What is natural in writing?*
Prolegomena to a *Natural Grapholinguistics*

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Naturalness Theory (NT) is founded on the notion of naturalness and claims that when a linguistic phenomenon can be processed by humans with little effort, both sensomotorically and cognitively, it is deemed more natural compared to other, more complex phenomena. Drawing on evidence such as language change, language acquisition, and language disorders, various parameters of naturalness (e.g., biuniqueness, constructional iconicity) have been postulated, which focus on the phonological and morphological subsystems of language. This paper offers an outline of how naturalness can be adapted to grapholinguistic phenomena. *Comparative graphematics* (cf. Weingarten 2011), extended to *comparative grapholinguistics*, is assessed as a method that can be used to reveal naturalness parameters which apply to both material (*graphetic*) and linguistic (*graphematic*) aspects of writing. The reduction of extrinsic symmetry across various scripts will be discussed as an example. By integrating these preliminary theoretical ideas into the framework of NT, it is demonstrated that so-called *Natural Grapholinguistics* could offer promising new insights as well as a *tertium comparationis* method for future comparative analyses of scripts and writing systems.

Keywords: grapholinguistics; writing system; script; naturalness; naturalness theory; comparative grapholinguistics; cross-linguistic studies; natural grapholinguistics

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1. Introduction

"I have taken it as granted that some writing systems are better than others. This question could certainly be debated," is a provocative claim made by Henry Rogers (1995: 31), who authored one of few linguistic introductions to writing systems (Rogers 2005). This very question about the relative quality of writing systems has frequently been broached. However, the debate mentioned has failed to materialize. This appears to be largely due to the assumption that a type of writing system [53] exists that is generally (with notable exceptions) considered the best: the alphabetic type (cf. Olson 1996: 8f.; Share 2008). Famously (or rather infamously), this view culminated in a controversial teleological assumption, namely, that all writing systems undergo a gradual development during which they pass through several stages, turning into alphabetic systems in the final stage (cf. Gelb 1969). It has been widely argued that this view is untenable (cf. Mattingly 1985; Miyamoto 2007; Coulmas 2009).

Still, many theoretical assumptions about writing systems seem to be considerably biased, as subjective phonocentric and ethnocentric (more precisely Eurocentric, cf. Ehlich 2007: 724; Yan 2002) views conspire to distort the bigger picture. Studies focusing on non-European writing systems such as Chinese, Japanese, Korean, Arabic, and Hebrew, for example, have slightly clarified the situation, but doubtlessly laudable descriptive efforts aside, the insights gained from these studies are often excluded from theoretical abstraction and model-building. This is evident when one considers the models of reading and writing that are still predominantly based on alphabetic writing systems and display an "alphabetism" in reading science (cf. Share 2014). It seems that what is still lacking within grapholinguistics is a willingness to compare (significantly) different writing systems on different levels while considering various aspects. Such comparisons would allow lowest common denominators to be found that could be used to determine what constitutes writing in general. In the context of research on reading, Share (2008: 604) remarks that "[t]o see the larger picture of how reading works […] calls for comparative analyses."

Comparative graphematics as proposed by Weingarten (2011) sets out to do exactly that: compare how given linguistic phenomena are dealt with in different writing systems by identifying "the linguistic parameters that underlie cross-linguistic differences between writing systems" (Weingarten 2011: 13). In this vein, comparative graphematics is solely descriptive. It is used to analyze how writing systems work; as such, it serves as a basis for processing studies that focus on how the structure of writing systems has bearing on our production and perception of them.

The approach presented in this paper represents an extension of *comparative graphematics* to *comparative grapholinguistics*, adding to the former the additional subbranch of *comparative graphetics*. Comparative grapholinguistics does not merely compare how writing systems deal with linguistic phenomena, however, but how we as writers and readers deal with the writing systems; it does so by allowing considerations of a variety of substantial external evidence to be made. Challenges and preferences might or might not share similarities across scripts or writing systems. As will be argued here, the existing commonalities and differences arise because the prototypical reader and writer is equipped with a brain, [54] eyes, hands, and a need or wish to communicate. It is exactly this very simplistic truth that allows us to evaluate what is *natural* in both language and writing.

While *naturalness* may appear to be a subjective and, thus, unfit term to the uninitiated, it is the notion at the core of linguistic *Naturalness Theory* (hereafter NT). In principle, this theory states that when a linguistic phenomenon can be processed by humans with little effort, it is deemed more natural as compared to other, more complex and, thus, less natural phenomena. Drawing upon evidence such as language acquisition, language disorders, and language change, various dimensions of naturalness have been postulated, the most prominent ones – biuniqueness, indexicality, optimal shape etc. – of which pertain to the phonological and morphological levels of language.

The approach proposed in this paper describes a way to apply the principles of NT to grapholinguistics and its subfields. The question that constitutes the title of this contribution – *what is natural in writing* – stands at the center of this endeavor. Tentatively termed *Natural Grapholinguistics*, the approach is not a naïve transfer of ideas, but a reasonable extension of the existing theory that addresses the distinct features of writing and how writing differs from language and speech, which are themselves two different phenomena. The goal of the paper is to reveal universal tendencies in scripts and writing systems to further the understanding of how these kinds of systems work on a fundamental level.

Section 2 of this paper is devoted to the concept of *naturalness* and NT. In section 3, I provide a definition of grapholinguistics and remark on concepts and terminology within this field for clarification. Subsequently, I argue that the investigation of writing, which is *per se* often called 'unnatural,' can be integrated into NT, as features of scripts and writing systems can just as easily be evaluated according to their naturalness. Some of the criteria that have been proposed under the pretext of finding an 'optimal/practical/ideal' writing system will then be described. These can be assigned to three categories, namely, linguistic fit, psychological/cognitive fit, and sociocultural/ideological fit. The core part of the paper will include a step-by-step application of the framework of NT to grapholinguistics, an outline of sub-theories, a presentation of different kinds of relevant external evidence, and a description of how the concepts of natural processes and naturalness parameters are transferred to the domain of writing. In section 4, the graphetic example of extrinsic symmetry, as, for instance, displayed by the basic shapes |b| and |d| of the Roman script, will be given to illustrate what possible gain of knowledge the proposed framework could offer. The paper's conclusion appears in section 5. [55]

2. Naturalness

2.1. A linguistic definition of *naturalness*

To identify natural features in scripts and writing systems, the term *naturalness* must be precisely defined in a linguistic context. The fact that it has previously been used in vague and pretheoretical ways (cf. Dressler 2000: 288), and often considered to be synonymous with "frequent, expected, simple, or intuitively plausible" (Dressler et al. 1987: 3), has fed into the criticisms that it is an inadequate term and should, therefore, be dispensed with altogether (cf., for example, Haspelmath 2006). Therefore, it is paramount to first delineate the technical understanding of the term from its numerous everyday meanings.

Merriam-Webster offers a total of 15 meanings for the word *natural* as it occurs in everyday language,[1] many of which can quickly be discarded when attempting to arrive at an adequate definition of the technical term *natural* with reference to a linguistic theory of *naturalness*. One of the meanings is "being in accordance with or determined by nature." The fitting antonym for this reading of *natural* is *unnatural*. When asking *what is natural in language*, the answer crucially depends on the "limitations of human capacities" (Hurch 2006: 541). These capacities as well as their limitations are themselves determined by nature, and specifically the nature of our human bodies and minds. Nature, in fact, directly determines what can be considered *natural* in language. This everyday meaning of the word approaches the core of linguistic naturalness but falls short of a comprehensive definition, for it would classify *anything* that could possibly be produced and perceived within the boundaries of human capacities as natural. It would, thus, be an exclusively descriptive notion (and not an informative one), rather than an evaluative one. If the definition were left at that, we would arrive at a situation in which phenomena are deemed natural if they are in the realm of the humanly possible – whether they are attested in language(s) or not; but the definition of *naturalness* as it is advocated here certainly does not stop there.

Another meaning listed by Merriam-Webster is "implanted or being as if implanted by nature: seemingly inborn," which, famously, is what generativists believe applies to language (or

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[1] Cf. https://www.merriam-webster.com/dictionary/natural (April 4th, 2018).

at least a predisposition for it), proclaiming a *faculty of language*. Naturalists do not concern themselves with the innateness of language as such. It is not language that can be classified as innate within NT, but rather some of the relevant external constraints that shape its makeup. Like the first meaning provided above, this view of things also describes language *per se* as something natural and, thus, it classifies everything occurring in it as *natural*. If [56] this notion were to be accepted, the application of a theory of linguistic naturalness would be grossly futile. But as Bailey (1974: 14, my emphasis), one of the first proponents of NT, states, "[t]he naturalist […] does not seek merely what works, but rather *what accords with man's linguistic faculties*. The naturalist is interested in formulations which are credible psychologically and physiologically."

