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Book of Abstracts

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Special role of morphology in English writing

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The relationship between spelling and sound is highly inconsistent in English. This inconsistency is often caused by the preservation of morphological information in spelling (e.g. retaining the stem HEAL in HEALTH). In this paper, we report a large-scale computational linguistic analysis designed to explore the morphological regularities associated with derivational English suffixes. This analysis reveals that the spellings of derivational suffixes transmit unique semantic information that is not present in their pronunciations. Further, we show that skilled English readers acquire these bits of information from writing in the absence of any formal instruction, and successfully exploit these cues explicitly and implicitly when dealing with written language. We discuss the implications of these findings for literacy instruction.

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Semantic interference and morphological facilitation in overt compound production: Behavioral and ERP evidence

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The present study examines how compounds (e.g., teaspoon) are stored and processed at the lemma and the word form level in the mental lexicon. According to two-stage models (e.g., Levelt et al. 1999) compounds are represented holistically at the lemma level and decomposed at the form level, while other models propose decomposed representations of compounds at the lemma level (Marelli et al., 2012).

In a picture-word interference (PWI) paradigm (SOA -100 ms), the effects of distractor words on noun-noun compound production (e.g., Teelöffel [tea spoon]) were examined with behavioral and electrophysiological measures (ERPs). In four distractor conditions, morphologically related distractors overlapped with the compound in the first (tea) or second constituent (spoon), while categorically related distractors overlapped with the whole word (fork), or the first constituent (juice). Each related condition was matched to an unrelated one.

The behavioral data showed semantic inference and morphological facilitation during overt compound production, which emerged at different stages of processing as indicated by the ERPs. For whole-word related categorical compared to unrelated distractors longer naming latencies and a sustained anterior negativity between 350-500 ms were obtained. No comparable effects were seen for distractors from the same category as the first constituent. Morphologically related distractors induced shorter naming latencies and a reduced N400 relative to their unrelated controls, independent of constituent. Interestingly, semantic interference was not evident before 300 ms post-stimulus onset at stages associated with lexical selection, but rather during later post-lexical stages of processing.

The findings suggest morpheme-based representations of compounds at the form level (e.g., Levelt et al. 1999).

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The influence of task constraints on morphological processing during written word production

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A large number of studies have shown the influence of morphemes in visual word recognition (Amenta & Crepaldi, 2012). By contrast, the influence of morphemes on written word production has been far less studied. Kandel et al. (2012) have shown that adults process derivational morphemes when writing (see also Bertram et al., 2016). This processing may interfere with written word production before beginning to write (increasing latencies) and/or during writing (increasing inter-letter interval durations). In this study, we examined whether the time course of morphological processing when handwriting depends on the nature of the task performed.

Thirty adults wrote two types of words in uppercase letters on a digitizer: morphologically complex words (e.g., voleur, "thumb") and simple words (e.g., abricot, "apricot"). These words were presented in two different tasks: a written picture naming task and a spelling-to-dictation task. We measured two dependent variables: writing latencies (i.e., the time between stimulus presentation and the beginning of writing) and inter-letter interval duration at the morphemic boundary (e.g., the time between the l and the e in vol/eur).

Longer writing latencies were observed for morphologically complex words in the naming task than in the spelling-to-dictation task. The task also influenced within-word variables: inter-letter intervals at the morphemic boundary were longer for morphologically complex words in the spelling-to-dictation task than in the naming task.

To conclude, the time course of morphological processing depends on the constraints of the task. When orthographic retrieval requires early semantic activation (i.e., the naming task), morphological effects are observed earlier than when semantic activation is not mandatory (i.e., spelling-to-dictation task). The differential involvement of semantic codes in the two tasks modulates the influence of morphological information during written word production.

