To be published as/cited as: Meletis, Dimitrios (2025). The normativity of linearity in writing and grapholinguistics. In Heather Winskel & Hye K. Pae (eds.), *Handbook of Nonlinear Writing Systems: Complex Processes and Learning Challenges*. Singapore: Springer Nature.

3 The Normativity of Linearity in Writing and Linguistics

Dimitrios Meletis*

Abstract This chapter critically examines the concept of 'non-linearity' in writing, challenging entrenched perceptions arising from the prioritization of linearity—linked to the temporal one-dimensionality of speech—in (grapho)linguistics. It argues that writing is inherently multidimensional, transcending a one-dimensional linear framework imposed by traditional linguistic norms. The chapter elucidates how writing can deviate from the expected linearity by characterizing the types of horizontal, vertical, segmental, and two-dimensional non-linearity. Through employing a normative lens, it contemplates how non-linear features reveal implicit biases surrounding writing systems and our theoretical understandings of them. The multidimensional character of writing is explored across several perspectives, including its systematic architecture, its materiality, and reading processes. This examination underscores the necessity of recognizing non-linear attributes of diverse writing systems and their use, advocating for an interdisciplinary approach within the emergent field of grapholinguistics.

Keywords: Normativity, doctrine of linearity, spatiality, multidimensionality, materiality

> […] all writing systems are linear. Coulmas (2003, p. 151)

> Once it is theoretically conceded that language is not confined to oral expression but may also be expressed visually then the principle of linearity has to be abandoned as a foundational principle of linguistics. For visual signs are not necessarily linear. Harris (1990, p. 39)

3.1 Why 'Non-Linearity'?

At the outset, it is necessary to reflect on (1) what 'non-linearity' means, and (2) from which perspective it is investigated here—both in this handbook and in the present chapter. To find out how the negative 'non-linearity'[1] is defined, it is vital to acknowledge what we conceive of

* Dimitrios Meletis (ORCiD: 0000-0002-8889-6459)
Department of Linguistics, University of Vienna
Sensengasse 3A, 1090 Vienna, Austria
dimitrios.meletis@outlook.com

[1] The word is written without a hyphen in the title of the handbook; I use the hyphen throughout to draw attention to the composition of the word.

as ‘linearity’. Judging by the phenomena discussed throughout the handbook (see also the examples in Section 3.2), the idea appears to be that writing is one-dimensional and ordered, i.e., that its units are laid out on/in a line and in a specific sequence delegated by language. Anything deviating from this expectation is deemed ‘non-linear’. However, as will be argued below, writing is, in many respects, fundamentally and, indeed, unsurprisingly non-linear. Put in positive terms, writing is a two-dimensional, spatial modality of language that exhibits (other) modes of organization not necessarily derived from speech or even language. Where, then, does the idea come from that writing is linear?

A simplified answer is that linguists have (inadequately) transferred to writing a normative expectation of ‘linearity’ from their conceptualization of speech/the spoken modality of language, which the influential linguist Ferdinand de Saussure famously proclaimed as the only real research object of linguistics while devaluing writing as a mere derivative of it.[2] In speech, sounds follow one another in an acoustic continuum: a speaker cannot produce two sounds simultaneously, and they are transient or fleeting, meaning once they are uttered, they are already gone.[3] Thus, materially, speech extends in a temporal one-dimensional line. Writing is different. For one, it is made up of discrete segments. It is also (semi-)permanent and, importantly, two- or even three-dimensional. From a product-based perspective,[4] unlike speech, writing is, thus, not a temporal but a spatial phenomenon. Even if it is produced in lines most of the time, those (semi-)permanent lines are almost always concatenated to produce spatially complex (multilinear and multidirectional) texts that are laid out two-dimensionally on flat planes—writing surfaces—where all elements exist and can be perceived (or at least roughly taken in, see Section 3.4) simultaneously. Thus, depending on which features of writing we prioritize in our analysis, both Florian Coulmas and Roy Harris are correct in their respective assessments—writing systems may in many ways operate linearly, but visual signs—and texts as complex amalgamations of those signs—are not necessarily (only) linear.

The linguistic focus on speech and its assumed linearity has arguably clouded our perception and conceptualization of writing,[5] a situation that has been referred to as the *doctrine of linearity*

---

[2] “A language and its written form constitute two separate systems of signs. The sole reason for the existence of the latter is to represent the former. The object of study in linguistics is not a combination of the written and the spoken word. The spoken word alone constitutes that object” (Saussure, [1916] 1983, p. 45).

[3] Notably, regressive assimilation and coarticulation may be considered as non-linear and non-unidirectional phonological phenomena, highlighting that speech, too, is not entirely linear.

[4] Note that the *processes* of writing and reading do, of course, also have a temporal dimension.

[5] Somewhat ironically, linearization and linearity may ultimately derive from writing and a literate view of speech; cf. Ingold (2016, p. 3), who notes that “[m]any scholars have claimed that writing imposed a kind of linearization on human consciousness, unknown to people of preliterate societies”. This ties in neatly with what Taylor (1997) and more recently Duncker (2022) have described: that an implicit and often unconscious focus on writing and literacy—a so-called *scriptism* (or sometimes *scripticism* or *written language bias*, Linell, 2005)—resulted in an analysis of speech through a literate lens. One consequence of this is that we transfer our normative expectation of linearity *back* to spoken utterances (though this time not at a material but at a functional level): in ‘normal’ communicative situations, speakers rarely utter ‘perfect’ sentences from start to finish as there are pauses, repetitions, repairs (note what this terminology already insinuates; see also Duncker, 2002, p. 19), new starts, etc. These are often judged as ‘inadequate’ against the ultimately literate ideal of ‘full’ or ‘complete’ sentences that is manifested in (formal registers of) writing (cf. Meletis & Dürscheid, 2022, p. 49). In conclusion, both the conceptualization of writing as linear and a scriptist

(Krämer, 2003a, 2003b, p. 520; Evertz-Rittich, 2024). This ultimately results in an ignorance of 'non-linear' features of writing—whether these concern its linguistic functionality or its materiality—and thus a lack of theoretical and methodological tools of dealing with them. This also explains why the phenomenon attended to in this handbook is 'non'-linearity, i.e., why it is defined and labeled[6] *ex negativo*: linearity has prevailed as the expected norm, with non-linearity being everything that deviates from it. Therefore, the main lens of this chapter will be a normative one, the main question being: How do different 'non-linear' phenomena in writing expose (implicit) norms about writing (the object level) as well as how we conceptualize it (the meta level)?

Another notion that was mentioned above is that writing is ordered, more specifically that it is ordered according to the units of speech or language that it is claimed to (merely) 'depict'. This derives from what Krämer (2003b, p. 518) calls the *phonographic doctrine* that is predominant in linguistics and has resulted in a massive marginalization of any questions of writing within the discipline: Not only are the conditions of how writing is produced and materialized inadequately believed to be the same as those of speech, writing—also already evident in Saussure's above-mentioned verdict—is also reduced to being "spatial, fixed speech", which denies writing any idiosyncratic material or functional features that cannot be explained through recourse to speech.[7] Thus, whenever the order of units of writing does not correspond with the order of the 'fixed' units of speech (e.g., when a sound string /abc/ is rendered in writing as, for example, <acb>), this is considered 'non-linear'. This is the crux of the *linearity principle* as proposed as a fundamental principle by Cook (2004, p. 13) in his description of the English writing system. He claims, for example, that a written string like <$1> is non-linear since what it is supposed to represent is the reverse spoken representation 'one dollar'.[8]

This English example is useful to uncover two more intricately related normative biases underlying our understanding of 'non-linearity'. Firstly, a Eurocentric and inherently teleological bias: linearity—in this context connoted very positively—is frequently being associated with *alphabets*, i.e., a specific type of writing system. Accordingly, it is sometimes insinuated that linearity was an achievement brought upon by the alphabet (see, for example, Groß, 1990, p. 234), thus disregarding the fact that many non-alphabetic writing systems exhibit the same (non-)linearity and modes of spatial organization that we find in alphabets (and did so before coming in touch with the alphabet). Related to this is a synchronic bias: Linearity is much more prominent and 'normative' when modern writing systems are described, as is the case in this handbook. Diachronically, the picture is drastically different, as writing systems

---

view that has treated speech as writing-like have led to inadequacies in the linguistic treatments of both speech and writing.