Accordingly, the goal of NT is to arrive at a definition of *gradual naturalness* that allows the evaluation of linguistic elements or structures in a given system as *more* or *less natural* with respect to (pre-)linguistic faculties, bearing in mind that all the elements and structures observable in language can ultimately be produced and perceived, since they do in fact occur in language. Thus, we should talk about phenomena being *more* or *less natural* instead of *natural* or *unnatural*. *Natural* is not an absolute, but a scalar notion that implies 'possible, but more or less easy for humans to use,' with the poles *completely natural* and *unnatural* being logically impossible configurations as far as language is concerned. Nothing can be *completely natural* since – as I will show – parameters of naturalness conflict with each other, and nothing can be *unnatural*, since its definition implies that it should not occur in language.[2] Instead, it is everything in between that is of interest to the naturalist, with all its subtle nuances and gradations. Thus, *natural* in this context always means *more natural than some other element* and *unnatural* means *less natural than some other element*.

Hence, linguistic elements at all linguistic levels – the phonological, morphological, syntactic etc. – must exhibit at least a minimal degree of naturalness for us to be able to process them. As ideal language users (for a discussion of this term, see Saniei 2011), we should hypothetically be capable of pronouncing/writing (or hearing/reading) all the units of a given language or writing system. The reality is drastically different: many of us might not be able to orally – let alone in written form – produce every element of a language for several reasons, one of which is the differing degrees of naturalness. Simply because we can use a broad variety of different linguistic elements does not mean that the processes involved are equally 'difficult.' The missing key part of a definition of linguistic naturalness is, thus, a criterion with which we can evaluate what is natural and where this item falls on the scale of naturalness.

In this context, words such as 'ease' or 'effort' are not uncommonly used as labels for such a criterion. These terms are meant to convey the fact that linguistic elements that are *easier* to process (i.e., require less effort to be processed than others) are more natural than elements that are *more difficult* to process. Dressler (2000: 588) specifies that *natural* is "often synonymous with cognitively simple or [57] easily accessible," while Mayerthaler concludes that the meaning of "more or less natural […] really boils down to '*more or less easy for the human brain*'" (Mayerthaler 1987: 27, emphasis in original). Thus, what is *more natural/less natural* cannot be evaluated solely language-internally, but requires the consideration of language-external evidence. This reveals that NT is a theory that relies heavily on the study of linguistic *performance* (cf. Dziubalska-Kołaczyk 2002: 104), because logically, the usage-based naturalness of linguistic elements can only be compared with respect to the effort of their production and perception when they are used.

An interim definition of linguistic naturalness would read as follows: *Naturalness* refers to the effort involved in using language with respect to external constraints – this includes production as well as perception. On the one hand, this effort stems from the physical and cognitive makeup of the human body, and primarily the brain. On the other hand, (psychosocial) considerations of humans as sociocommunicative beings are also crucial aspects of the notion of lin-

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[2] Cf. Birnbacher (2014: 5): "The question whether something is 'natural' can, as a rule, not be answered with yes or no, but instead with a more or less."

guistic naturalness, which is why Bailey (1984: 229) speaks of "a balance between (bioneuro-linguistic) structures and (sociopragmatic) communicational functions." This perfectly corresponds with Dressler's (1980: 75) understanding of naturalness: "Naturalness must be derived from considerations of the nature of man, who is not only a speaker-listener, but also a non-verbally communicating being conditioned by biological, psychological and social properties. Therefore[,] any 'natural linguistics' must be based on such extralinguistic considerations […]."

2.2. *Natural Phonology* (NP), *Natural Morphology* (NM), and other Naturalist approaches

In the late 1960s, the notion of *naturalness* as described above gained importance in linguistics with the advent of so-called *Natural Phonology* (NP). The central assumption of this approach, first formulated by David Stampe (1973), is that *phonological processes* are 'easier' to handle (i.e., involve less articulatory and perceptual effort) than the more demanding *morphophonological rules*. While processes "always apply when the phonological context is met, […] the application of rules depends on lexical specifications and/or grammatical domains" (Hurch 2006: 541). The former are deemed *natural*, while the latter – because they must be learned – are considered *unnatural*. An example of a natural phonological process is the devoicing of final obstruents, as in German *Hund* 'dog,' the phonological representation of which is /hʊnt/ – here, the feature [+voiced] is substituted by the feature [–voiced] in the final obstruent because voiced obstruents are more difficult [58] to produce (cf. Hurch & Nathan 1996: 235).[3] Processes, thus, have a phonetic motivation that stems from the physical makeup of humans. An example of an unnatural rule that lacks such a phonetic motivation is umlauting as in German SG *Mann* /man/ 'man,' PL *Männer* /ˈmɛnɐ/ 'men.' For a list of constitutive differences between processes and rules, see Hurch (1988: 8-11).

Within NP, the term *natural* refers to the view that "the forces governing […] phonological behavior […] are inherent to the limitations of human capacities of speech production and auditory perception" (Hurch 2006: 541). The notion of naturalness based on this premise has been employed as an explanation for synchronic phonological structures as well as diachronic phonological change. In NP, clearly reminiscent of Jakobson's *Kindersprache, Aphasie und allgemeine Lautgesetze* (1941), data from first language acquisition and aphasic speech are utilized as external evidence under the assumption that a greater number of *natural* phonological processes – as opposed to the *unnatural* rules – apply in the utterances and structures observable in these types of speech than in the healthy 'normal' speech of adults.

Two central concepts of NP are *fortitions* (or *foregrounding processes*) and *lenitions* (or *backgrounding processes*): fortitions enlarge the perceptual distance between sounds – meaning more effort is required for the speaker to produce an utterance – while lenitions "embrace all assimilatory tendencies which make pronunciation less expensive" (Hurch 2006: 542), thus, making it more difficult for a listener to understand an utterance (cf. Donegan & Stampe 1979; Donegan & Stampe 2009). This idea can, of course, also be applied to writing, especially handwritten production and the perception thereof, as will be shown in section 3.6.

Between the mid- and late-1970s, predominantly in the German-speaking area, *Natural Morphology* (NM) was developed by Wolfgang U. Dressler, Willi Mayerthaler, and Wolfgang U. Wurzel as the second and most prominent subcomponent of what has been subsumed under

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[3] Devoicing final obstruents being more natural than voicing them manifests itself in the fact that L1 speakers of languages with final obstruent devoicing – such as German, most Slavic languages, Lithuanian, Maltese – who do not have to inhibit the process in L1 acquisition later have difficulties in pronouncing voiced final obstruents when acquiring a L2 such as French or English. Conversely, L1 speakers of languages with voiced final obstruents have no difficulties when pronouncing voiceless final obstruents in a language like German. The most striking evidence for the naturalness of final devoicing, however, comes from the L2 acquisition of speakers of languages which lack final obstruents (such as Vietnamese, Chinese, and Japanese): they devoice these segments when they learn English (cf. Schmid 1997: 338; Donegan & Stampe 1979: 132f.).

the heading of NT (sometimes also referred to as *Natural Linguistics*). Here, the notion of naturalness is related to the notion of *unmarkedness* as developed by the Prague School (cf. Dressler 2000: 288; Dziubalska-Kołaczyk 2002). NM takes semiotics (especially Peircean semiotics) [59] as a metatheory (cf. Dressler 1999b; Crocco Galèas 1998: 8-10), claiming that it particularly has bearing on our cognitive processing of sign systems, language being one of them. It is a *functionalist* theory in which language is considered a tool to be used for communication and cognition; therefore, Dressler et al. (1987) stress that the concept of naturalness crucially relies on functional explanations.

It follows that an evaluation of linguistic naturalness must be based on extralinguistic foundations, primarily of a neurobiological and sociocommunicative nature. These foundations determine which linguistic structures can occur in the languages of the world and, in turn, which of those are preferred or not preferred by language users. They point out the relevance of external evidence such as *error linguistics, baby talk, second language acquisition, casual speech,* and *language games* in addition to *first language acquisition* and the *language of aphasics,* which were already utilized in NP (cf. Crocco Galèas 1998: 11; Dressler 1980: 76). However, not only external evidence is considered within NM, as "all types of evidence are important" (Dressler et al. 1987: 12). Some types of internal evidence include *frequency* (text as well as token, both on a typological and a language-specific level) and *evidence from pidgins and creoles* (cf. Dressler et al. 1987: 12–14). As will be shown in section 3.5, many of these types of evidence can also be used to uncover natural features of scripts and writing systems.

These forms of evidence serve as heuristic sources that help researchers identify naturalness parameters as well as their universally preferred values. The most important parameters that have been formulated in NM are 1) *constructional iconicity*, 2) *uniformity*, 3) *transparency*, 4) *optimal form*, and 5) *indexicality* (cf. section 3.6; for a more extensive list of parameters, cf. Crocco Galèas 1998).