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The role of semantic context in early morphological processing

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There is substantial evidence pointing to an early, automatic segmentation of written words into their constituent units (farm-er, wit-ness); however, less is known about the potential role of contextual information in modulating this analysis. We adapted the standard masked priming paradigm to

include an overt semantic prime in order to examine whether semantic context influences morpho-orthographic segmentation of complex words. In particular, we asked how the context will affect processing of semantically opaque forms (witness), where the embedded stem (wit) is incompatible with the meaning of the whole form. Results showed no masked priming facilitation for opaque forms in the presence of a semantic prime, indicating that context can influence early morphological analysis. Priming was found for both semantically transparent and opaque forms (farmer-farm, witness-wit) when there was no semantically-related context, consistent with the literature and an account positing early blind segmentation. These findings provide an important update to the long-standing debate on early morphological processing in written word recognition.

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Semantic effects in morphological priming: A cross-modal study of Hebrew

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Morphological priming effects are often interpreted as evidence that complex words are represented in terms of their constituent structure (Marslen-Wilson et al., 1994). Alternatively, Connectionist approaches attribute these priming effects to phonological and semantic overlap, without resorting to structured representations (Gonnerman et al., 2007). Evidence for the role of morphological structure in lexical organization comes from studies of Semitic languages, in which robust root-priming effects are obtained in the absence of semantic relatedness (Boudelaa & Marslen-Wilson, 2015). In the present study, we hypothesized that 'pure' morphological effects in Semitic are more restricted than previously thought, in that they would emerge only for productively computed, structured stems.

We conducted a cross-modal priming lexical decision experiment with 30 Hebrew native speakers, testing (i) whether verbs from a productive class ('Piel') and an unproductive class ('Paal') elicited root-priming effects (whether they facilitated the recognition of targets sharing a root, relatively to an unrelated word: /lexalek/-HTXLK, /laxlok/- HTXLK), and (ii) whether morphological priming effects were modulated by the degree of semantic relatedness between primes and targets. The results revealed significant root-priming effects for 'Piel'(t=2.84) and 'Paal'(t=3.08). However, verb class interacted with semantic relatedness (t=2.31), with larger semantic overlap yielding faster target recognition following 'Paal'(t=2.26), but not 'Piel'primes (t=0.64).

We propose that stems of unproductive Hebrew classes ('Paal') are stored as wholes leading to semantically mediated root priming. In contrast, stems of productive classes ('Piel') constitute structured representations and activate their roots directly. Our results challenge accounts in which all morphological effects in Semitic are independent of semantic relatedness, as well as accounts that dispense with structured representations altogether. Instead, they support a dual-morphology system in which constituent structure is closely aligned with productivity.

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Orthography-Semantic Consistency contribution to explaining semantic effects in masked morphological priming.

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The role of semantics in the early stages of morphological processing has been extensively studied, but results have been at times inconsistent.

To address this issue we propose the application of Orthography-Semantic Consistency (OSC), a measure of how well the meaning of a given word can be predicted from its form. OSC is operationally defined as the degree of semantic relatedness between a word and its orthographic relatives, computed as the frequency-weighted average semantic similarity between the meaning of a given word and the meanings of all the words containing that very same orthographic string (Marelli et al., 2015, QJEP, 68(8), 1571-1583).

OSC can provide a different perspective on morphological effects in masked priming. Since the orthographic word-set on which OSC is computed is constituted by words that could all in principle be used as primes, and the contribution to OSC of each orthographic relative is determined by its frequency, a straightforward prediction of the algorithm is that priming magnitude should be modulated by an interaction between OSC and prime frequency. We tested this hypothesis on a dataset containing data from seven masked priming studies. This analysis shows indeed that the impact of the prime is crucially qualified by its frequency in the semantic cohort activated by the target orthography, as captured by OSC.

This result suggests that semantics plays a role at early stages of visual word recognition (as captured by masked priming paradigms). However, the activated semantic network is crucially limited by the orthographic information associated to the word. In this perspective, the traditional dichotomy between form-before-meaning and form-with-meaning accounts could be reformulated in a unique approach postulating a deep entanglement between orthography and semantic features.

