Where the Principles Fail

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on the occasion of his 64th birthday

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Language as a Lacework of Layers, Including Visual Ones

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1. Introduction

Popular wisdom holds that spelling is not part of language. Linguists and laymen alike consider phonology, morphology et cetera to be integral parts of the system of language, but not their alphabet or the rules of orthography. But if, following Jackendoff (2002, 2007), a language system is a collection of layers of information and mapping relations between them, might not spelling be a layer too? Of course, spelling is different because it need not operate in synchrony with other layers, its essence is to allow spoken forms to escape the bounds of the here and now. It is also partly a matter of conscious design. Nevertheless, our own research and that of others suggests that, once it exists and is sufficiently wide spread among a speech community, spelling works its way into the lacework of layers and might indeed be entitled to layer status, with interesting consequences, such as an explanation of categorical perception.[1]

2. Spoken language: lacework of layers

One of the founts from which natural language flows, is our urge to attribute meaning to morphological distinctions in a wide sense. Nature nor origins of such distinctions matter, nor do semantic considerations. Only age counts. As one grows older, it gets more difficult to master new form-meaning relations, cf. the difficulty to master case systems or noun classes in another language than one's mother tongue.

Structurally, anything goes. Gradual differences are converted into gradual shades of meaning, dichotomous distinctions into semantic dichotomies. For instance, gradual phenomena like loudness and pitch assign some degree of

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[1] The present article combines the insights of a publication on orthography by Neijt (2009) and a book on language evolution by Smits (2009). It benefitted from remarks by Sieb Nooteboom and Robert Schreuder.

insistence, urgency or probability to utterances, whereas the negation *not* causes a clear dichotomy between pairs like *it is raining* and *it is not raining*.

The converses of these relations occur too: morphological dichotomies cause gradual shifts in meaning and vice versa. There is a morphological dichotomy between *it is raining in Blackpool* and *it is probably raining in Blackpool*, but their probability differs gradually. Tone of voice, facial expressions and body language help to specify a speaker's intentions, but on paper additional words or punctuation marks are in order. Sentences differ dichotomously through their presence or absence, but the semantic distinctions between *I should be going...*, *I should be going!* and *I should be going?* are both clear and gradual.

The same holds of quantities. *No ants in my bed* certainly implies that not a single ant can be found there, but *no ants in my garden* requires only that the number of ants there be negligible. It all comes down to knowledge of and experience with the world.

Categorical perception (Fig. 1) exemplifies how gradual morphological distinctions cause interpretive dichotomies. Physically, the tension of vocal chords and the articulatory position of, say, the tongue vary steplessly, as do the resulting sounds. Yet we perceive clear dichotomies like [d] – [t], [d] – [g], et cetera.

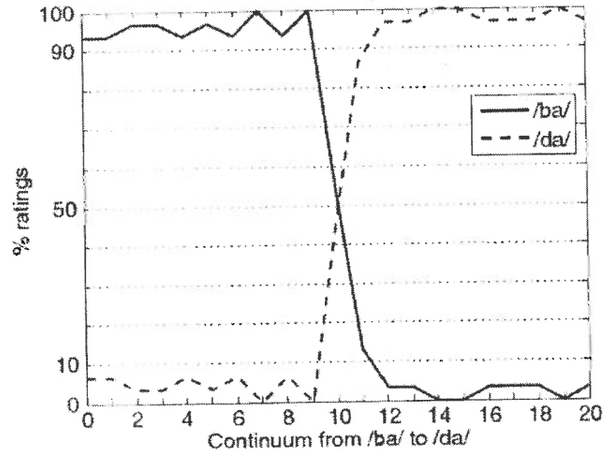

Figure 1. The x-axis shows the continuous trajectory from ba to da, divided into 20 steps by phonetic manipulation. The y-axis represents the scores for ba or da at each step: steps 0-9 yield ba, 11-20 result in perceived da (from Teinonen et al. 2008).