Following the developments in NP and NM, the main principles of NT were transferred to other linguistic levels and adapted according to their respective characteristics and needs. In addition to *Natural Syntax* (Mayerthaler, Fliedl & Winkler 1998; Orešnik 2004) and *Natural Textlinguistics* (Dressler 1989), a few other naturalness approaches have been developed. While examining Dziubalska-Kołaczyk's (2002: 15) list of these approaches and their respective representatives, it is striking to note that none of these attends to the phenomena of written language. This might be because, despite the fact that the question of 'the best' writing system has often been raised, only two linguists have ever explicitly referred to NT in their analyses of aspects of written language (cf. Munske 1994; Baroni 2011). The systematic application of NT's principles to grapholinguistics is, thus, still a desideratum – which is precisely what will be addressed by the approach outlined in this paper. [60]

2.3. Subtheories of Natural Morphology

NM opposes the reductionism of Saussurean dichotomies, especially the simple dichotomy of competence vs. performance, and seeks a more fine-grained differentiation of linguistic levels at which naturalness can be evaluated. Based on work going back to Louis Hjelmslev and Eugenio Coseriu, Dressler et al. (1987: 8f.) assume five levels of linguistic analysis in NM: 1) *universals* (which corresponds to Saussure's *faculté de langage*), 2) *types*, 3) *specific language systems* (Saussure's *langue* level), 4) norms, and 5) performance (Saussure's *parole*). The first three of these levels are translated into respective subtheories in NM: I) *system-independent* or *universal naturalness*, II) *typological naturalness* (more frequently labelled *typological adequacy*), and III) *system-dependent naturalness* (also referred to as *system adequacy*).

The first of these subtheories was developed by Mayerthaler (1981) and is considered to be a preference theory. It can be applied to study universal markedness relations and includes a definition of naturalness as the optimal symbolization of grammatical functions qua linguistic forms. Thus, unlike NP, which is based on articulatory and perceptual constraints, NM is motivated semiotically and cognitively (cf. Wurzel 1994: 2593; Bittner 1988: 29; Dressler et al.

1987). It must be stressed that a given language cannot simultaneously display the most natural values associated with all naturalness parameters. This is logically impossible since these parameters conflict with each other – a situation referred to as *naturalness conflict* (see also section 3.6).

This concept of naturalness conflict is central to the second subtheory: *typological adequacy*, which was proposed by Dressler (1988). Maximal naturalness values based on the parameters of iconicity, uniformity, and transparency (cf. section 3.6), for example, lead to disproportionately long and complex expressions. Hence, naturalness based on the parameters of indexicality and optimal shape is placed at a disadvantage – as is the case in Turkish, an agglutinative language (cf. Luschützky 2006: 2344). It follows that for a language type to exhibit naturalness on some parameters, it must 'sacrifice' it on others. NM, thus, interprets language types as "sets of consistent responses to naturalness conflicts" (Dressler 1999a: 141). What is deemed *natural* for a given type does not necessarily conform with what is natural system-independently, as the level of typological adequacy filters or overwrites universal preferences.

The third subtheory, which was devised by Wurzel (1984), is *system-dependent naturalness*. It is based on the observation that what is natural system-independently or typologically can be filtered by the structural characteristics of a given language system: "It is not hard to understand that the consideration of 'normalcy' by a speaker depends on his/her linguistic experience, i.e. on the respective lan-[61]guage-specific structural properties" (Wurzel 1987: 61). The morphological naturalness of a language system, thus, not only depends on system-independent and typological naturalness, but – on the lowest and most imminent level – on language-specific as well as other extralinguistic factors. This clearly applies to the analysis of scripts and writing systems as well, as I will argue in section 3.4.

3. Proposal of a *Natural Grapholinguistics*

3.1. Notes on grapholinguistics and its terminology

The term *grapholinguistics* refers to "the linguistic sub[-]discipline dealing with the scientific study of all aspects of written language" (Neef 2015: 711). It is the equivalent of German *Schriftlinguistik*, which was first proposed by Nerius & Augst (1988) and adopted by Dürscheid (2016) for the title of her seminal textbook. I follow Neef, Sahel & Weingarten (2012ff.) as well as Neef (2015) in using this term instead of one of numerous alternatives, such as *grammatology* (Gelb 1969; Daniels 1990, 2009a; in a different sense Derrida 1967), *graphonomy* (Hockett 1951; Daniels 2018), or *writing systems research* (the title of a prominent journal in the field). The term grapholinguistics not only can be aligned with designations used for other linguistic subdisciplines, such as psycholinguistics and sociolinguistics, but also originated in the long German tradition of acknowledging and investigating writing in its own right.
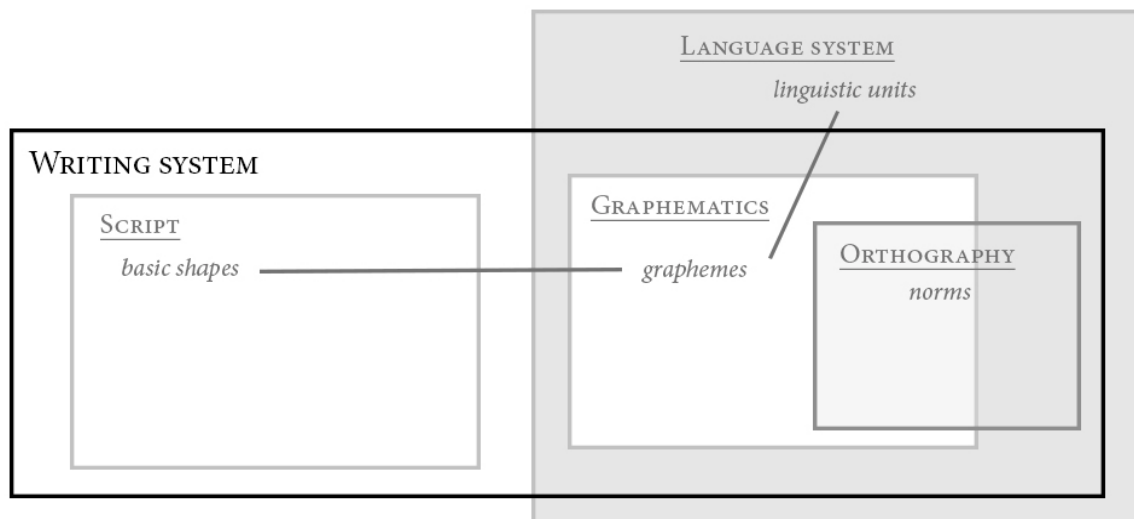
Figure 1: Structure of writing systems

According to Weingarten (2011: 17), a writing system is defined as "an ordered pair of a single language and a single script": (Language$_L$, Script$_S$). Based on this, Figure 1 shows the structure of a writing system with – following Neef's (2015) terminology – its different modules, namely a *language system*, a *script* (and other [62] visual resources), and *graphematics* as obligatory modules, and *orthography* as an optional module. Following this model, two main branches of the analysis of written language can be distinguished which are roughly analogous to the division of the analysis of spoken language into *phonetics* and *phonology*: *graphetics* and *graphematics*.[4] Additionally, a separate branch studies *orthography*, the standardization of writing.

    Graphetics is not purely linguistic; just like phonetics, questions are asked that go beyond the scope of linguistics, which also manifests itself in the associated methods used. Graphetics can be broadly defined as an interdisciplinary area of research in which questions about the materiality of writing are asked (cf. Meletis 2015). The main object of study is *scripts*, defined as inventories of discrete visuo-graphic basic shapes such as the Roman script, the Chinese script, and the Japanese inventories hiragana and katakana. In most cases, these inventories are *closed*, meaning that, after their invention, different degrees of change and finally stabilization (e.g., due to the invention of printing), no new units were added. However, notable exceptions exist, such as the creation of new basic shapes in the Chinese script (cf. Zhao & Baldauf 2008) or the addition of an uppercase |ß| (written as |ẞ|) in German.[5] The linguistic referents of basic shapes – what, for instance, |d|[6] refers to – are not of interest in graphetics. Instead, both diachronic and synchronic questions are asked about, for example, the gradual development of a script or how its features affect the way we process it. Aside from scripts, graphetics also studies other visual resources used in writing which include, for example, font choice or different styles of handwriting, forms of highlighting (bold print, underlining, etc.), and layout.

    Graphematics is the study of the graphematic module. In the *Modular theory of writing systems* proposed by Neef (2015), *graphematics* – which in this case refers to the linguistic sub-

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[4] Both terms, which are in line with *phonology, morphology*, and other similar terms, are polysemous, as they can refer to (a) *systems as objects of study* ('the *graphematics* of German' as in the graphematic system of the German writing system) or (b) the *linguistic branches* studying them. In this paper, the latter reading is predominant. If the first is intended, this will be indicated explicitly.

[5] Cf. http://www.rechtschreibrat.com/DOX/rfdr_PM_2017-06-29_Aktualisierung_Regelwerk.pdf (June 3rd, 2017).

[6] Graphetic units are enclosed in vertical strokes | | and graphematic units in angle brackets < >.

system and not the branch in which it is studied[7] – is a necessary module for a writing system to function. It is "conceived of as a rule [63] system" (Neef 2015: 713), with rules dealing with the possible relations of units of scripts and units of language(s). Given the fact that the relations between these kinds of units are often not one-to-one, Neef (2015: 716) posits a *graphematic solution space* that includes all graphematically-based possible spellings of a word (for instance *right*, *rite*, *write*, *ryte,* and so on for the phonological form /raɪt/ in English). It is the optional module of *orthography* that "prescribes how to write correctly within the limits of the graphematic solution space" (Neef 2015: 716), singling out which possible spelling(s) conform(s) to a certain norm and are deemed correct.[8] As such, an orthography is only part of a writing system; therefore, writing systems and orthographies are two different concepts that must be terminologically separated.