6 Other negative terms like 'misaligned' vowels (Winskel, 2009) for a non-linear phenomenon in Thai (see Section 3.2.2 and Winskel & Ratitamkul, this volume) reinforce this impression.

7 See also Ingold (2016, p. 29): "Thus writing has been understood simply as a visual representation of verbal sound, rather than as the enduring trace of a dextrous manual movement."

8 This example highlights that linearity affects not only the ordering of sounds but also the order of morphological or lexical units. Thus, for instance, as a reviewer has pointed out, there is also an implicit linear expectation that a morpheme string {abc} is represented as <abc> in writing. This means that the phonographic doctrine affects all levels of language and their representation in writing, and thus, also writing systems that rely on a different typological principle than phonography—like morphographic Chinese or the kanji in the mixed system of Japanese.

such as Egyptian hieroglyphs or the Mayan script illustrate complex non-linear arrangements. I make these biases explicit to argue that our conception of (non-)linearity and the norms we derive from it are bound to specific contexts and circumstances that should be kept in mind.

The remarks thus far have already partially answered the second question posed at the beginning of this chapter: the perspective taken in this handbook (which is fittingly titled 'Handbook of Reading in Nonlinear Scripts') is a system-based or—to use Saussure's distinction—*langue* one. Accordingly, the focus is on non-linear phenomena that are *inherent* to the very architecture of scripts or writing systems. Thus, the 'nonlinear' in the title does not refer to, on the one hand, the reading process ('non-linear reading of scripts'), which would be a process-based perspective, or, on the other hand, produced texts ('reading of non-linear texts'), which would be a textual, product-based or *parole*-perspective. Yet, non-linearity is present or even pervasive also on those two levels, which is why I will also treat them in the following. Importantly, a third perspective, which will not feature in this chapter, is a methodological one, namely non-linear approaches to studying writing systems[9] (influenced by nonlinear phonology; see McCarthy, 2001).

Its structure is as follows: Section 3.2 will present different types of 'non-linear' phenomena that operate within the line and are, thus, broadly seen, one-dimensional and linear. In Section 3.3, the focus is shifted to multidimensional spatiality, i.e., two- or even three-dimensional non-linearity in writing. Section 3.4 will ponder several questions regarding non-linearity in reading, and Section 3.5 provides a brief programmatic summary. Crucially, non-linearity in writing is an interdisciplinary issue, echoing the fact that an emerging grapholinguistics as the comprehensive study of writing and literacy is an interdisciplinary field (Meletis, 2020; Meletis & Dürscheid, 2022). Thus, an underlying tenet of this chapter is that non-linearity can only be captured using a combination of multiple perspectives—here, the dominant ones will be linguistic, psycholinguistic, and (language) philosophical. Its goals are to critically reflect and systematize.

3.2 Types of Linear Non-Linearity

The title of this section may, at first glance, appear paradox or downright contradictory. It refers to phenomena in writing that subvert our expectations of linearity in different ways—and yet, they occur *within* the linear space (or simply put: the line), making them linear at the same time. This, of course, challenges our seemingly multiple conceptions of 'non-linearity', highlighting the ambiguity of the term or, more accurately, the heterogeneity of the phenomena subsumed under it.

[9] Non-linear graphematics, which has its roots in Germanophone grapholinguistics (see, for example, Schmidt, 2014, and several chapters in Domahs & Primus, 2016), has transferred a non-linear, hierarchical view of language from nonlinear phonology. In the vein of a prosodic hierarchy, a hierarchy of graphematic units is assumed in which lower-level units combine to constitute units at a higher level: graphemes combine to form graphematic syllables, which combined form graphematic feet, which in combination constitute graphematic words, etc. While it is methodologically non-linear, e.g., by using tree diagrams, it does not explicitly study non-linearity in/of writing bur rather analyzes linear—and only alphabetic—writing in a non-linear fashion. For a non-linear approach to 'layering' (i.e., the recursion of elements in characters) in morphography, see Tranter (2013).

The linear space has been characterized in a grapholinguistic approach called the 'cartography' of the writing surface[10] (Reißig, 2015; Meletis, 2020; see Figure 3.1), which deals with the subdivision of the two-dimensional writing surface into several subspaces that are occupied by written material and separated by blank spaces of various magnitudes (Bredel, 2011; Meletis, 2015). The smallest space, the so-called *segmental space*, is occupied by written segments that themselves are conventionally perceived as independent units (e.g., Roman letters, Chinese characters, etc.; see Section 3.2.2), and multiple segmental spaces are separated by inter-letter spaces.[11] They are concatenated in a specific direction—dependent on the writing system either horizontally and left-to-right (e.g., English) or right-to-left (e.g., Hebrew), or vertically and (almost always) top-down (e.g., Chinese; but cf. the Hanunoo script, which is written and read bottom-top)—to form the *linear space*, which is materially occupied by lines, with lines being separated by whitespace between lines ('line spacing').[12] Lines, of course, unlike the polysegmental units produced in them (e.g., graphic words separated by inter-word spacing as in most alphabets, or more rarely, as in Thai, phrases separated by inter-phrase spacing), are not linguistic[13] but rather purely material units as they are dependent on the physical boundaries of a writing surface. As Harris (1995, p. 126) notes, they are "organized so as to make maximum use of the graphic space available".[14]

[10] This approach owes a lot to typography (and its distinctions between *micro-* vs. *macrotypography*) and the integration of typographic and semiotic knowledge and experience into linguistic and generally more interdisciplinary approaches to writing (see, for example, also Kress & van Leeuwen, 2021).

[11] These, of course, are not always materialized, for instance in cursive handwriting or in Arabic writing (also in print). This can, depending on the script and text in question, make it harder to identify segments in what essentially becomes a connected graphic continuum. On the other hand, there may be internal spaces in 'segmental' units, such as in hiragana <しい> (I thank the reviewer for this example). This highlights that both conventionality (i.e., *knowing* what a 'unit' in a writing system is and what is learnt as such in literacy acquisition) and graphematic functionality (i.e., which graphic elements belong together or not based on their function) influence, top-down, what counts as a 'segment' and what occupies the segmental space.

[12] This space between lines, the so-called 'interlinear space', can also be used for additional markings, such as additional text that is added later; examples include handwritten explanations or translations of words or larger portions in medieval parchment manuscripts or the Japanese *furigana* (or more general ruby characters), reading aids consisting of smaller syllabographic characters (*kana*) indicating the pronunciation of morphographic characters (*kanji*).

[13] One exception to this are, of course, poems, where line breaks are intentional and meaningful.

[14] This highlights that spatial considerations are sometimes primary, as a fascinating example concerning Egyptian hieroglyphs proves: "It is not uncommon to find hieroglyphs switched in their order for reasons of better spacing. Indeed 'graphic transposition', as it is called, is virtually the rule for some sign combinations, particularly those in which a bird hieroglyph is written next to a small squat sign or a tall thin one" (Davies, 1987, p. 13; see also Coulmas, 2003, p. 170).