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The role of surprisal in processing grammatical aspect during reading

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Studies have shown that during sentence processing people generate expectations about upcoming input which modulate processing time (see Kamide, Altmann, & Haywood, 2003; Levy, 2008). In this study, we investigate how probability-based expectations about grammatical aspect, i.e., the internal flow of time in an event, influence online processing (see Madden & Zwaan, 2003; Ferretti, Kutas, & McRae, 2007). We report results of an eye-tracking experiment in Finnish, as it is one of the few languages that morphologically marks grammatical aspect on transitive objects (rather than on the verb). Accusative case signals the perfective aspect and the partitive case the imperfective (Huumo, 2010). This allows us to investigate whether expectations about grammatical aspect are already generated early in time at the verb.

We carried out a sentence reading experiment with eye-tracking. The materials consisted of 150 transitive clauses. A given participant (n = 46) saw a particular verb only once, either in the partitive or accusative condition (e.g., *Tutkija kloonasi marsua/marsun laboratoriossa* 'The researcher was cloning/cloned the guinea pig in the laboratory'). For each verb, co-occurrence frequencies for the case markings were extracted from the Finnish Internet Parsebank (Kanerva, Luotolahti, Laippala, & Ginter, 2014) and were operationalized as surprisal, i.e., inverse log probability of the case marking given the verb (Levy, 2008).

A generalized additive mixed-effects model was fitted to the gaze duration on the verb and indicated an increase in gaze duration when surprisal increased. However, the difference in case marking was not statistically significant. To the best of our knowledge, this is the first study to offer evidence that aspectual information is activated early in time and already at the verb. The results support the view that semantic representations are rich and contain item-specific probabilistic information over prior experience with event structures.

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Morphological effects on pronunciation in German

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The morphological complexity of a word is thought to affect the time taken to prepare a verbal response. However, whether it also affects its pronunciation is currently under debate. In the present study, we investigated this issue in German using a reading aloud task. Sixty skilled adult readers read aloud 80 nonwords, comprising 40 morphologically-complex nonwords (e.g., HUNDUNG, where "Hund" is a stem, meaning "dog", and "ung" is a suffix) and 40 paired non-morphological nonwords (e.g., HUNDAT, where "Hund" is a stem but "at" is not a suffix). The acoustic durations of the stems in the two experimental conditions were measured and statistically compared. Stems of morphologically-complex nonwords were realized acoustically with shorter durations than the same stems of their non-morphological counterpart nonwords. Our results suggest that a word's morphological structure likely influences its pronunciation, thus posing a challenge to traditional theories of speech production, which postulate that phonetic processing does not have access to morphological information.

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Cross-morphemic transposed letter effects argue against a single decompositional pathway

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A masked priming experiment was designed to compare an account of visual polymorphemic word recognition that entails obligatory decomposition and a dual pathways account where such decomposition is supplemented with a whole-word recognition system through which words are decomposed post-lexically. Letter transposition was applied to word primes taken from a previous study, creating nonword primes by disrupting the suffix of truly derived words (e.g., *hunetr-HUNT*), the pseudo-suffix of pseudo-derived words (e.g., *corenr-CORN*), and the non-suffix of non-derived words (e.g., *casehw-CASH*). Priming was observed for the derived words whether disrupted or intact, and no priming was observed for the non-suffixed words whether disrupted or intact. In contrast, the priming found for the pseudo-derived words when they were intact disappeared when disrupted.

Such a result opposed the single pathway decomposition model since letter transposition should have affected truly suffixed and pseudo-suffixed words in exactly the same way. Instead, a dual pathways model was supported whereby decomposition occurs only through post-lexical decomposition when the affix is disrupted. However, such a conceptualisation was opposed by a second experiment in which priming was equally strong for inappropriately suffixed nonwords when disrupted (e.g., *novEILsm-NOVEL*) as when intact (e.g., *novelism-NOVEL*), given that nonwords cannot be decomposed post-lexically. Discussion will centre on how the two sets of results might be reconciled.