A brief characterization of the most relevant grapholinguistic units is useful at this point: In graphetics, the central unit is the *basic shape* (a proposed translation of the German term *Grundform* coined by Rezec 2009, 2013). It subsumes the visuo-spatial information necessary to distinguish different shapes. This includes the quantity and form of the elements as well as their topological configurations (e.g., that |T| consists of two strokes and how they are – with respect to each other – arranged in space). Accordingly, |a| and |ɑ| are two different basic shapes that are associated with the same grapheme <a>. On a lower level, basic shapes can be embodied by *graphs* (sometimes referred to as *glyphs*), concrete physical instantiations: |a|, |a|, and |a| are graphs of the basic shape |a|. If one writes down/types the word <banana>, three graphs of the basic shape |a| are produced – even though (at least in type) they might look exactly the same, they are three separate physical manifestations of one basic shape. The central unit of graphematics is the infamous *grapheme*, which can be interpreted as a relation between one (or more) basic shape(s) and one (or more) linguistic unit(s) such as phonemes and morphemes (cf. Figure 1). As such, the grapheme does not carry any visual information in and of itself and is *not* a mere synonym of 'letter' or 'character.'

3.2. The paradox of interpreting writing as *natural*

Having arrived at a preliminary definition of naturalness, the next sections will include descriptions of ways in which it can be applied to writing, a domain of [64] study that was entirely ignored by traditional NT. How can a definition of linguistic *naturalness* be transferred to grapholinguistics? Has the concept of *naturalness* been addressed in writing systems research – and if so, how?

A crucial paradox that must be addressed first is the fact that writing as such is often viewed as *unnatural*. This manifests itself when writing is compared to speech, as the latter is interpreted as primary both phylogenetically and ontogenetically (cf. Dürscheid 2016: 30). It follows that one definition of *natural*, "seemingly inborn," does not apply to writing, for it is not implanted by nature. Unlike speech, it requires explicit instruction and is learned later in life, and quite notably unlike speech, it is not acquired by everyone, if we consider that cultures exist without literacy. Also, compared to speech, writing is a relatively recent invention.[9] Writing is

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[7] Neef (2015) uses *graphematics* to signify part of a writing system theory and *writing systems research* as a name for the linguistic branch in which it is studied. From my perspective, writing systems consist of more than just the graphematic module, meaning that *writing systems research* also deals with aspects other than graphematics. I treat *writing systems research* as roughly synonymous with *grapholinguistics* – the latter being probably a bit broader.

[8] This, of course, is a module that was developed rather recently. Synchronically, many (though not all) writing systems are standardized through orthographies, while historically, different spellings for one word from inside the graphematic solution space were in use simultaneously, sometimes even within one text written by one author.

[9] An interesting question raised by an anonymous reviewer is whether writing would be seen as more *natural* than it is now or even as something as *natural* as speech if it had been around for "many more millennia" or if it were "presented simultaneously to language learners earlier in life." In other words,

not *natural* in this sense; it is *artificial*, which is itself not synonymous with *unnatural*. Words that are closely connected to *artificial* and help illustrate what it means are *man-made* and *invented*. This implies that writing must be *natural* since we *made* it, meaning that it consequently can only exhibit features that can be processed by humans.[10] These features can – just like features of language – be evaluated as more or less *natural*. An approach such as the proposed *Natural Grapholinguistics* acknowledges that writing *per se* is artificial and deeply entrenched within culture. [65]

Nonetheless, there are numerous crucial differences between writing and language as well as writing and speech that must be considered (cf. Dürscheid 2016: 24-34) for a serious account of *Natural Grapholinguistics* to be successful.

3.3. Proposed natural features of scripts and writing systems

In many publications, a picture of an 'optimal'[11] writing system has already appeared, which is based on some allegedly crucial criteria and/or features. This is most evident in guidelines describing how new writing systems should be devised. In *Advances in the creation and revision of writing systems* (Fishman 1977), a contribution is entitled *Principles for the design of practical writing systems* (Venezky 1977), perfectly illuminating how writing systems have been qualitatively evaluated based on criteria, or, in this case, 'principles,' for several decades. These, as plausible as they may appear, were mostly postulated intuitively. They are by no means irrelevant, but while searching for natural features in writing systems that are embedded in the theoretical framework of NT, features must be explained with reference to their underlying foundations – assuming these exist.

Table 1 presents collected 'criteria' for optimal scripts and/or writing systems that have been mentioned in the grapholinguistic literature.[12] Although these are diverse and seemingly unordered, they can be assigned to three categories: 1) the *linguistic fit*, 2) the *psychological/cognitive fit*, and 3) the *sociocultural/ideological* fit of scripts and writing systems. These categories give answers to three fundamental questions, respectively: 1) Does a writing system fit a given language? 2) Does a script or writing system fit human processing needs? 3) Does a script or writing system fit a given social, cultural, etc. context? The following remarks only concern writing systems. Questions about the fit of scripts would read – at least in part – differently.[13] They are not of lesser importance and shall be addressed in due course. [66]

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writing would probably be considered *natural* if the phylogenetic and ontogenetic discrepancy between speech and writing was not as remarkable as it is at this point in time.

[10] An anonymous reviewer remarked that the logic of this claim is strained, since it implies that also computers, for example, are natural since humans made them. The logic, however, is not strained; to illustrate this, it helps to invoke Birnbacher's (2014: 7) differentiation of *genetic* vs. *qualitative naturalness*: genetic naturalness is a historical term and refers to the question of how something originated, whereas qualitative naturalness is a phenomenological form of description and relates "to the way something actually appears and [is] related to the present." Artificial flowers, for example, are – and that is what their name refers to – genetically artificial, but at the same time they are qualitatively natural because they resemble natural flowers. In the genetic sense, writing is not natural but artificial since it was 'made' by humans and did not originate in nature – this also applies to computers. In a qualitative sense, however, writing is arguably at least partially natural – and so are computers – since it borrows at least some features from nature that makes it manageable for humans. I even believe that the qualitative naturalness stems from the genetic artificiality of having been created by humans, since humans can only create what they can handle.

[11] The word 'optimal' is reminiscent of *Optimality Theory* (OT). OT and NT are distinct theories that share some similarities, but most notably crucial differences (for some of these, see Hurch 1998).

[12] Some criteria are meant for scripts, some for writing systems, and some for both. This highlights the fact that these notions are often not kept apart in the literature.

[13] For example, scripts can have no 'linguistic fit' *per se* because an isolated analysis of scripts excludes the graphematic level and, thus, all relations of units of scripts with linguistic units. However, some aspects might be loosely considered as part of a 'linguistic fit' of scripts. One such factor could be the num-

Table 1: Proposed criteria for the evaluation of scripts and writing systems

Venezky (1977)	Coulmas (2009)	Cahill (2014)
• mechanically suited for the language it is to reflect (1) • compatible with [...] its social-cultural setting (3) • psychologically/pedagogically appropriate for its speakers (2)	• convenience (2) • general applicability and linguistic fit (1) • expressive power (1) • simplicity (1, 2) • stability through time (1) • monochrome coding	• linguistically sound (1) • acceptable to all stakeholders (3) • usable (2, 3)
Baroni (2011)	Smalley et al. (1963)	
• maximum distinctiveness (1, 2) • size of the graph(em)ic inventory (1) • cognitive salience (2) • maximum naturalness (1, 2, 3) • inner consistency (1)	• motivation for the learner (2, 3) • representation of speech (1) • ease of learning (2) • transfer (3) • ease of reproduction	(1) linguistic fit (2) psychological/cognitive fit (3) sociocultural/ideological fit

The 1) *linguistic fit* describes the nature of the relationship between a language and its writing system: in essence, it describes the graphematic module (cf. Baroni 2011). It is determined language-internally. This is precisely what characterizes most grapholinguistic publications: they describe how units of writing correspond with linguistic units. It follows that many writing systems have already been evaluated with respect to two naturalness parameters: transparency and uniformity (cf. section 3.6), subsumed as *biuniqueness*. The German grapheme <v> is not transparent since the shapes |v| and |V| are used for both /f/ as in <Vogel> 'bird' and /v/ as in <Vase> 'vase.' Inversely, a linguistic unit is uniformly represented if there is only one basic shape associated with it. This does not hold for German /f/ which can be written as |f|, |v|, and a combination of |p| and |h|, <ph> (cf. Nerius 2007; for an elaborate analysis of the graphematic solution space of /f/, see Balestra, Appelt & Neef 2014). If a grapheme did involve a relation between a basic shape that represents only one linguistic unit (a phoneme, syllable, morpheme, or something else),[14] and this linguistic unit were in turn only represented by that one basic shape, we would speak of a *biunique* relation [67] (cf. Munske 1994: 19f.), a situation that can be evidenced, for example, in IPA, where one basic shape correlates with exactly one sound (cf. Neef 2015: 714f.). This relation – in studies of phonographic systems often treated under the heading of *phoneme-grapheme-correspondence(s)* or, inversely, *grapheme-phoneme-correspondence(s)* – is used to describe whether a writing system/an orthography[15] is *shallow* (as Finnish) or *deep*

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ber of basic shapes a script supplies: If this number is smaller than the number of linguistic units that are to be written in a writing system that employs the script in question, some basic shapes either must be used for more than one grapheme (resulting in a low transparency of the writing system) or new basic shapes must be invented or borrowed from a different script to provide every linguistic unit with a distinct graphetic gestalt (cf. Daniels 2006).

