A Modular Theoretic Approach to the Japanese Writing System: Possibilities and Challenges

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Abstract. The Modular Theory of Writing Systems (MT) provides a three-module model of the correspondence between the elements of a script and the properties of a language at the level of individual words. Characterised by its non-derivational linguistic approach, MT has the potential to develop into a general theory of script-to-language relationship in any type of writing system. However, it is currently focused on the analysis of modern alphabetic systems, with little regard for non-alphabetic systems. To examine the theory's compatibility with a typologically wider range of writing systems, the present paper discusses the functional aspects of the present-day Japanese writing system within the MT framework. This system offers a good testing ground because it makes a mixed use of logographic, moraic and alphabetic scripts. The discussion highlights the possibilities and challenges of current MT and presents some proposals to increase its applicability to non-alphabetic systems.

Introduction

Writing allows us to communicate linguistic messages through graphic representations in a conventional and systematic way (Gelb, 1963, pp. 11–20; DeFrancis, 1989, pp. 4–6; Coulmas, 2003, pp. 1–17; Rogers, 2005, pp. 2–4; Sampson, 2015, pp. 18–39; Daniels, 2018, pp. 156–157). Each writing system enables this function by pairing a particular script with a specific language according to a unique set of conventions. Despite their rich diversity, the world's writing systems show important similarities—as well as differences—in the way they relate the elements of a script to the properties of a language (e.g., Justeson, 1976, pp. 58–

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76). An important task of grapholinguistics, then, is to develop a theoretical framework for describing and explaining this relationship in and across writing systems.[1]

It is in this context that the present paper focuses on the Modular Theory of Writing Systems (MT: Neef, 2012; 2015). MT provides a general model of script-to-language relationship at the level of individual words, conceptualised in terms of three modules called *language system*, *graphematics* and *systematic orthography* (Section 1). This model is built on two important assumptions that distinguish it from previous models of writing systems. The first assumption is that every writing system is constructed on an abstract language system (Neef, 2012, p. 4; 2015, p. 709). This notion opens the way for a uniform linguistic analysis of writing systems without viewing them as a surrogate of concrete speech (cf. Saussure, 1983/1916, p. 45; Bloomfield, 1933, p. 21) or as autonomous sign systems (cf. Vachek, 1973, pp. 14–17; Harris, 1995, pp. 56–63). The second assumption is that such a linguistically based analysis of writing systems should be based on declarative descriptions of the underlying language systems (Neef, 2015, p. 709). This paradigm accounts for properties of linguistic structure in terms of well-formedness conditions applicable to a single level of representation, instead of derivational rules converting one level of representation into another (cf. Chomsky and Halle, 1968, p. 49; Chomsky, 1970, pp. 287–294; Sproat, 2000, pp. 18–19). With this non-derivational linguistic approach, MT has the potential to expand into a general theory of how words are written in different writing systems (Section 1.3).

Crucially, however, the current MT model has a fairly limited scope of application. It draws almost entirely on observations of modern alphabetic systems like German and English, where characters and character combinations relate primarily to individual vowels and consonants.[2] In other words, MT makes virtually no mention of non-alphabetic systems, which may be either phonographic or highly lo-

1. Neef (2015, p. 711) defines grapholinguistics as "[t]he linguistic sub discipline dealing with the scientific study of all aspects of written language". Similarly, Haralambous (2020, p. 12), states that this field of research "aims to study aspects of language that are particular to its written representation, at all levels of linguistics". As is evident from the title of the present volume and its preceding conference, the term 'grapholinguistics' is becoming increasingly accepted as an alternative to other terms such as 'grammatology', 'graphology', 'graphemics', 'graphonomy' and 'writing systems research'. See Daniels (2018, pp. 4–5) for an overview of the various designations given to the study of writing, writing systems and written language.

2. The present paper uses 'alphabetic' to refer to any writing system based on both vocalic and consonantal segments. Some might prefer 'segmental', which appears to specify the type of underlying phonological unit. However, this alternative term is too broad because it covers all subtypes of segment-based systems without reference to the presence or absence of vocalic signs or the spatial arrangement of segmental signs (e.g., compare the writing systems of Finnish, Arabic, Hindi and Korean; for

gographic in nature (Section 1.2). This is a major drawback given the prevalence of such systems throughout the history of writing around the world. Hence, despite its designation as a "theory of writing systems" (Neef, 2015, p. 708), MT in its present form is effectively a theory of alphabetic systems. Therefore, it remains an open question whether it can actually be expanded into a full-fledged theory of script-to-language relationship across different types of writing systems.

This paper aims to address the above question through a partial analysis of the current Japanese writing system. As widely documented, this system employs a mixture of four main scripts that function as typologically distinct sets of written signs: logographic *kanji* (漢字), moraic *hiragana* (平仮名) and *katakana* (片仮名), and alphabetic *rōmaji* (ローマ字) (e.g., Smith, 1996, pp. 209–213; Sasahara, 2001, pp. 704–705; Honda, 2012, pp. 38–71; Taylor and Taylor, 2014, pp. 271–302). As such, it serves as a useful test case for examining the adaptability of MT to non-alphabetic systems. Through a discussion of the main characteristics of the Japanese writing system, the present paper seeks to highlight the possibilities and challenges of the current MT model. The discussion is organised as follows. Section 1 introduces the key concepts of MT. Section 2 discusses their applicability to the analysis of how the four scripts are used to write words in Japanese. Section 3 examines the notions of logography and logographic systems assumed in MT. Section 4 summarises the discussion and draws conclusions.

