Hyphenation as Reading Aid in German Compounds
an Eye-tracking Study

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Background

- German is a compound-loving language, there are many **long & complex compounds**
- German compounds are usually written concatenated
- The official spelling guidelines **permit hyphenation** of complex compounds
- Hyphenation is the optimal solution for compound spelling[5]:
  + maximum information about the morphological structure
  + graphical preservation as a unit
- But the **hyphen is rarely used** for structuring compounds

The hyphen…

…**signals** morphological boundaries & therefore **facilitates** segmentation[3]

…**optimizes** oculomotor activities (word recognition, speech processing)[2]

…**inhibits** the direct syntactic processing of the first constituent. First both components are identified as lexical units and then linked to one syntactic unit[2]

What we know

- Frequent concatenated compounds are recognized as errors when hyphenated[1,8]
- Left-branching ((AB)C) is the unmarked case in German (75% of all triconstituent compounds) and is expected by the reader[4,6]
- Long letters (e.g. k, d, f, g, p) support syllable segmentation[7]

Stimuli

- 40 nominal compounds consisting of three or four lexemes:
  - ➢ 5-9 syllables
  - ➢ 20 right-branching (Ersatz+(innen+verteidigerin))
  - ➢ 20 left-branching ((Gemüse+messer)+mord)
  - ➢ 15 contain only lengthless letters Bananensamenaussaat
  - ➢ 25 contain long letters Gezeitenmessinstrument
- Infrequent/occasional compounds
- No linking element -s at the major constituent boundary → -s indicates a morpheme boundary and is perceived as ‘acoustic hyphen’

Eye-tracking Method

- 40 compounds tested in different sentences in hyphenated and non-hyphenated spelling (same syntactic structure, 80 sentences in total)
- 40 filler sentences (reversed syntactic structure)
- Control task: Answering a sentence related true/false question

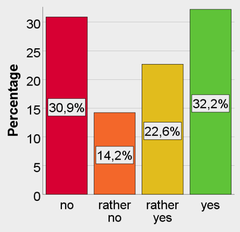
Experiment 1 – Questionnaire

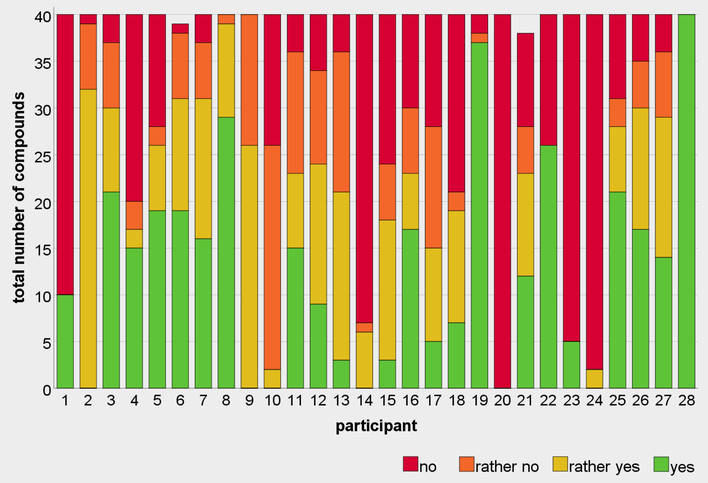
Do people accept hyphenated compounds as correct spellings?

| 28 native German participants | age *m* = 31.4 | heterogeneous educational background |

Results

- General understanding of the compounds meaning (scale 0 to 3): *m* = 2.66, *SD* = .787
- Acceptance of the hyphenation as correct spelling (scale 0 to 3): *m* = 1.56, *SD* = 1.229





✓The hyphen spelling is considered not completely wrong because the compounds used are infrequent/occasional → the spelling is not orthographically prescribed

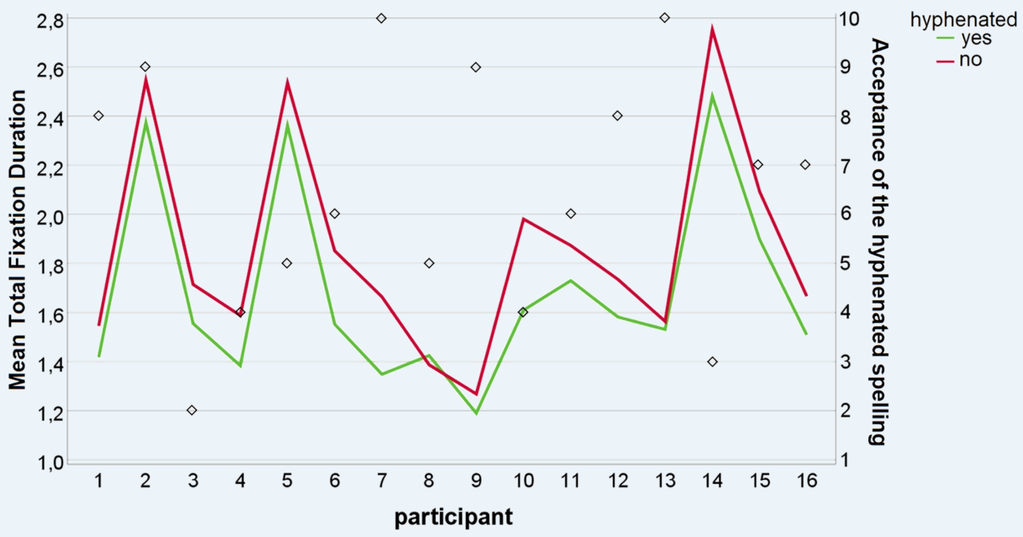
✓**Strong participant-acceptance-correlation** (*Cramers V* = .533, *p* = .000): χ^2 (81) = 951.466, *p* = .000, *n* = 1 117