[14] Most writing systems are not purely of one type (e.g., alphabetic, morphographic, and so on) and different graphemes within the same system can refer to different linguistic levels. It must be further investigated how this mixing interacts with the parameter of biuniqueness.

[15] Mentioning both modules in this context is not an indication of a reluctance to commit, but is related to the question: what do the attributes *shallow* and *deep* truly refer to? I argue that it can be both modules: a

(as English) (cf. Katz & Frost 1992), a gradual distinction that can be used to help assess (part of) the linguistic fit of a given writing system.

Share & Daniels (2016: 23-26) point out that this monodimensional concept of orthographic depth applies predominantly to European alphabets and challenge its value for other types of writing systems. They propose ten dimensions of orthographic depth:[16] (1) historical orthographic inertia, (2) spelling constancy despite morphophonemic variation, (3) omission of phonological elements, (4) dual-purpose letters, (5) diglossia, (6) graphic considerations, (7) ligaturing, (8) visual complexity, (9) non-linearity, and (10) inventory size. Not all of these criteria can be categorized under the heading of 'linguistic fit,' as some of them concern the psychological, sociocultural, or technological fit (see below). Altogether, what Share & Daniels define as dimensions of 'orthographic depth' roughly corresponds to what I expect to be relevant parameters of the naturalness of scripts and writing systems, which is underlined by the fact that they "regard these 10 dimensions as merely a catalyst for discussion of the multi-dimensional nature of writing system complexity" (Share & Daniels 2016: 26). However, in line with the criteria listed in Table 1, the assumption of these dimensions is not motivated by external evidence – at least not explicitly. It is the goal of the proposed Natural Grapholinguistics not only to list relevant features of scripts and writing systems but to describe *how*, and, more importantly, to explain *why* they are relevant.

While the 'linguistic fit' of a writing system is determined without recourse to external evidence, this does not hold for the next two categories, the relevance of which has been underlined, for example, by Venezky (1977, 2004). [68]

The 2) *psychological/cognitive fit* of a writing system describes the relationship between human faculties – not only psychological, but also physical and cognitive – and a given writing system. It describes how well a writing system – and its linguistic fit, meaning the semiotic relations between written units and linguistic units (see above) – suit the processing needs of the system's users: readers and writers. The following questions are relevant to the study of this fit: Exactly how does the linguistic fit of a writing system influence its psychological fit? Which features are crucial for processing to work smoothly? More generally put: How does the structure of a system influence performance? The efficiency and ease of reading and writing acquisition, for example, is a reflection of the psychological fit of a writing system.

Hypothetically, one could initially determine the psychological fit – by conducting reading and writing experiments, for example – and, based on the results, make assumptions about the linguistic fit. The broadest hypothesis[17] concerning the relation of the two is: the better the linguistic fit of a system, the better its psychological fit; the same is expected to hold vice versa. This does not mean that causality goes in both directions: the psychological fit appears to be a consequence of the linguistic fit, while the linguistic fit is not (at least not directly) caused by the psychological fit. However, in this context, the *change* of scripts and writing systems must be considered: Although users may not consciously intend to do so, features of writing systems may be changed or eliminated when they are not psychologically suited (in the vein of both 'natural grammatical change,' cf. Wurzel 1997, and 'invisible hand'-theories, cf. Keller 2014).

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writing system is shallow if the graphematic relations between basic shapes and linguistic units are predominantly biunique, while an orthography is shallow if the prescriptive *standardization* of the writing system is biunique. In theory, a writing system that exhibits a high degree of biuniqueness could still be deep if the biuniqueness is obscured by idiosyncratic and unsystematic orthographic conventions. These unformed thoughts need to be tested further.

[16] An anonymous reviewer criticizes Share & Daniels' (2016) use of the term *orthographic depth* because in its original reading, it is "limited to how closely the spelling fits the actual pronunciation, that is, the unidimensional matter of phonological fit." For this reason, an alternative term such as *orthographic opacity* might be preferable.

[17] Such hypotheses as these can be used as a basis for the development of specific analyses of given writing systems, which will be conducted in subsequent dissertation work.

In this way, the psychological fit can act as a catalyst for change and, thus, can influence the linguistic fit.

Sociocommunicative factors also determine what is natural in writing, along with psychological and neurobiological constraints: The 3) *sociocultural* or *ideological fit* deals with questions relating to exactly this kind of sociocommunicative naturalness. Alas, it has often been neglected in research on writing systems. A similar situation holds within NT, as Dressler (1980: 75) writes: "typical 'naturalists' implicitly agree with a methodological separation of the psychological/biological and the social factors. The former must be dealt with first, the latter later on. Unfortunately, most of us tend to omit or postpone indefinitely the treatment of social factors […]."

Cahill (2014) describes several non-linguistic factors that play seminal roles in the context of the creation of new writing systems for as-yet unwritten languages, including the adoption of an existing script or the design of an entirely new script. These factors include governmental policies that are enforced upon writing sys-[69]tems, sociolinguistic factors such as attitudes towards dialects and other languages (e.g., wanting the script and/or writing system to 'look' or *not* to 'look' like the written form of another language), and the wish to signal affiliation to a certain social group (see also Sebba 2009 and Unseth 2005). Whether a (new) writing system succeeds depends critically on these factors, which is why Cahill (2014: 23) stresses "the importance of local community involvement" for the creation of new writing systems. If a community dislikes and rejects a writing system that has been devised for its language, the system has effectively failed, even if its linguistic and/or psychological fit(s) exhibit(s) high degrees of naturalness.

Factors that could be assigned to this latter category of non-linguistic factors are *technological factors*; these include the availability of fonts and keyboards that make the use and dissemination of a writing system possible, which corresponds to Smalley et. al's (1963) 'ease of reproduction' criterion but also criteria such as 'transfer' or 'monochrome coding' (see Table 1). These factors showcase a categorical difference between spoken language and written language: to write, we need tools (cf. Dürscheid 2016: 31). They might warrant their own category, for instance 4) *technological fit*. This question is left open for further discussion.

In conclusion, the criteria shown in Table 1 as well as the categories to which they are assigned are by no means useless; they can serve as preliminary features whose validity has to be tested using external evidence or they can be used by researchers as tools to help them organize natural features of writing systems after having deduced these from external evidence.

3.4. Subtheories of Natural Grapholinguistics

On the first and highest level of system-independent naturalness, the central question is: what is universally preferred both graphetically and graphematically? Graphetically, our physical and cognitive makeup undeniably determines what is natural on a universal level. How are different basic shapes visually processed? Are there any preferences concerning the number of elements in basic shapes or the topological configurations of these elements (questions addressed by Changizi & Shimojo 2005 and Changizi et al. 2006[18])? How exactly can *visual complexity* be defined and which categories – quality, quantity, positioning of information, and so on – are essential? From the perspective of the (hand)writer, which shapes or [70] sequences of shapes involve movements that can be executed more naturally (cf. Watt 2015)?

Questions of graphetic naturalness can pertain to two different levels: At the (a) *microlevel*, we are concerned with the naturalness of individual basic shapes in isolation. What is it about a 22-stroke basic shape from the (traditional) Chinese script such as |聽| used to refer to

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[18] But note Daniels's (2018: 152) critique of these studies' flaws. According to him, not only does the decomposition of basic shapes into strokes not correspond with the actual practice of scribes, but also the omission of any logosyllabically used scripts (which have a larger number of units than other scripts) or more visually complex scripts such as Malayalam and Sinhala should be considered as weaknesses.

the morpheme *tīng* 'hear' that makes it easy or difficult to process? Different questions arise at the (b) *macro-level* upon which we analyze an entire inventory, meaning that we focus on the relations between the units of a script. For instance, basic shapes need to be distinctive enough. What constitutes the minimal graphetic distance between two shapes? In section 4, we will see that extrinsic symmetry greatly diminishes graphetic distance, making it more difficult for readers to distinguish different shapes. This could, in consequence, translate to invoking the wrong graphematic relation on a graphematic level.

Graphematic questions can also be asked at the universal level. Probably the most pressing question of the whole endeavor concerns preferences about the relation between writing and language (i.e., the linguistic fit). The answer to this question should not be phonocentrically or Eurocentrically biased with respect to the kind of linguistic unit that is preferably represented in graphematic relations. Thus, no preference is presupposed as to whether phonemes, morphemes, or something else should be represented,[19] for this question cannot be answered on such a general level. Instead, this must be investigated type-specifically or even system-specifically, and this investigation is dealt with in the two next subtheories. On the level of system-independent graphematic naturalness, one can only assume that the most natural relations between linguistic and visual units are biunique, such as those predominant in shallow writing systems/orthographies. However, an interesting theory that Sampson (this volume) proposes is the tendency of writing systems to evolve "from being phonetically-based when they are [71] young, towards being lexically-distinctive as they mature"; a crucial driving force in this process of evolution is the act of striving to achieve lexical distinctiveness. This is a good example of a probabilistic tendency that acts on the universal graphematic level. It also fits well into the theoretical framework of NT, as it assumes that some features that are more natural for a larger (or more dominant) proportion of readers and/or writers prevail over the course of the development of a writing system.