1. Key Concepts of MT

As already mentioned, current MT is essentially a theory of alphabetic systems, where the elements of a script relate mainly to the segmental level of phonology. It is built on specific assumptions and claims about the formal and functional elements of writing systems (Section 1.1), the distinction between phonographic and logographic systems (Section 1.2), and the architecture of alphabetic systems (Section 1.3).

1.1. Formal and Functional Elements

Every writing system employs a certain number of discrete graphic marks. Each mark can take a variety of similar but different shapes in written, printed, or electronically displayed texts. Thus, one can speak

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discussions, see Faber, 1992, pp. 118–123, and Gnanadesikan, 2017, pp. 19–31). While a more accurate description would be obtained by adopting a combinatorial term like 'fully vowelled linear segmentary' (Gnanadesikan, 2017, p. 28), this option makes it difficult to refer to all non-alphabetic systems as a single class.

of a set of abstract forms embodied by a larger set of concrete shapes. In MT terminology (Neef, 2015, pp. 711–713), *script* and *character* respectively denote any such abstract set and each member thereof, whereas *font* and *glyph* denote their concrete counterparts.[3] This is illustrated by the lower case Roman script in (1); the pipes | | enclose each character of the script, and the arrow shows the character's correspondence to the glyphs of different fonts on the right side.

(1) Script : Character :: Font : Glyph

|a| → a, a, a, a, *a*, *a*, …
|b| → b, b, b, b, *b*, *b*, …
|c| → c, c, c, c, *c*, *c*, …
⋮
|z| → z, z, z, z, *z*, *z*, …

Importantly, MT views scripts and characters (as well as fonts and glyphs) as purely formal elements of writing. For a script to function as a writing system, it must be paired with a particular language in a systematic way. At the basis of this pairing is a conventional association between characters or character combinations and different properties of the language in question. In the English writing system, for example, characters are associated with phonological units (e.g., |p| → [p]), morphosyntactic units (e.g., |$| → DOLLAR) or syntactic information (e.g., |?| → 'interrogative'). Using a dyadic model of signs (Saussure, 1983/1916, pp. 99–100), one may speak of *written signs*, each comprising a character or character combination as the signifier and a linguistic property or a piece of linguistic information as the signified.[4] MT distinguishes four types of written signs based on their signifieds (Neef, 2015, p. 711). The present paper assumes this classification with a partly modified terminology as shown below, where the angle brackets <> enclose a written sign: *phonographs* correspond to phonological units (2a), *logographs* to morphosyntactic units (2b), *ciphers* to numbers (2c), and *punctuation marks* to information about linguistic structure (2d).[5]

3. As 'font' is conventionally associated with typography, 'hand' might be a better alternative for referring to any set of glyphs used in handwriting (Douglas, 2017, pp. 5–6).

4. Defined this way, the notion of 'written sign' is comparable with the semiotic reinterpretation of 'grapheme' proposed by Meletis (2019, p. 9–10). These and related concepts and terms require further discussion in the future.

5. Neef (2015, p. 712) uses 'letters' and 'logographs' to refer to (2a) and (2b), respectively. This paper adopts 'phonographs' for the first class instead, as 'letters' are conventionally restricted to the signs of phonological segments employed in alphabetic and consonantal systems (Sampson, 2015, pp. 10–11). Besides, for both (2a) and (2b), the *-graph* ending is preferred over the original *-gram* ending because only the former can be used in their derived forms (e.g., phonographic versus *phonogram-

(2) Written signs

a.	<p>	:	|p|	→	[p]
b.	<$>	:	|$|	→	DOLLAR
c.	<1>	:	|1|	→	ONE
d.	<?>	:	|?|	→	'interrogative'

Using these notions, MT distinguishes three aspects of writing systems. The first two belong to the formal aspect, one being concrete (i.e., glyphs and fonts) and the other being more abstract (i.e., characters and scripts). The third one is the functional aspect, where graphic signifiers are linked with linguistic signifieds (i.e., written signs). Each of these aspects is studied in different subfields of grapholinguistics: *typography* (3a) and *graphetics* (3b) are concerned with the formal aspects of writing systems, and MT with their functional aspects (3c) (Neef, 2015, p. 711).

(3) Subfields of grapholinguistics

a.	Typography	concerns glyphs and fonts
b.	Graphetics	concerns characters and scripts
c.	MT	concerns written signs

1.2. Phonographic and Logographic Systems

MT adopts a traditional distinction of two broad types of writing systems according to the main type of written signs used therein (Neef, 2015, p. 713). In this scheme, a writing system is described as being *phonographic* if the characters principally function as phonographs, or *logographic* if they mainly operate as logographs (e.g., Sampson, 2015, pp. 24–26).[6]

Phonographic systems are further divided into subtypes according to the main type of phonological unit represented by the phonographs. While different studies use different classifications and terminologies, common labels include full segmental or alphabetic (e.g., English), consonantal or abjad (e.g., Arabic), alphasyllabic or abugida (e.g., Hindi),

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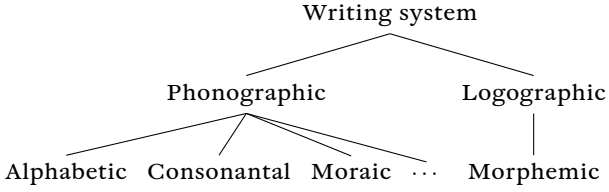
mic). It may also be possible to treat ciphers (2c) as a subclass of logographs because they are associated with numerals as morphosyntactic units (e.g., ONE) rather than numerical concepts (e.g., 'lowest cardinal number'); however, this treatment requires further elaboration because some numerical notation systems operate in notably different ways from glottographic (i.e., language-based) notations (Pettersson, 1996, pp. 798–805; Sproat, 2000, p. 198). The present classification also needs to be refined to deal with other types of non-glottographic signs such as semantic classifiers and ideographs attested across writing systems.

