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ERPs reveal an iconic relation between sublexical phonology and affective meaning

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ABSTRACT

Classical linguistic theory assumes that formal aspects, like sound, are not internally related to the meaning of words. However, recent research suggests language might code affective meaning such as threat and alert sublexically. Positing affective phonological iconicity as a systematic organization principle of the German lexicon, we calculated sublexical affective values for sub-syllabic phonological word segments from a large-scale affective lexical German database by averaging valence and arousal ratings of all words any phonological segment appears in. We tested word stimuli with either consistent or inconsistent mappings between lexical affective meaning and sublexical affective values (negative-valence/high-arousal vs. neutral-valence/low-arousal) in an EEG visual-lexical-decision task. A mismatch between sublexical and lexical affective values elicited an increased N400 response. These results reveal that systematic affective phonological iconicity – extracted from the lexicon - impacts the extraction of lexical word meaning during reading.

1. Introduction

According to de Saussure (1959) the arbitrary relation between the signifier and the signified is a fundamental feature of language. Nevertheless, there is also a long tradition stating that some semantic residue echoes in the mere sound of words (Bühler, 1934; Jakobson & Waugh, 1979; Jespersen, 1922; Tsur, 1992). Potential form-meaning mappings through structural resemblance, i.e., iconicity (Peirce, 1931), have strong implications for the evolution, development, and processing of language linking linguistic form to human experience (see Lockwood & Dingemanse, 2015; Perniss & Vigliocco, 2014).

Empirical support for non-arbitrary sound-meaning mappings is continuously growing (see Dingemanse, Blasi, Lupyan, Christiansen, & Monaghan, 2015; Dingemanse, Perlman, & Perniss, 2020; Perniss, Thompson, & Vigliocco, 2010, for reviews). For instance, the influential *kiki-bouba* effect links phonology to the spatial dimension of shape as participants agree in their labeling of spiky or curvy shapes as either *kiki* or *bouba* (or *takete/maluma*. See Köhler, 1929; Ramachandran & Hubbard, 2001), replicable across languages (Ćwiek et al., 2021; Styles & Gawne, 2017) and age groups (Kawahara et al., 2019; Maurer, Pathman, & Mondloch, 2006; Ozturk, Krehm, & Vouloumanos, 2012; Peña, Mehler, & Nespor, 2011). Asano et al. (2015) showed that presenting 11-month-old infants with spiky or round shapes and congruent or incongruent pseudowords (*kipi* or *moma*) yielded a larger N400 response to incongruent stimuli. Kovic, Plunkett, and Westermann (2010) presented very similar results for adults with event-related-potential (ERP) effects arising at 200 ms. Also, the link between size and phonology, which shows in labeling small versus large objects dependent on phonemic contrasts (Sapir, 1929), later refined as frequency-code-hypothesis (Ohala, 1983), was replicated by Thompson and Estes (2011). Going beyond artificial pseudoword material, Winter and Perlman (2021) described the mimesis of acoustics of small objects or animals for English size adjectives.

Cross-linguistic studies used (Japanese) ideophones (marked words

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that depict sensory imagery, Dingemanse, 2012) as natural sound-symbolic stimuli (Dingemanse, 2018; Dingemanse, Schuerman, Reinisch, Tufvesson, & Mitterer, 2016). Lockwood, Hagoort, and Dingemanse (2016) suggested principles of phonological iconicity to be effective across language boundaries: learning the real compared to an incorrect meaning of foreign ideophones correlated with more correct memories and an increased P3 and late positive ERP complex. Iconicity also seems to affect the efficiency of language processing. Building upon seminal studies on signed languages (Thompson, Vinson, & Vigliocco, 2010), Sidhu, Vigliocco, and Pexman (2019) using iconicity ratings for English words (Perry, Perlman, & Lupyan, 2015; Winter, Perlman, Perry, & Lupyan, 2017), reported lexical-decision advantages for more iconic words. Recent corpus-linguistic studies explored phonological systematicity of existing vocabularies, indicating non-arbitrary sound-meaning relations to permeate the lexicon for shape (Sidhu, Westbury, Hollis, & Pexman, 2021, demonstrating the *kiki-bouba* effect in English words), size (Winter & Perlman, 2021), color (Johansson, Anikin, & Aseyev, 2020), spatial relations (Johansson & Zlatev, 2013), or grammar (Kelly, 1992; Pimentel, McCarthy, Blasi, Roark, & Cotterell, 2019; Shih, 2020). All in all, research on phonological iconicity has involved various meaning dimensions (see Dingemanse et al., 2020; Schmidtke, Conrad, & Jacobs, 2014, for reviews) and recent studies emphasized its importance in language acquisition (e.g., Kantartzis, Imai, Evans, & Kita, 2019; Nielsen & Dingemanse, 2020) and diachronic language change (Dellert, Erben Johansson, Frid, & Carling, 2021; Monaghan & Roberts, 2021; Vinson et al., 2021).

