/ḡó/	<oo'>	<ḡó>
			M – xH	/ḡǒ/	<oo">	<ḡǒ>

Some consider the marking of L and xL tones as <ḡo, =o> respectively to be counter-intuitive. For an explanation of the historical reasons for this choice, see Roberts (submitted).

By far the majority of Eastern Dan words have only one foot, and any words with three or more feet tend to be compounds. Since the 1982 orthography is incapable of marking tone on word medial feet there is a limited amount of under-representation on words of more than one foot.<sup>13</sup>

The 1982 orthography marks one symbol fewer than the number of phonemic tones in the language, representing M tone with absence of an accent. The 2014 orthography might have followed this principle, but it was considered more appropriate to represent all five phonemic levels, permitting the second vowel of a level sequence to be unaccented; thus, [ǒǒ] is spelled <ǒǒ>.<sup>14</sup>

12. The xL tone tends to be typed as <-o> but handwritten as <\_o>.

13. In fact, the 1982 orthography has a greater degree of tonal under-representation than necessary, because contour tones on two-foot words, which could easily be represented with the punctuation system, are not fully marked for reasons that remain unclear. We did not specifically address this issue in our experiment.

14. In a limited number of words, a single short vowel bears a HxL contour which the 2014 orthography represents with a circumflex ([ó̂]; 1982 <'o->; 2014 <ó̂>). As for the even less frequent MxL contour, all the affected words fortuitously contain a nasal vowel, so the 2014 orthography writes them without introducing an extra diacritic (e.g., ([dĩ̃]); 1982 <din->; 2014 <dĩ̃> *bunger*). Both these contours were excluded from the experimental teaching materials on account of their extreme infrequency.



## 2.5. Summary

Table 4 summarizes the consonant, vowel and tone representations in the 1982 orthography and the 2014 orthography.

TABLE 4. Summary of the 1982 and 2014 orthographies

	1982	2014
Consonants	over-representation of 3 consonants.	biunique correspondence; maintains <n> but only to mark nasal vowels.
Vowels	over-representation of 3 vowels; limited use of special characters; 2 oral vowels written as digraphs.	biunique correspondence; replaces umlauted vowels with special characters; replaces digraphs with special characters.
Tone	largely biunique correspondence, but some under-representation of words of more than one foot; punctuation in word initial and final position.	biunique correspondence; accents in superscript position.

## 3. Arguments for and against Orthography Reform

Before proceeding with an account of the experiment, it will be helpful to discuss various arguments for and against orthography reform that we have noted during the course of our fieldwork. These will be framed within Smalley's (1963) five criteria for developing optimal orthographies: maximum motivation and acceptance<sup>15</sup> (Section 3.1), maximum representation of speech (Section 3.2), maximum ease of learning (Section 3.3), maximum ease of transfer (Section 3.4), and maximum ease of reproduction (Section 3.5).

### 3.1. Maximum Motivation and Acceptance

This criterion has to do with the extent to which learners are motivated to use the orthography, and its acceptance by society and those in au-

15. The original states: "Maximum motivation for the learner, and acceptance by his society and controlling groups such as the government." (Smalley, 1963, p. 34)

thority. Orthography development typically takes place over decades and centuries rather than months and years, so a reassessment by the second generation of literacy stakeholders should be viewed as a perfectly acceptable stage in a longer process (Karan, 2014). Yet some question why there is a need to change when teachers have successfully taught the 1982 orthography for so long. The older ones among them will remember that the literacy program took years to recover from the only previous experience of reform, in 1982, and that was at a time when motivation for literacy was fervently high. They fear that a second reform may have a much greater negative impact on a generation in which motivation for literacy is much lower. A counter-argument is that any reform may prove to be less turbulent than it was in 1982, precisely because it will impact far fewer people.

Furthermore, some consider that the scope of the 2014 orthography is too far-reaching, because it involves multiple changes to all three phonological levels: consonants, vowels and tone. Recent orthography reform in European languages warns us that resistance is likely towards even the most modest and conservative changes. A literate community develops an attachment to a familiar orthography, gradually becoming blind, or even attached to its imperfections. To outsiders, the cumulative visual effect of the punctuation symbols in the 1982 orthography can look cluttered and aesthetically displeasing. Yet Eastern Dan learners never complained of this; on the contrary, they were proud of its distinctiveness.

### 3.2. Maximum Representation of Speech

This criterion has to do with the extent to which the orthography adheres to the phonemic principle. The 1982 orthography over-represents some consonants and vowels, and under-represents tone on words of more than one foot. A hard-nosed linguist might go further, arguing that the back unrounded vowel series contains an illogical mixture of symbols: Four of them are written with umlauts <ü, ö, ä, ë>, but the fifth <a> is not. Also, the umlauted letters <ü, ö, ä> are graphic modifications of the back rounded vowels <u, o, o>, whereas the umlauted letter <ë> is a graphic modification of the front unrounded vowel <e>, and in any case the graphemes <e, ë> do not share the same aperture. However, such picky linguistic concerns are generally far removed from the needs of learners. The 2014 orthography resolves all these issues by adhering to the phonemic principle and being relatively consistent with the IPA.

### 3.3. Maximum Ease of Learning

This criterion has to do with the extent to which the orthography is easy for learners to master. Some have expressed concern that the allophonic

representation of the three vowel phonemes /e, o, ɤ/ on xH tone syllables with the graphemes <ɿ, v, ü>, respectively takes up too much time in the classroom. Teachers of the 1982 orthography even present the letters <ɿ, v> to pupils as “i malade” and “v malade” (“sick i” and “sick v”) respectively because of their wobbly shapes, which would seem to indicate that they are denigrating them. The 2014 orthography eliminates this allography, but not entirely satisfactory, because recent research has revealed that the series /ɿ, ɔ, ʏ/ are phonemic in at least some dialects. A further pedagogical issue is that the under-representation of tone on words with more than one foot in the 1982 orthography leads many learners to avoid compounding which would otherwise be helpful for word identification. Again, the 2014 orthography eliminates this problem.