6. Some studies use the labels *cenemic* and *pleremic* to refer to these types of writing systems (Haas, 1983, p. 16). For a general overview of writing system typologies, see Daniels (1996, pp. 8–10) and Joyce and Borgwaldt (2011, pp. 1–6). For discussions, see Sproat (2000, pp. 132–144), Rogers (2005, pp. 269–279), Sampson (2015, pp. 18–39) and Joyce (2016, pp. 288–297).

moraic or core syllabic (e.g., Cherokee), full syllabic (e.g., Modern Yi), and so on.[7] Logographic systems, on the other hand, are considered to have only one subtype, namely morphemic systems employing mainly morphographs or the signs of individual morphemes (Hill, 1967, p. 93). This is summarised schematically in (4); the morphemic nature of logographic systems will be discussed in Section 3.

(4) Phonographic and logographic systems



1.3. Three Modules

As already mentioned, the current MT model is primarily concerned with the script-to-language relationship within words in modern alphabetic systems. This relationship is captured at a single level of abstraction, namely in terms of the correspondence between characters (as opposed to glyphs) or character combinations and phonological segments (as opposed to phones). Regarding the latter, MT's non-derivational linguistic approach entails an exclusive focus placed on the surface (as opposed to underlying) phonological representation. This is shown in (5), exemplified by the relationship between the written and phonological forms of the English word *writing*.

(5) Script-to-language relationship for <writing>

Typography	writing			*Phonetics*
MT	|writing|	→	['ɹaɪtɪŋ]	*Surface phonology*
			/raɪt+ɪŋ/	*Underlying phonology*
			WRITE+ing	*Morphology*

MT assumes three modules to explain this relationship. The first module is the *language system*, which provides the foundation for each writing system to function as a language-based sign system (Neef, 2012, p. 4; Neef, 2015, pp. 709–711). Adopting the structural and generative conception of language, MT distinguishes two parts for each language system: *grammar*, which captures the regular aspects of a language, and *lexicon*, which covers all irregular properties in the same language. More specifically, grammar comprises phonology, morphology,

7. For a recent review and discussion of typologies of phonographic systems, see Sproat (2000, pp. 131–144), Ratcliffe (2001, pp. 3–6), Buckley (2018, pp. 32–46) and Gnanadesikan (2017, pp. 16–30).

semantics and syntax, whereas lexicon defines morphemes as the arbitrary associations of forms and meanings.[8]

A language system enables another module called *graphematics* to provide possible written representations of individual words in that language (Neef, 2012, pp. 4–6; Neef, 2015, pp. 713–714). This second module defines all conventional associations between characters or character combinations and phonological segments permitted in the writing system. If the graphematics allows more than one way to represent the same phonological segment, it generates a set of theoretically possible spellings for each word containing that segment. In MT terminology, this set is known as the *graphematic solution space* (Neef, 2012, pp. 10–11; Neef, 2015, p. 716). To illustrate, German [vɑl] denotes several distinct meanings including 'whale', 'choice' and different place names (Neef, 2012, pp. 10–11). It is possible to spell this phonological form in a number of different ways because the German graphematics permits multiple characters and character combinations to represent its constituent segments (6).

(6) German graphematics for [v], [ɑ], [l][9]

a. <w>	∨	<v>	∨	<vh>	→	[v]
b. <a>	∨	<aa>	∨	<ah>	→	[ɑ]
c. <l>	∨	<ll>	∨	<lh>	→	[l]

Consequently, there is a large graphematic solution space for each of the homophonous words. It contains both attested spellings and unattested but theoretically possible spellings (7).

(7) German graphematic solution space for [vɑl]

<wal> <waal> <wahl> <whal> <whaal> <whahl> <walh> ...
<val> <vaal> <vahl> <vhal> <vhaal> <vhahl> <valh> ...

In actuality, however, different spellings are used by convention to distinguish between the homophones (8). In MT, this is explained by the third module called *systematic orthography*, which prescribes how to spell individual words correctly within the limitation of the graphematic solution space (Neef, 2012, pp. 11–13; 2015, pp. 715–718). These constraints are 'systematic' in the sense that they apply to particular layers

8. MT assumes that a writing system can refer to any part of the grammar and lexicon of a language. This point is exemplified by the spellings of French [ɛme] in different inflections (e.g., <aimer> 'love-INF' versus <aimez> 'love-3.PL'), which presuppose reference to both the phonological and morphosyntactic aspects of the forms in question (Neef, 2015, p. 710).

9. Throughout this paper, the disjunction symbol <∨> is used to indicate the presence of multiple items on either side of graphematic correspondence. There can be two or more characters or character combinations associated with a single linguistic property, or two or more linguistic properties associated with a single character or character combination.

of the vocabulary. For example, an analysis of German spelling justifies a constraint that <aa> cannot be used to represent [ɑ] (8a,b) except in foreign proper names (8c,d).