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When we tolerate a morphosyntactic error: An ERP study on non-native accented speech

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Grammatical processing can be affected by speaker identity (Hanulikova et al., 2012), as well as construction frequency (Hahne & Friederici, 1999). However, it is still not clear whether native listeners are sensitive to the typicality of grammatical errors from a set of speakers (e.g., non-native L2 speakers). To address this question we considered grammatical errors that English natives speaking in Spanish frequently produce (i.e., gender errors) or infrequently produce (i.e., number errors; Franceschina, 2001). Spanish sentences, containing either gender or number agreement violations, as well as the corresponding controls, were presented in native or English accent. The participants were Spanish natives who reported being familiar with English accented Spanish and identified gender errors as a common mistake. ERP results time-locked to the onset of the target noun showed an interaction between Accent (native, nonnative), Grammar (control, gender, number) and topographical factors in the following time windows: 400-550, 800-1100, 1100-1400. Follow-up ANOVAs on native accent showed that gender and number violations elicited larger left negativities and larger P600s as compared to the control conditions. With the non-native accent, number violations elicited a greater P600 compared to controls. Gender violations with non-native accent elicited larger central-posterior negative effects between 400 and 550 ms, with no evidence of a P600 effect. The native accent results agree with previous ERP studies on morphosyntactic processing in auditory sentences, suggesting an early detection phase followed by reanalysis (Friederici, 2002). With non-native accent, while less-common errors were detected and repaired, frequently-produced errors did not show late repair processes but only a N400-like response, possibly reflecting difficulties during the target noun lexical retrieval. The present results provide evidence that the time course of parsing depends on the input error typicality.

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Stages of morphological processing revealed by rhyme priming

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Stem priming effects can be attributed to combinations of morphological, phonological, and semantic factors. To understand morphological processing, these factors should be dissociated. Previous

research addressed this through time-course of effects (Feldman 2000) or carefully-constructed controls (Stockall & Marantz 2006).

Previously, we incorporated rhyme into a stem-priming task controlling semantic factors across critical (*dough → showed*) and control pairs (*dough → code*). We find evidence of priming for morphologically complex words preceded by words rhyming with their stems (*dough → showed*): *morphologically-mediated rhyme* (MMR) priming.

Here, we examine MMR by looking at (1) directional asymmetries and (2) stem allomorphy. Through allomorphy, we dissociate morphological and phonological factors. Does MMR index solely morphological factors (stem identity in *grew* / *grow*) or morphological and phonological factors combined (allomorph identity in *show* / *showed*)?

We constructed six prime conditions, controlling for frequency and semantic relatedness. All primes are paired with identical targets, reducing extraneous variance.

123 participants completed an online auditory lexical decision study for course credit (1:1 word:pseudoword, 1:4 experimental:filler). Participants responded to 8 pairs/condition. Transformed response times were analysed using linear mixed-effects models.

In contrast to rhyme priming (p<0.001), we find no evidence for MMR effects with regulars or irregulars. Together with our previous results, this indicates a directional asymmetry for the MMR effect.

This asymmetry may be due to the time-course of lexical competition. For *showed → dough*, we predict inhibition of *show* in the prime, preventing MMR effects for the target. For *dough → showed*, inhibition of *show* is predicted to occur after MMR facilitation has already occurred in processing the target. Additional studies will address this hypothesis by comparing stem priming with MMR effects and also revisiting previous research.