### 3.4. Maximum Ease of Transfer

This criterion has to do with the extent to which the orthography facilitates transfer of literacy skills to and from other languages. Some stakeholders have expressed concern that the allophonic representation of the consonant phonemes /b, d, l/ with the graphemes <m, n, r> in the 1982 orthography places an unnecessary pedagogical burden on teachers and learners. But these letters were included out of a concern that those who are literate in French will be used to hearing and writing these sounds. The 2014 orthography eliminates this allography, thus tending more towards the needs of monolingual learners.

Another transfer issue has to do with regional practice. At least two of the fourteen Ivoirian languages that used to use the punctuation strategy for marking tone—Mwan (Perekhval'skaya and Yegbé, 2018) and Guro (N. Kuznetsova, O. Kuznetsova, and Vydrin, 2009)—have abandoned it, and plans are afoot to switch in Western Dan (Loh Japhet p.c.) and Gban too (Taki Oya Robert p.c.). Toura has also recently replaced the digraph <ng> with the special character <ŋ> (Thomas Bearth, p. c.). The ILA is in favor of these changes. However, although government authorities might give high priority to inter-language harmonization as a sign of national unity, in practice few Ivoirians learn to read and write in more than one local language.

### 3.5. Maximum Ease of Reproduction

This criterion has to do with the extent to which the orthography facilitates typing and publishing. One of the main advantages of the 1982 orthography was that the four punctuation symbols required were all available on manual typewriters, a blind eye being turned to the potential for confusion of the L tone symbol with the equal sign <=> in math

booklets.<sup>16</sup> But beyond this, both orthographies contain elements that pose challenges for reproduction: The 1982 orthography has four special characters and one (pervasive) diacritic; the 2014 orthography has seven special characters and seven diacritics.

Neither could the developers of the 1982 tone marking strategy have foreseen that it would one day throw up numerous drawbacks in the early days of computer use. First, it did not facilitate alphabetical sorting, since words are merely grouped according to their word-initial tone marks. Second, spreadsheet programs interpret the L tone symbol <=> as introducing a mathematical formula, and the H tone symbol <'> as introducing a string of text. Third, word processing programs interpreted the punctuation marks as being beyond the domain of the orthographic word, so they were excluded from operations such as word selection and searches. The xL tone symbol <-> was particularly problematic because software interpreted it as a hyphen, triggering unwanted line-breaks: A randomly picked 23-line article from the *Pamebbame* newspaper contains no fewer than seven cases of this. Such issues are by no means insurmountable in the era of Unicode,<sup>17</sup> as long as writers are trained to choose word-forming characters—i.e., modifier letters that resemble the standard but are endowed with word-forming properties (Cahill 2019, p. 4; SIL 2018, pp. 5–6<sup>18</sup>)—but most Eastern Dan literates remain unaware of this and resort to the simple keystrokes at their fingertips. As for the issue of alphabetic sorting, locale data—i.e., basic information on certain language specific needs and preferences that are necessary to display text including sort order (Osborn, 2010, p. 75)—could be submitted to Unicode, but very few African languages have done this to date.

In any case, the real IT challenge nowadays is ensuring that Eastern Dan is reproducible on smartphones, which are far more widespread among young people than computers ever were in their parents' generation. An Android keyboard for the 2014 orthography has already been developed for this purpose.<sup>19</sup> For further discussion of Eastern Dan IT compatibility, see Paterson III (2019).

16. The use of double quotation marks in the 1982 orthography never created a conflict with symbolizing direct speech, because it follows the French convention of «chevrons» for this purpose.

17. [www.unicode.org/versions/Unicode12.0.0/](http://www.unicode.org/versions/Unicode12.0.0/) (accessed 7 May 2019). See also Anderson, R., and Whistler (2005). For a summary of Unicode and the background to its development, see Osborn (2010).

18. Specifically: <"> U+02BA MODIFIER LETTER DOUBLE PRIME; <'> U+02B9 MODIFIER LETTER PRIME; <-> U+02D7 MODIFIER LETTER MINUS SIGN or <-> U+2011 NON-BREAKING HYPHEN (all introduced in Unicode 1.1, 1993); <=> U+A78A MODIFIER LETTER SHORT EQUALS SIGN (introduced in Unicode 5.1, 2008).

19. We acknowledge Andrew Cunningham's work in developing the freely downloadable Eastern Dan Android keyboard. Users should install Keyman (<https://keyman.com>) then follow this link: <https://drive.google.com/>

Budgetary considerations are not to be ignored in a social context with extremely limited financial resources. It would be irresponsible for an outsider to promote orthography reform without also finding ways of financing the reproduction of literature and the organization of transition classes. It is incontrovertible that texts written in the 1982 orthography, with its linear tone marking, are 10% longer and therefore considerably more expensive to publish than those written using the 2014 orthography. However, some have expressed concern that the costs of reprinting the existing literature would be prohibitive and that literature will henceforth be split into pre- and post-reform publications. Others are of the opinion that, if reform must happen, it should be before the publication of the whole Bible (planned for 2020) because once it is in print, it will become authoritative, on the evidence that the New Testament (SBI, 1991) has proved to be by far the best-selling Eastern Dan book.

The above arguments only put forth the possible positive and negative consequences of spelling reform. In the following sections, we complement this qualitative approach with quantitative data from the classroom investigating the effects of the 1982 and 2014 orthographies on reading and writing performance.

## 4. The Experiment

### 4.1. Aim

The aim of the experiment was to test two ways of marking:

- (i) *tone*: word initial and final punctuation (the 1982 orthography) against superscript diacritics (the 2014 orthography);
- (ii) *segments*: over-representation of consonants and vowels (the 1982 orthography) against biunique grapheme-phoneme correspondence (the 2014 orthography), and umlauts (the 1982 orthography) against special characters (the 2014 orthography).

The experiment tested oral reading (measured in terms of speed, accuracy and comprehension) and writing (measured in terms of accuracy).

