Unifying the written with the spoken for language learners? Augmenting and reducing information of texts by Prosodic Writing and Syllabic Typing

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Unifying the written with the spoken for language learners? Augmenting and reducing information of texts by *Prosodic Writing* and *Syllabic Typing*

When conventional writing systems represent spoken language, the writing process involves both, the addition and subtraction of information. On the one hand, information is **added** on the segmental level, since certain phonemes, omitted in everyday speech, are nevertheless encoded in the script through graphemes (e.g. spoken: "I don't wanna go!" → written: "I don't want to go!"). On the other hand, information is **subtracted** on the suprasegmental level, since written words neglect the prosody of spoken language (e.g. spoken with stress: "I don't WANT to go!" → written: "I don't want to go!"). This imbalance of informational aspects, this "information-distributional shift" is a problem for language learners, because they cannot match the written with the spoken; they often cannot comprehend utterances from listening, though they could from reading (or v.v.). Variations of writing systems could narrow this gap between the written and the spoken language. This paper presents two such variations: *Prosodic Writing* and *Syllabic Typing*. *Prosodic Writing* is a writing style in which suprasegmental information is **superimposed** on words and sentences for language learners: letter strings go up and down, and fluctuate in size and in width in order to reflect pitch movements, intensity and durational variations (e.g. German "zentral" → "zent**ral**"). *Syllabic Typing* is a typing style, a mode of simultaneous multi-key typing (chording) which **reduces** orthographic redundancy (redundant information on symbolic level) by replacing ordered letter sequences through randomized ones (e.g. "enclose" → "encloes"). Both variations have been applied in the classroom. *Prosodic Writing* can help learners read written texts aloud in a better way, *Syllabic Typing* can help learners to reinforce vocabulary and language structures, and together, they could support learners to understand spoken and written language more consistently.

KEYWORDS
Prosodic Writing (PW), increasing/reducing information, redundancy, *Syllabic Typing,* QWERTY keyboard, chord keyboard.

1. Introduction

How much information from spoken utterances should be preserved in a transcription, in a written text? The answer depends on the readers, whether they are native speakers or language learners. While this paper focuses on the latter, a discussion of the former will serve as a starting point. The relationship between spoken language and written language as produced and utilized by native speakers is complex: Spoken language contains a lot of information that is omitted in a written text. The linguistic content is being encoded, whereas paralinguistic information – expressed in prosodic elements like intonation, stresses or pauses – is omitted.

However, written language is not only a *generalization* of the spoken utterances through the negligence of certain individual or speech-melodic components. It is also an *idealization* of utterances, since these often include defunct or even missing phonemes, which – nevertheless – are encoded by the corresponding graphemes in the script. In particular, unstressed syllables are often incomprehensible in isolation, and listeners as well as speech recognition devices have to rely on the *orthographic redundancy* and *context* in order to reconstruct the linguistic content of a spoken text.

Thus, a written text is not simply the spoken text in a different medium, but it is rather a *transformation*, preserving the linguistic core of the spoken text, but doing so by neglecting some data components and adding others, roughly speaking by a shift of the informational center of gravity from the suprasegmental to the segmental side (see Table 1).

This *imbalance* or *distortion* is hardly noticeable to a native speaker. His cognitive processes are well trained to extract – to unpack and reconstruct – the linguistic code from the written or the spoken, and mostly nothing but this linguistic output reaches his consciousness, the content in the two modalities is perceived as consistent or even identical. He only becomes consciously aware of the substance in the case of disrupted data like illegible handwriting or conversations amidst a noisy background, if the noise levels exceed certain limits.

Table 1: Imbalance of spoken and written language

Two modalities	An utterance contains: The spoken	It does not contain: The unspoken
A transcript contains: The written	Linguistic core (incomplete; recoverable through redundancy)	Certain phonemes of unstressed syllables, segmental information, ...
It does not contain: The unwritten	Prosody, suprasegmental information, ...	... (Irrelevant for this paper)

However, the imbalance of the written and the spoken creates inconsistency for language learners, and this is a serious problem, since they often do not understand the spoken, though they would understand the written, and vice versa.

This paper therefore questions the apparent predominance of standard writing systems for language learners, which becomes obvious when opening conventional language textbooks or learning sites.

The hypothesis of this research is that certain variations of the writing systems would make the correspondences of the written and the spoken more evident, and thus would support the learners in grasping or guessing also the hidden elements in both domains.

The paper presents one example for superimposing data on a written text, data, which usually is only contained in the spoken domain (Section 2: *Prosodic Writing*), and one example for subtracting certain data, which is usually contained much clearer in the written (Section 3: *Syllabic Typing*). Section 4 compares the two writing system variations and discusses these variations in terms of redundancy.[i]

2. *Prosodic Writing*

This section introduces *Prosodic Writing*, a writing system that also makes prosody visible in the written text. Concept, experience in classes, empirical results, limitations and future work are summarized. The examples are in German, but most things said hold for English as well.