Here, we propose that emotional relevance is a driving factor of phonological iconicity. Osgood and Suci (1955) showed with a semantic differential that most variety in lexico-semantic meaning can be accounted for by valence and arousal, defining the most widely used dimensional conceptualization of emotion (Barrett, 2006; Russell, 1980; Wundt, 1904). In general, communication of affect, e.g., interjections, may have been crucial for language development (Darwin, 1871; Jespersen, 1922; Panksepp, 2008). Preceding and modulating the emergence of vocabulary, vocal emotion expressions, likely encoded by different sounds, might feature an iconic, internal relation with specific emotions. Consequently, we suggest that iconic phonological coding of affect is still part of modern vocabularies, providing affective cues at the sublexical level of phonemes.

Partly in line with this, cognitive poetics provided heterogeneous results on the use of specific phonemes varying with the emotional content of literature (Aryani, Kraxenberger, Ullrich, Jacobs, & Conrad, 2016; Auracher, Albers, Zhai, Gareeva, & Stavniychuk, 2010; Auracher, Menninghaus, & Scharinger, 2020; Fónagy, 1961; Miall, 2001; Whissell, 1999, 2000). Also, due to their articulatory overlap with facial emotional expressions, single phonemes, e.g., /i:/ vs. /o:/, could represent positive vs. negative features (Rummer & Schweppe, 2019). Furthermore, valence ratings in five Indo-European languages were associated with word initial phonemes, with decreasing naming latencies for negative valence suggesting an iconic source of rapid alert (Adelman, Estes, & Cossu, 2018). Similarly, Aryani, Conrad, Schmidtke, and Jacobs (2018) related affective impressions to specific phonetic features in pseudowords (but see Monaghan & Fletcher, 2019).

To investigate whether affective iconicity systematically permeates the vocabulary of a language – beyond single "iconic words" or single phonemes – we used a large-scale approach for over 6000 German words (Schmidtke & Conrad, 2018). We posit that, for instance, words with negative and arousing semantic meaning typically contain specific sublexical phonological units that serve as sublexical markers of alert (see Adelman et al., 2018). The wider such phenomena spread across the vocabulary, the more likely meaningful "sublexical affective values", henceforth SAV, can be calculated for phonological units, based on their distribution across the overall lexical affective space of valence and arousal.

We have previously shown how these SAV differ between poems in accordance to affective labels from their author (Aryani et al., 2016; Ullrich, Aryani, Kraxenberger, Jacobs, & Conrad, 2017), and correlate with ERPs during prelexical processing in a lexical-decision-task (Ullrich, Kotz, Schmidtke, Aryani, & Conrad, 2016). Schmidtke and Conrad (2018) showed that "high-arousal" sublexical units are detected faster in a visual search task, suggesting an iconic link between SAV and alert.

Importantly, these prior SAV results were obtained regardless of lexical affective meaning of target words (Schmidtke & Conrad, 2018; Ullrich et al., 2016). They can, therefore, only be attributed to prelexical processing (see also Sučević, Savić, Popović, Styles, & Ković, 2015). However, phonological units with a bias to occur more often in words with specific affective meaning might systematically carry saliency across levels of language processing. What remains unclear, is, thus, whether affective phonological iconicity plays a role for higher, cognitive, levels of language processing beyond prelexical perception, when a word's formal aspects must be integrated with semantic meaning.

We hypothesize that extracting meaning from printed words is sensitive to systematic affective sound-meaning-correspondences across the lexicon of a language, and words with a consistent mapping between SAVs and lexical semantics are easier to process.

The present study tested this twofold hypothesis in a lexical-decision task, manipulating both the lexical affective meaning of German words (see Citron, 2012; Kotz & Paulmann, 2011, for reviews) and the potential affective iconicity or their sublexical phonology. We assessed the ease of lexical access by means of the N400 (Kutas & Federmeier, 2011), an event-related brain response in the EEG. An N400 amplitude indicates how difficult it is to integrate a word into a given context (see Barber & Kutas, 2007, for a review). We hypothesized that the N400 response would decrease when *sublexical* and *lexical affective values* match in affectively iconic words.

2. Materials and methods

2.1. Participants

41 right-handed native German speakers without neurological or vision problems, students of the Freie-Universität-Berlin, participated in the study. Data of 35 participants - with minimum 50 segments surviving artifact-rejection in every experimental condition – were further analyzed (21 women; age: M = 26.7, SD = 4.2 years).