### 4.2. Design

The experiment followed a between-groups  $2 \times 2$  factorial design, permitting us to examine the effects of segments and tone independently

of each other, as well as any potential interaction between them. Participants were divided into four parallel classes by matched random assignment, and each experimental group was taught one of four orthographies in an intensive five-day course. Participants were given eleven dictation tests during the intervention and oral reading tasks following it. Table 5 shows the overall design and the number of participants in each experimental group. Orthography A is the 1982 orthography; orthography B combines the 2014 segments with the 1982 tones; orthography C combines the 1982 segments with the 2014 tones; orthography D is the 2014 orthography.

TABLE 5. Experiment design

		SEGMENTS	
		1982	2014
TONE	1982	A ( <i>n</i> = 16)	C ( <i>n</i> = 17)
	2014	B ( <i>n</i> = 17)	D ( <i>n</i> = 18)

Figures 1–4 illustrate the visual effect of the four orthographies.<sup>20</sup>

"Yua -ya =Göö- 'kun, "kεε "yua 'ö =Göö- -bha, mε 'bha 'yaa -a dɔ. =Göö- zuë" -ya -kě, =Göö- "ting -yö -sü, -a suë" -nu =wa 'go mü. =Göö- 'yaa wlüü" -dhe yö, 'yaa ö 'bhuëë- bho, -a 'bhuëë- =ya -da. =Wa =Göö- zü zua, "yua 'yaa bo. =Wa "bhuëë kö bho =dua 'ka, =wa -a -kpa, =wa -a "yi nu =Göö- -dhe, -a -bha "yua 'yaa bo.

FIGURE 1. Orthography A: 1982 SEGMENTS, 1982 TONES

Yúa yà Göö kún, kée yúa ó Göö bhà, mē bhá yáa à dɔ. Göö züë yà kě, Göö tǐng yò sũ, à sũë nù wà gó mü. Göö yáa wlüü dhè yö, yáa ö bhúëë bhô, à bhúëë yà dâ. Wà Göö zũ zúa, yúa yáa bô. Wà bhúëë kö bhô dùa ká, wà à kpà, wà à yí nù Göö dhè, à bhà yúa yáa bô.

FIGURE 2. Orthography B: 1982 SEGMENTS, 2014 TONES

20. English translation of the text sample: "Geu has grown sick, but nobody knows what kind of illness it is. Geu has heartache, difficulty breathing, and his fingernails have fallen off. Geu cannot stand up, he does not shave himself, and his beard has grown. He has had an injection in the buttocks, but the illness has not stopped. People have cut cashew tree shavings with an axe, boiled them and given the concoction to Geu, but his illness has not stopped."

"Yua =ya =Gɔɔ- 'kun, "kɛɛ "yua 'ɔ =Gɔɔ- -bha, bhɛn 'bha 'yaa -a dɔ. =Gɔɔ- zuɔ" -ya -kɔ, =Gɔɔ- "teŋ -yɔ -su, -a suɔ" -dhun =wa 'go bhun. =Gɔɔ- 'yaa wluu" -dhe yɔ, 'yaa ɔ 'bhuɔɔ- bho, -a 'bhuɔɔ- =ya -da. =Wa =Gɔɔ- zu zua, "yua 'yaa bo. =Wa "bhuɔɔ kɔ bho =dua 'ka, =wa -a -kpa, =wa -a "yi dhun =Gɔɔ- -dhe, -a -bha "yua 'yaa bo.

FIGURE 3. Orthography C: 2014 SEGMENTS, 1982 TONES

Yúa yà Gɔɔ kún, kɛɛ yúa ɔ Gɔɔ bhà, bhɛn bhá yáa à dɔ. Gɔɔ zúú yà kɔ, Gɔɔ tɛŋ yɔ sù, à sùú dhùn wà gó bhùn. Gɔɔ yáa wluú dhè yɔ, yáa ɔ bhúúú bhò, à bhúúú yà dà. Wà Gɔɔ zú zúa, yúa yáa bhò. Wà bhúúú kɔ bhò dùa ká, wà à kpà, wà à yí dhùn Gɔɔ dhè, à bhà yúa yáa bò.

FIGURE 4. Orthography D: 2014 SEGMENTS, 2014 TONES

### 4.3. Materials

Before the field phase, we prepared four versions of the experimental pedagogical and test materials. The lessons were based on those in the primer that teaches the 1982 orthography (Tiémoko, Déli Tiémoko, Bolli, and Flik, 1994) with the addition of dedicated tone lessons. The total number of lessons was reduced from 53 to 38 by eliminating those focusing on sound-symbol correspondences that the participants would already recognize from their knowledge of French. The four courses were identical in structure and content except with regard to the orthographies themselves.<sup>21</sup>

### 4.4. Timetable and Personnel

The field phase of the experiment, which took place in Man<sup>22</sup> spanned twelve weeks from January to March 2017 (Table 6).

21. It should be noted that, because of time constraints, the experiment focused only on short words even though one of the main advantages of the 2014 orthography is that it permits tone marking on long words (See Section 2.4). Testing these was beyond the scope of our research.

22. We had originally planned to run the experiment in Santa (about 65 kms north-west of Man), where the reference dialect of Gweetaa is spoken. However, an exploratory visit there in September 2015 caused us to abandon this idea, because neither primary school had enough pupils, the education level of potential teachers was insufficient, and communication networks were unreliable. We then arranged to run the experiment at the Mont Glas Primary School in Man, but a nationwide teacher's strike in January 2017 forced us to abandon this plan only a few days before we were due to begin.

TABLE 6. Timetable for the field phase

	Week	Event	AM	PM
	1	Arrival, administration		
1st cycle	2	Supervisor training	A	C
	3–4	Pilot test	A	C
	5	Intervention	A, C	A, C
	6	Recordings, scoring	A, C	A, C
2nd cycle	7	Supervisor training	B	D
	8–9	Pilot test	B	D
	10	Intervention	B, D	B, D
	11	Recordings, scoring	B, D	B, D
	12	Administration, departure		

#### 4.4.1. Supervisors

The principle author trained two supervisors in orthographies A and C in week 2 and in orthographies B and D in week 7.