2.1 Introduction of the concept

Prosodic Writing is a writing style or writing system that also encodes the prosody of spoken language (Rude 2002, Rude 2017). Prosody is comprised of all suprasegmental features of spoken language. In the scope of this research, mainly intonation, stress, pauses and the resulting rhythm are being addressed. These phenomena emerge from fluctuations of the three perceptual variables pitch, loudness and duration of consecutive syllables, the carriers and basic units of prosody (narrow sense of prosody[ii]).

Prosodic Writing strives at visualizing prosody through showing (1) pitch movements by vertical letter fluctuations (similar to expressing a melody by the vertical fluctuations of notes in a music score), (2) loudness variations by size fluctuations of letters (louder syllables/vowels represented by larger font), and (3) speed variations by fluctuations in letter density (higher speech rate is represented by a more condensed font). It can be realized by computer or by hand.

Thus, the sentence “Ich bin Ausländer …” (Fig. 1, line 1) is written with larger “Ich” and “Aus”, expressing stresses on these syllables, a smaller and condensed type of “bin” to express both the absence of stress and the higher speech rate, and with a rising letter string on “-länder” in order to show the rising intonation of this phrase, expressing its continuation[iii] in lines 2 and 3.

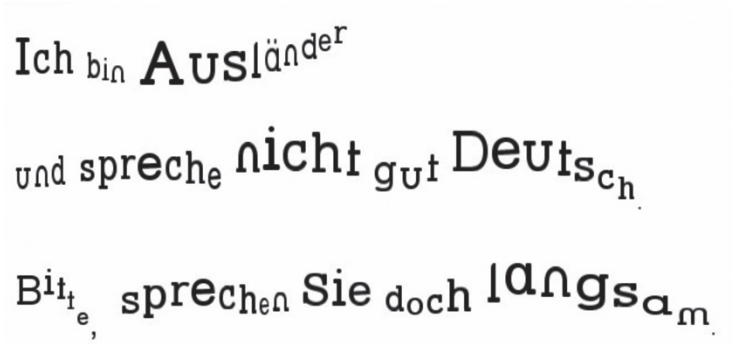

Fig. 1: *Prosodic Writing (PW)* expresses intonation, stress, pauses and the resulting rhythm. (English word-by-word: "I am (a) foreigner", "and speak not good German.", "Please, speak you EMPHASIS-MARKER slowly!"; *PW* generation tool by Takakazu Nakane (Rude 2014).

Students receive such texts and practice to read out the sentences by also using audio. It might be too much to ask students to produce a version of *PW* as in Fig. 1 when preparing a speech or another text for being spoken out. However, a simplified version could already express the stress pattern, e.g. secondary stress by caps, and primary stress by caps & underline, as in Fig. 2, and such a simplified version could be done by students themselves.

ich bin AUSländer und SPREche NICHT gut DEUTSCH.
ich bin AUSländer und SPREche NICHT gut deutsch.
BITte, LANGsam, BIT-TE, LANG-SAM.

Fig. 2: Simplified version of Fig. 1, showing just stress and rhythm.

2.2 Benefits and experience in class

Giving students such materials allows a shift of focus on prosodic language aspects whenever needed. The rhythmic, intonational and durational cues can be ignored, as long as grammar is explained or discussed in a lesson. However, whenever pronunciation problems arise, the visualized features can be exploited in order to interpret the information structure or to produce utterances with proper intonation.

Students judge *PW* as helpful and often as more helpful than other comparable visualizations, e.g. symbolic markings additionally to text, which have also been introduced and used in class. Students note occasionally the ease with which they can see and perceive the prosodic cues in PW samples at a glance, a comment that hardly appears with respect to symbolic cues. Additionally, the analog coding of the prosodic cues of Fig. 1 could gradually be reduced as the learners get more advanced, in a similar way as stimuli can be slowly reduced and yet cause the same effect in other organisms.

2.3 Empirical evidence of the effect of *PW* and prosody visualizations

One possible critique could be, that visual cues might be superfluous nowadays, since audio versions of texts are either available or easily producible. But the different modality makes a qualitative difference, as a study with *Prosodic Writing* suggested: The study indicated that there is a good reason to supply a specific visualization, when there is already a strong – but misleading – visual-audio association.