2.2. Stimuli and design

312 words were selected from the Schmidtke and Conrad (2018) in a 2 × 2 design, involving an orthogonal manipulation of the factors *lexical (LAV)* and *sublexical-affective-values (SAV)* (each time contrasting "alert": negative-valence/high-arousal vs. "neutral": neutral-valence/low-arousal. Lexically negative/high-arousal stimuli had at least moderately negative valence (<−0.82 on a − 3 to +3 scale) and at least moderately elevated arousal ratings (>2.83; 1–5 scale). Neutral lexical values ranged between −0.76 and + 0.75 (valence) and 1.67–2.79 (arousal).

SAV calculation: All words in the database were transcribed phonemically and segmented into syllabic onsets, nuclei, and codas. For each phonological segment, normative rating values of all words comprising it in an identical syllabic position were averaged, e.g., averaging arousal/valence ratings for all words containing a syllabic onset /kr/ for the SAV for /kr/. Then, for every word, SAVs for all segments were averaged to assign words to the different cells of the factor *sublexical-affective-values*. A split half of the resulting scales at −0.04 (valence), and at 2.90 (arousal) assigned stimuli to different *sublecixal-affective-value* conditions (see Table 1),

This made, e.g., *Krieg* (war) and *Zucht* (military discipline) **negative/high-arousal stimuli with consistent affective phonology**, but *Fluch* (curse) and *Mord* (murder) **iconically inconsistent**.

For **lexically-neutral words**, phonology was **affectively consistent** in, e.g., *Glas* (glass) and *Land* (land), but **inconsistent** in *Topf* (pot) or

Table 1
listing stimulus example words for the four conditions of the 2 × 2 design contrasting lexical and sublexical (SAV) affective values (negative-valence/high-arousal vs. neutral-valence/low-arousal). Specific valence (V) and arousal (A) values are given for syllabic onsets (ON), nuclei (NU), and codas (CO) determining SAV for the entire stimuli. N words gives the number of words in the database of Schmidtke and Conrad (2018) used to calculate this SAV for phonological segments. Conditions with consistent matching between SAV and lexical affective values are shaowed.

Category	STIMULUS	Lexical valence	SAV V_STIM	SAV_V_ON (N words)	SAV_V_NU (N words)	SAV_V_CO (N words)	Lexical arousal	SAV A_STIM	SAV_A_ON (N words)	SAV_A_NU (N words)	SAV_A_CO (N words)
Lex. neg-high and Sublex. neg-high	**Krieg** krik (war)	-2.90	**-0.12**	-0.51 (78)	0.08 (970)	0.02 (265)	4.57	**2.97**	3.10 (78)	2.94 (970)	2.93 (265)
	Zucht =Uxt (discipline)	-1.23	**-0.13**	-0.03 (345)	-0.13 (742)	-0.29 (82)	3.41	**2.95**	2.9 (345)	2.95 (742)	3.09 (82)
	Raub rBp (robbery)	-1.8	**-0.14**	0.02 (742)	-0.09 (342)	-0.38 (190)	3.89	**2.93**	3.02 (742)	2.85 342	3.0 (190)
Lex. neg-high and Sublex. neut-low	**Fluch** flux (curse)	-2.1	**0.05**	-0.007 (56)	-0.23 (376)	-0.12 (543)	3.65	**2.86**	2.94 (56)	2.86 (376)	2.87 (543)
	Mord mOrt (murder)	-2.8	**0.13**	0.004 (598)	-0.12 (488)	0.15 (84)	4.44	**2.89**	2.84 (598)	2.91 (488)	2.98 (84)
	Leid lWt (woe)	-2	**-0.02**	-0.03 (799)	-0.03 (614)	-0.01 (387)	4.17	**2.82**	2.79 (799)	2.91 (614)	2.88 (387)
Lex. neut-low and Sublex. neg-high	**Preis** prWs (price)	0.1	**-0.1**	-0.11 (79)	-0.03 (614)	-0.14 (522)	2.61	**2.91**	3.01 (79)	2.91 (614)	2.92 (522)
	Topf tO+ (pot)	0.19	**-0.16**	-0.004 (987)	-0.10 (488)	-0.41 (13)	2.04	**2.92**	2.92 (987)	2.91 (488)	2.9 (13)
	Reis 'rWs (rice)	0.69	**-0.05**	0.02 (742)	-0.03 (614)	-0.14 (522)	2.03	**2.92**	3.02 (742)	2.91 (614)	2.92 (522)
Lex. neut-low and Sublex. neut-low	**Glas** glas (glass)	0.64	**-0.03**	0.13 (30)	-0.04 (778)	-0.14 (522)	1.77	**2.80**	2.77 (30)	2.81 (778)	2.92 (522)
	Land l&nt (land)	0.50	**0.04**	-0.03 (799)	0.12 (1579)	0.26 (249)	1.82	**2.82**	2.79 (799)	2.91 (1579)	2.78 (249)
	Moll mOl (minor)	-0.1	**1.02**	-0.04 (598)	-0.01 (488)	0.04 (568)	2.28	**2.84**	2.84 (598)	2.91 (488)	2.82 (568)