#### 4.4.2. Pilot Test Participants

The supervisors then led two, ten-day pilot tests (weeks 3–4, orthographies A and C; weeks 8–9, orthographies B and D) with a total of 18 adult participants. The aim of this phase was to test the experimental materials with a small manageable group, but in fact the results proved sufficiently trustworthy that we decided to integrate them into the final statistical analysis, controlling for this difference. From each group, we recruited one person as a classroom assistant and scorer for the main intervention.<sup>23</sup>

#### 4.4.3. Intervention Participants

The intervention itself took place in weeks 5 (orthographies A and C) and 10 (orthographies B and D) with a total of fifty adults. This was followed by recorded tasks and scoring in weeks 6 and 11 respectively. All participants, in the pilot tests and intervention, were L1 speakers of Eastern Dan and participated for payment. None of them had prior knowledge of either the 1982 or the 2014 orthographies, but all of them had a minimum of four years formal education, which meant that they

23. Our original plan was for this phase of the experiment to be a teacher training course from which we would recruit people to independently teach during the intervention, but two weeks proved to be insufficient time to achieve this objective.



were all minimally literate in French.<sup>24</sup> The language of instruction was Eastern Dan.

#### 4.5. Intervention

Each course consisted of 38×30 minute content lessons, five revision lessons and eleven dictation tests. The total teacher-pupil contact time was 32.5 hours. Table 7 summarizes the lesson content.

TABLE 7. Lesson content

Lesson	Content	Lesson	Content
1	Short and long vowels	12	Revision: Contour tones
2	Level tones xH ~ H	13	/kp ~ gb/
3	Level tones H ~ M	14	/l/ [l, r]
4	Level tones M ~ L	15	/e/ [e, ɛ]
5	Level tones L ~ xL	16	/o/ [o, u]
6	Revision: Level tones	17	/ʁ/ [ø, ʊ]
7	/ŋ/	18–23	Oral vowels: /ʌ, u, ε, ɔ, æ, ɒ/
8	Falling contours xH-xL, H-xL	24–30	Nasal vowels: /ã, â, û, ê, ô, î, ü/
9	Falling contours H-xL ~ M-xL	31	/bh/ [bh ~ m]
10	Falling contours M-xL, L-xL	32	/dh/ [dh ~ n]
11	Rising contours M-xH, M-H	33–38	Diphthongs: /ia, iʌ, iʁ, ua, uʌ, uʁ/

#### 4.6. Independent Variables

All the participants filled in a sociolinguistic questionnaire in French before the course began. Any whose L2 literacy skills were not sufficiently developed to do this were interviewed in Eastern Dan and responses recorded in French on their behalf. We also tracked lateness and absences. Table 8 summarizes the demographic variables.

24. The average age of participants in this experiment (28 years old) was much lower than in the first experiment (47 years old), because we proactively recruited young people out of a concern that little is being done to pass Eastern Dan literacy on to the younger generation. This was not an obligatory feature of the experiment design.

TABLE 8. Demographic variables

STATUS	Whether the participant attended the pilot test or the main intervention
GENDER	Participant's gender (male or female)
AGE	Participant's age (measured in years)
EDUCATION	Formal education completed (measured in years)
DIALECT	Participant's dialect profile
DIASPORA	How long the participant had spent living outside of the Eastern Dan territory, measured in years.
ABSENCE	Lateness and absences, measured in minutes.

This demographic data enabled us to assign participants in matched quadruplets. One-way ANOVAs conducted on all demographic variables retrospectively showed that the groups were indeed matched (e.g., AGE  $F(4, 64) = .110, p = .95$ ; EDUCATION  $F(4, 64) = .203, p = .90$ ).

#### 4.7. Performance Variables

Tables 9 and 10 summarize the Eastern Dan and French performance variables associated with the dictation and oral reading tasks. Following Roberts (2013, 4, fn. 5), we use the term *Orthographic tone bearing unit* (TBU) to mean “any letter which can potentially be marked with a tone diacritic”.

TABLE 9. Eastern Dan performance variables

L1 DICTATION	Correct as a percentage of total number of words
L1 LIST SPEED	Oral reading speed of Eastern Dan word list measured in orthographic TBUs per minute
L1 LIST ERRORS	Errors per 100 orthographic TBUs on oral reading of Eastern Dan word list
L1 TEXT SPEED	Oral reading speed of Eastern Dan text measured in orthographic TBUs per minute
L1 TEXT ERRORS	Errors per 100 orthographic TBUs on oral reading of Eastern Dan text
L1 COMPREHENSION	Correct answers out of ten to comprehension questions about the Eastern Dan text.

TABLE 10. French performance variables

L2 TEXT SPEED	Oral reading speed of French text measured in syllables per minute
L2 TEXT ERRORS	Oral reading errors per 100 syllables on French text
L2 COMPREHENSION	Correct answers out of ten to comprehension questions about the French text.

## 5. Results

We ran a Multivariate Analysis of Covariance (MANCOVA) model with all dependent variables, examining them separately in terms of the main effect of segments and tones, and also the interaction between the two. Covariates entered into the model consisted of GENDER, AGE, EDUCATION, and all French performance variables (i.e., L2 TEXT SPEED, L2 TEXT ERRORS, L2 COMPREHENSION). The statistical analysis was performed using IBM SPSS software.<sup>25</sup> Only results that are significant ( $p < .05$ ) and marginally significant ( $p < .10$ ) are reported in the following sections.

### 5.1. Dictation

Eleven dictations consisting of 15 monosyllabic words each were spread across the five days of the intervention (165 words in total). Each dictation tested skills acquired in the immediately preceding lessons. The teacher said each word three times, preceding the first utterance of each triplet with consecutive cardinal numerals to provide a tone frame for the test word itself. The teacher repeated the entire list at the end. Dictation performance was first measured in terms of overall success, the whole word being scored as either correct or incorrect. Raw scores were converted to percentages (L1 DICTATION).<sup>26</sup>

Table 11 reports mean accuracy rates on L1 DICTATION and standard deviations in parentheses. Orthography C (2014 SEGMENTS, 1982 TONES) emerges as the winner, while orthography B (1982 SEGMENTS,

25. <https://www.ibm.com/analytics/data-science/predictive-analytics/spss-trials> (accessed 21 October 2019).