In an experiment with Japanese learners of the German language, a text containing the word "zentral" (German for "central") was to be read out loud. The students received the text in normal writing in a pre-test, and in *PW* in a post-test, groups A & C additionally had the audio source, group B did not. Interestingly, group B, while relying only on the visual (Fig. 3, "zentral", showing clearly the stress on the second syllable), outperformed group C, which received both text and audio ("zentral", with clearly audible stress on the second syllable). In the pre-test, only one of all 15 students stressed the word correctly (though A and C already had the audio source), but in the post-test all five students in the non-audio group B did, while just two of four in the audio-plus-visual group C stressed the word correctly. This result is surprising and suggests that strong interfering audio patterns (English: "central", stress on first syllable) possibly suppressed the correct perception and reproduction of stress location of the audio form of the German word (second syllable) for some of the students of group C, but that the limitation to the visual pattern (Fig. 3) could break the strong negative interference for the whole group B (Rude 2012).

Furthermore, the students of the visual-only group B reached a durational ratio of 2:1 between stressed and unstressed syllable, which is similar to the ratio of the model native speaker on the audio CD for that textbook passage, and which roughly corresponds to the ratio of the widths of the visualized syllables in Fig. 3. However, it should not be forgotten that both groups were rather small, such that a generalization of these results is not possible.

Fig. 3: The German word "zentral" – here visualized in PW and enlarged – has its word stress on the 2nd syllable and a durational ratio of about 1:2 between the unstressed ("zen") and stressed ("(t)ral") syllable, mirrored in the visual; this is in contrast to the English "central". (Reprint from Rude 2012)

In a recent study in Belgium it was shown, that children could be significantly helped with reading expressively, when prosodic cues were visualized in a text (Bessemans et al. 2019). In this study, prosody was visualized in a very similar way to *PW*: stress was visualized by using boldness for keywords, a wider font

(horizontally stretched characters) for duration (lengthening) and a raised font (superscript with constant font size, raised by a constant value, not as in *PW* continuously) for pitch. There was a significant improvement in prosody when using these visualizations in the three parameters of stress, duration and pitch, but only when the functions of the three visualization components were explicitly explained to the children. Initially, the researchers had expected the children to grasp the meanings of the three prosodic cues intuitively (Bessemans 2019, 14); but this turned out to be wrong, just as the same expectation was wrong in Rude (2002). However, if explicitly taught (as also done in Rude (2012) above, between pre-test and post-test), such visualizations seem to be very helpful for teaching prosody.

2.4 Limitations

The production of *PW* by computer as in Fig. 1 is time consuming, since the user interface requires its user to enter the parameters for the 3 dimensions (pitch, loudness & duration) separately. The manual production of *PW* samples, as the one in Fig. 3, also takes some time, but this process is more holistic,[iv] and can eventually become as subconscious and automatic as the production of real prosody when speaking. Therefore, the author uses mainly handwritten materials of *PW* in class.

Since no convenient tool exists to produce either of these materials, a wider application of *Prosodic Writing* is hampered. The initiation of an open source project, or of drawing classes held by experts of the visual arts with a musical sense might be a solution out of this dilemma.

2.5 Section summary and future work

PW (Prosodic Writing) is a rather intuitive way to visualize prosody in a language class. However, it must be clear that the visualization itself is only one element in the acquisition process of proper prosody. Embedding the visualizations in a meaningful teaching progression is essential for being effective. First of all, visualizations need to be mentally connected to perception, to the "real thing", to authentic or near-authentic audio data. Second, controlled practice and frequent repetitions are necessary to link this perception with the corresponding articulation and automation.

Instead of simplifying the writing system as in Fig. 2, a similar but well-established form could be chosen: the transcripts of GAT[v] (Selting, Auer & Barth-Weingarten 2011). In the basic transcript of GAT, sentence stress (GAT terminology: focus accent) is notated through capitalizing the letters of the stressed syllable (Ibid., 19); in the fine transcript, secondary stresses (GAT terminology: secondary accents) are also marked through the capitalization of the first core vowel (Ibid., 25). Other conventions exist for pitch movements or pauses. The advantage is that it is a widespread "variation of a writing system", a transcription system focusing on prosody, used in the domain of conversation analysis e.g. for some examples in the "Handbook of English Pronunciation" (Reed 2015). The disadvantage is that it has been designed with the analyst in mind and not the language learner.

One possible progression[vi] in the language classroom could be (1) the

introduction of a new text in *PW* with additional information (linguistic content plus prosodic cues), (2) a later repetition of this text in GAT or a similar variation with a subset of prosodic cues, (3) a further repetition of the text in the standard writing system with its minimum of prosodic cues, which are given by the standard punctuation (e.g. full stop usually indicates falling intonation, etc.).

This progression of visual materials to contain less and less information can be continued even beyond standard text, since standard texts are redundant, they contain "superfluous" information. It could become a text with "reduced redundancy", like a gap-filling text, which forces the learner to reconstruct the original standard text from memory, by using and "reinforcing" his general language knowledge. This is the focus of the next section.