Preis (price).

Words contained maximum nine letters to avoid refixations. Overall word length and frequency, imageability, word class, orthographic/ phonological neighborhood, syllabic structure and complexity, positional frequencies of all single graphemes/phonemes, bigrams/ biphones, or syllabic segments were matched across the four cells of the design. Nonwords were pronounceable pseudowords matching word stimuli in number, length, and syllabic structure. Stimuli (and stim-characteristics) are available in Conrad, Ullrich, Schmidtke, & Kotz, 2022, (see also Ullrich et al., 2016, using the same stimuli as "maximum controlled set" for prelexical SAV effects).

2.3. Procedure

Stimuli appeared in the center of a computer screen in white color on a black background using Presentation software (Version 0.70, Neuro-Behavioral Systems, Inc., 2004). Participants were instructed to indicate as fast and accurately as possible whether the presented stimulus was a "word" or not via two buttons. Left- and right-hand responses to words and nonwords were counterbalanced across participants. Each trial began with a fixation cross (500 ms), followed by a blank screen (500 ms). Stimuli were presented in randomized order for 500 ms, followed by a blank screen until participants responded, and a subsequent uniform-random-scattered inter-stimulus interval of 700 − 1500 ms.

2.4. EEG recording and (pre-)processing

EEG recording used, fixed to the scalp in an elastic cap, 61 AgCl-electrodes (Fp1,Fpz,Fp2,AF3,AF4,F5,F3,F1,Fz,F2,F4,F6,FT7,FC3,FC1, FCz,FC2,FC4,FT8,T7,C5,C3,C1,Cz,C2,C4,C6,T8,TP7,CP5,CP3,CP1,CPz, CP2,CP4,CP6,TP8,P9,P7,P5,P3,P1,Pz,P2,P4,P6,P8,P10,PO9,PO7,PO3, POz,PO4,PO8,PO10,O1,Oz,O2,Iz,M1,M2) using two 32-channel amplifiers (BrainAmp, Brain Products, Germany) according to the International 10–20 system (American Electroencephalographic Society, 1991; Jasper, 1958). Average impedances were kept below 2 kΩ. The electrooculogram (EOG) was monitored by two electrodes at the outer canthi of the participant's eyes and two electrodes above and below the right eye. EEG and EOG signals were recorded with a sampling rate of 500 Hz, referenced to the right mastoid, but re-referenced offline to linked mastoids. The AFz electrode was used as ground electrode. Later offline filtering included a bandpass filter of 0.1–20 Hz and a 50 Hz notch filter. Independent component analysis (ICA; Makeig, Bell, Jung, & Sejnowski, 1996) served to identify and remove eye movement artifacts. The continuous EEG signal was cut into segments of 950 ms total length, 150 ms pre-stimulus baseline plus 800 ms post-stimulus interval. After baseline correction, automatic artifact-rejection excluded trials containing differences >80 μV in intervals of 70 ms or amplitudes >50 or < -50 μV. An N400 effect was expected around 300 and 500 ms post-stimulus onset (Kutas & Federmeier, 2011; Lau, Phillips, & Poeppel, 2008). Within this time window, we ran a peak-detection for the grand averaged data. The observed negative deflection at CPz, most representative of the N400 (Dimigen, Sommer, Hohlfeld, Jacobs, & Kliegl, 2011; Kutas & Federmeier, 2011), peaked at 354 ms. Accordingly, we chose a time window of 150 ms (280-430 ms) with this peak in its center. The following 9 central electrodes entered a centro-posterior region of interest (ROI) analysis for the N400 (see Dimigen et al., 2011; Kutas & Federmeier, 2011, but see Šoškić, Jovanović, Styles, Kappenman, & Ković, 2021, for extensive review): C1,Cz,C2,CP1,CPz,CP2,P1,Pz,P2.

Segments corresponding to correctly answered word trials with a mean activity [μV] deviating less than 2 SD from means per participant and condition were subjected to further analysis (mean N segments/condition: 60.3–61.7, no significant differences).