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A sensitive period for morphology? Morphosyntactic feature retrieval in bilinguals

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The relation between age and language acquisition has been subject to controversial debates in the language sciences. In particular, the question whether there is an ideal time window for the acquisition of grammatical knowledge has received much attention. The present study investigated effects of age of acquisition (AoA) of an L2 on the processing of fine-grained grammatical operations. In a cross-modal priming lexical decision study including 106 Russian learners of German with a wide range of AoAs between 0 and 22 years (mean CEFR level of German: C1), we examined differences of processing cost from inflected German strong verb forms with marked (wirft-werfen) versus unmarked stems (werfen-wirft) relative to repetition priming (wirft-wirft, werfen-werfen). Previous research with monolingual German speakers yielded higher processing cost for marked stem primes compared to unmarked ones relative to identical controls (Krause et al., 2015). Higher processing cost reflected extra processing effort for marked stem primes due to unprimed morphosyntactic target features and served as crucial measure of morphosyntactic sensitivity. The current pattern of results yielded a significant three-way interaction of AoA on the processing cost for marked versus unmarked stem allomorphs (p=.01), indicating greater processing cost for marked stem primes (wirft-werfen) with increasing AoA (p=.012). In addition, non-linear breakpoint regressions revealed a reliable discontinuity of this AoA effect (p=.034) with a gradual increase in processing cost for marked stem primes until the age of 10 (p=.002), which levels off thereafter (p=.332). In contrast, unmarked stem primes did not elicit such a discontinuity (p=1.0). We conclude that morphosyntactic feature retrieval is only operative during online language comprehension if exposure occurred

early enough. More generally, the results suggest that the acquisition of grammatical information is selectively constrained by a sensitive period.

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How Finnish morphology can confuse the L2-speaker

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Finnish morphology is notoriously difficult for L2 speakers. The rich inflectional paradigms and the abundant compound possibilities enforces anybody who wishes to be even a moderate proficient language user in Finnish to quickly develop morphological knowledge and awareness in this language. The current study investigates to what extent this development is complicated by morphophonological variation in the inflectional paradigms. That is, in Finnish the word stem frequently changes when it is combined with inflectional suffixes, e.g., tauko 'break' => tauolla 'at the break' or sota 'war' => sodan 'the war's'. These changes obscure the stem and may make the decomposition process - segmenting the morphologically complex word into constituent morphemes (tauo+lla; as Finnish-speakers usually do, see Bertram, Laine, Karvinen, 1999) - very complex. The current study tested 38 native speakers and 34 L2-speakers in a visual lexical decision experiment including monomorphemic nouns (e.g., kaupunki 'city'), inflections without stem changes, e.g., loma 'holiday' => lomalla 'on holiday') and inflected words with stem changes (e.g., tauolla 'at the break'). The results showed the standard delay in inflectional processing but this delay was enlarged in case of stem changes for both L1 and L2 speakers. However, whereas for L1 speakers the error rates were low across conditions (1 to 2 %), L2-speakers made much more mistakes with inflections including stem changes than for monomorphemic nouns or 'normal' inflections. The results underline the notion that sophisticated ideosyncratic language peculiarities greatly confuse the L2-speaker and that these peculiarities require extra attention in educational settings.

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Is prefix identification position-specific?

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How morpheme position is represented within the word recognition system is an issue of great importance to any model postulating a sublexical decomposition of morphologically-complex words. Crepaldi, Rastle & Davis (2010) and Crepaldi, Hemsworth, Davis & Rastle (2015) studied this matter focusing their attention on the processing of English suffixes, and reached the conclusion that their representations are position-specific (i.e., they are accessed by the word recognition system only when they appear following the stem). Although the evidence provided in these experiments is restricted to suffixes, the authors mention that similar results would be expected with prefixes: they are probably stripped from word onsets but not from word endings. However, some evidence has

been found suggesting that derived prefixed and suffixed words are organized and accessed differently in the mental lexicon, and that the representations of prefixes and suffixes are not equivalent (Beyersmann, Ziegler & Grainger, 2015; Ferrari & Kacinik, 2014; Giraudo & Grainger, 2003; Kim, Wang & Taft, 2015).