3. *Syllabic Typing* and *Prosodic Typing*

This section introduces *Syllabic Typing* and *Prosodic Typing*, two typing styles on a computer keyboard that exploit chording, the parallel activation of multiple keys, either exclusively (*Syllabic Typing*) or partially (*Prosodic Typing*). With AutoCorrect (MS Word) turned off, texts with scrambled characters will be produced. These can be used for repetition exercises, games or tests, just like the cloze test or the C-test. In this section concept, experience in classes, results, and limitations are reported, and future work is outlined.

3.1 Introduction of the concept

Syllabic Typing is a typing style that uses multi-key strokes including all keys constituting one syllable at a time. *Prosodic Typing* is a hybrid form of typing, a combination of sequential typing and *Syllabic Typing*. *Prosodic Typing* mimics the alternation of stressed and unstressed syllables of speaking in typing.

It is important to distinguish between the process and the product of *Syllabic Typing*, and – accordingly – between the process and the product of *Prosodic Typing*. Details concerning the process can be found in Appendix 3 and (Rude 2019); here, we are more concerned with the products in their uncorrected forms, since they can be applied more quickly in language teaching.

Fig. 4 shows the sentences from Fig. 1 as standard text (above) and in *Syllabic Typing* (below). AutoCorrect was disabled; yet, the words "bin" (line 1: "am") and "und" (line 2: "and") were typed correctly – by chance; the orthographic form is among the six possible permutations of the letters of a trigram. (2 characters: 2 permutations, 4 characters: 24 permutations, 5 characters: 120 permutations)

Ich bin Ausländer
und spreche nicht gut Deutsch.
Bitte, sprechen Sie doch langsam.

ihc bin saulnäedr
und pesrech ctnhi tgu edutcsh.
tbiet, pesrcnhe esi hocd nlagsam.

Fig. 4: Standard text (top) and *Syllabic Typing* (bottom)
The sentences from Fig. 1 in *Syllabic Typing*; AutoCorrect was disabled; permutations were limited to within-syllable, not across syllable borders. Capitalization was neglected.

Fig. 5 shows the same sentences as Fig. 4, now in Prosodic Typing. AutoCorrect was again disabled; now, the stressed words "ich" etc. and the stressed syllables "aus" etc. are typed sequentially and thus orthographically. Scrambling involved complete syllables (up to 4 characters) in the upper text, only bi- or trigrams (up to 3 characters) in the middle text. The lower text was formatted as to foreground stressed and to set back unstressed syllables (smaller font, gray), and capitalized according to usual practice (sentence-initial words & nouns start with capital letters).

ich bni ausänldre
und spreech nicht tgu deutsch.
bitet, sprecnhe sie cdho langsam.

ich bni ausänledr
dun spreech nicht tgu deutsch.
bitte, sprehcne sie odhc langsam.

Ich bni Ausnäledr
und sprehec nicht tgu Deutsch.
Bitet, spreechn Sie chdo langsma.

Fig. 5: Three types of *Prosodic Typing*: Top: Unstressed syllable characters are completely scrambled. Center: unstressed syllable characters are scrambled in subparts (only bigrams and trigrams). Bottom: unstressed syllables are additionally in gray and in a smaller font; plus capitalization of sentence initials and the first letters of nouns.

Out of the five samples, *Syllabic Typing* (Fig. 4, bottom) has the lowest redundancy: All syllables are scrambled and it is very hard to read. The sample in *Prosodic Typing* with foregrounded stressed syllables is interesting (Fig. 5, bottom): Scrambling of unstressed syllables reduces the redundancy, but foregrounding of stressed syllables adds prosodic information, adds redundancy, such that its overall redundancy might be comparable to the standard text (Fig. 4, top).

3.2 Benefits and experience in class

The purpose of such texts is repetition (reinforcement), quizzes (fun, competition) and tests (evaluation). They were used in German language classes for these three purposes in autumn 2019. As tests, they are easy to administer, just like gap-filling tests. And due to their similarity to ordinary gap-filling tests, a good correlation between the achieved score in such tests and the general language competence (or preparation effort) can be expected. Some student voices (with written agreement to be cited anonymously) are listed here in short, they stem from the following question from a questionnaire:

(A) Ja, ich ko___ gern m__! (B) Bruedr Jakob! Bruder Jabok

1. How would you rate the usefulness of these exercises for repetition and learning of vocabulary or language structures?

Table 2: Ten shortened learner comments comparing (A) vs. (B)

A for study, B for review
A for productive learning, B more fun
A for pure memory, B for spelling, beginners
without grey letters: reinforce memory more
NO COMMENT
useful, but can bring confusion sometimes
gray letters are very helpful in first weeks
helps figure out "what sounds right"
more different types of exercises!
Type A is too difficult.
I think that A type might be more useful.