2.5. Data analysis

2.5.1. Behavioral data

Correct response latencies (2 SD outlier-trimmed) and errors were analyzed using linear mixed-effects models and mixed-effects logistic regression.

2.5.2. EEG data

ROI analyses were conducted based on linear mixed-effects models with the mean activity [μV] values of the selected time window using R 4.1.1 (R Core Team, 2021) and *lme4* (v1.1–27.1; Bates et al., 2011). Visual inspection of plots of residuals against fitted values did not reveal deviations from normality or homoscedasticity. Within-subject factors *lexical* (LAV; 2 levels) and *sublexical-affective-values* (SAV; 2 levels) were used as fixed factors. Random effects were constructed using random intercepts for items and subjects as well as random slopes for subjects for the main effects, constituting the most complex structure of random effects before models failed to converge.

The final model reads:

$\mu V \sim 1 + LAV * SAV\ (1 + LAV + SAV|subject) + (1|item)$.

P-values were obtained by testing the full model containing all fixed effects of interest against the null-model containing only random effects by likelihood-ratio-tests, followed by an ANOVA based on Satterthwaite approximation of degrees of freedom using the *afex*-package (Singmann, Bolker, Westfall, Aust, & Ben-Shachar, 2021). Significant interactions between the two factors were examined using Tukey-adjusted post-hoc tests using the *emmeans*-package (Lenth, 2021) looking for a) a main effect of inconsistency (non-matching vs. matching sublexical-lexical affective values), and b) differential effects of SAV within the two cells of the factor *lexical-affective-values*. Measuring effect size, we calculated Cohen's d using *EMAtools*-package (Kleiman, 2021). Figures were created using *ggplot2*-package (Wickham, 2016).

3. Results

Dataset and R-analysis-script can be retrieved from https://osf.io/gam9y/ (Conrad et al., 2022).

3.1. Behavioral results

No effects for either analysis were observed in the RT or error data (all p's > 0.1)

3.2. N400 ROI analysis

Within the time window of 280-430 ms, we found no main effects, but a highly-significant interaction between the factors *sublexical* and *lexical-affective-values*, $\chi^2(3, N = 12) = 13.66$, $p = 0.003$, $b = 1.34$, $SE = 0.37$, $d = 0.42$, ($F(1,305.23) = 13.35$, $p < 0.001$). Collapsing the four cells into a contrast of *inconsistent* vs. *consistent* sound-to-meaning mapping of words, the interaction resulted in a significant consistency effect (Fig. 1), $\chi^2(1, N = 7) = 10.78$, $p = 0.001$, $b = -0.67$, $SE = 0.20$ $d = -0.88$, ($F(1,61.01) = 11.85$, $p = 0.001$), with increasing negativity for *inconsistent* ($M = 3.31$) compared to *consistent* words ($M = 3.98$). Resolving the interaction (see Fig. 2), we found inverted SAV effects for the different conditions of *lexical-affective-values*: N400 amplitudes significantly increased with alert as compared to neutral SAVs for lexically-neutral words ($M = 3.19$ vs. $M = 3.90$; $z = -2.676$, $p = 0.037$, $d = -0.45$; Fig. 3), but tended to decrease for the same contrast in negative/high-arousing words ($M = 4.05$ vs. $M = 3.42$; $z = 2.384$, $p = 0.0801$, $d = 0.41$; Fig. 4).

4. Discussion

We confirm an increased N400 response for mismatching sublexical phonology and semantic affective meaning – in a lexical-decision-task where neither overt phonology nor explicit processing of affective dimensions was required.

This suggests that participants were sensitive to affective phonological iconicity using sublexical markers of affect – increasing semantic processing effort for respective mismatch. Our results extend previous findings of iconicity enhancing language processing (Schmidtke & Conrad, 2018; Sidhu et al., 2019; Thompson et al., 2010), connecting a