"In the course of this long evolution, a language usually got the *sort* of writing system it deserved," remarked Halliday ([1977] 2010: 103, my emphasis). When he speaks of a *sort* of writing system, what he is most likely referring to is its type. Compared with the number of assumed language types, types of writing systems are surprisingly sparse. The basic dichotomy between phonographic and morphographic writing systems becomes only minimally nuanced by establishing several subtypes of phonographic systems – namely alphabets, abjads, abugidas, and syllabaries (cf. Daniels 2017; see Gnanadesikan 2017 for a critique of this typology and a more fine-grained approach), a list that is sometimes complemented with a 'featural' type embodied by the Korean writing system (cf. Sampson 2015). So, is Halliday correct in his opinion? Do languages get the type of writing system they 'deserve'? Do features of language types correlate with and, thus, seem to associate with certain features of types of writing systems?

Hypothetically, in an agglutinating language such as Turkish, could graphemes referring to syllables[20] – at least for the numerous biunique affixes that are (mostly) monosyllabic – increase

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[19] Daniels (2017: 76) offers convincing evidence that in writing, there is a primacy of the syllable: "Psycholinguists find that people not literate in an alphabetic script are unable to manipulate portions of the speech stream at the level of the segment [...]; educational psychologists find that syllabic approaches to teaching children to read can be more successful than approaches requiring them to identify subsyllabic segments [...]; phonologists increasingly work with levels of analysis other than that of the segment or individual sound [...]." Furthermore, both writing systems invented by nonliterates who were aware of the existence of writing, and the three writing systems invented from scratch, namely, Sumerian, Chinese and ancient Maya, are syllabic. However, as Daniels (2017: 84) also notes, this fits the typological nature of these languages, as they are predominantly monosyllabic. So, while the syllable seems to be the primary linguistic unit that plays a role in writing, the typological adequacy – the fit of a certain type of writing system for a certain type of language – can obviously override this primacy.

[20] It must be noted that Turkish was historically written in Arabic script; however, writing systems using Arabic script are not classified as syllabaries, but as abjads (cf. Daniels 2017).

economy of production?[21] In a word like <evlerimde> 'in my houses,' segmented as *ev-ler-im-de* and consisting of the lexeme *ev* 'house' and the grammatical affixes *ler* 'PLURAL,' *im* 'my,' and *de* 'in,' could the lexeme be written alphabetically while the affixes are written with syllabographic graphemes that refer to syllables or even with morphographic graphemes that refer to grammatical morphemes and syllables simultaneously? In this case, instead of three units as in <ler> or two units as in <im> or <de>, single units could be produced, respectively.[22] This situation is highly similar to the actual allocation of functions within the Japanese writing system, where morphographic [72] *kanji* are used for primary lexical categories (nouns, verbs and adjective stems, some adverbs) and syllabographic *hiragana* for particles, auxiliary verbs, inflectional affixes of nouns, verbs, adjectives, and so on[23] (cf. Smith 1996: 209-212).

In the context of typological adequacy, the Chinese writing system is often cited: writing Chinese with an alphabetic writing system that is phonologically biunique would – even if it indicated tone – result in myriad homographs that lack semantic clues as to the meanings to which written words refer, a function that is served by radicals in the morpho(syllabo)graphic Chinese writing system (cf. Daniels 2017: 81f.). Absurd situations would arise in which an identical graphematic word could be reproduced several times in a minimal context, each time representing a different meaning.[24] Of course, if the graphematic solution space were large enough, morphographic alphabetic spellings of the type of French <aimez> 'they love' vs. <aimer> 'to love' or the English <to> vs. <too> could provide distinctiveness, but one could argue that this is exactly what the Chinese writing system currently in use already does with its radicals. It merely attaches more weight to the semantic than the phonological level of language, although phonetic components do hint at pronunciations. One of the main advantages of the morphographic Chinese writing system is that it enables the mutual intelligibility of different Chinese 'dialects' even when spoken pronunciations are not mutually intelligible (cf. Chen 2004: 114-128). If a strictly or even predominantly phonographic writing system were employed, this advantage would be eliminated.

Within the last subtheory elaborated in NM, that of system-dependent naturalness, a central conceptual question remains moot: Can we really speak of naturalness at this level, or – as Wurzel stated in a quote above – is 'normalcy' intended instead? As Haspelmath (2006: 60) notes, what is *natural* at this level is determined by frequency (but cf. Dressler et al.'s criticism of Haspelmath's frequentism in Dressler, Libben & Korecky-Kröll 2014). As explained in NM, the lowest level of system-dependent naturalness can overwrite the levels of system-independent naturalness and typological adequacy. The driving forces behind this are *frequency* and *productivity*. If something appears frequently and/or is productive enough within a system, it becomes 'normal.' This, however, does not mean that it is simultaneously *natural*. What is 'normal' in a given system can be highly idiosyncratic. [73]

As an example, most writing systems are typologically-mixed systems (cf. Günther 1988: 43). In this context, aside from the mixing observed in the Japanese writing system, where it is a central and constitutive feature, one could think of logographic elements such as digits or special characters (i.e., <§>) in the English writing system or phonographic elements such as the above-mentioned phonetic components of Chinese characters (cf. Coulmas 1996: 80-83). This

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[21] Another possibility would be an abugida, with <ler> being a <C$_V$C> sequence: <l$_e$r>. Here, technically, as the vowel is part of the akshara <l$_e$>, fewer units would be needed than in an alphabet.

[22] Turkish exhibits vowel harmony, meaning that the vowel in <ler> depends on features of the vowels preceding it; the affix could – in another context – likewise be <lar> (cf. Lewis 2000: 14-19). A possible syllabographic grapheme would be underspecified in terms of the vowel, which could prove less natural than spelling out all the affixes alphabetically.

[23] And syllabographic *katakana* is used for even more functions: "to write foreign names and loanwords, onomatopoetic and mimetic words, exclamations, and some specialized scientific terminology" (Smith 1996: 212).

[24] Chao (1968: 120) gives the extreme example of a story consisting of 36 instantiations of the syllable *xi* with one of the four tones. He notes that "[i]t makes absolutely no sense when read aloud in modern Mandarin, but from the writing a reader of classical Chinese can make out the story […]."

goes to show that individual systems cannot neatly be assigned to one "pure" type of writing system. Even if they predominantly belong to one type, they still display idiosyncratic system-dependent characteristics. This is reinforced through extralinguistic factors, such as political, normative, cultural, and technological factors. It is these extralinguistic factors that frequently enforce unnatural features upon writing systems. These remarks already serve as a bridge to the next subtheory: norms.

The level of norms has not been developed as well within NM as the other levels. However, in grapholinguistics, a crucial distinction imposes itself that is pivotal for an understanding on this level: the difference between the concepts of *writing system* and *orthography*. These terms are often shockingly misused as synonyms, or *writing system* is not used at all and *orthography* is employed instead. As briefly noted in section 3.1, orthographies are optional, normatively-standardized modules of writing systems. As such, they are prescriptive and restrict the resources and possibilities of writing systems. Furthermore, they are often not systematic: The possibilities of writing a word chosen from the graphematic solution space, determining how a word is 'correctly' written, can be highly arbitrary, sometimes even in contradiction to graphematic rules. Examples are German <Mama> 'mum' or <Anorak> 'anorak,' spellings that are not graphematically licensed, but which are still correct according to conventional orthographic rules (cf. Neef 2005: 135).

Factors such as standardization generally come from the outside in that they are usually not imposed upon a system by most of its users but by authorities or commissioned institutions such as the *Rat für deutsche Rechtschreibung* (Council for German Orthography)[25] in Germany and the *bunka-chō* (文化庁, Agency for Cultural Affairs),[26] part of the Ministry of Education, Culture, Sports, Science and Technology, in Japan. However, orthographic rules *are* in fact partially based on the conventions upon which language users have initially and implicitly agreed in the sense of an 'invisible hand' (cf. Keller 2014; Neef 2015: 716).

The frequent arbitrariness of orthographies as well as the fact that they are not primarily designed to exhibit a natural psychological fit must be considered. In this vein, orthographies act as kinds of "walls" in front of the linguist because they [74] greatly complicate the search for natural elements in the writing systems behind them. The arbitrary orthographic surface often does not reveal anything about what is going on in the minds of the writers who produce it (cf. Kohrt 1987: 341; Berg 2016). Therefore, violations of orthographic norms, whether they are conscious or unconscious, are central to the investigation of grapholinguistic naturalness. Variation (i.e., the use of variants *within* the realm of orthographic norms, for example German <aufgrund> vs. <auf Grund> 'because of,' which are both licensed spellings) is also highly relevant because it reflects the flexibility of an underlying writing system and can be used to investigate the writers' preferences.