3.3 Summary of results and general argument

On a Likert scale with 5 values (1: extremely useful, 3: neutral, 5: not at all useful), the 11 students judged both types in average on the useful side, type A (1.82) slightly better than type B (2.00). This result suggests that text with scrambled letters are accepted by students. One associates the letter jumble with fun, another with figuring out something. Some consider scrambled texts as more useful for the beginning stage, when the ordinary gap-filling task is still

too difficult, but for later, some express a preference for normal gap-filling.

It is important to explain to students the difference between bottom-up and top-down approaches when solving such exercises. If scrambling involves 4 letters or more, there are too many possible permutations (24 or more) for an efficient synthetic search (trying to create the missing word by putting different characters together, bottom-up). In that case, it is better to read and understand the whole sentence, and the missing word might just pop up from our memory (top-down). The scrambled letters just serve to verify the guess.

As a general argument for the efficacy of scrambled quizzes or tests: Since it is similar to other reduced redundancy tests (noise test, cloze test, C-test, dictation), and since some of them are used not only for testing but also for learning (gap-filling, dictation), it can be expected that also the scramble test or quiz contributes to learning.

3.4 Limitations

For the product: the preferences of students are mixed, and therefore, no single method should be preferred, but rather a combination of tests, puzzles and exercises should be used.

For the process (see also App. 3): *Syllabic Typing* requires training, and a beginner should already be capable of touch-typing (typing blindly): A hunt-and-peck typist (visual key selection) will not experience a speed benefit as in Appendix 3, Fig. 6 (the author had about 40 years of sequential typing practice and 2 years of syllabic typing practice; learning curves for novices will likely be lower). Furthermore, only so-called n-key rollover QWERTY keyboards are suitable for *Syllabic Typing,* since they transmit all key characters of multi-keystrokes to the computer; regular QWERTY keyboards don't, they will suppress some keys of multi-keystrokes.

3.5 Section summary and future work

For the reader of the product of *Syllabic Typing*: uncorrected text can serve as a continuation of the suggested progression for language learners (section 2.5, last paragraph. Step 1: *PW*, step 2: GAT, step 3: Standard orthography) – information being stepwise subtracted –, this section will continue the process of subtracting information: Step 4 could look like the bottom text in Fig. 5, with only some of the syllables being scrambled (the ones in small caps) and some prosodic information added. The final version could look like the bottom text in Fig. 4, where almost all syllables are scrambled and which can only be deciphered if students know the text already by heart e.g. the lyrics of a song (see also App. 1 & 2 for examples).

For the writer or the typist, using *Syllabic Typing* as a process: *Syllabic Typing* or – in a training phase – the combination of conventional sequential typing and *Syllabic Typing* might be a more natural way of typing than sequential typing alone. And – since no new keyboard layout has to be learned – the learning process is not time critical. 500 syllable types account for about 80% of syllable tokens (German, English, and others), and kinesthetic memory could support the learning process, in particular for high frequency syllables and words in a foreign language.

4. Discussion

There is ample research on the legibility of scrambled texts as those in Fig. 4 and 5, e.g. the Ph.D. thesis by Rawlinson (1976) and many related academic and non-academic articles. But the point here is a different one, a more general one.

If the scrambled syllables are replaced by a simple gap, we would get something like a cloze test (Spolsky 69) or a C-Test (Eckes & Grotjahn 2006). These gap-filling tests are so-called reduced redundancy tests and are known to be highly correlated to general language ability. Redundancy relates to the fact, that natural language contains principally superfluous information, which does not contribute to the linguistic core (redundancy is about 50%, Shannon & Weaver 1949, 46[vii]). However, redundancy is necessary for various other reasons, for example for being able to communicate in noisy environments (unstressed syllables might be inaudible, but through the redundancy, the listener can still reconstruct the linguistic core). Now, the ability to deal with reduced levels of redundancy reflects the general language ability of language learners. (If a language learner utilizes the redundancy to make up for some unknown words, he will be more effected by noise.)

From this perspective, we could rename this paper to: "Controlling the signal-to-noise ratio of written texts for language learners? Augmenting and reducing redundancy of texts by *Prosodic Writing* and *Syllabic Typing*". Why? *Prosodic Writing* is highly redundant: It has augmented redundancy, since it contains prosodic cues which are superfluous for native speakers, but not for language learners. And *Syllabic Typing* produces texts with reduced redundancy similar to those in cloze tests, the C-test, the noise-test (listening test with gradually increasing levels of added noise, Splonsky 1969, 12f.), or simple dictation. In particular, the latter is not only a testing device, but an established learning device as well.

Just like nowadays audio materials control the noise level and thus control redundancy for stimulating, training and testing language learners (e.g. listening exercises with noisy announcements similar to authentic ones at a train station), a similar approach for the writing systems would only be straightforward.