26. We also scored results separately for consonants, vowels and tone, but subsequent ANOVAs revealed such high correlations between each pair (C and V:  $r(68) = .91$ ,  $p < .001$ ; C and T:  $r(68) = .77$ ,  $p < .001$ ; T and V:  $r(68) = .91$ ,  $p < .001$ ) that we decided to treat them as a composite in the MANOVA. The same comment applies to the oral reading error scores.

2014 TONES) lags far behind. This combination, with its diacritic stacking, is by far the most difficult to master.

TABLE 11. Overall dictation success rates (and standard deviations)

		SEGMENTS	
		1982	2014
TONE	1982	A: 63.71% (18.83)	C: 64.67% (19.56)
	2014	B: 43.17% (23.62)	D: 62.12% (17.16)

A preliminary ANOVA on L1 DICTATION revealed that those writing 1982 TONES (i.e., orthographies A and C) scored significantly higher than those writing 2014 TONES (i.e., orthographies B and D;  $F(3, 64) = 5.71$ ,  $p = .02$ ) and that those writing 2014 SEGMENTS (i.e., orthographies C and D) scored significantly higher than those writing 1982 SEGMENTS (i.e., orthographies A and B;  $F(3, 64) = 4.24$ ,  $p = .04$ ). There was also a marginally significant interaction between segments and tones ( $F(3, 64) = 3.46$ ,  $p = .07$ ) revealing that those writing 2014 SEGMENTS (i.e., orthographies C and D) perform equally well irrespective of tone condition but those writing 1982 SEGMENTS (i.e., orthographies A and B) perform better when also marking 1982 TONES.

The MANCOVA analysis confirmed a significant main effect of tone on L1 DICTATION, with those writing 1982 TONES (i.e., orthographies A and C) scoring higher than those writing 2014 TONES (i.e., orthographies B and D;  $F(1, 44) = 9.900$ ,  $p < .01$ ). Only one independent variable, L2 COMPREHENSION, predicted L1 DICTATION scores ( $b = .408$ ,  $t = 3.48$ ,  $p < .001$ ).

We also examined dictation success rates on the seven individual segments that were manipulated in the experimental orthographies. Table 12 shows the individual scores as a percentage of the number of occurrences, with the highest scores underlined.<sup>27</sup> In all cases, those writing the 2014 SEGMENTS (orthographies C and D) score higher than those writing the 1982 SEGMENTS (orthographies A and B).

We scored dictation performance on individual level tones in the same way (Table 13). In three cases (H, M, L) those learning the 2014 TONES combined with the 2014 SEGMENTS score highest (orthography D). For the other two tones (xH, xL), those learning the 1982 TONES and the 2014 SEGMENTS scored highest (orthography C), although not dramatically more so than those learning the 2014 TONES and the 2014

27. For the vowel phonemes, the scores combine oral, nasal, short and long vowels.

TABLE 12. Dictation success rates on individual segmental phonemes

ORTHO- GRAPHY	SEGMENTS	TONES	/b/	/d/	/l/	/ŋ/	/e/	/ɾ/	/o/
A	1982	1982	76.14	86.46	89.35	83.41	69.64	74.11	58.75
B	1982	2014	73.26	70.10	89.98	77.89	63.87	69.41	45.88
C	2014	1982	95.19	91.67	97.39	90.06	77.31	83.58	84.71
D	2014	2014	94.44	<u>98.15</u>	94.65	89.46	74.60	<u>79.85</u>	<u>92.22</u>

TABLE 13. Dictation success rates on individual level tones

ORTHO- GRAPHY	SEGMENTS	TONES	/ó/ xH	/ó/ H	/õ/ M	/ò/ L	/ò/ xL
A	1982	1982	73.68	67.71	65.10	54.69	68.42
B	1982	2014	55.73	41.18	51.72	31.99	52.79
C	2014	1982	85.14	60.78	72.55	58.82	74.15
D	2014	2014	<u>81.73</u>	<u>80.56</u>	<u>84.26</u>	<u>65.63</u>	<u>74.12</u>

TABLE 14. Dictation success rates on individual contour tones

ORTHO- GRAPHY	SEGMENTS	TONES	Falling			Rising		
			/óò/ xHxL	/óò/ HxL	/òò/ MxL	/òó/ LxL	/òó/ MxH	/òó/ MH
A	1982	1982	66.67	66.18	45.63	75.00	69.64	65.63
B	1982	2014	58.82	41.18	37.65	35.29	49.58	<u>29.41</u>
C	2014	1982	66.67	69.20	53.53	82.35	79.83	36.76
D	2014	2014	<u>75.93</u>	<u>68.95</u>	<u>63.33</u>	<u>55.56</u>	<u>65.87</u>	-

SEGMENTS (orthography D). Scores for orthography B (1982 SEGMENTS, 2014 TONE), again, are consistently the lowest.

A similar pattern emerges when scoring contour tones (Table 14). For three of the tones (H-xL, L-xL, M-xH), participants perform more accurately when writing the 2014 SEGMENTS combined with the 1982 TONES (orthography C). But for two of the tones (xH-xL, M-xL), it is orthography D (2014 SEGMENTS, 2014 TONES) that attracts the highest average scores.<sup>28</sup>

28. The score for writing the MH contour tone in Orthography D is unavailable due to a data entry error. There were only four occurrences.

## 5.2. Oral Reading (List)

The intervention was followed by recorded oral reading tests spread over two consecutive days. First, each participant was recorded reading a list of 20 Eastern Dan one-foot words beginning with the phonemes /b, d/.<sup>29</sup> Speed was measured in terms of orthographic TBUs per minute (L1 LIST SPEED).

Table 15 reports the results of L1 LIST SPEED. Those reading the 1982 SEGMENTS and 1982 TONES (orthography A) read fastest, while those reading the 2014 SEGMENTS and 2014 TONES (orthography D) read slowest.