Experiment 2 – Eye-tracking

| 45-minute examination with a Tobii Pro TX300 Eye-tracker | 16 native German participants (students) | age *m* = 27.8 |

Results

1. Total Fixation Duration (TFD) and Visit Counts

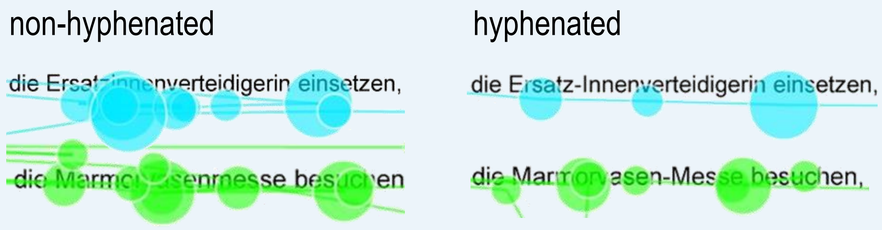


Hyphen		TFD	Visit Count
Yes	Mean	1.68	2.65
	Std. Deviation	0.88	1.29
No	Mean	1.86	2.31
	Std. Deviation	1.04	1.12

TFD: *z* = -2.783, *p* = .005 | Visit Count: *z* = -4.846, *p* = .000

”Gestern Morgen wollte der Forscher das Gezeitenmessinstrument ausleihen, weil er an der Nordsee Messungen durchführen wollte.”

”Letzten Montag sollte der Forscher ein Gezeiten-Messinstrument testen, aber das Gerät hatte noch einen technischen Fehler.”



✓Hyphenated compounds are read significantly faster but at the same time are fixated more often

✓The beneficial effect is independent of whether the participants consider hyphenation to be correct or incorrect (r_s = -.275, *p* = .303 , *n* = 16)

2. Branching direction

Total Fixation Duration

Structure	Hyphen	Mean	Std. Deviation
Left-branching	Yes	1.75	0.87
	No	1.81	0.93
Right-branching	Yes	1.61	0.89
	No	1.90	1.13

Right-branching: *z* = -3.311, *p* = .001 | Left-branching: *z* = -.593, *p* = .553

✓Hyphenation has a beneficial effect on the total fixation duration for both branching directions

✓But only right-branching compounds show significantly shorter fixation durations when a hyphen is inserted
→ The hyphen is a welcome structuring hint, as this structure is rather unexpected by the reader

3. Graphematic syllable structure

long letters	g p k d f Plastikzimmerpflanze
lengthless letter	a e m s w o Bananensamenaussaat

✓Compounds containing only lengthless letters are significantly shorter fixated when hyphenated

	Hyphen		TFD
Containing long letters	Yes	Mean	1.73
		Std. Deviation	0.91
	No	Mean	1.90
		Std. Deviation	1.06
Containing only lengthless letters	Yes	Mean	1.59
		Std. Deviation	0.83
	No	Mean	1.79
		Std. Deviation	0.98

long letters: *z* = -2.100, *p* = .036 | only lengthless letters: *z* = -1.904, *p* = .057

Discussion

- Hyphenation is a **reading aid** for infrequent/occasional triconstituent compounds: It speeds up reading but at the same time increases the number of views and fixations
- **Skilled readers benefit from hyphenation** even if the readers consider hyphens in compounds to be incorrect
- The factors of **graphematic syllable structure** and **branching direction** additionally determine the beneficial effect of the hyphen
- There was no clear effect measurable for the compound length

[1]**Bertram, R./ Kuperman, V./ Baayen, R. H./ Hyönä, J.** (2011): The hyphen as segmentation cue in compound processing: It’s getting better all the time. In: *Scandinavian Journal of Psychology* 52. p. 530-544.

[2]**Bredel, U.** (2008): *Die Interpunktion des Deutschen. Ein kompositionelles System zur Online-Steuerung des Lesens*. Tübingen: Niemeyer.

[3]**Gallmann, P.** (1985): *Graphische Elemente der geschriebenen Sprache. Grundlagen für eine Reform der Orthographie.* Tübingen: Niemeyer.

[4]**Geilfuß-Wolfgang, J.** (2013): Gute und schlechte Bindestriche in dreiteiligen Komposita. In: Neef, M./ Scherer, C. (Eds.): *Die Schnittstelle von Morphologie und geschriebener Sprache.* Berlin/ Boston: De Gruyter. p. 135-156.

[5]**Scherer, C.** (2012): Vom Reisezentrum zum Reise Zentrum. Variation in der Schreibung von N+N-Komposita. In: Gaeta, L./ Schlücker, B. (Eds.): *Das Deutsche als kompositionsfreudige Sprache. Strukturelle Eigenschaften und systembezogene Aspekte.* Berlin/ Boston: De Gruyter. p. 57-82.

[6]**Wellmann, H.** (1991): Morphologie der Substantivkomposita. In: Ortner, L./ Müller-Bollhagen, E./ Ortner, H./ Wellmann, H./ Pümpel-Mader, M./ Gärtner, H. (Eds.): *Deutsche Wortbildung. Typen und Tendenzen in der Gegenwartssprache. Band 4: Substantivkomposita.* Berlin: De Gruyter. p. 3-111.

[7]**Fuhrhop, N./ Carroll, R./ Drews, C./ Ruigendijk, E.** (2016): Sind Buchstabenformen eine Lesehilfe? In: *Mitteilungen des Deutschen Germanistenverbandes* 63(2). Göttingen: V&R Unipress.

[8]**Pfeiffer, M.** (2002): *Lesen von Komposita.* Diplomarbeit, RWTH Aachen. (Cited in Geilfuß-Wolfgang 2013)