5. Conclusion

This paper suggests using variations of standard writing systems in language learning in addition to standard texts, since the latter are only the optimum for native speakers and only the goal for learners, but not necessarily the means to reach this goal. Tables 3 and 4 (adaptations of Table 1) show the problem addressed in this paper, the inconsistency between the domains of spoken language (Table 3, linguistic core plus prosody) and the domain of written language (Table 4, linguistic core plus certain segmentals). This inconsistency is no problem for adult native speakers who can reconstruct the complete domains (written or spoken) from the linguistic core, thanks to the redundancy of languages. For language learners (and for native children) the inconsistency

is a severe problem, and it becomes evident, when they cannot understand a linguistic unit in one domain (e.g. a spoken utterance) which they could understand in the other (in the written domain).

There is evidence that training with *information-augmented* texts, with prosodic cues, are helpful for children to read more expressively and thus help them to produce proper prosody; there are also findings that *Prosodic Writing* has a strong visual impact on language learners that can occasionally break the negative interference from a 2nd language (English) to a 3rd language of study (German) and can lead to correct accentuation, paradoxically even without audio source. For the learners, *PW* is a writing system with augmented information (Table 5). For adult native speakers, such texts represent redundancy-augmented texts (no need to visualize prosody).

There is also good reason for using texts with *reduced information and redundancy*, like gap-filling tasks or dictation (among others), since they measure very accurately language competence over all skills; in this paper, *Syllabic Typing* or *Prosodic Typing* have been suggested, since they produce scrambled text (Table 6). This can yield tasks which are similar to gap-filling tasks and which are possibly more suitable for beginning language learners.

More important than the individual benefits is a general look at the tables: Table 5 shows that the domain of *PW* is the union of the domains of the spoken and the written, whereas Table 6 reveals that the domain of *Syllabic* or *Prosodic Typing* represents the intersection of both. The set union can be said to unify the written with the spoken to some degree, since it contains elements of both almost equally; and so does the intersection. Using all four types of systems in a balanced way might help to solve the inconsistency problem for language learners.

Table 3: The domain of spoken language

Two modalities	The spoken	The unspoken
The written	Linguistic core,	Certain segmentals, ...
The unwritten	Prosody, ...	...

Table 4: The domain of the standard writing system, made by adult native speakers

Two modalities	The spoken	The unspoken
The written	Linguistic core,	Certain segmentals, ...
The unwritten	Prosody, ...	...

Table 5: The domain of *Prosodic Writing (PW)* (augmented information/ redundancy)

Two modalities	The spoken	The unspoken
The written	Linguistic core	Certain segmentals, ...
The unwritten	Prosody, ...	...

Table 6: The domain of *Syllabic/Prosodic Typing* (reduced information/ redundancy)

Two modalities	The spoken	The unspoken
The written	Linguistic core	Certain segmentals, ...
The unwritten	Prosody, ...	...

Notes:

i. The author likes to express his sincere thanks to Torsten Rupp, to the anonymous reviewers and to the editorial committee for their valuable comments. Remaining shortcomings are completely my responsibility.

ii. In a wider sense, also tension belongs to prosodic phenomena, however, this feature – not directly connected to pitch, loudness and duration – will not be treated here.

iii. A high end tone is usually associated with non-finality in German or English.

iv. Holistic in the sense that the 3D prosody of successive syllables is not being consciously decomposed into its three constituents (pitch, loudness and duration), but imagined and expressed as one integral 3D shape.

v. GAT: Gesprächsanalytisches Transkriptionssystem (transcript of talk-in-interaction), NOT: General Aptitude Test.

vi. The term of progression shall express the fact that the learner needs to supply progressively more information from his cognitive resources, since less and less information is supplied by the text itself.

vii. "The redundancy of ordinary English, not considering statistical structure over greater distances than about eight letters, is roughly 50%. This means that when we write English half of what we write is determined by the structure of the language and half is chosen freely."

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Appendix 1: Example for reduced information: Specific knowledge needed.

Repetition of lyrics by gap-filling exercises, in (5) with words partially given (similar to C-test), in (6) … (8) with scrambled letters given. Instruction:
Just for fun: How quick can you finish? **Max: __/59**

5. Wol___ wir i__ Ki__ geh'n
   Ich ge__ lieber schla___.
   Ich ha__ kei__ Lust, ach ne__!
   Tut m__ leid, ich ka__ nicht!
   Ich ka__ heu__ nicht!
   Ja, ich ko___ gern m__!
   Ich ko___ ger__ mit, oh ja! __/16

6. Froh zu esin bedarf es weing
   und wre froh ist, sit ein Köngi! __/ 5

7. Bruedr Jakob! Brured Jabok
   schläfst ud chon? chsälfst du noch?
   Hörst du ctnhi eid Gloneck?
   indg, dang, dong! __/10

8. Grün, gnür, grün inds alel meine Kleiedr
   grün, nürg, grün sti alsle was hci hab'.
   Darum lieb' hci allse swa grün tsi,
   weil eimn Schatz nie Jäerg ist.
   Rot, ort, rot ..., weil mein cshtaz ine Reiert ist.
   Shcwarz ... ein Schornstinefeerg tis.