TABLE 15. Mean oral reading speed of Eastern Dan word list in orthographic TBUs per minute (and standard deviations)

		SEGMENTS	
		1982	2014
TONE	1982	A: 14.45 (6.01)	C: 10.29 (4.25)
	2014	B: 10.53 (6.12)	D: 7.38 (2.90)

The MANCOVA analysis revealed a significant main effect of segments on L1 LIST SPEED ( $F(1, 44) = 13.274$ ,  $p < .001$ , partial  $\eta^2 = .232$ ), with those reading the 1982 SEGMENTS ( $M = 13.80$ ) performing faster than those reading the 2014 SEGMENTS ( $M = 9.35$ ). It also revealed a marginally significant main effect of tones on L1 LIST SPEED ( $F(1, 44) = 2.883$ ,  $p < .10$ , partial  $\eta^2 = .061$ ), with those reading the 1982 TONES performing faster than those reading 2014 TONES.

As for errors, they were defined as substitutions, insertions and omissions, and did not include repetitions and self-corrections. Raw error counts were converted to errors per 100 orthographic TBUs (L1 LIST ERRORS). Table 16 reports the results of overall reading errors on the Eastern Dan word list. Those reading the 2014 SEGMENTS and 1982 TONES (orthography C) made the fewest errors, whilst those reading the 2014 SEGMENTS and 2014 TONES (orthography D) made the most.

The MANCOVA analysis revealed a marginally significant interaction for L1 LIST ERRORS ( $F(1, 44) = 3.462$ ,  $p < .10$ , partial  $\eta^2 = .0739$ ). For those reading 1982 SEGMENTS, it made little difference whether they were reading 1982 TONES (Orthography A) or 2014 TONES (Orthography B). However, for those reading 2014 SEGMENTS, also reading 2014

29. We focused on these two phonemes at the specific request of Valentin Vydrin who considers them to be essential to his reform.

TABLE 16. Mean L1 oral reading errors per 100 orthographic TBUs of Eastern Dan word list (and standard deviations)

		SEGMENTS	
		1982	2014
TONE	1982	A: 42.89 (19.46)	C: 39.78 (14.13)
	2014	B: 40.11 (17.88)	D: 48.24 (21.06)

TONES (Orthography D) resulted in significantly more errors than those reading 1982 TONES (Orthography C).

### 5.3. Oral Reading (Text)

In the same recording session, each participant was recorded orally reading two previously unseen texts, one in Eastern Dan (193 words), the other in French (143 words). Speed was measured in terms of orthographic TBUs per minute for Eastern Dan (L1 TEXT SPEED) and syllables per minute for French.<sup>30</sup>

Table 17 reports the mean results of oral reading speed of the Eastern Dan text. Those reading the 2014 orthography (orthography D) read slower than the other three groups who all performed at a similar rate.

TABLE 17. Mean oral reading speed of Eastern Dan text in orthographic TBUs per minute (and standard deviations)

		SEGMENTS	
		1982	2014
TONE	1982	A: 32.82 (8.94)	C: 33.75 (9.11)
	2014	B: 33.66 (12.67)	D: 25.07 (6.67)

The MANCOVA analysis revealed a statistically significant interaction between segments and tones for L1 SPEED ( $F(1, 44) = 4.341, p < .05$ , partial  $\eta^2 = .090$ ). For those reading 1982 SEGMENTS, whether they read 1982 TONES (orthography A) or 2014 TONES (orthography B) made little

30. We consider the classic 'words per minute' measure to be inappropriate for cross-linguistic comparison, because words vary in language between languages. For further discussion of this issue, see Roberts (submitted).

difference to their oral reading speed. However, combining 2014 SEGMENTS and 2014 TONES (orthography D) resulted in a much slower reading speed than combining 2014 SEGMENTS with 1982 TONES (orthography C).

Errors were defined as before. Raw error counts were converted to errors per 100 orthographic TBUs for Eastern Dan (L1 TEXT ERRORS) and errors per 100 syllables for French (L2 TEXT ERRORS). None of the differences between the four orthographic conditions was statistically significant.

#### 5.4. Comprehension

The recording sessions also included two comprehension tasks, orally answering ten questions each about the Eastern Dan and French texts. In both cases, the questions were asked and answered in Eastern Dan. Questions were devised to test a mixture of explicit and implicit information (cf. Piper, Schroeder, and Trudell 2016, pp. 140–142), but scoring did not differentiate between these. Oral reading comprehension was measured in terms of correct answers out of ten (L1 COMPREHENSION, L2 COMPREHENSION). We found no statistically significant evidence that group assignment had an impact on oral reading comprehension of the Eastern Dan text. Participants understood the text equally well regardless of the orthography they were exposed to.

#### 5.5. Summary

Table 18 summarizes the results of the statistical analysis, and shows that quantitative evidence falls uniquely in favor of orthography C on three of the eight measures, and partially so on two others. The experimental orthography that employs the 2014 segments but maintains the 1982 tone marking strategy is therefore the most efficient in promoting reading and writing fluency.

### 6. Discussion

#### 6.1. Methodology

It will be helpful to comment on various aspects of the experiment design before interpreting the results.

The choice of sample was a compromise. On the one hand, it would arguably have been preferable to conduct the experiment with illiterates to avoid the possibility of any influence from French. On the other hand,



TABLE 18. Summary of the statistical analysis

Task	Evidence in favor of orthography...	Segments	Tone
Dictation accuracy (overall)	C	2014	1982
Dictation accuracy (individual segments)	C, D	2014	1982, 2014
Dictation accuracy (individual tones)	C, D	2014	1982, 2014
Oral reading speed (list)	A	1982	1982
Oral reading accuracy (list)	C	2014	1982
Oral reading speed (text)	C	2014	1982
Oral reading accuracy (text)	-	-	-
Oral reading comprehension (text)	-	-	-

working with adults with a minimum of formal schooling meant we did not have to teach the Eastern Dan alphabet from scratch in the limited time available; 12 of the 36 letters were already known.

The technique of preceding each word in the dictation task with consecutive cardinal numbers as tone frames proved effective, as participants would have been unable to identify the tones of words in isolation. A more authentic way of achieving the same outcome would be to embed the target word in a natural frame (e.g., “I saw a *noun*”; “I like to *verb*”), while still having participants write only the test word.