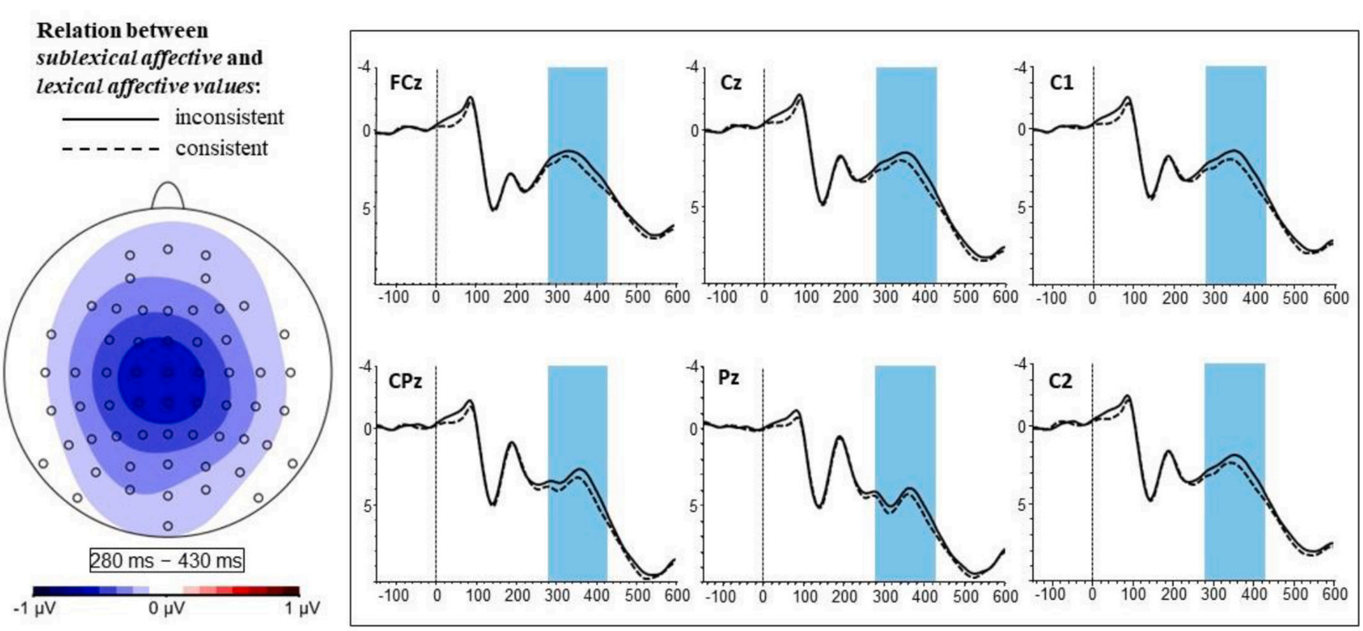

Fig. 1. Overall ERP effect of inconsistency between lexical and sublexical affective values.

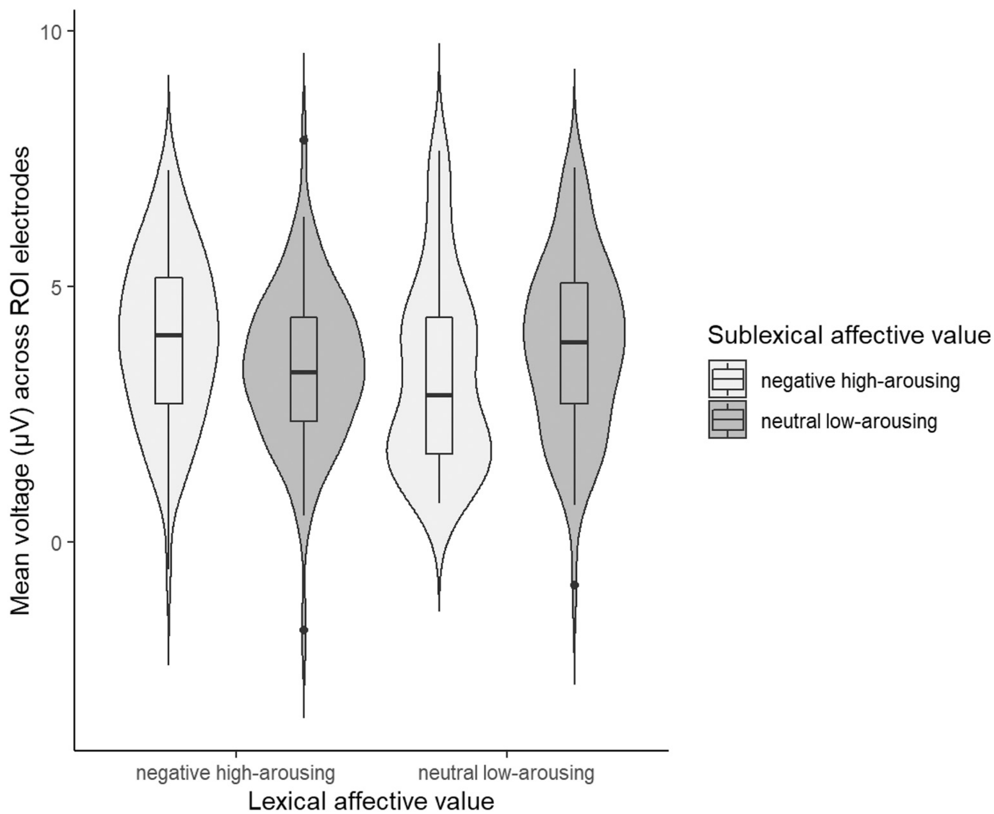

Fig. 2. Mean N 400 amplitudes for stimulus words in all different conditions of lexical and sublexical affective values.