Wßie ... ine Bäerck ist.
Btnu ... ein Maler ist. __/28

Appendix 2: Example for reduced redundancy test:

General language knowlege is sufficient to solve this test. Instruction: Machen Sie die Sätze komplett!

Please complete the sentences and words. Please write clearly with a black or blue pen (no pencil!) into the boxes and use caps appropriately. Corrector: Please do not write into the boxes, but just circle the correct answers/boxes! Finally, sum up, please! Max: 24 P

1. Was studieren Sie? – Ich studiere Wirtschfastwissenschafetn.
2. Zählen Sie bitte von 10 bis 15. – Okay. Zehn, elf, wzföl, dreizehn, rviezehn, fünfzehn.
3. Ist der Konsonant lang oder ruzk? – Er ist lang. – Das ist leider nicht richtig, das ist facshl.
4. Meine Eltern sind pensiontier und leben in üdsafrika.
5. Wo dsin Sie geboren? – Ich bin in der Türike geboren.
6. Gesrtne war sie krank. Aber heute ist sie wieder gesund und sehr fröhihlc.
7. Singen Sie gerne Liedr? – Nein, leider nicht. – Das macht nictsh! Wir haben ja „Youtube“!
8. Waumr gehen Sie heute nicht in die Universität? – Weil ich Bauchhew habe.
9. Kommne Sie am Dienstag in die Uni? – Nein, aber am Mittcwho komme ich.
10. Sind Sie berufstätitg? – Ja, ich bin Politizs.
11. Was machen Sie in der Freiizte? – Ich schlafe gerne! – Das ist ja langweigli!
12. Welche Staatsangehörigietk haben Sie? – Ich bin Engländneri.

Appendix 3: Details on the process of *Syllabic Typing* and an experiment

Usually, simultaneous typing or chording is done on chord keyboards, e.g. for stenography. There are phonetic chord keyboards (stenotype 2019), used for example by court reporters in the U.S.A., and orthographic chord keyboards (Velotype 2019), which are more common in Europe and available for many languages. However, a QWERTY keyboard could also be used as a chord keyboard. QWERTY keyboards are usually used as sequential keyboards, typing one character at a time. But this is a very abstract process, since we do not assemble spoken language that way – phoneme by phoneme. In fact, early typewriters were not designed to produce text quickly, but just to correctly produce mechanical print.

The smallest functional units in speaking, but also in listening, writing and reading are syllables rather than phonemes. Gleitman & Rozin (1977, 48) state: “In general, syllables are the smallest coherent units of speech: they tend to be physically undissectable, they are the smallest separately pronounceable units of speech, and they may be produced in preplanned units.” Consistent with this

view, Adams (1980, 46) concludes for English: "The present hypothesis fills in the gap. It suggests, as Rozin & Gleitman (1977) have suggested before, that written English is in reality a three tiered system: It is at once an alphabet, a logography, and a syllabary. This insight adds meaning to our knowledge that logographies and syllabaries have not, in history, been abruptly displaced by alphabetic scripts, but instead, have evolved gradually into them."

If so, there is no reason to restrict our input on a computer keyboard to sequential alphabetic input – single characters one after the other.

There is no physiological reason for our fingers to produce language in sequential units (phonemes/graphemes) smaller than those smallest coherent units of our speech organs (syllables). The opposite is true: there are only cognitive reasons against such a restriction on QWERTY keyboards.

Key-sequentiality was a mechanical restriction of early typewriters, however, with the advent of the computer keyboard, this restriction is obsolete. *Syllabic Typing* could be more natural, supportive for language learners (simplifying the acquisition of basic, high frequency words and syllables) and quicker than sequential typing.

In an experiment, the sequence "der die das ", the three German definite articles, was typed repetitively by the author in every trial in both modes, sequentially (12 single keystrokes) and simultaneously (3 single-key plus 3 multi-keystrokes) for 1 min each. Figure 6 shows the result, the learning curve over 131 trials (initially 6 trials per day, later 3 trials per day), a comparison of wpm values (words per minutes) for sequential typing (lower curve) and simultaneous typing (upper curve). Except in trial 8, simultaneous typing was always quicker than sequential typing.