We have a lingering concern about lesson order. The fact that the implosive phonemes /b, d/ have nasal allophones [m, n] which are rendered explicit in two of the experimental orthographies left us with no choice but to teach them after the nasal vowels. Yet their high frequency in natural contexts would have been a reasonable argument for teaching them much earlier, and doing so would have had the benefit of greatly amplifying the stock of available words for the initial lessons. Furthermore, teaching the two implosives early on would have better prepared participants for the oral reading task which specifically focused on a list of words beginning with them. We did not control for lesson order, but it would be desirable to develop ways of doing so in future experiments.

With these methodological concerns in mind, we now turn to a discussion of the experiment results as they impacted writers and readers.

## 6.2. Writing Results

The results of this experiment show that, for writers of Eastern Dan, the punctuation strategy is easier to master than superscript diacritics

for marking tone. This is likely to be, at least in part, because of their linear position. It is often remarked that, in languages that mark tone with superscript diacritics, writers often formulate entire sentences before returning to fill in the diacritics, while others leave them out completely. These two writing practices have always been completely absent in Eastern Dan, because the position of the punctuation symbols forces the writer to make choices about tone marking simultaneously with those concerning consonant and vowel symbols.

As for consonants and vowels, Eastern Dan writers find the 2014 segments easier to write than the 1982 segments and the obvious explanation is that there are fewer symbols to master in the 2014 orthography. The experimental courses contained six lessons in which those teaching orthographies A and B had to introduce two symbols, while those teaching orthographies C and D could use the equivalent time to focus on one symbol. When over-representation is avoided it frees up teaching time. Another possible explanation for the advantage of the 2014 segments is that the 1982 segments contain four vowel graphemes written with umlauts, dramatically increasing the diacritic density which is already relatively high because of tone marking. The diacritic density of orthographies C and D, in which only tone is marked, is 57.3%, whereas that of orthographies A and B, in which tone and some vowels are marked is 92.4%. Writers make gains when the orthography steers clear of any potential for visual crowding.

As for orthography B, no Eastern Dan literacy stakeholder is suggesting it as a viable system. It is awkward typographically, because it superimposes tone diacritics on umlauted vowels. But including this permutation was necessary in order to achieve a balanced design, and it incidentally provided an opportunity to test the effect of stacked diacritics. The low scores for Orthography B suggest that they should be avoided in orthography design.

### 6.3. Reading Results

An orthographic strategy that benefits writers does not necessarily produce equivalent advantages for readers. In the reading tasks, the only statistically significant main effects are for reading speed of the list and the text, not for errors or comprehension. Neither the 2014 segments nor the 2014 tones helped participants to read the word list faster: they performed best with the 1982 orthography. However, once words are placed in context, a different pattern emerges: for those reading the text with the 2014 segments, combining these with the 1982 tones was more advantageous in terms of reading speed than combining them with the 2014 tones.

As for oral reading error rates, the 2014 tones increase the error rates when coupled with the 2014 segments on the word list. However, this effect was not replicated when reading the text. Crucially, the support of context enables readers of all four experimental orthographies to read with equal levels of accuracy. The same is true of comprehension: no particular orthographic variation perturbs the reader's understanding once words are placed in context. This is one of the most unexpected findings of the experiment and it stands as a reminder of the extent to which readers, at least those with pre-existing L2 literacy skills, can apparently adapt with ease to remarkably divergent orthographic strategies when transitioning to their L1, even one like orthography B that obviously has a less than optimal configuration.

## 7. Conclusion

The 1982 Eastern Dan orthography is well-known for its use of word-initial and word-final punctuation to mark tone, and discussions in the literature about this aspect of the orthography have tended to overshadow important segmental issues. Our results reveal that participants are struggling more with writing the 1982 consonants and vowels than they are with writing the 1982 tone marks.

The results of the writing, reading speed (text), and reading error (list) measures all point to an advantage for orthography C. The 1982 tone marks appear to be doing their job well, while the overrepresentation of consonants and vowels is clearly detrimental for writers and slows down reading speed. The 2014 segments have the social advantage that they could be introduced one by one over time, and there are also pedagogical implications. A revised literacy primer along the lines of orthographies C or D would contain six fewer segmental lessons, which would leave more room for incorporating designated tone lessons that are lacking in the existing primer.

Our experiment did not attempt to tease apart the parameters of symbolization (punctuation vs. diacritics) and position (word-initial and word-final vs. superscript). Therefore, if orthographies A and C are more effective than orthographies B and D, we still do not know whether it is because of the choice of symbols or because of the choice of position. This would make an interesting subject for future experimentation.

We found no convincing evidence that readers and writers are struggling with the counter-intuitive symbolization for L and xL tones. However, inverting them in the 1982 orthography would be desirable for two reasons. Pedagogically, it would enhance their iconic value, making them easier to teach; sociolinguistically, it would bring Eastern Dan into alignment with the 1979 government guidelines and practice elsewhere in the country.

However, such punctilious concerns have been unexpectedly swept away, as our research project ends with a curious twist. Even though the experimental results point in favor of orthography C, a recent meeting of 68 orthography stakeholders in Man on 8 December 2018 decided unanimously to adopt Vydrin's spelling reform (i.e., orthography D) in its entirety (Zeh, 2018, p. 2). Since then, five, two-week transition classes have been organized, retraining about 250 literacy workers (Emmanuel Zeh, p.c.). Several books have been published in the 2014 orthography, including a guide (Vydrin, Zeh, and Gué, 2019), a transition guide (Anonymous, 2019) and reading materials (Saint-Exupéry 2019; Tiémoko 2019).

Decision makers were doubtless influenced by the fact that the *Institut de Linguistique Appliquée* is now advocating the representation of tone by means of superscript diacritics in place of punctuation for Ivoirian languages. The linguistic arguments, such as the ability to mark tone on word medial feet, as well as those to do with IT compatibility, also contributed to consensus building. But the local enthusiasm for reform also suggests that the social process of being involved in a classroom experiment, with its opportunity for exposure to the 2014 orthography, has had a greater impact on decision makers than the scientific results of it. Any researcher involved in the process of such reforms should not underestimate the challenges of conveying complex quantitative experimental results to lay people who are empowered to reform their own orthography but whose cultural and educational background mean that they are not necessarily going to be persuaded by the scientific method.