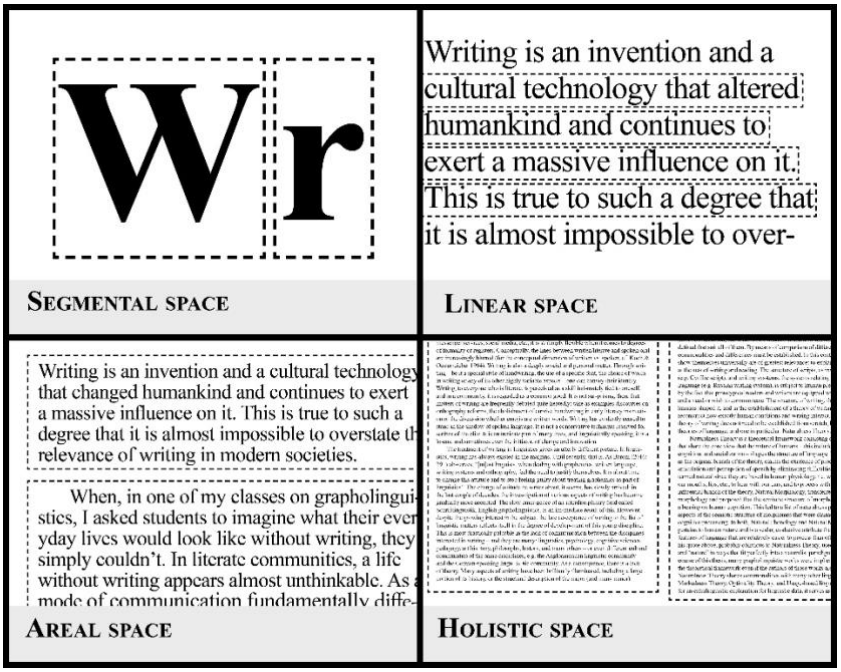

Figure 3.1: The cartography of the writing surface, adapted from Meletis (2020, p. 39)

It is within these two smallest subspaces, now, that the phenomena described in the following subsections occur: segmental non-linearity in the segmental space (3.2.2), and the suprasegmental types of horizontal (3.2.1.1) and vertical (3.2.1.2) non-linearity within the linear space. Note that since the areal and the holistic spaces are already two-dimensional phenomena, they as well as their intrinsic non-linearity will be discussed in Section 3.3.

3.2.1 Suprasegmental Non-Linearity

Prior to the characterization of these first two types, it must be noted that their labels—'horizontal' and 'vertical'—are relative and here refer to writing systems with a horizontal writing direction (such as English); in writing systems with a primarily vertical writing direction, these attributes would have to be reversed. Their alternative designations proposed below hold regardless of writing direction.

3.2.1.1 Horizontal Non-Linearity or Unaligned Linearity

Horizontal non-linearity subverts our normative expectation that units of writing must be ordered by appearing in the same sequence as the units of language (phonemes, syllables, morphemes, words) that they relate to and are supposed to align with. Cook (2004) even elevates this to the status of a principle with his 'linearity principle' (see above); in a semiotic approach to writing systems, it is captured by the parameter of positional transparency (Meletis, 2020, Chapters 6.7, 7.2.7). This expectation of alignment rests upon the view that writing only represents language—and that it does so completely faithfully and without its own idiosyncratic features. A prominent example of this type are the 'misaligned' vowel graphemes of Thai (Winskel, 2009; Winskel & Ratitamkul, this volume). In writing, they precede the consonant graphemes that they depend on while in the spoken form of the corresponding words, the vowel sounds follow the consonants: an example is <โ◌> /o/ as in <โต>, written <oːt> but pronounced /toːɬ/ 'big'. Units may also be discontinuous, such as the vowel <เ◌ะ> /e/, which is split into

two segmental parts that enclose a consonant (similar to a circumfix in morphology) whereas in the spoken equivalent, the vowel merely follows the consonant: <เกะกะ>[15] /keʔɲ.kaʔɲ/ 'messy, disorderly'. This illustrates the simultaneity of written units within a written utterance and can be roughly compared to what Cook (2004, p. 13, emphasis in original) describes for English:

> If the word 'mate' were approached in […] linear fashion, the order would be first /m/, then /æ/, then /t/, that is, the word 'mat'. The final <e> does not, therefore, signal an /iː/ at the end of the word, but that the *preceding* vowel <a> corresponds to /eɪ/ rather than /æ/. The final <e> is vital to the spoken correspondence of the preceding <a> but comes two letters after it. The information that 'silent' <e> provides is not linear since it is out of step with the letter sequence in the word.

Importantly, while transposed letters are a common mistake (at the level of performance) made by users across writing systems (see also Section 3.4), the examples discussed above are inbuilt parts of their systems rather than a deviance. In other words, here, we are dealing with *systematic non-linearity*, which will later be distinguished from textual non-linearity (see Section 3.3).

As mentioned above, this type of non-linearity occurs within the linear space; against this background, and given that it subverts our expectation of alignment, it could be termed *unaligned linearity*[16].

3.2.1.2 Vertical Non-Linearity or Multilinearity

As the second suprasegmental type of (non-)linearity, *vertical non-linearity* concerns additions or expansions not within the extension and directionality of the linear space (e.g., horizontal in English), but in the other dimension. For example, in the French writing system, which is written horizontally, a type of vertical non-linearity is the addition of diacritics like accents on letters such as in <á> or <ê>. This type of non-linearity raises two important points: firstly, the linear space is itself internally organized and subdivided in several spaces (or lines, which is why this type could also be called *multilinearity*; see also Roberts, this volume).[17] For the Roman script, and influenced by work in typography, this has been captured with the help of the three-(or sometimes four-)line schema, where the different vertical subspaces—the high, central, and low spaces—are occupied by different parts of letters (such as ascenders or descenders), which are placed on the *base line* (see Figure 3.2; Meletis, 2020, pp. 41f.). Such an internal organization of the linear space can also be found in other scripts (see Figure 3.3.3). Arguably, it is thus not only additive elements like diacritics that invoke a certain multilinearity, but already extending parts of 'linear' written units like letters, given that <y> occupies the

---

[15] This example shows that <◌ะ> occurs both as its own dependent vowel grapheme—in which case it represents /a/—or as a part of complex, discontinuous vowels, in which it marks vowel length, specifically shortness.

[16] Note that the negated '*un*aligned' still invokes the impression of a deviance, rendering this designation suboptimal as well. It does, however, successfully disentangle alignment/orderedness from (non-)linearity.