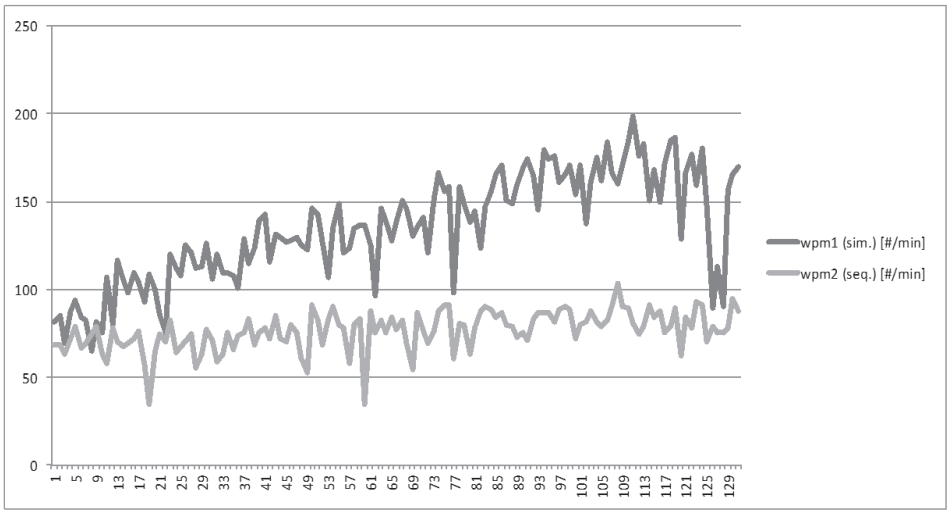

Fig. 6: Above: Learning curve for *Syllabic Typing* "(der) (die) (das) "with six strokes (3 multi-keystrokes of 3-character words plus 3 spaces); below, sequential typing with twelve single keystrokes (9 characters plus 3 spaces). *Syllabic Typing* reached almost 200 wpm and was – except in trial 8 – always quicker than sequential typing.

If we assume that chords (multi-keystrokes) can be typed as quickly as individual keys (single keystrokes), the speed ratio might reach 200% (6 strokes vs. 12 strokes for the given sequence), and thus the theoretical advantage or gain (ratio minus 100%) could be 100% for this string. In fact, the experiment showed in all but one trial a positive gain, mostly higher than 50% and often around 100% (Fig. 7).

Two critical remarks: (1) the proportional relation between the two learning curves ceased towards the last 10 trials (see Fig. 6). Though there might be a simple reason (these trials have been made during a conference and partially on a train), it should be stated that the performance loss affected much more *Syllabic Typing* than sequential typing; sequential typing could be more robust against external disturbances, the reasons for this being unclear. (2) The string "der die das " is extremely simple through its limitation to three monosyllabic words of three characters each, and therefore puts simultaneous typing in a clear advantage. Of course, more experiments have to be done, with more realistic input e.g. with complete sentences and polysyllabic words.

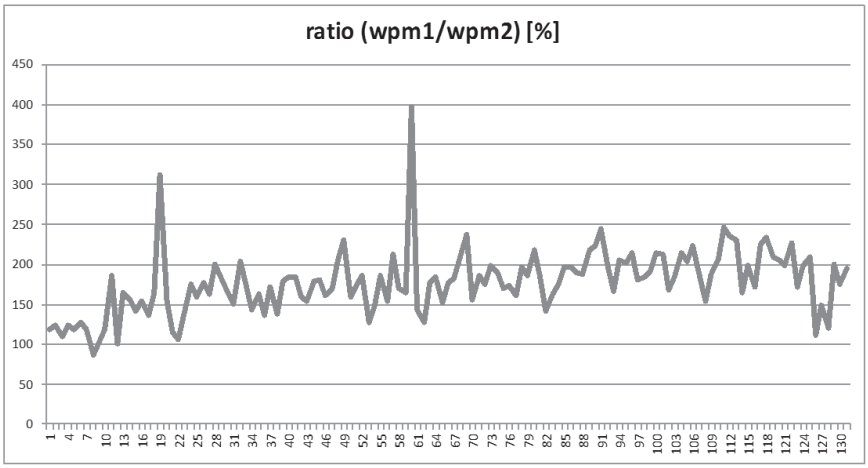

Fig. 7: Ratio of wpm-values of *Syllabic Typing* vs. sequential typing from Fig. 6: This ratio is just once below 100% (in trial 8), but in the second half often around 200% corresponding to a speed gain of 100%, a doubling of the keying rate (counting individual keys per time unit). This speed gain can simply be explained by the advantage of multi-key strokes to individual key strokes, namely by assuming a constant maximum striking rate, whether a single key or a chord is pressed.

Yet, despite these limitations, the experimental result is a clear indication that a speed advantage can be expected from allowing multi-key strokes on a QWERTY keyboard. Even if the gain after certain training might be much lower than 100%, the facts that no fundamental re-learning is necessary (the position of keys is unaltered) and that learning could take place incrementally during normal usage (many users use computer keyboards for decades) justifies further research of *Syllabic Typing* on QWERTY keyboards.