Timing in the written production of German compounds

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General Method

Measuring the time course of writing can give insights into the processes of word production after the initiation of writing.
General Method: *Controlled influences*

- typing skill
- keyboard layout
- motor patterns
- letter context
- grapheme and bigram frequency
- ...

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General Method

- SM: hin-durch
- S: Lin-de
- L: Kin-d

```plaintext
<table>
<thead>
<tr>
<th></th>
<th>h</th>
<th>i</th>
<th>n</th>
<th>d</th>
<th>u</th>
<th>r</th>
<th>c</th>
<th>h</th>
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<tbody>
<tr>
<td>L</td>
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</tr>
</tbody>
</table>
```
Syllable & Morpheme boundaries are influenced by word frequencies.

The bigram <nd> is present in all stimuli.

The first graph shows time in ms, with characters on the x-axis and time on the y-axis. The graph includes data points for SM: hin-durch, S: Lin-de, and L: Kin-d.

The second graph illustrates syllable & morpheme boundaries, with letter boundaries indicated as well. The bigram <nd> is present in all stimuli.
Introduction

• Only syllable and morpheme boundaries are influenced by word-frequencies (SM-effect) (Will, et al., 2003).

• Word frequency effects are considered as evidence for lexical access to the word form (Jescheniak & Levelt, 1994).
Introduction

Alternative explanations for the SM-effect

• composition: complex words are constructed from their morphemes
• holistic access: complex words are accessed as their whole word form

In current models both routes are available and compete (e.g. Caramazza et al., 1988) or can converge on a single representation (Baayen & Schreuder, 1999).
Method: *What we measure*

```
  Post          fach
```

```
P  O  S  T  F  A  C  H
```

IKI

\[ t \]
Method: *What we want to know*

Mental Lexicon

P O S T F A C H

IKI

\( t \)
Method: Possibility 1

P O S T F A C H

IKI

t
Method: Possibility 2

Diagram showing the process of forming a compound word with the sequence 'Post fach'. The timing indicator 'IKI' is shown with an arrow pointing to 'fach', indicating the point of focus or importance in the formation process.
Method

Lexical effects

- relative frequency (Hay, 2000)
- semantic transparency
- productivity
- phonological transparency
- graphotactically probability (prelexical)
- ...
Method: *Stimuli dimensions*

*Stimuli:* German compounds were varied in three dimensions:

1. **relative frequency** (relation between the frequency of the whole word and the frequency of the base)
2. **frequency level**
3. **semantic transparency**
Method: *Stimuli*

Stimuli dimension 1: **relative frequency**

Postfach > Fach  
Kotflügel < Flügel

Stimuli dimension 1: **relative frequency**

*Post*  
*Fach*  

wwFreq = 696  
baseFreq = 72

*Post*  
*Fach*  

wwFreq = 7  
baseFreq = 106

*Kot*  
*flügel*  

wwFreq = 696  
baseFreq = 72

*Kot*  
*flügel*  

wwFreq = 7  
baseFreq = 106
Method: *Stimuli*

Stimuli dimension 2: *Frequency level*

- **+wwFreq-Hi**
  - Post
  - fach
  - \( \text{wwFreq} = 696 \)
  - \( \text{baseFreq} = 72 \)

- **+baseFreq-Hi**
  - Kot
  - flügel
  - \( \text{wwFreq} = 7 \)
  - \( \text{baseFreq} = 106 \)

- **+wwFreq-Lo**
  - Schrot
  - flinte
  - \( \text{wwFreq} = 3 \)
  - \( \text{baseFreq} = 1 \)

- **+baseFreq-Lo**
  - Licht
  - filter
  - \( \text{wwFreq} = 0 \)
  - \( \text{baseFreq} = 22 \)
Method: *Stimuli*

Stimuli dimension 3: **Semantic transparency level**

- **intrans**
  - Kot
  - flügel
  - Rating: 4.6
  - Std. Dev.: 0.5

- **trans**
  - Licht
  - filter
  - Rating: 1.8
  - Std. Dev.: 0.4
Method: Stimuli Distribution

- Stimuli Distribution
  - +wwFreq-Hi-intrans
    - DET  BASE  n=16
  - +wwFreq-Hi-trans
    - DET  BASE  n=9
  - +wwFreq-Lo-intrans
    - DET  BASE  n=13
  - +wwFreq-Lo-trans
    - DET  BASE  n=13
  - +baseFreq-Hi-intrans
    - DET  BASE  n=22
  - +baseFreq-Hi-trans
    - DET  BASE  n=30
  - +baseFreq-Lo-intrans
    - DET  BASE  n=20
  - +baseFreq-Lo-trans
    - DET  BASE  n=32

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Method: Procedure

Procedure:

• Stimuli appeared in a randomised fashion in the upper half of a 19” computer screen.
• Participants were instructed to read the stimulus and to type the word on the keyboard as fast as possible without errors.
• Simultaneously, with the typing of the first letter of the target word, the stimulus disappeared from the screen, i.e. viewing times were self paced.
Method: Participants

Participants:

- 45 students of the University of Osnabrueck.
- All were native speakers of German.
- All were able to type fluently, although no strict criteria were applied (average writing speed: 46.0 words/min, std.dev.: 8.4).
- 34 female, 11 male.
- Mean age: 25.9 years, std.dev.: 3.6
- 42 students were right-handed, 3 left handed.
Results: **Statistical issues**

- Mistyped words (13.2%) and values exceeding 2.5 standard deviations of the mean IKI of the participant/item (4.2%) were discarded from the analysis.
- Original measurements were averaged over subjects.
Results

Mean SM-InterKey Intervals in +whole-word frequency vs. +base frequency compounds

Mean IKIs ± Std.Dev. in ms

+whole word Frequency items

Mean 342 ± Std.Dev.

+base Frequency items

Mean 352 ± Std.Dev.
Results

Mean SM-InterKey Intervals in high vs. low +whole-word frequency and +base frequency compounds
Results

Mean IKIs in semantically transparent vs. intransparent and high vs. low +whole-word frequency compounds
Results

Relative effect sizes ($\eta^2$) for +whole word Freq items

- high/low: 31.4%
- (in-)trans: 1.8%
- high/low*: 0.5%
- error: 66.3%
Results

Mean IKIs in **semantically transparent vs. intransparent** and **high vs. low +base frequency compounds**
Results summary

• In the overall comparison, no significant influence of relative frequency was found.

+whole word Frequency

Post fach

+base Frequency

Kot flügel

slightly (non-sig) faster than
Results summary: Frequency level

• A significant effect of frequency was found in compounds with whole word frequency being higher than the base frequency.

• No effects were found in items with base frequency being higher than the whole word frequency.
Results summary: *Transparency*

- All SM-IKI mean values in semantically *intransparent* items were faster than those of the semantically *transparent* items.
- But *no significant effect* of transparency was found.
Discussion

• The level of whole-word frequency affects timing of within word typing.
• The level of base frequency has no significant effect.

We conclude that we are not dealing with compositional effects but with a re-access of the whole-word form.
Discussion

- The non-significant but consistent effect of transparency may reflect semantic influences occurring during the whole word form access.
Discussion
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References