The phenomenon is as enigmatic as it is well established (Liberman et al. 1957). The usual explanation calls on categorical production, the idea that there is no middle ground between /b/ and /d/. Alternatively, unconscious reconstruction of incoming signals by the hearer is assumed. Only recently, Teinonen et al. (2008) showed that extra visual information might explain the phenomenon. In their study, six months old infants learned to distinguish between *ba* and *da* through the co-occurrence of the auditory signals with a dichotomous visual clue: with *ba* the

speaker's mouth is closed, with *da* it is not. If true, language learning draws upon related information from several layers, in this case an acoustic and a visual one.

This idea is supported by the so-called McGurk effect (McGurk and MacDonald 1976), which occurs when even adults hear someone saying *ba ba ba ba*... while watching someone mouthing *ba ga ba ga*... McGurk's subjects reported hearing neither *ba* nor *ga*, but *da* whenever they saw an open mouth. If they closed their eyes, the effect disappeared. Thus, simultaneously experiencing [g] visually and [b] acoustically results in a perceived consonant [d]. Obviously, different layers of information simultaneously contribute to interpretation, which is only to be expected if languages have Jackendoff's (2002, 2007) parallel architecture.

Extrapolating categorical perception from speech sounds to language acquisition in general, we propose that perceived systematic differences involving information from multiple layers are interpreted as categorical distinctions. This probably happens in phonematic recognition (Fig. 2 and 3). The positions of the tongue, lower jaw and vocal chords vary continuously with no discernable edges between movements or sounds. They also move in accord with each other, e.g. not as in Figure 2, but as sketched in Figure 3. This harmony causes us to hear separate, clearly different segments of speech (Nooteboom 2007).

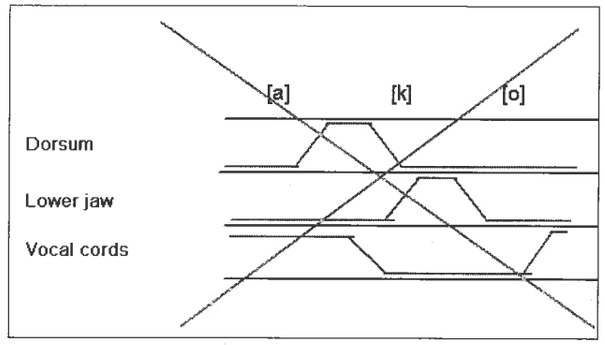

Figure 2. In speaking, tongue and lower jaw move up and down and vocal chords vibrate at different rates or not at all. These gradual articulatory movements never randomly break step, as sketched in this figure. (from Nooteboom 2007: 138).

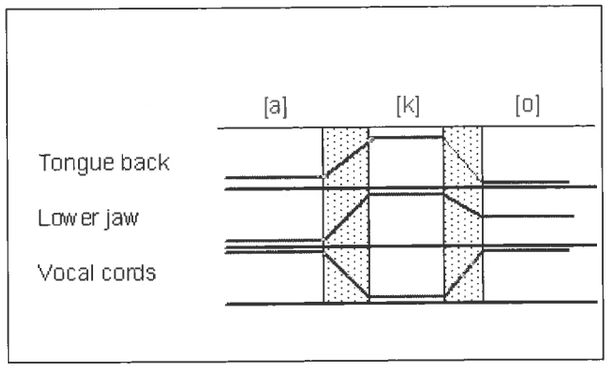

Figure 3. This figure shows what really happens, albeit in much simplified form: the movements are highly synchronised. It is their co-occurrence that causes us to experience clearly distinguishable separate segments of sound (from Nooteboom 2007: 138).

Extra layers of information obviously need not be visual, as they were in the work of Teinonen et al. (2008) or McGurk and MacDonald (1976), but may consist of different kinds of articulatory movements too. Even semantic information may serve this purpose. Language users learn to discern acoustically different forms like the pair *beer* and *deer* not just on account of the necessarily different configurations of the mouth, but also because they have different meanings (Peperkamp and Dupoux 2007). Meaning seems to be a necessary part of the process, for there is no visual clue in a pair like *deer – tear*, and both are visually identical to *sheer*, *hear*, *near*, *sear* and *leer*, while *beer* is indistinguishable from *mere* and *peer*. Therefore, it looks like the combination of acoustic and semantic information helps us to learn the difference between them. All this yields the following first theorem:

> **Theorem of Added Layer Value**: In acquiring language, learners profit from the multilayered character of the available information. Layers may contain completely different kinds of information.