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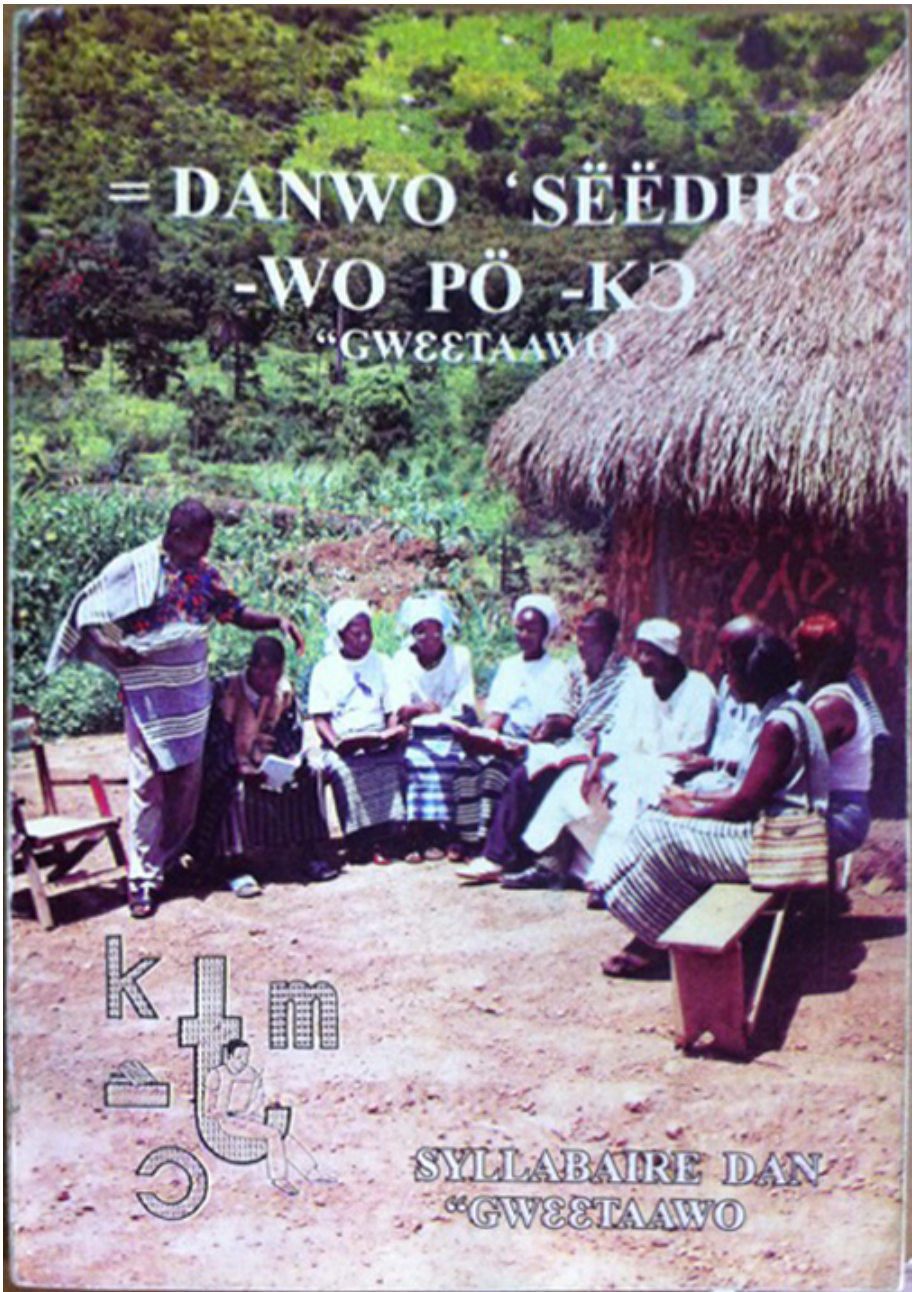


FIGURE 5. The cover of the Eastern Dan literacy primer in the 1982 orthography





FIGURE 6. An Eastern Dan teacher training class

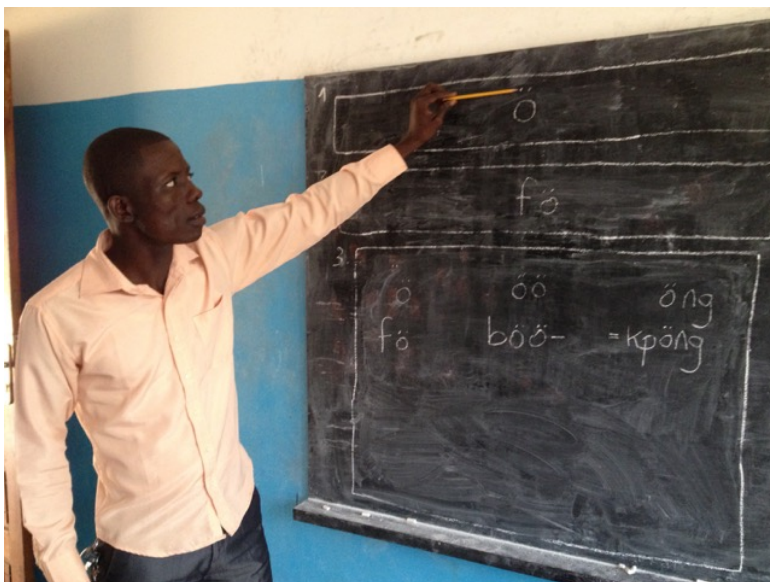


FIGURE 7. Emmanuel Zeh (literacy supervisor and principal collaborator) teaching the 1982 orthography



FIGURE 8. Pilot testing for the 2017 experiment

Antoine de Saint-Exupéry



# Gblùdāgb̄-dhán

dànwò gú



Bháandhè

Pàbhēnbhàbhèn — EDILIS

2019

FIGURE 9. Cover of “The Little Prince” (Saint-Exupéry, 2019) translated into Eastern Dan, a new publication in the 2014 orthography