[17] This distinguishes vertical non-linearity from additions in the *inter*linear space, which are not part of the line *per se* but occupy the space 'between lines'. Fittingly, additions in the interlinear space are exactly that—additions, which means they are technically, in a narrower sense, not necessary. Multilinear elements like diacritics or vowel graphemes are, by contrast, more central and only in specific cases optional.

central and low spaces, and a letter like Georgian <ჟ> extends over all spaces of the line (i.e., also the high space). This, crucially, proves that the line itself is already fundamentally two-dimensional, as are the units occupying it—at least it if they are not just one-dimensional lines reminiscent of units like Chinese <一> *yī* 'one'—and even this unit occurs in a relative position inside the two-dimensional linear space that is (potentially) meaningful, rendering it non-linear.[18]

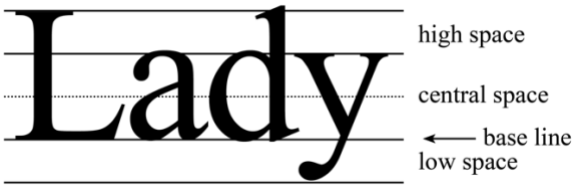

Figure 3.2: The three-space (high, central, low) schema in Roman script, from Meletis (2020, p. 42)

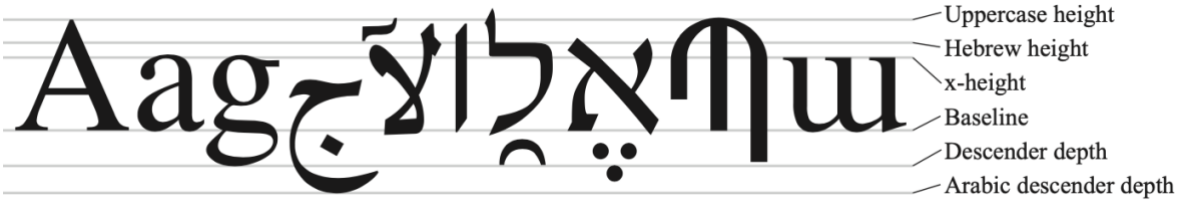

Figure 3.3: Multilinearity in the Roman, Arabic, Hebrew, and Armenian scripts, from Haralambous (2024, p. 41)

The second point is: Given examples like the above-mentioned <ჟ>, where a full vertical extension is realized by an individual unit, is this type not actually segmental rather than suprasegmental? Admittedly, there exist arguments to classify it as either of the two, but the full extent of the systematic internal organization of the linear space—such as the three-space schema—can only be recognized when several units in a script (as a visual system) are seen in relation to each other, as only this uncovers their commonalities and differences. In other words, an ascender can only be identified as such in comparison with other units that lack it. Furthermore, there are unambiguously suprasegmental vertical elements such as the horizontal stroke on top of Devanagari words (the *shirorekha*) like <लेखन> [leː.kʰə̃n] 'writing'. And the suprasegmental nature of this type becomes even more obvious when it is compared with segmental non-linearity, where every segmental space has its 'own' internal organization (see next section).

Examples of vertical non-linearity include, as mentioned, diacritics in alphabets (see Part II of this volume), a striking example—in terms of diacritic density—being Vietnamese. Consider the first part from the Vietnamese Wikipedia entry for 'writing system'[19]: <Hệ chữ viết là một phương pháp lưu trữ thông tin và chuyển…>, notable especially for units with vertical stacking

[18] Truly 'one-dimensional' writing, i.e., linear writing in the strictest sense possible, cannot exist, as it would consist only of a line, thus lacking multiple graphically distinct units that can take on the function of corresponding with the units of language represented. This would violate principles such as segmentality, finiteness, sequentiality, multiplicity, and alternation, which are fundamental material and functional features of writing (Meletis, 2020, pp. 273–276). In this context, a reviewer has mentioned Morse code as a possible exception worth considering.

[19] Cf. https://vi.wikipedia.org/wiki/H%E1%BB%87_ch%E1%BB%AF_vi%E1%BA%BFt (14 November 2024).

like <ê>. Non-alphabetic examples[20] include elements disambiguating formally identical consonant graphemes (called *i'jām*)—e.g., on <ص< /sˤ/ vs. <ض< /dˤ/—and the optional short vowel graphemes (*ḥarakāt*) in abjadic Arabic, to some degree also the vowel graphemes that are attached above or below consonant graphemes in abugidas, such as <े> /e:/ and <ु> /u/ in Devanagari, where we can sometimes also witness remarkable vertical complexity as in Tibetan (see Figure 3.4). Note that in all these examples, horizontal linearity is kept relatively intact, as the 'additional' vertical elements are—on the horizontal axis—spatially aligned with the graphemes that they belong to.

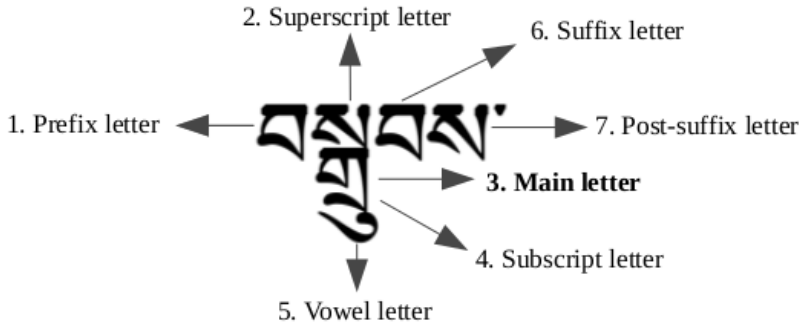

Figure 3.4: Vertical stacking in Tibetan, from https://tibetanlanguage.school/learn/standard-tibetan/unit-2/ (14 November 2024)

A writing system—or more specifically a specific form of writing systems—that has been consistently ignored in (grapho)linguistics is braille (but see Englebretson et al., 2023; Spitzmüller & Klein, in press; Sircar, this volume). While its 'letters' are arranged along a line, they also exhibit multilinearity as the spatial organization (i.e., the number and position) of one recurring element—a dot—along three vertical subspaces in a six-dot matrix signifies different linguistic values: for example, <⠁>[21] *a*, <⠓> *h*, <⠎> *s*. Its marginalization as an object of research is not only directly linked to the marginalization of the communities using it but is, arguably, also due to the peculiarities of the system: braille is, as is all writing, graphic (from Greek *γράφω gráphō*, 'scratch, carve'), i.e., *both* visual and tactile; however, it prioritizes the tactile or haptic channel, and it does so by operating in three dimensions. To be read, it must be felt—and this is possible because of its three-dimensional nature, with the letters being embossed on a writing surface.[22] The fact that braille remains understudied points to an implicit visuocentrism of (grapho)linguistics based on the fact that almost all writing is meant to be

[20] In this context, it is worth mentioning that a reviewer has questioned the status of the dakuten and handakuten diacritics in Japanese kana, which are added to the upper-right of a unit within the same segmental space (e.g., か /ka/ + ゛ = が /ga/). Given that kana do not have a consistent linear substructure similar to the one exhibited by Roman letters, meaning every kana has its own internal structure within the segmental space, I would consider this an example of segmental non-linearity or internal spatiality (see Section 3.2.2).

[21] The font used here is shadowed, meaning it indicates (smaller) dots for the cells that are unraised/unembossed. This is done to visualize the entire 6-point matrix.

[22] An interesting question is whether finger-tracking, i.e., the tracking of finger movements by readers on/of a braille text (see Millar, 1997; Aranyanak, 2014) shows that finger/hand movements and 'tactile fixations' (Zhao et al., 2021) resemble saccades, fixations, and regressions during the reading of visual text, and more specifically whether in the minds of braille readers, a two-dimensional text is formed, or whether the tactile and cognitive processes of reading braille are actually more linear than the taking in/reading of visual text on a two-dimensional surface (see Section 3.4; Sircar, this volume).

seen. With its unique nature, braille underscores not only what Harris (1995, 2005) has rightly claimed—that the main principle of writing is not visuality, but spatiality—but also that the two are not intrinsically coupled. In other words, a writing system does not have to be visual in order to be (non-)linear.

3.2.2 Segmental Non-Linearity or Internal Spatiality

While the preceding two types dealt with (non-)linearity that operates within the linear space, the type we now turn to concerns a more granular level, that of the segment. So-called *segmental non-linearity* captures the fact that some segments have a complex internal composition—in other words, they are not atomic units but are instead themselves made up of atomic units. Yet, despite their complexity, the written units in question only occupy one segmental space, highlighting that this space has, to some degree, its own *internal spatiality*. From the perspective of the normativity of linearity, this type subverts our expectation that the smallest units of writing are simple, one-element shapes.