This theorem raises the question whether alphabetic writing systems might be a relevant kind of information. Frost and Ziegler (2007) and Taft et al. (2008) have found psycholinguistic indications that they do. Aspects of the acquisition of Dutch point the same way.

3. Linguistics rebutted by psycholinguistics

Are phonemes real basic building blocks of languages, or are they artifacts of alphabetic writing instead? Contrary to received opinion, Morais et al. (1979) and Ehri and Wilce (1980) showed that segmentation skill and phonemic awareness are not only a prerequisite but also a consequence of printed word learning. But the tone had been set long before by de Saussure (1916: 54). "Writing is a trap", the founding father of modern linguistics maintained, "Its action is vicious and tyrannical, and its

misdeeds are monstrosities." Such was the enmity towards writing of the man whose ideas perfused mainstream research and language education throughout the twentieth century. For instance, Bloomfield (1993: 21) claimed that "Writing is not language, but merely a way of encoding language by means of visible marks." "A language", he stated, "is the same no matter what system of writing may be used to record it, just as a person is the same no matter how you take his picture." For good measure he added that "in order to study writing, we must know something about language, but the reverse is not true". And Perre et al. (2009: 73) insist that restructuring, the notion that phonological representations are "contaminated" by orthographic knowledge, is a "counter-intuitive phenomenon for at least three reasons: (1) spoken language is a product of biological evolution, whereas reading and writing are recent cultural inventions, (2) children learn to speak many years before they are taught reading and writing, and (3) spoken words use the auditory modality whereas visual words use the visual modality."

It is hardly surprising that such beliefs about the relation between a language and its writing system gave rise to the current popular wisdom that spelling is not part of language. *The Sound Pattern of English* (SPE, Chomsky and Halle 1967) is a rare partial exception. The model developed there accounts for the variant surface forms by postulating underlying phonological forms which are abstract, but generally very close to conventional orthography (p. 48, 49 and passim). From the perspective that underlying forms are in fact synonyms of written forms, the SPE-model includes a layer of written forms. Similarly, Zonneveld (1980) uses the formalism of generative phonology to develop an autonomous description of Dutch orthography, assuming that orthography and phonology are systems of the same kind.

For some time now, evidence from psycholinguistic research has been accumulating that Chomsky and Halle (1967) and Zonneveld (1980) were actually on the right track and that, although generally accepted, the idea that alphabetic writing systems are isolated from the language system proper, is wrong. For instance, Treiman et al. (1994: 1336) conclude that their findings "challenge the idea, common among modern linguists, that linguistic representations derived from spoken language are primary and that orthography is a mere secondary adjunct. Instead, our results suggest that phonology and orthography are closely related systems that interact during development."

Upon closer inspection, the summary dismissal of restructuring as counter-intuitive by Perre et al. (2009) proves to be ill-founded as well. To begin with, the intuitions involved are those that have been shaped and honed in students of language by what they learned from their teachers and textbooks over the past century.

Next, their belief that spoken language is – in short – "natural" and written language "cultural" is twice mistaken. First, the existence of sign languages shows that speech is not an essential property of natural languages. Second, spoken language might be as cultural an invention as writing (Koster 2005, 2006, 2010). Perhaps the biological basis of the distinction between human beings and animals is fundamental to the creation of both spoken language and writing.

Perre et al. (2009)'s second distinction, the fact that reading and writing are acquired much later in life than speech, may just reflect that writing by hand

requires sophisticated motor skills that take years to mature. The age difference might also explain why learning to write feels like an arduous task, in sharp contrast with the apparent effortlessness that characterises learning to speak. Younger brains are more flexible, later rewiring of the brain may only take place under duress.