The aim of our experiment is to determine whether Spanish prefixes are recognized as such only when they are in their typical position (preceding the base), or if they are activated independently of their position, as stem representations seem to be (Crepaldi, Rastle, Davis & Lupker, 2013). For this purpose, we have adapted Crepaldi et al's (2010) first experiment by designing morphologically-structured nonword stimuli in two conditions: prefix-plus-stem and stem-plus-prefix. If prefix representations are position-specific, a morpheme interference effect should emerge in lexical decision tasks for the prefix-plus-stem stimuli relative to matched nonwords without a morphological structure, but no such processing disadvantage should be found for the stem-plus-prefix stimuli. On the contrary, if prefixes are position-invariant, we should observe comparable interference for both type of stimuli. Results will be presented and discussed.

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Inflectional regularity and gender in agreement processing: evidence from Russian

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Many experimental studies examined different aspects of number agreement, while agreement in other features received less attention. We report a self-paced reading experiment studying how the inflectional class (declension) a noun belongs to and its gender influence the processing of gender agreement in Russian.

Russian has two numbers and six cases, and every declension has a different set of endings associated with them. About 46% of Russian nouns are 2nd declension masculine (*syn* 'son'), 29% are 1st declension feminine (*zhena* 'wife'), 18% are 2nd declension neuter (*okno* 'window'), 5% are 3rd declension feminine (*mat'* 'mother'), 1% are 1st declension masculine (*djadja* 'uncle'), and 1% are classified as irregular (the numbers are taken from (Slioussar & Samojlova, 2015)). Thus, most consonant-final Nom.Sg forms are masculine, and most feminine Nom.Sg forms end in -*a*, with 3D feminine nouns being less usual. Verbs show gender agreement in past tense.

We had 36 target sentence sets. Sentences in one set contained the same six words except for the first one, the subject noun (2D-M / 1D-F / 3D-F, balanced in frequency and length) and the second one, the verb form (M or F). This yielded six experimental conditions, three of them with a gender agreement error.

Reading times were analyzed using RM ANOVA. Agreement errors were noticed significantly later with 3D-F nouns than with 1D-F or 2D-M ones. However, error-related delay on subsequent words was significantly more pronounced for M subjects than for F ones (both 1D and 3D). The latter result suggests that predictions we make about predicate gender are stronger for M subjects (see also (Slioussar & Malko, 2016) for agreement attraction). The former shows that interestingly, the speed of error detection is at least partly independent from that, being affected by inflectional regularity.

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Challenging late vocabulary insertion: Evidence from Russian

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In late insertion theories of morphology, phonological form can play no role in
determining syntactic properties in the process of features interact with semantic ones when determining the choice of a morpheme. Russian expressive derivation provide evidence that phonological form must sometimes be considered before the presupposed Vocabulary Insertion step takes place. In this presentation, I analyze two types of evidence from Russian expressive forms: (suffixes that have both different meanings and phonologically conditioned distribution) and gender assignment. Pseudo-allomorphs. Although the [-ok, -ik, -čik] masculine diminutive suffixes were considered allomorphs in previous studies (Gouskova et al., 2015; Polivanova, 1967). The assumption is based on their distribution in Standard Russian, which is close to complementary and can be predicted from phonological factors, and on their assumed synonymy. In this paper, I demonstrate both corpus and experimental evidence that these suffixes have semantic differences that influence their distribution on a pair with phonological factors. Moreover, by manipulating phonological factors I could change the impact of semantic context in the experiment.
Gender assignment. I have studied diminutive and augmentative forms using both web-search and experiments. Variation appears in gender assignment with every suffix that would pattern the resulting expressive noun to a different declension class than its base noun. This is not surprising considering the previous work on declension classes and gender (Corbett, 1982; Tarasenkova, 2010 among others). However, the fact that declension class does not define the gender, but only contributes to the choice of it, was not previously discussed. Other factors that contribute gender assignment are: gender markedness and existence of variants of an affix that belong to different declension classes (e.g. –išče class IB, -išča class II). The latter is not a feature and is difficult to account for inside a late insertion theory.