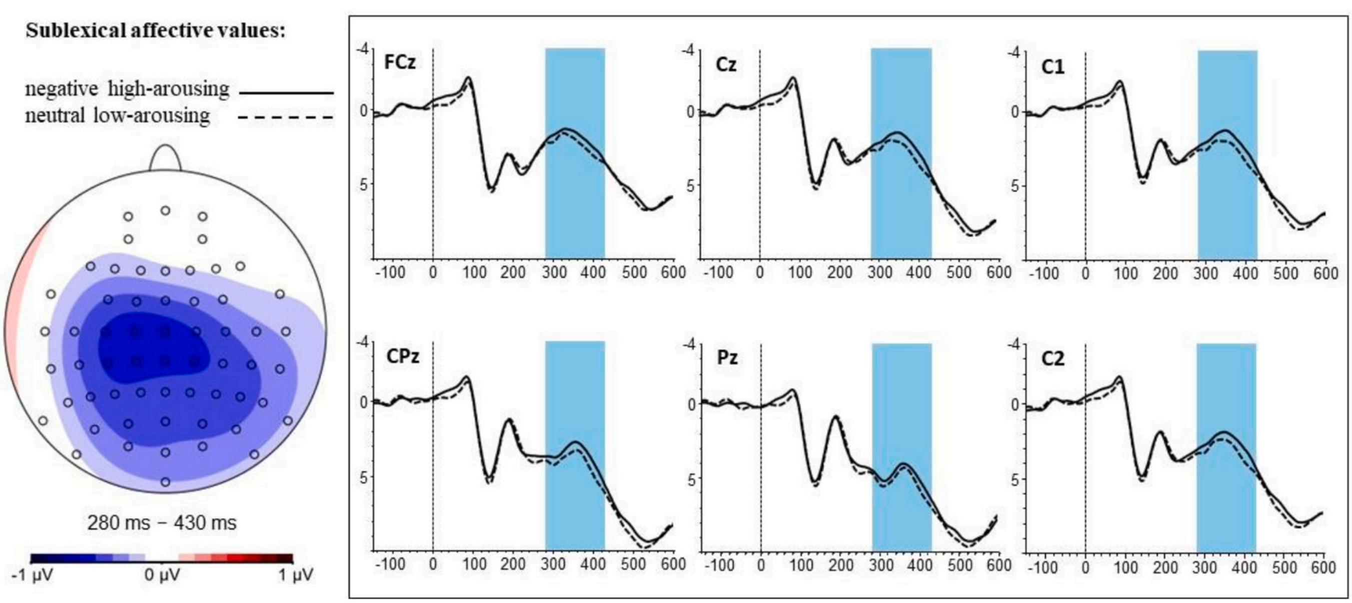

Fig. 3. ERP effects of sublexical affective values in words of neutral-valence/low-arousal.

large-scale approach on the systematic affective-iconic organization of language with neuroscientific evidence of resulting consequences:

Our data show that the German language systematically involves affective phonological iconicity in both a) the way phonological segments occur across the bi-dimensional lexical affective space of valence and arousal, and b) these sound-to-meaning correspondences in the lexicon determine automatic access to the meaning of words.

Our SAV operationalization implies language uses position-specific intrasyllabic phoneme clusters as markers of affect – increasing the signal power of words with high emotional relevance, in particular, involving threat (see Adelman et al., 2018). Iconic phonological patterns emerging from our purely numerical approach, can already be seen at the phonemic feature level (Johansson & Zlatev, 2013), e.g., shorter vowel length, voiceless sibilants, and decreasing sonority of consonants apparently associate with “alert” SAV (see Table 1 and the Appendix). On the other hand, also complex combinations of consonants – typical for German language – offer a wide range of highly salient phonological units possibly carrying intrinsic relations with affect to a more complex