A large portion of this handbook is devoted to examples of this type, such as Chinese with its semantic and phonological components that can occupy different positions within a character written in an 'idealized square' (Figure 3.5; see also Ma, this volume; Gallant, Chen & Li, this volume), or Korean Hangul, where the consonant and vowel letters are arranged in syllable blocks (Figure 3.6; see Pae, Yi & Bae, this volume). Both Chinese characters/*hanzi* (and, by extension, the Japanese *kanji* derived from it) as well as Hangul syllable blocks occupy segmental spaces. In effect, these writing systems boast several possible spatial configurations within the segmental space that could be conceived of as their own[23] 'mini-layout' which, in some (necessarily simpler) ways, echoes spatial arrangements of the two-dimensional writing surface as a whole. Thus, unlike in writing systems that deploy multilinearity (such as alphabets based on Roman script), it is not possible to insert division lines that cut through the entire linear space to highlight its internal organization because the graphemes occupying it exhibit compositional diversity governed by constraints concerning aspects such as position or directionality.

Figure 3.5: Positions of components in Chinese, from http://www.chinaknowledge.de/Literature/Script/hanzi-typography.html (15 November 2024)

[23] Of course, not each segmental space has its own arrangement, as there is a limited number of combinatorial possibilities constrained by the systematic regularities—i.e., the graphotactics (see Footnote 35)—of the writing system.

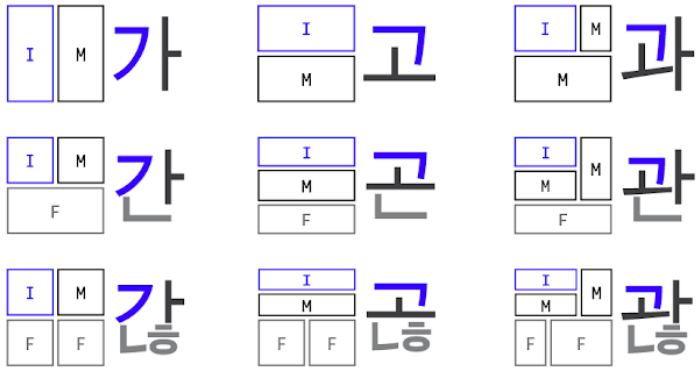

Figure 3.6: Possible configurations of the syllable block in Hangul, with initial (I), medial (M), and final (F) letters, from http://lektongroups.blogspot.com/2011/03/korean-type-system.html (15 November 2024)

3.3 Two-dimensional Non-Linearity or Multidimensionality

Considering that technically, as argued in this chapter, writing is not at all a linear phenomenon, an alternative to the terminologically negative 'non-linearity' would be *spatiality*, or more specifically—given that linearity or one-dimensionality are technically also spatial—*multidimensionality*. For writing is, both at a systematic and at a textual level (see below), mostly two-dimensional. If we go beyond the 'artificial flatness' (Krämer, 2022) of writing surfaces to consider their materiality and haptics[24] (which are primary in braille, see above) instead of just their visual appearance, they are even three-dimensional.[25] The study of the meaning and function of the multidimensional spatial arrangement of writing has been given various names, such as *written syntagmatics* (Harris, 1995), *semiotypology* (Tchertov, 2000), or *toposyntax* (Klinkenberg & Polis, 2018).

In this section, I want to shift the focus to the remaining two subspaces of the writing surface, those that are undeniably two-dimensional—the areal and holistic spaces (see Figure 3.1). The *areal space* is occupied by textual elements such as paragraphs or columns (in which lines are combined with one another), while the holistic space represents the 'whole' of a two-dimensional writing surface that can be taken in during a glance—which could be, for example, a double-page in a book or the portion of a website that is currently being displayed and viewed on a screen. Describing the holistic space requires us to look at entire layouts of texts including all elements and all spatial, textual, etc. relations between them (e.g., between a superscript footnote number in the running text and the actual footnote located at the bottom of the page). Here, given that texts very often consist not only of written material (but also of figures, photos, etc.), we also need to consider aspects of multimodality.

All of this evokes a fourth and broad type of non-linearity, which could be called *two-dimensional non-linearity*. It does not exactly subvert any norms that users or linguists have

---

[24] Cf. also Harris (1995, p. 123): "Many historians of writing appear to make the tacit assumption that written forms are two-dimensional configurations, i.e. the presence of an additional layer of paint, ink or pigment, or the occurrence of indentation, are ignored. But in various types of context these features may be semiologically relevant."

[25] A fascinating example in which the third dimension comes to the forefront is the Ogham system mostly used for (Old) Irish, which was inscribed around the edges of rocks running from bottom to top. To read it, a reader had to view both sides of the rock separated by the edge.

about writing or written texts; instead, it is often simply ignored because of the belief that it does not contribute 'directly' to linguistic meaning. We find it, for instance, in Aztec. Interestingly, with Aztec and similar systems we run into the limits of what counts as 'writing' as it is debated whether they count as writing in the narrow—glottographic—sense or, conversely, whether the definition of writing should be more inclusive (cf. Perri et al., 2024; Zamora Corona, 2022). The primary factor in this debate is the referential function of the signs used in these systems, i.e., the question of whether and how they refer to language or extralinguistic referents directly. Another significant factor, however, is their non-linearity and in many cases multi- or possibly non-directionality (their *emblematic composition*, cf. Fedorova & Perri, 2024), which complicates a description of these systems with the help of established categories of studying writing—i.e., those influenced by the doctrine of linearity. Reading in those systems is, in some ways, akin to reading/looking at infographics, meaning there is no fixed reading order when the entire holistic space is concerned. This distinguishes this fourth type of non-linearity from the other three: in vertical, horizontal, and segmental non-linearity, elements usually have a fixed order and position, which they may lack (or which is less strict) in two-dimensional non-linearity.

Like the other types, two-dimensional non-linearity can be—albeit rarely—systematic, in which case it is also system-specific (and this is, again, the primary focus of this handbook). In Aztec, for example, spatial arrangement is claimed to contribute to the meaning at a more fundamental level than layouts do in texts based on writing systems like English (see, for example, Fedorova & Perri, 2024). However, two-dimensional non-linearity manifests primarily in the production of texts based on a given system, which makes it more *textual* than systematic, i.e., more part of our literacy practices that rely on and actualize the system rather than the system itself. Indeed, we find two-dimensional non-linearity in texts written in virtually all of the world's writing systems simply because they are compositionally complex and laid out two-dimensionally.[26] This makes it a near-universal feature of writing. Admittedly, at the textual level, too, it serves specific purposes, rendering the distinction between systematic and textual non-linearity blurry. However, there is a banal 'test': we could, theoretically, write texts in writing systems like English in a single line without ever breaking it (if the material support—such as a very long scroll—allows for that). For example, for digital writing, the application *Notepad*, which comes pre-installed on Windows computers, allows writing in one continuous line. By comparison, in writing systems in which multidimensionality is systematic, lacking line breaks or complex spatial arrangements would lead to ungrammaticality and thus a failure in signification of what the text is intended to signify—in other words, here, non-linearity is the norm.[27]

Multidimensionality also yields features of writing that are unique to it, such as the list mode, a special two-dimensional mode of representing information/content. Both the use of signals indicating list items (such as bullets or numbering) and the extension of list items over just part

[26] This is echoed by Fedorova and Perri (2024, p. 75), who note that "non-linear or emblematic representation of content is primary in textualization practices of any script".