(8) German orthographic forms for [vɑl] homophones
  a. <Wal> 'whale'
  b. <Wahl> 'choice'
  c. <Waal> 'River Waal in the Netherlands'
  d. <Vaal> 'River Vaal in South Africa'

It should be noted that systematic orthography does not always provide a sole fixed spelling of a given word. For instance, the above constraint on the well-formed spelling of [ɑ] in German still leaves <a> (8a) and <ah> (8b) as two possible representations of the segment. Instead of using these forms interchangeably, the German writing system has standardised conventions stipulating which form should be used on a word-to-word basis (e.g., <a> for [vɑl] 'whale' but not for [vɑl] 'choice'). MT distinguishes such conventions from systematic orthography and refers to them as *conventional orthography* (Neef, 2012, p. 13; 2015, p. 716).

It is also important to add that systematic orthography is characterised as an optional module (Neef, 2015, p. 716). There are two logical possibilities for an alphabetic system to fully function without this module. The first one is that its graphematics implements a strict one-to-one correspondence between characters and phonological segments.[10] The second one is that the writing system allows more than one characters to represent a single segment and yet relies entirely on conventional orthography to determine the correct spellings of individual words. This latter possibility is not explicitly discussed in the MT literature and requires further exploration in the future.

To summarise, MT explains the script-to-language relationship in alphabetic systems by assuming the three modules described in (9a-c).

(9) Three modules of MT

a.	Language system	provides a linguistic foundation
b.	Graphematics	associates characters with segments
c.	Systematic orthography	optionally decides correct spellings

10. As an example of this possibility, Neef (2015, pp. 714–715) cites the International Phonetic Alphabet (IPA) as used for transcribing English. While the IPA can be aptly characterised as a phonologically based alphabetic system (e.g., Coulmas, 2003, pp. 28–33), it is a purpose-built 'technography' as opposed to naturally developed 'orthography' (Mountford, 1996, pp. 627–629). It is open to question whether writing systems belonging to such different categories can be compared on the same level.

2. Japanese Writing System

Using the key concepts of MT outlined above, this section examines their compatibility with the analysis of the current Japanese writing system. After a brief outline of the underlying language system (Section 2.1), a partial analysis of the writing system is developed in the light of the notions of graphematics (Section 2.2) and systematic orthography (Section 2.3).

2.1. Language System

Starting with segmental phonology, there has never been a general consensus on how to phonemicise the sounds of modern Japanese. However, assuming the non-derivational linguistic approach of MT, it is possible to make some meaningful generalisations about the sound system at the surface phonological level (based on Vance, 2008, pp. 53–112, 225–232; Labrune, 2012, pp. 25–101, 132–141; Saitō, 2013, pp. 84–96). With regard to vowels, Japanese has five contrastive sounds (10a), each also contrasting with a quantitatively longer counterpart (10b). As for consonants, there are some twenty plain contrastive sounds (10c). Among these, [ɴ] occurs only syllable-finally and is in complementary distribution with [m], [n] and other nasal sounds in that position (e.g., [aɴ], [am.ma], [an.na]). Some consonants have palatalised counterparts (10d), which are not allowed before [e], allophonic before [i], and contrastive before [a o ɯ].[11] Each voiceless obstruent consonant, except for the non-sibilant [ɸ ç h], contrasts with a quantitatively longer counterpart (10e), which occurs only ambisyllabically (e.g., [apːa] = [apˀ.pa]).

(10) Japanese sound system
  a. [i e a o ɯ]
  b. [iː eː aː oː ɯː]
  c. [p b t d k g ɸ s ɕ ç h ʦ ʣ ʨ ʤ m n ɴ ɾ j w]
  d. [pʲ bʲ kʲ gʲ mʲ ɲ ɾʲ]
  e. [pː pʲː tː kː kʲː sː ɕː ʦː ʨː]

Moving on to prosodic phonology (based on Vance, 2008, pp. 115–126, 225–232; Labrune, 2012, pp. 142–161; Saitō, 2013, pp. 97–103, 113–116), the above segments are organised into maximally $(C_1)V(C_2)$ syllables (11a-d). The C_2 is either [ɴ] (11c) or an ambisyllabic long consonant occupying the coda position (11d). Japanese is a mora-timed and weight-by-position language (Hayes, 1989, pp. 258–260), wherein a

11. While palatalised [tʲ dʲ ɸʲ] have a somewhat similar distribution, they are contrastive only before [ɯ] in a limited number of loanwords, and are often replaced by [ʨ ʤ ç], respectively (e.g., [tʲɯ↓ːba] ~ [ʨɯ↓ːba] 'tuba').

light (C)V syllable (11a) counts as one mora and a heavy (C)V: or (C)VC syllable (11b-d) counts as two morae (e.g., Kubozono, 1999, pp. 48–55). Japanese phonology also has lexical pitch accent, which assigns a steep pitch fall to some words (11e) but not to others (11f).[12]

(11) Japanese syllable structure and lexical pitch accent
  a. [ka]
  b. [kaː]
  c. [kaɴ]
  d. [kap(ːa)]
  e. [ka↓tːa] 'win-PAST.AFF'
  f. [katːa] 'buy-PAST.AFF'

Turning now to morphology and word formation (based on Shibatani, 1990, pp. 215–256; Tsujimura, 2013, pp. 125–157; Nitta et al., 2010, pp. 73–92, 225–232), Japanese morphemes may be free or bound, the latter being prefixes, suffixes or enclitics. These morphemes form both monomorphemic (12a) and polymorphemic words, the latter including compounds (12b), derivatives (12c) and inflected items (12d).