Perre et al. themselves refute their own third and last objection to including alphabetic writing systems in the language system at large, drawing on their own study and on recent literature showing that the orthographic modality does affect spoken language processing (Perre et al. 2009: 74). Time and again orthography turns out to be co-activated on-line whenever we hear a spoken word (Pattamadilok et al. 2008; Taft et al. 2008; Ziegler et al. 2008). Orthography may even change the nature of phonological representations, a hypothesis for which evidence was found by Castro-Caldas et al. (1998) and Taft (2006). Such studies show that learning to read and write "literally" changes the way the brain processes spoken language. Lastly, Perre et al. might have called upon the aforementioned McGurk effect, the most perspicuous illustration of the influence the visual modality exerts on speech perception.

In sum, the belief that writing is not language proves unfounded. Instead, spelling appears to be just another layer of information involved in acquiring and using language. We therefore amend our first theorem as follows:

> **Theorem of Added Layer Value (extended)**: In acquiring language, learners profit from the multilayered character of the available information. Layers may contain completely different kinds of information, including orthographic information.

The theorem now predicts, for example, that the experiment by Teinonen et al. (2009) reported above would have worked equally well if the opened and closed mouths had been replaced by pictures of D and B, respectively. But it also entails that the systemic underpinnings of a language change in important ways when it acquires a written form, with real consequences for its users. That puts a burden on researchers as well. In a layered architecture à la Jackendoff, two lines of research must be pursued. First, the internal structure of each layer needs to be investigated, its elements and how they combine. This is taken good care of in grammars. What merits special attention is only the study of the internal structure of the writing system of a language. This is of course not a blank spot. Descriptions of writing systems in general exist (e.g. Nunn 1998 for Dutch; Venezky 1999 for American English, etc.), as do detailed analyses of interpunction (Nunberg 1990) and the internal structure of alphabetic signs (Primus 2007), to name a few. Our concern here is discovering the mapping relations between layers in such systems.

4. Dutch worries about *d*s, *t*s and *dt*s

Learners of Dutch must discover how to choose between *t* and *d*. Initially, as in a pair like *tak* – *dak* ("branch" – "roof"), this is unproblematic. But as any speaker of Dutch knows full well, doing so at the end of especially verbs, where *t* and *d* occur next to *dt*, is a different cup of tea altogether. This choice is a notorious black spot even for experienced writers, receiving great attention in schools. Less known but equally interesting is the fact that there are persistent problems within verb forms

too (Ernestus and Baayen 2001; De Schryver et al. 2008). They caused the invention of *'t kofschip*, the name of an old-fashioned boat: when in doubt, choose *t* over *d* only if in the infinitive the verb stem ends in a consonant in that mnemonic. Even adults still use it occasionally to keep track of the orthography of acoustically equivocal pairs like *ontluisde* ("deloused", with infinitive *ontluiz-en*) and *aankruiste* ("ticked", with infinitive *aankruis-en*).

Verb forms excepted, adults have no need for *'t kofschip*. They rarely if ever make mistakes like **olifanden* ("elephants", from singular *olifant*), **hoogde* ("height", should be *hoogte*), **honten* ("dogs", from *hond*) or **liefte* ("love", should be *liefde*). But children in the early stages of learning to read and write do struggle with such forms (Neijt and Schreuder 2007; Hanssen et al. in preparation). After the first few months of instruction they produce as many as 40% mistakes, slowly improving to about 25% by the end of the school year, and to around 10% after the second year.

This may not be as mysterious as it seems. First remember how Teinonen et al. (2009) showed that additional dichotomous visual information helps infants learn to distinguish [b] from [d] acoustically. Then consider that children acquire the distinction between word initial [d] and [t] on the basis of semantic evidence. Within medial consonant clusters, however, the role of semantics is negligible. By then, context has usually decided whether an unfinished string *har* is likely to develop into *harde* ("hard") or *harten* ("hearts"), or whether *zwaar* is most likely to go on to become *zwaarden* ("swords") or *zwaarte* ("heaviness"). The precise quality of the dental in such cases can remain unspecified in spoken Dutch.