[27] I am thankful to the reviewer for bringing to my attention the example of Hieroglyphic Luwian, where boustrophedon seems to be the preferred rather than a materially determined directional strategy of writing (cf. Payne, 2014, p. 10). However, the question remains whether it is a *systematic* feature in that producing Luwian hieroglyphs in one line—i.e., *not* breaking at specific points—would render a text ungrammatical; if this is not the case, it is still a textual feature.

of the linear space—meaning they often take up less space than full lines—indicate that a portion of text is not to be read as running text but as a list (cf. Reißig, 2015).

An example that ought to be mentioned in the context of two-dimensional non-linearity—also because it is routinely ignored in (grapho)linguistics—is notation or even writing systems for sign languages (for the difference as well as examples of both, see Bianchini, in press). Depending on the amount of information they want to transfer from the signed modality to the written one, they must transpose three-dimensional visual but also temporally dynamic signs consisting of components that occur simultaneously in space and time (hand shapes, hand orientations, locations, movements, and non-manuals) into static two-dimensional graphemes. Unsurprisingly, spatial arrangement and non-linearity prove to be cardinal challenges here, arguably contributing to the fact that no writing system for a sign language has actually come into widespread use. An example of a text—the nursery rhyme 'Jack and Jill' in *SignWriting* is given in Figure 3.7. Bianchini (in press) explains how the signs are structured and arranged:

> The characters of SignWriting are arranged in a thumbnail, called 'vignette', a two-dimensional graphic space that analogically represents the three-dimensional signing space: the disposition of the characters in this graphic space takes into account the position of the different parts of the body in relation to the horizontal and vertical axis of the signer; information concerning the in-depth placement of elements is rendered through graphic solutions (line thickness, character color, etc.); the relative temporality of the different elements is conveyed by the segmentation of the flow of discourse in the vignette (i. e., if two elements appear on the same vignette they likely happen at the same time, or it is not important to know their order).

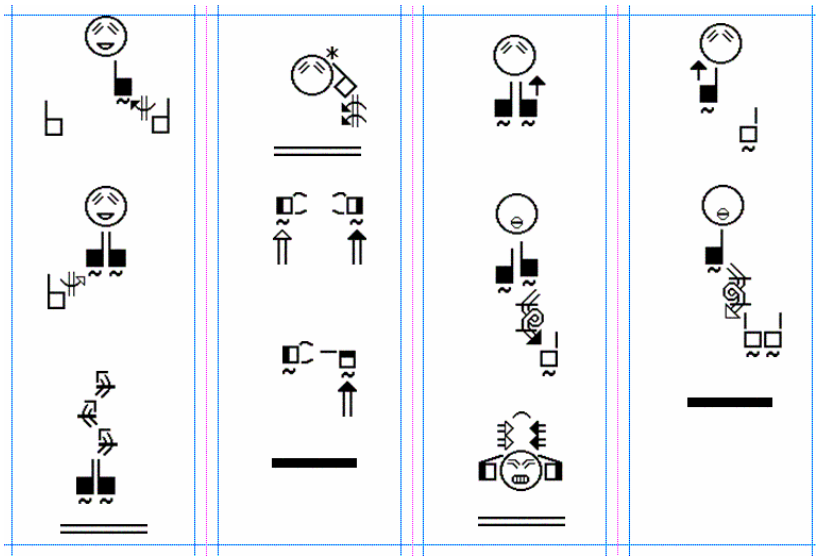

Figure 3.7: Nursery rhyme 'Jack and Jill' in ASL written in four SignWriting vignettes, from https://en.wikipedia.org/wiki/SignWriting#/media/File:Jack_and_Jill.gif (14 November 2024)

3.4 Non-Linear Reading

With this, we turn to a process-based and largely psycholinguistic perspective. Referring back to what the handbook is called—Handbook of Reading in Nonlinear Scripts—it is obvious that the attribute 'non-linear' does not refer to the reading process. However, as research on eye tracking has shown (Clifton et al., 2007; see also Miwa, this volume), reading is not *per se* linear in that eye movements in the reading of normal (running) text do not proceed smoothly and linearly over the line(s) being read but consist of jumps (*saccades*), *fixations* in which information is being taken in, and also *regressions* (i.e., jumps back when something must be

re-fixated). And at this point we have not yet considered complex spatial arrangements or layouts, which also affect eye movements. This is simply but aptly illustrated by a meme that has been circulating on the internet for quite a while, which—for most users—reliably predicts in which sequence the text on the square is going to be read (Figure 3.8). Admittedly, aside from spatial arrangement, font size plays a crucial role here, as arguably does experience that readers have with similar layouts[28] consisting of headlines/headings in combination with eyebrow headings, also called 'kickers' (the smaller text above), and subheadings (the smaller text below). Nevertheless, what this example shows is that reading is not neatly linear or monodirectional. As readers, we not only operate within the line that we are currently reading, but scan an entire page (or even more, which above was characterized as the holistic space). However, scanning is not reading, a distinction that Harris (1995, p. 45) highlights: "So even if we can 'take in' a page at a glance, we can seldom read what is written on it at a glance, unless there is very little written on it and its spatial organization is not too complex."

Figure 3.8: Meme meant to evoke/illustrate multidirectional eye movements, from https://m.media-amazon.com/images/I/51RmXVA+eqL._AC_UF1000,1000_QL80_.jpg (14 November 2024)

The relative non-linearity of reading is related to what has been called the *notational iconicity* of writing (Krämer, 2003a, 2003b), a technical translation that fails to directly capture the core of the German term 'Schriftbildlichkeit' (lit. 'pictoriality of writing'). 'Schriftbildlichkeit' focuses on the often-discarded material qualities of written texts, specifically their dual nature: they convey linguistic content, but in their arrangement and appearance, they also share features with images, and our perception of them exhibits similarities with how we perceive and process images (see Groß, 1990, 1994). This is also echoed somewhat in production, where writing text is not that different from drawing an image, as Ingold (2016, p. 151) argues: "Learning to write is a matter not of interiorizing a technology but of acquiring a skill. Precisely the same is true of learning to draw. Indeed[,] since writing is itself a modality of drawing, the two processes of enskilment are strictly inseparable". Interestingly, in his important book *Gesture and Speech*, archaeologist André Leroi-Gourhan (1993) argues that the defining character of writing as we know it today, by contrast to drawing, is its linearity. Thus, it is by this so-called 'linear

[28] In semiotic and linguistic research on typography, layouts that—provided readers have the required knowledge—allow an immediate identification of the text genre (such as newspaper front pages, recipes, poems) have been called *typographic dispositifs* (Wehde, 2000).

graphism' that we "recognize writing proper, and the more it is linearized the more does writing come to be distinguished from drawing" (Ingold, 2016, p. 154). In a nutshell, texts are two-dimensional image-like percepts from which we can retrieve and read linear linguistic content.[29]