(12) Japanese morphology and word formation
  a. [ɯta↓] 'song'
  b. [ɯtagoe] 'song+voice' (= singing voice)
  c. [oɯta] 'HON-song'
  d. [ɯtatːa] 'sing-PAST.AFF'

Syntactically (based on Shibatani, 1990, pp. 257–262; Tsujimura, 2013, pp. 229–254), Japanese is characterised as a head-final language. It has basic subject-object-verb (SOV) word order, with postpositional particles marking grammatical relations (13).

(13) Japanese syntax

gakɯseː ga ɯta↓ o ɯtatːa
student NOM song ACC sing-PAST.AFF

'A student sang a song.'

With respect to the lexicon (based on Shibatani, 1990, pp. 140–157; Tsujimura, 2013, pp. 229–254; Kageyama and Saito, 2016, pp. 12–29), Japanese lexical items can be classified into four main groups according to their etymological origins. These are known as Native Japanese (NJ) (14a), Sino-Japanese (SJ) (14b), Mimetic (14c) and Foreign (14d). The fifth group of hybrid is also called for because Japanese words include compounds of morphemes from different sublexicons (14e).

12. This paper uses a downward-pointing arrow to indicate the position of a pitch fall (Vance, 2008, p. 143).

(14) Japanese lexicon
  a. [kotoba↓] 'word'
  b. [ɡo] 'word'
  c. [wa↓ːdo] 'word' (< Eng. *word*)
  d. [pe↓ɾapera] 'fluent, chitchatty'
  e. [keɴsakɯwa↓ːdo] 'search word' (SJ + Foreign)

2.2. Graphematics

As noted above, the current Japanese writing system employs a mixture of multiple scripts, namely logographic kanji, moraic hiragana and katakana, and alphabetic rōmaji (Backhouse, 1984, p. 219; Smith, 1996, p. 214; Joyce, 2011, p. 62; Honda, 2012, pp. 38–39).[13] While it is theoretically possible to write Japanese entirely in one script or another, the current norm is to use them all for different purposes in a complementary manner (15).[14] Thus, one may speak of a complex system of written signs divided into typologically distinct but functionally interlinked subparts.

(15) Japanese scripts[15]

Name	*Characters represent*	*Script used to write*
Kanji	Morphemes(?)	Lexical items (SJ & NJ)
Hiragana	Morae	Affixes & enclitics (NJ)
Katakana	Morae	Lexical items (Foreign & Mimetic)
Rōmaji	Vowels & consonants	Lexical items (Foreign)

Consequently, Japanese is usually written in a multi-script text (16a), where the characters of different scripts correspond to different properties of linguistic representation (16b).

13. Japanese braille (点字 *tenji*) constitutes a separate tactile writing system, which has different formal and functional features from the multi-script visual writing system under discussion (Unger, 1984, p. 254; Hosokawa, 2001, pp. 652–655).

14. Some might find it impossible to write Japanese solely in the kanji script, assuming that they cannot indicate grammatical information. However, this is a viable option given the historical use of *man'yōgana* (万葉仮名) or phonographically used kanji characters (e.g., Seeley, 2000, p. 190).

15. Some notes are in order here. Firstly, the question mark has been added after 'Morphemes' because of uncertainty surrounding the morphemic or morphographic nature of kanji (see below and Section 3). Secondly, hiragana and katakana characters are described as being moraic by some (e.g., Honda, 2012, pp. 72–93) and as core syllabic by others (e.g., Buckley, 2018, pp. 38–42). Thirdly, some scholars use 'arufabetto' (アルファベット) to refer to the Roman script and reserves 'rōmaji' for the Romanised notation of Japanese words (e.g., Satake, 2005, pp. 34–36). Finally, rōmaji (or arufabetto) characters are commonly used for abbreviations of words across sublexicons (ibid., p. 36), in which case they exhibit the characteristics of both phonographs and logographs (Sven Osterkamp and Yannis Haralambous, personal communication).

(16) Japanese multi-script text

a. 東京はローマ字で〈Tōkyō〉だ。

b. toːkʲoː wa ɾoːmadʑi de toːkʲoː da
Tokyo TOP Rōmaji INS Tokyo COP
'Tokyo is <Tōkyō> in Rōmaji.'

To account for this fact using the MT model, the present paper proposes to introduce the notion of *structured graphematics*. That is, the graphematic module needs to be divided into submodules, which define the associations between characters or character combinations and linguistic properties in the respective scripts. This is illustrated in (17), showing the graphematic rules for each character used in the example (16) above. The rules are tentative ones for kanji (17a), where it is also possible to interpret the characters as being associated with morphemes (e.g., <東> → {toː} ∨ {higaɕi}; Section 3).

(17) Japanese graphematics[16]

a. i. <東> → [toː] ∨ [higaɕi]
ii. <京> → [kʲoː] ∨ [keː]
iii. <字> → [dʑi] ∨ [adʑa]

b. i. <は> → [ha] ∨ [wa]
ii. <で> → [de]
iii. <だ> → [da]

c. i. <ロ> → [ɾo]
ii. <ー> → [ː]
iii. <マ> → [ma]

d. i. <t> → [t]
ii. <ō> → [oː]
iii. <k> → [k]
iv. <y> → [j]

Structured graphematics sufficiently captures both the integrity of the four scripts and their functional division in the Japanese writing

16. Many-to-one associations between characters and their linguistic properties are prevalent in the kanji submodule, creating a significant amount of ambiguity in character decoding (Honda, 2012, pp. 156–160). Neef and Balestra (2011, pp. 113–129) use the term *graphematic transparency* to refer to a similar kind of ambiguity in alphabetic systems and propose a way to measure it in German and Italian. Whether their measurement framework is adaptable to Japanese and other non-alphabetic systems remains a topic for future research.

system.[17] Importantly, the kind of correspondence rules assumed for alphabetic systems can also be used for the non-alphabetic kanji, hiragana and katakana (17a–c) as well as the alphabetic rōmaji (17d). Based on this observation, the present paper suggests that assuming the graphematic module is meaningful for the analysis of typologically different writing systems.

