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

<table>
<thead>
<tr>
<th>characters</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>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
General Method

The bigram <nd> is present in all stimuli.

Syllable & Morpheme boundary are influenced by word frequencies

Syllable boundary

Letter boundary

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

Method: What we measure

Post fach

IKI t

POST T F A C H

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Method: *What we want to know*

Mental Lexicon

P O S T F A C H

IKI

t
Method: *Possibility 1*
Method: *Possibility 2*
Method

Lexical effects

- relative frequency (Hay, 2000)
- semantic transparency
- productivity
- phonological transparency
- graphotactic probability (prelexical)
- ...

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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
Method: Stimuli

Stimuli dimension 2: Frequency level

**Stimuli**

- **Post**
  - $\text{wwFreq} = 696$
  - $\text{baseFreq} = 72$

- **Kot**
  - $\text{wwFreq} = 7$
  - $\text{baseFreq} = 106$

- **Schrot**
  - $\text{wwFreq} = 3$
  - $\text{baseFreq} = 1$

- **Licht**
  - $\text{wwFreq} = 0$
  - $\text{baseFreq} = 22$

**Note:**
- The stimuli are divided into two dimensions: frequency level and baseline frequency. The arrows indicate the direction of the stimulus presentation.
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

- +wwFreq-Hi-intrans
  - n=16
  - 25
- +wwFreq-Hi-trans
  - n=9
- +wwFreq-Lo-intrans
  - n=13
  - 51
- +wwFreq-Lo-trans
  - n=13

- +baseFreq-Hi-intrans
  - n=22
  - 52
- +baseFreq-Hi-trans
  - n=30
- +baseFreq-Lo-intrans
  - n=20
  - 52
- +baseFreq-Lo-trans
  - n=32
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

![Graph showing mean SM-InterKey Intervals in +whole-word frequency vs. +base frequency compounds with values 342 and 352.](image-url)
Results

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

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean (ms)</th>
<th>Std Dev. (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>high +wwFreq</td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>low +wwFreq</td>
<td>362</td>
<td></td>
</tr>
<tr>
<td>high +baseFreq</td>
<td>347</td>
<td></td>
</tr>
<tr>
<td>low +baseFreq</td>
<td>357</td>
<td></td>
</tr>
</tbody>
</table>

+whole word Frequency items    +base Frequency items
Results

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

![Chart showing mean IKIs in ms for semantically transparent and intransparent compounds with high and low whole-word frequency. The chart includes bars for 'intrans' and 'trans' categories with high and low whole-word frequency.]

Mean IKIs ± Std.Dev. in ms

- Intrans: high +whole word freq = 313 ms, low +whole word freq = 344 ms
- Trans: high +whole word freq = 332 ms, low +whole word freq = 381 ms
Results

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

- Error: 66.3%
- High/low: 31.4%
- (in-)trans: 1.8%
- High/low*: 0.5%
- (in-)trans: 0.5%
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

IKI

t

+base Frequency

Kot  flügel

IKI

t

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

[Diagram showing the sequence of words: Post, fach, and the word IKI]
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