Not so, however, when it comes down to writing. The alphabet contains no provision for fuzzy dentals, it has to be either *t* or *d*. This forces the learner to discriminate unequivocally between *t* and *d* in medial consonant clusters. Eventually, adults do so effortlessly in frequent words, especially when there is an attendant semantic distinction.

If the above is reasonably on the right track, a second theorem follows naturally:

> **Theorem of Alphabetic Autonomy**: Alphabetic writing systems arose and function as asynchronous counterparts to spoken language. Once they are sufficiently widely spread among a speech community, they function as an independent layer of information and representation within a language system by way of exaptation, on equal footing with visual, acoustic, semantic or yet other synchronic layers.

5. Implications and necessities

Interestingly, like certain other layers, spelling itself is layered. The arrays of punctuation marks and diacritics have been added over time as separate layers of information. Different language communities have done so in different ways, just like alphabets and rules of orthography differ between languages. In this respect spelling is like other layers of the language system.

Much of the details of alphabetic writing systems and their evolution remain barely charted territory. What is clear, is that properties of alphabetic writing systems have a concrete bearing on the acquisition of language, regardless of

popular wisdom. They even change the way adults relate to parts of their language – through literacy, they become and stay aware of characteristics of medial consonant clusters that otherwise would probably remain unspecified for life.

In this light, the traditionally cavalier treatment of spelling is no longer warranted. Instead, we should be aware that spelling equals neither phonology, nor morphology or semantics, but is an independent self-contained layer of information inherent to the language system. The impact of writing systems on language learners and language users strongly suggests that a dynamic multi-layered architecture is an essential property of human languages.

References

Bloomfield, Leonard. 1933. *Language*. London: George Allen & Unwin Ltd.

Castro-Caldas, Alexandre, Karl Magnus Petersson, Alexandra Reis, Sharon Stone-Elander & Martin Ingvar. 1998. The illiterate brain. Learning to read and write during childhood influences the functional organization of the adult brain. *Brain* 12, 1053-1063.

Chomsky, Noam & Morris Halle. 1968. *The sound pattern of English*. New York, Evanston, London: Harper & Row.

De Schryver, Johan, Anneke Neijt, Pol Ghesquière & Mirjam Ernestus. 2008. Analogy, frequency, and sound Change: The case of Dutch devoicing. *Journal of Germanic Linguistics* 20(2). 159-195.

Ehri, Linnea C. & Lee S. Wilce. 1980. The influence of orthography on readers' conceptualization of the phonemic structure of words. *Applied Psycholinguistics* 1. 371-385.

Ernestus, Mirjam & R. Harald Baayen. 2001. Choosing between the Dutch past-tense suffixes *-te* and *-de*. In Ton van der Wouden & Helen de Hoop (eds.), *Linguistics in the Netherlands 2001*, 77-78. Amsterdam: John Benjamins.

Frost, Ram & Johannes C. Ziegler. 2007. Speech and spelling interaction: the interdependence of visual and auditory word recognition. In M. Gareth Gaskell (ed.), *Oxford handbook of psycholinguistics*, 107-118. Oxford: Oxford University Press.

Hanssen, Esther, Robert Schreuder & Anneke Neijt. In preparation. The acquisition of fuzzy dentals in word medial position.

Jackendoff, Ray. 2002. *Foundations of language: Brain, meaning, grammar, evolution*. Oxford: Oxford University Press.

Jackendoff, Ray. 2007. *Language, consciousness, culture: Essays on mental structure*. Cambridge, Massachusetts: MIT Press.

Koster, Jan. 2005. Is linguistics a natural science? In Hans Broekhuis, Norbert Corver, Riny Huybregts, Ursula Kleinhenz & Jan Koster (eds.), *Organizing grammar: Linguistic studies in honor of Henk van Riemsdijk*, 350-358. Berlin & New York: Mouton De Gruyter.

Koster, Jan. 2006. Taal als technologie [Language as technology]. *TABU* 35. 87-118.

Koster, Jan. 2010. Recursion and the lexicon. In Harry van der Hulst (ed.), *Recursion and human language*, 285-297. Berlin & New York: Mouton de Gruyter.