2.3. Systematic Orthography

As observed in the German examples discussed above (Section 1.3), the presence of multiple characters representing the same phonological segment generates a graphematic solution space for words containing that segment. According to MT, systematic orthography filters all theoretically possible spellings of a given word and determines the well-formed spelling. If this still leaves more than one spellings, conventional orthography decides the correct one on a word-to-word basis.

Similar examples of many-to-one correspondence can be found in the graphematic module of the current Japanese writing system. Perhaps unsurprisingly, it is possible to speak of a graphematic solution space with respect to the non-alphabetic submodules (18a–c) as well as the alphabetic one (18d). Thus, regardless of the type of writing system, having multiple ways to represent the same linguistic property necessarily entails multiple ways to write words containing that property.

(18) Japanese graphematic solution space and orthographic forms[18]

a. i. <見> ∨ <観> → [mi]
   ii. <見た> [mi↓ta] 'see-PAST.AFF'
   iii. <観た> [mi↓ta] 'see-PAST.AFF'

b. i. <お> ∨ <を> → [o]
   ii. <かお> [kao] 'face'
   iii. <かを> [kao] 'mosquito ACC'

c. i. <ー> ∨ <エ> → [ː] immediately after (C)e

17. The same notion may also be used to account for other writing systems. Although the mixed use of multiple scripts is a distinctive characteristic of Japanese, variants of multi-script writing are also found in many writing systems of the world. For example, English employs not only the Roman script but also sets of logographs, ciphers and punctuation marks (see the examples in (2a–d) above). While it is possible to characterise the former as the script of primary importance and the latter of secondary importance, further discussion is needed to establish criteria for such a distinction.

18. In each set of examples presented here, the first line shows two characters or character combinations (separated by the disjunction symbol) that correspond to a single phonological form. The second line presents an example written word containing the more frequent representation of the form in question. The third line gives another example with a less frequent representation.

ii. <バレー> [baˡɾeː] ‘volleyball’
iii. <バレエ> [baˡɾeː] ‘ballet’

d. i. <ī> ∨ <ii> → [iː]
ii. <Īda> [iˡːda] ‘Polish personal name’
iii. <Iida> [iˡːda] ‘Japanese city name’

Crucially, however, it is difficult to find evidence for a systematic orthography in the Japanese writing system. To illustrate with the kanji examples above, there is no reason to believe that the items in (18a.ii) and (18a.iii) are separate words belonging to different layers of the Japanese vocabulary. In other words, the choice between the two kanji characters is only explicable in terms of conventional rather than systematic orthography. Regarding the hiragana examples in (18b.ii) and (18b.iii), it is conventional to use <お> for [o] in any word and <を> for the accusative particle with the same phonological form.[19] The katakana examples in (18c.ii) and (18c.iii) show the default use of <ー> for representing [ː] and the exceptional word-specific use of <エ> for vowel length in the second syllable.[20] The Rōmaji examples in (18d.ii) and (18d.iii) show proper nouns written in the common Hebonshiki romanisation system; whereas the first character in the former can go with or without the macron (i.e., either <Īda> or <Ida>), the double-character spelling in the latter seems to be the norm for writing the city name (i.e., <Iida> but neither *<Īda> nor *<Ida>).[21]

Nevertheless, it may still be possible to argue for the presence of a systematic orthography in Japanese. It will be recalled that there is a functional division between the four scripts employed in the writing system. This is loosely defined by a set of orthographic guidelines promulgated by the Japanese Cabinet, and is implemented more or less systematically in administration, education and publication. At the same

19. While the current norm is to write the former in kanji 顔 and the latter in kanji and hiragana 蚊を, it is possible to write them entirely in hiragana as shown here (see Section 2.2 above and the discussion below for the fungible use of scripts in Japanese). Historically, <お> and <を> were used to represent [o] and [wo], respectively. After the loss of syllable-initial [w] before [o i e] in around 1000 CE (Frellesvig, 2010, pp. 206–207), both characters correspond to [o]. The conventional use of <を> for the accusative particle was codified in the first official guidelines for hiragana orthography promulgated by the Japanese Cabinet in 1946 (現代かなづかい *Gendai Kanazukai* ‘Modern Kana Usage’). The same convention is stipulated by the current version updated in 1986 (現代仮名遣い *Gendai Kanazukai* ‘Modern Kana Usage’).

20. The same syllable is usually written as <レー> as exemplified by <レーザー> [ɾeˡːʣaː] ‘laser’ and <ジレー> [ʣiˡɾeː] ‘gilet’. Nothing suggests a systematically differentiated representation of [eː] in loanwords based on the source language (e.g., English versus French).

21. The English version of the official website of Iida City in Nagano Prefecture consistently uses this spelling (`https://www.city.iida.lg.jp/`).

time, it is also a common practice to use different scripts interchangeably to write the same lexical item for various purposes (Joyce and Masuda, 2019, pp. 255–274). Taking these facts together, one may speak of a variant of systematic orthography that permits, rather than prohibits, the fungible use of scripts in this writing system. Further research is needed to elaborate on the systematicity and flexibility of orthographic conventions in Japanese and other writing systems.