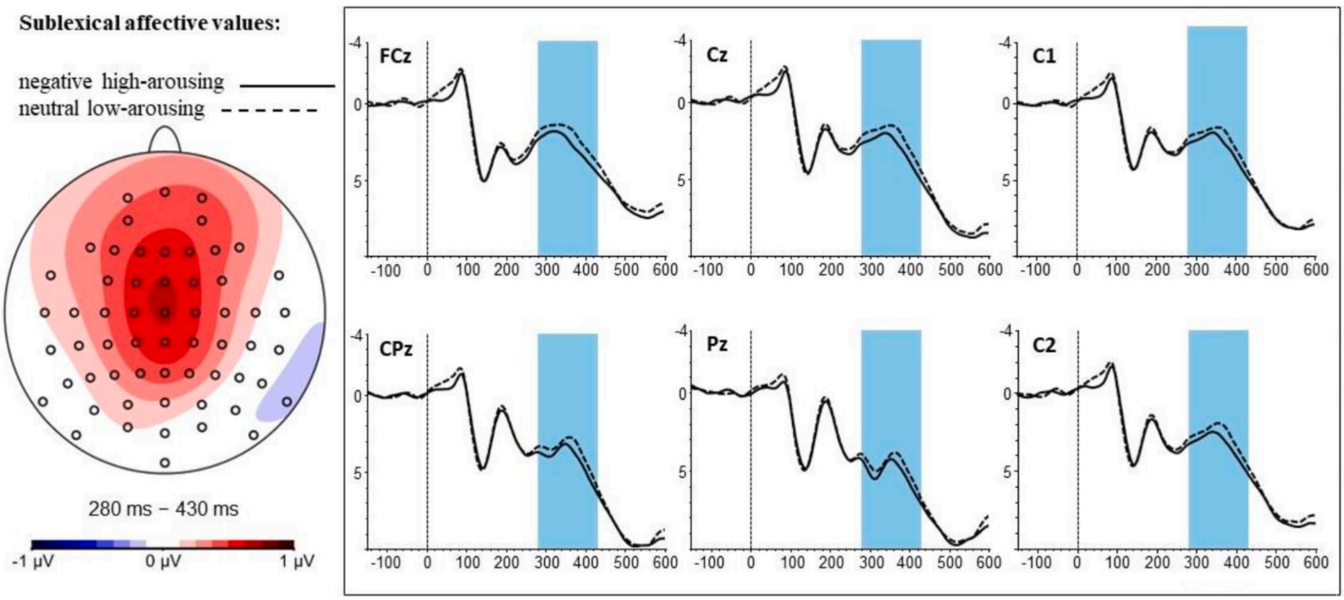

Fig. 4. ERP effects of sublexical affective values in words of negative-valence/high-arousal.

level, e.g., syllabic onsets of our sublexical "alert" stimuli – frequently occurring in words of high arousal – kr(kr) and z(=), may appear like a mimesis of the menacing sounds produced by predators highly feared by our ancestors (wolves and snakes).

Our data suggest that language phonologically grounds symbols (words) representing semantic meaning in affective experience – presumably since its origins. Language serves a denotative and an appellative function (Bühler, 1934; Jakobson, 1960). As to the latter, using the entire span of arousal and valence, affective iconicity of phonemes might mark any message as alerting or reassuring, and intuitively trigger approach or avoidance - sounding, for instance, exciting or dull, smooth and mellow, or sharp and cynical – using preferentially sonorants vs. plosives, voiceless sibilants, long vs. short vowels, etc. – supplying words with an affective tonality – described by SAV.

Using only negative affective stimuli may have prevented behavioral effects to arise. Behavioral and ERP effects are not always associated or directly correlated (e.g., Barber, Otten, Kousta, & Vigliocco, 2013). The N400 is considered a more sensitive measure of semantic activation than – and often appears without – RT effects (e.g., Heil, Rolke, & Pecchinenda, 2004; Kotz, 2001). These represent only the final (response) point of a complex process and are very sensitive to control (Neely, 1991). Unlike positive stimuli that consistently trigger speeded responses, negative words produce heterogenous behavioral effects where a general processing advantage for affective stimuli (Kousta, Vinson, & Vigliocco, 2009, see Kauschke, Bahn, Vesker, & Schwarzer, 2019, for review) can be opposed to a tendency to avoid negative stimuli (Estes & Verges, 2008; Kuperman, Estes, Brysbaert, & Warriner, 2014). Here, a cognitive processing advantage for iconic negative words (as reflected in the N400) might not have speeded responses because of behavioral avoidance tendencies (Brouillet & Syssau, 2005; Estes & Verges, 2008) that might increase when the affective load of negative stimuli is emphasized through phonological iconicity.

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Credit author statement

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Susann Ullrich: Investigation, Formal Analysis, Writing - original draft.

David Schmidtke, Investigation, Formal Analysis, Writing - original draft.

Sonja Kotz, Conceptualization, Funding Acquisition, Supervision, Writing - review.

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