Thus far, the focus of this section was on the reading of text that more or less fulfils all our normative expectations of linearity (within multidimensional texts). An important question is how we react to linear non-linearity in reading, especially if it is textual deviance (i.e., erroneous) rather than a systematic feature.[30] As for horizontal non-linearity, in a recent study on the transposed letter effect (e.g., whether JUGDE primes the reading of JUDGE) in which the phenomenon was compared with the transposition of other visual stimuli (digits and geometrical forms), Massol et. al (2025) found evidence "in favor of a flexible position coding mechanism that is specific to letter strings, which emerges with reading experience as a consequence of parallel processing of letters within words". Working with an open bigram model[31] (Grainger & van Heuven, 2004), they argue that transposed letters do not pose a great challenge to experienced readers because our orthographic processing has developed a certain flexibility that is based on the fact that the position coding for letter strings is relative[32] rather than absolute. To mention another example that went viral, most readers' flexibility in reading jumbled English was highlighted by a text about a fictitious research program at Cambridge University that circulated online around 2003 and starts with the sentence "Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae"[33] (cited from Velan & Frost, 2007, p. 913). Crucially, as Velan and Frost (2007) found in a comparison of letter transpositions in English vs. Hebrew, this effect is (unsurprisingly) language-specific as it depends on the structure of the writing system: in Hebrew written words, a triconsonantal root morpheme is represented by ordered consonant graphemes; a transposition of graphemes will mostly change the meaning of the root, greatly disrupting reading, e.g. in <ל-ח-ש> *l-χ-ʃ* 'to whisper' vs. <ח-ל-ש> *ʃ-l-χ* 'to send' (see Meletis, 2020, pp. 322–327 for examples from more writing systems).[34]

In a nutshell, readers, in principle, can develop a certain flexibility with respect to letter position. However, there are writing system-specific limits to just how non-linear texts can become in order for reading to still be successful. This calls for an acknowledgement of the diversity of writing systems that ought not to be swept under the rug, making necessary adequate descriptive tools in grapholinguistics and models of reading in psycholinguistics.

---

[29] From a productional perspective, these are reversed: In lines we convey linguistic content, and we can use these lines to create image-like products on a two-dimensional surface.

[30] For a systematic example, see Winskel (2009) on the processing of both intrasyllabic vs. cross-syllable 'misaligned' vowels in Thai.

[31] Open bigrams are ordered letter pairs that can be contiguous or non-contiguous: for instance, the word DOG contains the contiguous open bigrams DO, OG, and the non-contiguous DG.

[32] Cf. also Harris (1995, p. 124, emphasis in original) in his semiotic approach: "Writing typically operates in a way which does *not* depend on establishing a fixed value for any absolute position in graphic space. Instead, what is sought is the establishment of the *relative* position of any scriptorial form to other forms sharing the graphic space in question."

[33] Due to a lack of space, the claim about the relevance of the intact first and last letters cannot be discussed here, but see White et al. (2008) for the importance of word-beginning letters.

[34] An example concerning segmental non-linearity is the possible or preferred position of semantic vs. phonological components within Chinese characters, an implicit graphotactic constraint that even first graders have already acquired (Shu & Anderson, 1999).

3.5 Beyond the Doctrine of Linearity

In concluding this exploration of the normativity surrounding linearity in writing and (grapho-)linguistics, it becomes clear that the prevailing idea of linearity—rooted predominantly in a paradox literacy-biased but speech-centric view of language—has constrained our understanding of the richness and complexity of writing systems and their use. This 'doctrine of linearity' oversimplifies the multifaceted nature of writing, relegating its inherent non-linearity—both systematic and textual—to the margins of grapholinguistic discourse.

Table 3.1: Summary of the normative linear expectations and alternative views

Type	Subverted normative expectation	Alternative view
segmental non-linearity (internal spatiality)	The smallest 'units' of writing—which occupy segmental spaces—are simple, i.e., atomistic one-element shapes.	Written segments are often composed of smaller graphe(ma)tic elements (e.g., semantic and phonological components in Chinese).
horizontal non-linearity (unaligned linearity)	Units of writing must align with units of language (in phonographic writing systems, this means speech) that they 'depict', i.e., they must be ordered in the same way.	Writing systems have their own graphotactic constraints[35] and regularities that should not only be studied in relation to (possibly non-aligned) units of speech or language but also independently.
vertical non-linearity (multilinearity)	The line itself is one-dimensional and does not have an internal organization.	The line is two-dimensional and the extension and position of units within this two-dimensional space is meaningful.
two-dimensional non-linearity (multidimensionality)	The two-dimensional spatial arrangement of larger chunks of text ('layout') is just a combination of linear spaces devoid of its own (linguistic) functions.	The spatial arrangement of written (and non-written) material on writing surfaces as well as their materiality contribute to the meaning and perception of texts and should be included in their study.

By unmasking the biases and normative expectations inherent in the linearity principle and offering alternative views (see Table 3.1), this chapter has highlighted the importance of considering multiple perspectives—linguistic, psycholinguistic, and philosophical—when analyzing writing systems.

[35] Graphotactics, by analogy with phonotactics and morphotactics, describes "restrictions on ways in which the elements of a writing system may combine with each other" (cf. McCawley, 1994, p. 115). It includes "rules that state which combinations or distributions of basic shapes as well as graphemes are possible (or 'grammatical') in a given writing system. At a different level, it evaluates combinations of elementary forms within basic shapes (such as subsegmental components in Chinese graphemes). In other words, graphotactics is necessary at the graphetic level for the formation of well-formed basic shapes as well as at the graphematic level for the formation of well-formed units (or better 'strings') of writing that are larger than the grapheme" (Meletis, 2020, p. 131).

As we pivot away from the notion that perceives linearity as the standard, we embrace a more inclusive, multidimensional understanding of writing (and reading). This shift in focus necessitates new frameworks and methodologies in grapholinguistics, enabling scholars to adequately explore and appreciate the variable nature of written texts across cultures and systems. Ultimately, embracing non-linearity enriches our comprehension of writing and literacy, urging us to recognize and appreciate the diverse, dynamic interplay between form and meaning/function.

References

Aranyanak, I. (2014). *An experimental analysis of braille reading using a high-resolution tracking system* (Doctoral dissertation). National University of Ireland, Maynooth.

Bianchini, C. S. (in press). Notation systems for sign languages in the Germanic area. In D. Meletis, S. Hartmann, & R. Treiman (Eds.), *Handbook of Germanic writing systems and literacies* (Handbooks of Germanic Linguistics). De Gruyter.

Bredel, U. (2011). *Interpunktion*. Winter.

Clifton, C. Jr., Staub A., & Rayner, K. (2007). Eye movements in reading words and sentences. In R. P. G. van Gompel, Martin H. Fischer, Wayne S. Murray, & Robin L. Hill (Eds.), *Eye movements. A window on mind and brain* (pp. 341–371). Elsevier Science. https://doi.org/10.1016/B978-008044980-7/50017-3

Cook, V. (2004). *The English writing system*. Routledge.

Coulmas, F. (2003). *Writing systems: An introduction to their linguistic analysis*. Cambridge University Press. https://doi.org/10.1017/CBO9781139164597

Davies, W. V. (1987). *Egyptian hieroglyphs*. British Museum.

Domahs, U., & Primus, B. (Eds.). (2016). *Handbuch Laut, Gebärde, Buchstabe*. De Gruyter. https://doi.org/10.1515/9783110295993

Duncker, D. (2022). Scriptism with a vengeance. Or, how writing was forgotten. *Language & Communication, 86*, 18–27. https://doi.org/10.1016/j.langcom.2022.06.005

Englebretson, R., Holbrook, M. C., & Fischer-Baum, S. (2023). A position paper on researching braille in the cognitive sciences: Decentering the sighted norm. *Applied Psycholinguistics, 44*(3), 400–415. https://doi.org/10.1017/S0142716423000061

Evertz-Rittich, M. (2024). Linearitätsdogma. In M. Neef, S. Sahel, & R. Weingarten (Eds.), *Schriftlinguistik* (pp. 531–532). De Gruyter.