The module of orthography also calls for comparisons: What do orthographies and orthographic rules for different kinds of writing systems look like? It seems intuitively obvious that they can take on different forms. Indeed, not all writing systems exhibit orthographies that are comparable to those in certain alphabetic writing systems in which "aspects […] most commonly codified […] are grapheme-phoneme correspondence, word division, hyphenation, capitalization, and the spelling of loan words" (Coulmas 1996: 379). In some cases, orthography may refer instead to the graphetic than the graphematic level of a writing system. In Arabic, for example, when omitting or misplacing a dot, the result can be a different basic shape than the one intended, such as دَ and ذَ, which are different basic shapes and take part in different graphematic relations (cf. Brosh 2015). Lacking visual salience, the dot can nonetheless serve as one, and sometimes the only, distinctive feature in Arabic script. Consequently, when it is omitted, a different grapheme will be invoked, and the word is 'misspelled.' Minimal graphetic distance between two distinct shapes is, thus, a source of errors.

This can similarly occur in Chinese script when strokes are forgotten or produced in an incorrect position (cf. Coulmas 1996: 380). Even the sequence of producing the strokes is prescribed (cf. Law et al. 1998), although an error in the sequence of production might not be visible in the written product. Writing systems that use the Roman script, such as German and English, are more error-prone on a graphematic level. While it can prove equally fatal if an element of a basic shape is omitted or misplaced (note that, for example, only a single stroke distinguishes |E| from |F|), mistakes that result from the vastness of the graphematic solution spaces are much more common. Because the English phoneme /s/ is not uniformly represented by one grapheme, for example, <city> could possibly also be spelled <*sity> or even <*scity>, among other possibilities. However, these latter variants, while licensed by the system, do not conform to the orthographic norm and, hence, are considered incorrect. [75]

3.5. External evidence

We may now consider how external evidence can be used to uncover relevant naturalness parameters of scripts and writing systems. Basically, the same kinds of evidence described within NP and NM are relevant. First and foremost, this is first (language) writing system acquisition, referred to as *L1WS acquisition* (cf. Cook & Bassetti 2005). What do children initially acquire when they learn to write and read? This question must be cautiously separated from and treated differently than the question of the order in which elements are acquired in L1 acquisition – although there might be insightful parallels between L1 and L1WS acquisition. As we have seen above, language is – in the prototypical case – "inborn" in the sense that it seems to require no extreme effort for children to acquire. Writing differs in that it is mostly taught and learned in the form of instruction which, in turn, is determined not only by the individual teacher but also – crucially – in a top-down manner by the government in the form of curricula and related systems.[27] Because it is determined externally, the order in which children acquire elements of writing systems cannot be readily regarded as particularly telling.[28] Questions such as "which phonemes/morphemes are acquired earlier?" cannot be transferred to grapholinguistics because the ontogeny of language and writing differs fundamentally.

However, an aspect that is as relevant as the order of acquisition is the mistakes made in acquisition. This type of external evidence is also referred to as *error linguistics*. In this area of research, studies are conducted not only on the mistakes of children but also on those of adults. Furthermore, a broader definition of error also includes conscious choices that orthographically would be considered errors: examples are the omission of punctuation or, especially in German, the neglect of [76] rules pertaining to capitalization. These are, by the way, both forms of lenitions, as we will see below.

Furthermore, what can also be revealing is the analysis of how aphasics or, more generally, people who suffer from disorders of written expression and reading deal with these very pro-

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[27] Here, it must be noted that some children acquire – often without instruction – first rudimentary skills in reading and writing before they enter school. In Anbar's (1986) study, six preschool children from different backgrounds and with varying IQs learned to read without being formally instructed, and their individual processes of reading acquisition show significantly similar patterns. Making an interesting terminological choice, she believes this finding indicates "a *natural* process taking place in the reading development of preschool children who grow up in a particularly literate environment" and that *natural* in this case is supposed to mean "that this process is neither directed nor guided from outside the child by the parents or by some standard reading method, but rather develops within each child as a result of something internal to him or her" (Anbar 1986: 78, my emphasis). Thus, she equates *natural* with 'acquired without instruction.'

[28] However, as an anonymous reviewer noted, teachers "rely on their intuition about the order of presentation; or their textbooks may be written by someone with feeling for issues of how to best instruct children." This means that L1WS might be externally determined, but the instruction is by no means completely random.

cesses (cf. Reitz 1994; Gregg 1995; McCardle et. al 2011). Here, seemingly stable elements that are retained despite these disturbances are considered more natural.

Another central type of evidence is change. Since one prediction of NT is that systems tend to eliminate unnatural features, changes as well as developments in scripts and writing systems will likely reveal more about which features are natural or unnatural. A point about NT that is often adamantly criticized is its seeming teleology, propagating that systems change to become more natural to arrive at an 'ideal' state. This, however, is logically impossible. Change – and this is true for scripts as well as writing systems – "is local and not global because of goal conflicts which characterize all functional systems; […] owing to the tendency of each component of grammar to increase its own naturalness, markedness reduction on one level usually brings about markedness increase on another" (Bertacca 2002: 9; cf. also Wurzel 1997). If, for example, the basic shapes of Arabic script change such that they become increasingly similar, resulting in the distinctiveness for the reader lessening, the reason for this might be a primacy of writing and the fact that similar basic shapes reduce the kineto-graphetic programs a writer must memorize (cf. Salomon 2012 for some patterns of script change).

3.6. Natural processes, naturalness parameters

To transfer the more physically-grounded principles of NP to *Natural Graphetics*, the first question that becomes imminent is how the concept of natural processes can be reinterpreted. Processes that could be classified as fortitions and lenitions do in fact occur in handwriting. Consider, for example, a note you have written to yourself. In many cases, the written product will probably not be as legible as something you would have addressed to another person.

An interesting example for this can be found in pre-modern Japanese letter writing (or the prescriptive instruction thereof), where the social relationship and the difference/sameness of the sender's and addressee's status can be inferred from the degree of cursivization. If a sender wanted to show his or her respect for the addressee, the degree of cursivization was held very low. However, if a person wrote to someone on a hierarchically-lower social level, basic shapes were often distorted to a remarkable extent, sometimes presumably resulting in illegibility; Schreiber calls this *dehonorificating cursivization* (cf. Schreiber submitted). This example illustrates the sociocommunicative foundation of naturalness that results [77] from the interpretation of language as – among other things – a tool for communication: we want to be understood when conveying a message, while our communication partner wants to understand us, at least in an ideal scenario.

Movements made in handwriting (as studied by *graphonomics*, cf. Kao et al. 1986) can generally be viewed through the lens of natural processes: the central question here is which combinations of basic shapes require less effort than others and are, thus, potentially preferred by the producer. This might or might not act upon the *graphotactics*, the rules of how units in a given writing system may be combined.

A modern form of graphetic fortition occurs when we write electronically: printing something bold, underlining it, or setting it in a larger font size. These conscious choices can be interpreted as forms of fortitions. Graphetic fortitions, thus, can be defined as processes which make the product more legible for the addressee. Note the crucial difference between *legibility* and *readability*: something needs to be legible on a material (i.e., graphetic) level to be visually *recognized*; something needs to be readable on a conceptual (i.e., graphematic) level to be *understood*.

Bearing this in mind, lenitions and fortitions can likewise occur at the presumably more conscious graphematic level: the use of abbreviations such as "e.g." or "i.e." is a graphematic lenition. It allows the person producing the text to carry out the writing process more quickly and economically (which should not be confused with 'easily'). The reader, however, must be familiar with these abbreviations; if he or she is, the reading process will not be disturbed. If he or she is not, which may happen when more infrequent abbreviations are used, the text might not be understood. Conversely, spelling everything in uppercase letters, given a writing system

is used that is equipped with distinct inventories of upper- and lowercase basic shapes, can be interpreted as a type of fortition.

In a next step, the semiotically motivated parameters of NM can be reviewed in a grapholinguistic context.

1) Constructional iconicity: A semantically-marked category should be represented by an increase of substance in the *signifier*, such as SG *boy*, PL *boy+s* (cf. Wurzel 1994: 2592).

In writing, the category of plurality can iconically be represented through an increase in visual/graphical material, cf. the Chinese grapheme <木> *mù* 'tree.' Plurality in the signified material, such as in the example of 'more than one tree' in the case of the woods, is signaled through the graphic reduplication of the basic shape, as in <森林> *sēnlín* 'woods.' The increase in the material signified, thus, is iconically represented through an increase in the signifier. The plural in French, for example, often only differs from the singular in its written, but [78] not in its spoken, form: the graphematic words <artiste> 'artist' and <artistes> 'artists,' when spoken in isolation, both have the same pronunciation [aʁ.tist]; the grapheme <-s> serves as an immediate visual marker of a grammatical category, in this case plurality, iconically representing an increase in semantic content and rendering the written form of the word informatively richer and more natural than the spoken version. Other similar examples are the abbreviations <proff.> *professori* 'professors,' plural of Italian <prof.> *professore* 'professor,' or French <MM.>, standing for *messieurs* 'gentlemen,' plural of <M.> which stands for *monsieur* 'gentleman.'