3. Logography and Logographic Systems

While MT says very little about non-alphabetic systems, it makes the following remark concerning logography and logographic systems:

> Logographic writing systems differ from phonographic writing systems in that their basic units are logograms, [...], i.e., functional classes that correspond to words or morphemes. (Neef, 2015, p. 713).

As previously mentioned, this statement reflects the traditional classification of writing systems into two broad types according to the primary type of written signs (Section 1.2). In the literature, however, there is an ongoing debate over the validity of this dichotomous division. Some studies view all writing systems as being primarily phonographic, even if they may also employ a smaller or larger number of logographs (e.g., DeFrancis, 1989, pp. 56–64). Some others agree on the primary importance of phonographs but maintain that logographs also play an important role in virtually all writing systems (e.g., Sproat, 2000, pp. 139–143). Yet another group of studies reject the primacy of phonography and classify all writing systems into the phonographic type and the *morphographic* type (e.g., Joyce, 2011, pp. 63–72).[22] With respect to MT, the disagreement over the dichotomy between phonographic and logographic systems calls into question the position of logography in its theoretical framework.

To address the above question, it would be meaningful to take a closer look at the graphematic aspects of Japanese kanji, which are widely regarded as the prime example of logography (e.g., Sampson, 2015, p. 208; Sproat, 2000, p. 154). One notable feature of this submodule is that characters and character combinations correspond to meaning-carrying phonological forms in many words. For instance, <愛> represents [a$^{\downarrow}$i],

22. Whereas 'logographic / logography' implies the use of mono- and polymorphemic word signs, 'morphographic / morphography' suggests that the writing system in question primarily employs the signs of free and bound morphemes (Joyce, 2011, pp. 69–70). This latter term is becoming increasingly accepted as an alternative to the more traditional 'morphemic' label (Rogers, 2005, pp. 14–15; cf. Hill, 1967, p. 93).

which can form a morphologically simplex word (19a) or an element of complex words (19b,c). A comparison of these and other related words reveals that this phonological form is associated with the meaning 'love'. Because the sound-meaning unit is not analysable into smaller parts, it can be regarded as a morpheme or the minimal meaningful unit in a language. Through a similar analysis, one can say that kanji characters represent morphemes in a large number of kanji-written words (Joyce, 2011, p. 71). This observation appears to support the notion that logographic systems are essentially morphemic and hence 'morphographic' in nature (Section 1.2).

(19) Morphographic kanji
  a. <愛> [a↓i] 'love'
  b. <愛情> [aidʑoː] 'love+emotion' (= affection)
  c. <恋愛> [ɾeɴai] 'yearning+love' (= romance)

However, it is also important to note that kanji characters do not always represent morphemes. For one thing, they may correspond to phonological forms carrying no discernible meaning. For example, <陛> is only used in the word shown in (20a), where it corresponds to [heː].[23] Although this phonological form historically denoted 'a flight of steps in a palace', such a meaning is synchronically unidentifiable because the character's idiosyncratic usage makes a comparative analysis impossible. A similar description holds for <袒> (20b) as well as for <挨> and <拶> (20c).[24] It is difficult, if not at all impossible, to say that these

23. The largest Japanese dictionary *Nihon Kokugo Daijiten* (Kitahara et al., 2000) includes two more headwords containing this character, namely <陛戟> [heːgeki] 'imperial guard' and <楓陛> [ɸɯːheː] 'flight of steps in a palace'. However, they are extremely infrequent in contemporary Japanese, and no instance of either item is found in the 100-million word Balanced Corpus of Contemporary Written Japanese (BCCWJ: https://pj.ninjal.ac.jp/corpus_center/bccwj/en/).

24. A related example can be found in <葡萄> [bɯdoː] 'grape'. Historically, the two constituent characters were invented for the specific purpose of writing the disyllabic monomorphemic word in Chinese. Kanji-written words of this kind can be found in both Chinese and Japanese. A notable feature of these items is the presence of a shared semantic component or 'radical' in both constituent characters (e.g., the three-stroke 'grass' component in <葡> and <萄>), presumably denoting morphological and semantic unity of the word in question (Sproat, 2000, pp. 148–154). Cornelia Schindelin has suggested the term *radical harmony* for this device, in analogy to 'vowel harmony' in phonology (personal communication). In graphematic terms, there are two possible interpretations of radical harmony. The first interpretation is that the constituent characters function as word-specific syllabographs corresponding respectively to the first and second syllables (e.g., <葡> → [bɯ] + <萄> → [doː] when used for {BUDŌ}; Honda, 2019, p. 202). The second possibility is that they form a digraphic morphograph representing the morpheme in a holistic fashion (e.g., <葡萄> → {BUDŌ}; Zev Handel and Gordian Schreiber, personal communication). Further discussion is needed to elaborate on this issue.

characters represent morphemes as minimal meaningful units (Honda, 2019, p. 197).

(20) Non-morphographic kanji
  a. <陛下> [heˈːka] 'Majesty'
  b. <福祉> [ɸɯkɯˈɕi] 'welfare'
  c. <挨拶> [aˈisatsɯ] 'greeting'

For another thing, kanji characters may be used phonographically to write certain words, even if they represent individual morphemes elsewhere. This rebus-like use, known traditionally as *ateji* (当て字), is found in many orthographic kanji-written words (21a). The same method is also widely used to produce non-orthographic alternatives to orthographically written words for a more playful stylistic effect (21b).[25] In both cases, individual characters correspond to different portions of the word's phonological form, with little or no regard to their associated meanings. When kanji characters are used this way, there is no reason to assume that they represent individual morphemes (Joyce, 2011, p. 71).