Liberman, Alvin M., Katherine S. Harris, Howard S. Hoffman & Belver C. Griffith. 1957. The discrimination of speech sounds within and across phoneme boundaries. *Journal of Experimental Psychology* 54(5). 358–368.

McGurk, Harry & John MacDonald. 1976. Hearing lips and seeing voices. *Nature* 264. 746–748.

Morais, José, Luz Cary, Jesus Alegria & Paul Bertelson. 1979. Does awareness of speech as a sequence of phones arise spontaneously? *Cognition* 7. 323-331.

Neijt, Anneke. 2009. Spelling als handelswaar [Orthography as merchandise]. *Tijdschrift voor Nederlandse taal en letterkunde* 125. 182-188.

Neijt, Anneke & Robert Schreuder. 2007. Asymmetrical phoneme-grapheme mapping of coronal plosives in Dutch. *Written Language and Literacy* 10. 139-154.

Nooteboom, Sieb. 2007. Alphabetics. From phonemes to letters or from letters to phonemes? *Written Language and Literacy* 10. 129-143.

Nunberg, Geoffrey. 1990. *The linguistics of punctuation.* CLSI Lecture Notes 18. Menlo Park, Stanford & Palo Alto: CLSI.

Nunn, Anneke. 1998. *Dutch orthography.* Nijmegen: Radboud University dissertation. LOT dissertation series 6. The Hague: Holland Academic Graphics.

Pattamadilok, Chotiga, Laetitia Perre, Stéphane Dufau & Johannes C. Ziegler. 2008. On-line orthographic influences on spoken language in a semantic task. *Journal of Cognitive Neuroscience* 21(1). 169-179.

Perre, Laetitia, Chotiga Pattamadilok, Marie Montant & Johannes C. Ziegler. 2009. Orthographic effects in spoken language: On-line activation or phonological restructuring? *Brain Research* 1275. 73-80.

Peperkamp, Sharon & Emmanuel Dupoux. 2007. Learning the mapping from surface to underlying representations in an artificial language. In Jennifer Cole & José I. Hualde (eds.), *Laboratory Phonology* 9, 315-338. Berlin & New York: Mouton de Gruyter.

Primus, Beatrice. 2004. A featural analysis of the Modern Roman Alphabet. *Written Language & Literacy* 7(2). 235-274.

Primus, Beatrice. 2007. The typological and historical variation of punctuation systems: Comma constraints. *Written Language & Literacy* 10(2). 103-128.

Saussure, Ferdinand de. 1959 [1916]. *Course in General Linguistics*. [Translation by Charles Bally & Albert Sechehaye (eds.). *Course de linguistique générale*.] New York: Philosophical Library.

Smits, Rik. 2009. *Dageraad. Hoe taal de mens maakte.* [*Dawn. How language made us man.*] Amsterdam: Nieuw Amsterdam Uitgevers.

Taft, Marcus. 2006. Orthographically influenced abstract phonological representation: Evidence from non-rhotic speakers. *Journal of Psycholinguistic Research* 35(1). 67-78.

Taft, Marcus, Anne Castles, Chris Davis, Goran Lazendic & Minh Nguyen-Hoan. 2008. Automatic activation of orthography in spoken word recognition: pseudohomograph priming. *Journal of Memory and Language* 58. 366-379.

Teinonen, Tuomas, Richard N. Aslin, Paavo Alku & Gergely Csibra 2008. Visual speech contributes to phonetic learning in 6-month-old infants. *Cognition* 108. 850-855.

Treiman, Rebecca, Marie Cassar & Andrea Zukowski. 1994. What types of linguistic information do children use in spelling? The case of flaps. *Child Development* 65(5). 1318–1337.

Venezky, Richard L. 1999. *The American way of spelling.* New York: Guilford Press.

Ziegler, Johannes C., Ana Petrova & Ludovic Ferrand. 2008. Feedback consistency effects in visual and auditory word recognition: Where do we stand after more than a decade? *Journal of Experimental Psychology: Learning, Memory, and Cognition* 34(3). 643-661.

Zonneveld, Wim. 1980. Autonome Spelling. *De Nieuwe Taalgids* 73. 518-537.