Fedorova, L. L., & Perri, A. (2024). Emblematic techniques as textual strategies in non-linear and linear scripts. In Y. Haralambous (Ed.), *Grapholinguistics in the 21st Century. June 8–10, 2022. Proceedings, Part I* (pp. 75–99) (Grapholinguistics and Its Applications, Vol. 9). Fluxus Editions. https://doi.org/10.36824/2022-graf-perr

Grainger, J., & Van Heuven, W. J. B. (2004). Modeling letter position coding in printed word perception. In P. Bonin (Ed.), *Mental lexicon: "Some words to talk about words"* (pp. 1–24). Nova Science.

Groß, S. (1990). Schrift-Bild. Die Zeit des Augen-Blicks. In G. C. Tholen & M. O. Scholl (Eds.), *Zeit-Zeichen. Aufschübe und Interferenzen zwischen Endzeit und Echtzeit* (pp. 231–246). VCH.

Groß, S. (1994). *Lese-Zeichen. Kognition, Medium und Materialität im Leseprozeß*. Wissenschaftliche Buchgesellschaft.

Haralambous, Y. (2024). *A course in natural language processing*. Springer. https://doi.org/10.1007/978-3-031-27226-4

Harris, R. (1990). On redefining linguistics. In D. Hayley & T. J. Taylor (Eds.), *Redefining linguistics* (pp. 18–52). Routledge.

Harris, R. (1995). *Signs of writing*. Routledge.

Harris, R. (2005). Schrift und linguistische Theorie. In G. Grube, W. Kogge, & S. Krämer (Eds.), *Schrift: Kulturtechnik zwischen Auge, Hand und Maschine* (pp. 61–80) (Kulturtechnik). Wilhelm Fink.

Ingold, T. (2016). *Lines. A brief history*. Routledge. https://doi.org/10.4324/9781315625324

Klinkenberg, J.-M., & Polis, S. (2018). On scripturology. *Signata, 9*, 57–102. https://doi.org/10.4000/signata.1885

Krämer, S. (2003a). ‚Schriftbildlichkeit' oder: Über eine (fast) vergessene Dimension der Schrift. In S. Krämer & H. Bredekamp (Eds.), *Bild, Schrift, Zahl* (pp. 157–176). Wilhelm Fink.

Krämer, S. (2003b). Writing, notational iconicity, calculus: On writing as a cultural technique. *Modern Language Notes, 118*(3), 518–537. https://doi.org/10.1353/mln.2003.0059

Krämer, S. (2022). Reflections on ‘operative iconicity’ and ‘artificial flatness’. In D. Wengrow (Ed.), *Image, thought, and the making of social worlds* (pp. 251–272). Propylaeum. https://doi.org/10.11588/propylaeum.842.c10813
Kress, G., & van Leeuwen, T. (2021). *Reading images: The grammar of visual design* (3rd ed.). Routledge.
Leroi-Gourhan, A. (1993). *Gesture and speech*. MIT Press.
Linell, P. (2005). *The written language bias in linguistics: Its nature, origins and transformations*. (Routledge Advances in Communication and Linguistic Theory). Routledge. https://doi.org/10.4324/9780203342763
Massol, S., Acha, J., Rondot, L., Vergara-Martinez, M., Favre, E., & Lété, B. (2025). Transposed-character effects during learning to read: When does letter and non-letter strings processing become different? *Journal of Experimental Child Psychology, 249*, 106081. https://doi.org/10.1016/j.jecp.2024.106081
McCarthy, J. J. (2001). Nonlinear phonology. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social and Behavioral Sciences* (pp. 11392–11395). Pergamon.
McCawley, J. D. (1994). Some graphotactic constraints. In W. C. Watt (Ed.), Writing systems and cognition (pp. 115–127). Springer. https://doi.org/10.1007/978-94-015-8285-8_7
Meletis, D. (2015). *Graphetik: Form und Materialität von Schrift* (Typo|Druck). Verlag Werner Hülsbusch. https://resolver.obvsg.at/urn:nbn:at:at-ubg:3-6661
Meletis, D. (2020). *The nature of writing. A theory of grapholinguistics*. Fluxus Editions. https://doi.org/10.36824/2020-meletis
Meletis, D., & Dürscheid, C. (2022). *Writing systems and their use: An overview of grapholinguistics* (Trends in Linguistics. Studies and Monographs, Vol. 369). De Gruyter Mouton. https://doi.org/10.1515/9783110757835
Millar, S. (1997). *Reading by touch*. Routledge.
Payne, A. (2014). *Iron age Hieroglyphic Luwian inscriptions*. Society of Biblical Literature.
Perri, A., Perondi, L., Capo, D., Arista, R., & Dalai, G. (2024). Alternative graphemics: Aztec writing system as a case study towards an integrated, digitalized model of non-typographic graphemics. *Ocula, 24*(30), 43–64. https://doi.org/10.57576/ocula2024-5
Reißig, T. (2015). *Typographie und Grammatik: Untersuchung zum Verhältnis von Syntax und Raum*. Stauffenburg.
Saussure, F. de. (1983). *Course in general linguistics* (R. Harris, Trans.). R. Duckworth. (Original work published 1916)
Schmidt, K. (2014). Morphophonographic regularities in German: The graphematic syllable boundary. *Written Language & Literacy, 17*(2), 253–281. https://doi.org/10.1075/wll.17.2.04sch
Shu, H., & Anderson, R. C. (1999). Learning to read Chinese: The development of metalinguistic awareness. In J. Wang, A. W. Inhoff, & H.-C. Chen (Eds.), *Reading Chinese script: A cognitive analysis* (pp. 1–18). Lawrence Erlbaum.
Spitzmüller, J., & Klein, D. (in press). Braille. In D. Meletis, S. Hartmann, & R. Treiman (Eds.), *Handbook of Germanic writing systems and literacies* (Handbooks of Germanic Linguistics). De Gruyter.
Taylor, T. J. (1997). *Theorizing language: Analysis, normativity, rhetoric, history*. Pergamon.
Tchertov, L. F. (2000). On structural peculiarities of spatial texts. In P. Pellegrino (Ed.), *L’espace dans l’image et dans le texte* (pp. 41–50). Ed. Quattro Venti.
Tranter, N. (2013). Logography and layering: A functional cross-linguistic analysis. *Written Language & Literacy, 16*(1), 1–31. https://doi.org/10.1075/wll.16.1.01tra
Velan, H., & Frost, R. (2007). Cambridge University versus Hebrew University: The impact of letter transposition on reading English and Hebrew. *Psychonomic Bulletin & Review, 14*(5), 913–918. https://doi.org/10.3758/BF03194121
Wehde, S. (2000). *Typographische Kultur: Eine zeichentheoretische und kulturgeschichtliche Studie zur Typographie und ihrer Entwicklung* (Studien und Texte zur Sozialgeschichte der Literatur 69). Niemeyer. https://doi.org/10.1515/9783110945799
White, S. J., Johnson, R. L., Liversedge, S. P., & Rayner, K. (2008). Eye movements when reading transposed text: The importance of word-beginning letters. *Journal of Experimental Psychology: Human Perception and Performance, 34*(5), 1261–1276. https://doi.org/10.1037/0096-1523.34.5.1261
Winskel, H. (2009). Reading in Thai: The case of misaligned vowels. *Reading and Writing, 22*(1), 1–24. https://doi.org/10.1007/s11145-007-9100-z
Zamora Corona, A. R. (2022). Towards a complex theory of writing: The case of Aztec and Mixtec codices. *Signata, 13*. https://doi.org/10.4000/signata.3866
Zhou, K., Bardot, S., Serrano, M., Simonnet, M., Oriola, B., & Jouffrais, C. (2021). Tactile fixations: A behavioral marker on how people with visual impairments explore raised-line graphics. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI ’21)* (pp. 1–12). Association for Computing Machinery. https://doi.org/10.1145/3411764.3445578