(21) Orthographic and non-orthographic ateji[26]
  a. i. <出> → [de(ˈɾɯ)] 'go out'
  ii. <鱈> → [taˈɾa] 'cod'
  iii. <目> → [meˈ] 'eye'
  iv. <出鱈目> [detaɾame] 'hogwash'
  b. i. <羅> → [ɾa] 'silk gauze'
  ii. <武> → [bɯ] 'military affairs'
  iii. <羅武> [ɾaˈbɯ] 'love' (conventionally, katakana <ラブ>)

It should also be added that it is not always clear whether individual kanji characters correspond to morphemes in words with an apparently complex morphological structure (Vance, 2002, p. 187; Honda, 2019, pp. 195–197). To give an example, <勉強> [beɴkʲoː] 'study' is etymologically a compound of <勉> [beɴ] 'strive, serve, fill a post, etc.' and <強> [kʲoː] 'strength, might, strong person, etc.'.[27] From a strictly synchronic standpoint, however, there is little evidence indicating whether or not

25. Phonographic use of logographs, as well as logographic use of phonographs, is widely attested across writing systems; see descriptions of individual systems in Daniels and Bright (1996) and Kōno, Chino, and Nishida (2001). This point calls into question the validity of the traditional dichotomy between phonography and logography or morphography (Osterkamp and Schreiber, 2021; cf. Handel, 2020).

26. The characters <出> (21a.i), <目> (21a.iii) and <武> (21b.ii) are also associated with other sound-meaning units, which are omitted here for clarity.

27. In this word, the uvular nasal [ɴ] is phonetically realised as the velar nasal [ŋ] due to anticipatory assimilation of place of articulation. This detail is omitted in the surface phonological transcription adopted in this paper.

the same word retains such compositionality in present-day Japanese. The same can be said for many kanji-written words, both common and uncommon. This observation allows three possible interpretations for the constituent characters in such items: separate morphographs (22a), one polygraphic morphograph (22b) or separate syllabographs with lexically conditioned distributions (22c).

(22) Possible interpretations of <勉強>

a. <勉> → {beɴ} + <強> → {kʲoː}

b. <勉強> → {beɴkʲoː}

c. <勉> → [beɴ] + <強> → [kʲoː] when used for {beɴkʲoː}

The plausibility of the first interpretation depends on specific assumptions about morphological structure and morphemehood (Joyce, 2011, pp. 69–73). The second interpretation requires a theory of what count as polygraphs in different types of writing systems, which is still at an early stage of development (Osterkamp and Schreiber, 2019).[28] The third one implies that each constituent character represents the phonological exponent of the whole or a portion of a morpheme, a claim that needs further examination (Honda, 2019, pp. 202–203).

With respect to MT, the above observations raise several questions about its treatment of logography and logographic systems (23).

(23) Questions about logography and logographic systems

a. How should MT conceptualise logography in relation to morphography and phonography? Are they mutually exclusive concepts, or do they have commonalities as well as differences?

b. Is it appropriate for MT to assume the traditional dichotomy between phonographic and logographic (or morphographic) systems as fundamentally different types of writing systems?

c. Does MT need to make reference to morphology as well as phonology to account for the script-to-language relationship in logographic (or morphographic) systems?

d. If reference to morphology is necessary, what theories of morphological structure and morphemehood would be compatible with the general framework of MT?

28. The term 'polygraph' is usually reserved for the multi-character representation of a single segment or syllable in phonographic systems (e.g., Sproat, 2000, 140, fn. 2). The Japanese writing system employs a considerable number of *jukuji* (熟字) or monomorphemic kanji character combinations, giving rise to the hitherto underexplored notion of 'polygraphic morphographs' or 'morphographic polygraphs' (Honda, 2012, pp. 120–123; Osterkamp and Schreiber, 2019).

4. Conclusion

This paper has explored the adaptability of MT to the analysis of non-alphabetic systems through a discussion of the current Japanese writing system. Using the key concepts of MT, a partial analysis of kanji, hiragana, katakana and rōmaji has been presented to highlight the possibilities and challenges of this theory. A summary of the discussion is given below (24).

(24) Summary and remaining issues

a. Current MT is essentially a theory of alphabetic systems. However, with its non-derivational linguistic approach, MT has the potential for expanding into a general theory of script-to-language relationship across different types of writing systems.

b. In principle, the theory's three-module model is adaptable to the analysis of the Japanese writing system. This suggests that the key concepts of MT are applicable to non-alphabetic systems.

c. However, some of the basic assumptions about graphematics and systematic orthography require modification in this context:

   i. The notion of structured graphematics should be introduced to account for the functional division between kanji, hiragana, katakana and rōmaji.

   ii. Further research is needed to elaborate on the systematicity and flexibility of orthographic conventions in view of the choice of characters and the fungible use of scripts in Japanese.

d. Observations on the graphematic aspects of kanji characters call for further discussion of issues related to logography and logographic systems.

In conclusion, a MT approach to the Japanese writing system provides a new perspective on the capability of this theory to account for the script-to-language relationship in different types of writing systems. Further research is called for to elaborate and examine the generality of MT.

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