2) Uniformity: In a paradigm that is characterized by uniformity, one function should be encoded by only one form. Examples are the progressive aspect in English which is exclusively encoded by the gerund suffix *-ing* (cf. Crocco Galèas 1998: 66) or the superlative in German which is expressed by the suffix *-st*; note, however, that the relation between *-st* and the superlative is uniform, but not transparent, since *-st* also encodes the 2. PERS. SG of verbs (Dressler 1999a: 137).

In alphabetic writing systems, this parameter shifts the focus to the direction of analysis *phoneme → basic shape* (sometimes referred to as *backward regularity*, cf. Bigozzi, Tarchi & Pinto 2016). The most natural relation would be that, in a grapheme, one phoneme is assigned one basic shape. To provide a non-alphabetic example, in Chinese it can be considered more natural if a seme like *water* is only represented by one radical, in this case radical 85, < 氵 >.

3) Transparency: The use of the inverse parameter to uniformity demands that one marker/one form have one function. An example is the Italian inflectional suffix *-ss-* that expresses the imperfect subjunctive in all three conjugations, e.g. in *tem-e-ss-i* 'I worked' (cf. Crocco Galèas 1998: 70).

A graphematic example of transparency is the consistent representation of vowels in *aksharas* – the smallest units in many Southeastern Asian writing systems (cf. Fedorova 2013). The short vowel /i/ in the Thai writing system is consistently – and transparently – represented by the 'diacritic'[29] ◌ิ, short /u/ by ◌ุ. From a graphematic perspective, the direction of analysis is *basic shape → phoneme* (*forward regularity*), making the written level the point of reference as described in Neef's (2005) analysis of the German writing system. [79]

Semiotic relations that are both uniform and transparent are termed *biunique*.

4) Optimal form: A metric (bisyllabic) foot was proclaimed in NM as the optimal form for a word; affixes are preferably monosyllabic (cf. Dressler 2006: 540).

From a graphetic point of view, the question of visual complexity arises in the context of the 'optimal' form: how dense is the visual information and how is it distributed within the space available for a given basic shape? From a script-graphetic point of view (cf. Meletis 2015) and without recourse to the graphematic level, the Chinese character |一| is obviously visually less complex than |钁| and, from this perspective, represents a more optimal form, exhibiting a

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[29] Note the problematic use of the term 'diacritic' in this context. For a discussion on this topic, see Daniels (2006), Kurzon (2008), and Daniels (2009b).

greater amount of naturalness both for the writer and the reader.[30] This isolated comparison of two basic shapes must be critically reevaluated when the size of the whole inventory and the distinctiveness of the individual shapes are considered. In an inventory such as the Chinese script, which has thousands of characters that each need to fit into the same virtual square, it seems to defy logic that all of them could have such low visual complexity without becoming visually too similar. Thus, if all basic shapes were to conform to the parameter of optimal shape, they would visually converge (as it can be argued has partially occurred in Arabic script), and the distinctiveness necessary for recognition and reading would be diminished. It follows that the optimal shape – at least in large inventories – conflicts with distinctiveness.

In terms of this parameter, a central question is: how interwoven is the graphetic level with the graphematic, that is linguistic level? If the optimal form of a word in each language that employs a phonographic writing system is interpreted as a word consisting of two phonological syllables – as observed in NM – we must ask how these syllables correspond with graphematic syllables and in turn, how these are manifested graphetically. How many graphematic syllables make up an 'optimal' graphematic form? In a writing system that lacks inter-word spaces, what is graphematically considered a word – if such a concept exists in these systems? Do any other (e.g. visual) factors indicate where a word ends [80] and the next begins, similarly to Fuhrhop & Buchmann's (2009) observation that visual length indicates graphematic syllables in German?

5) Indexicality: Direct adjacency of affixes to their base is more highly preferred than a greater distance between the affix and base (caused, for example, by intervening interfixes). An example is the Spanish diminutive *puebl-ito* 'little town,' which is more natural than the alternative *puebl-ec-ito* 'small town' (cf. Dressler 1999a: 136).

A possible question that results from the transfer of this parameter to grapholinguistics is the arrangement and weight of semantic and phonetic components in Chinese characters, which respectively indicate meaning and pronunciation. Another question for which indexicality plays a role is the arrangement of written elements on a page (headlines, paragraphs, columns, footnotes, etc.): which arrangements are more natural, which less natural?

The naturalness parameters that are exclusive to writing remain to be discovered. New naturalness parameters will most certainly be identified, since phonology and morphology are fields that fundamentally differ from graphetics and graphematics. One of these new parameters will be described in the next section.

4. Example: (A)symmetry

A likely candidate for a universal graphetic naturalness parameter is (a)symmetry. In the Roman script, some pairs of letters are extrinsically symmetrical[31] on the vertical axis, such as |b| and |d| or |p| and |q|.[32] This constitutes a challenge for the recognition and, consequently, the reading process, since humans recognize objects regardless of the angle from which they are observed, a phenomenon that is referred to as (cognitive) *object constancy* or *mirror invariance* (for a review of visual symmetry perception, cf. Giannouli 2013). On the macro-level of graphetic sys-

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[30] An anonymous reviewer suggested that |饟| might be a combination of basic shapes rather than a basic shape itself and compares it to digraphs such as <sh> or <ch> in alphabetic writing systems. The difference between this single complex Chinese character and alphabetic digraphs is that the former occupies only one segmental space on the writing surface while in the latter, two basic shapes spread over two segmental spaces (ligatures are a different story). Also, while in the basic shape |林|, the shape |木| is undeniably reduplicated and the two resulting shapes are combined as one new shape, this is already a conceptual, graphematic analysis. When one remains on the purely graphetic, that is purely visual level, |林| is one basic shape (because it is one segment) and is visually more complex than |木|.

[31] Extrinsic symmetry means that two distinct shapes in an inventory are symmetric. Intrinsic symmetry, on the other hand, is the symmetry *in* a shape itself: |M| is intrinsically symmetrical on the vertical axis, for example, and |K| on the horizontal axis.

[32] But note that in many fonts, these pairs of basic shapes are not perfectly symmetrical, for example, through the use of serifs that – in this case – serve as distinctive features (cf. Wiebelt 2004: 278-280).

tem-independent naturalness, this leads to the decreased distinctiveness of the basic shapes in an inventory, but on the other hand – accepting that naturalness conflicts exist – it increases the economy of production, since fewer shapes must [81] be memorized, and the size of the inventory is reduced. In perception, extrinsic asymmetry is more natural; in production, extrinsic symmetry arguably is.[33]

Examining the external evidence, we see that both children who acquire writing and reading and language users with impairments are challenged by this kind of symmetry, resulting in the production of mistakes (Pegado et al. 2011; Lachmann & Geyer 2003). This is probably the reason symmetry is systematically reduced in script change, as Wiebelt (2003, 2004) showed in her extensive study of 41 scripts. Interestingly, *mature scripts* – that is, scripts that have been invented long ago and have subsequently been in use for a long time – lacked symmetry. (Relatively) young scripts that were not invented for natural use, referred to as *invented scripts* by Wiebelt (2004), and that are often not used by a large community or used to write a real natural language (cf. the scripts invented by J. R. R. Tolkien), on the other hand, display a great deal of extrinsic symmetry. A possible explanation for this could be that, in the context of inventing a script, the focus is on the production and not on the perception, and the economy of production (and memorization) for the inventor is increased by creating distinct shapes that are extrinsically symmetrical. The subsequent long period of use by larger communities and, thus, the primacy of perception, reduces symmetry.

This, however, is merely a starting point. A next step would be to investigate the way extrinsic symmetry is processed in a variety of other scripts. If the above holds for these as well, (a)symmetry can be accepted as a relevant parameter of graphetic naturalness.

5. Conclusions

Although the cultural technique of writing is still often seen as secondary to speech and, compared to the latter, deemed 'unnatural,' even systems as artificial and culturally determined as scripts and writing systems can be evaluated based on how they serve both the languages for which they are used and us (i.e., the readers and writers). How fit are the writing systems – visually, kinetically, cognitively, or sociocommunicatively – to fulfill the functions we allocate to writing today? As outlined in this paper, *comparison* is crucial to understand writing as it can help researchers evaluate the linguistic, psychological, and sociocultural fit of scripts and writing systems. As elaborated in Naturalness Theory, external evidence such as the acquisition of writing and the changes evident in the history of writing shed light on what is *more* and *less* *natural*, serving as a *tertium com*-[82]*parationis*. *Natural Grapholinguistics*, thus, is an approach that emphasizes the importance of cross-grapholinguistic studies. These types of studies can uncover not only what is universally natural, but also what is natural in different types of scripts and writing systems or, at the lowest level, specific scripts and writing systems. In a nutshell: *Natural Grapholinguistics* allows researchers to deepen their knowledge about the nature of writing.

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[33] In the case of intrinsic symmetry, an anonymous reviewer argues, symmetry can be beneficial both for production and for perception.

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