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The suffix priming effect in children: A developmental perspective

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The role of morphological processing has been shown to be very relevant in learning to read. However, there is little evidence from a developmental perspective about the processing of derivational suffixes. In this study we focus on them and carry out an experiment with 70 children in which we explore the suffix priming effect. Children of fourth and fifth grade took part in this experiment as well as adults. The experiment consisted in a masked priming lexical decision task (go, no-go version) in which complex and simple words are primed by other words sharing the suffix (as in lechero->jornalero) and word ending (as in araña->España) or not (surfista->jornalero; carpeta->España). The results of adults replicate previous studies by showing that only in the case of complex words the related condition elicits a significant facilitation (see Duñabeitia, Perea & Carreiras, 2008). In the overall analyses it is shown that children are increasingly sensitive to the experimental manipulation. In particular there are significant differences among fourth graders and adults but a lack of significant differences among fifth graders and adults. An inspection of the pattern observed clearly show an evolution of the morphological priming effect taking place in the school ages analyzed.

Although previous studies showed a significant role for suffixes, from the best of our knowledge this is the first time the suffix priming effect is assessed in children. The results are interpreted from a developmental perspective of current theoretical models of morphological processing by which children are increasingly able to process and benefit from the processing of suffixes.

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Derivational depth and the role of the lexicon in morphological decomposition

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Within theoretical linguistics, the study of morphology is as much concerned with the structure of words in a particular language as with a way to capture the variation that exists across languages. Accordingly, empirical investigations into morphological processing have focused on a variety of languages ranging from English and German (cf. Crepaldi et al. 2015; Smolka et al. 2015) to templatic languages such as Hebrew and Arabic (Boudelaa et al. 2004; Feldman et al. 1994). Surprisingly, few studies have addressed a common issue in many languages –derivational depth.

Morphologically complex words can differ in their degree of derivational depth. To give an example, while both *running* and *eyeing* end in the same suffix, *eyeing* has more internal morphological complexity than *running*. For *eyeing*, two derivations are required to decompose down to the base word eye,N (eye,N > eye,V > eyeing). For *running*, on the other hand, the base run,V is only one derivation away. Using fMRI techniques, Pliatsikas et al. (2014) showed sensitivity to this difference through increased activation in the LIFG during the processing of *eyeing* compared with *running*.

In the present study, we move beyond the processing of specific lexical representations (e.g. *running*; *eyeing*) to understand the general mechanisms involved in the processing of morphological complexity. In order to do this, we investigated the processing of well-formed complex pseudonouns in German such as **Denkbarkeit***(thinkability,N) (***denken**>**denkbar*** >Denkbarkeit*) andHoffbarkeit* (hopeability,N) (*hoffen* > **hoffbar*** >Hoffbarkeit*) that differ in the derivational depth required to access an entry in the lexicon. Using behavioural, electrophysiological and fMRI techniques with native speakers of German, we have found that speakers are sensitive to degrees of morphological complexity in all complex words and pseudowords, but also rely on information stored in the lexicon during recognition of morphologically complex items.

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Contemporary French morphology trends: A case-study of formal neologisms in newspapers monitor corpora

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Every Language is constantly evolving, due to several historical, sociological and economic reasons. Morphology is one of the aspects of the linguistic change. One way to grasp these changes is to

study word-formation trends, also named formal neology, which mainly resorts to derivation, composition, truncation and borrowing (Schmid, 2015). In this work, we propose to explore new word morphological trends in contemporary French.

This study is part of an ongoing project, Néoveille, which aims at detecting, tracking and analyzing neologisms on monitor corpora, notably in French. The web platform (www.neoveille.org) enables to detect and track the lifecycle of neologisms through multivariate (linked to diastraty and diatopy) statistics (Cartier, 2016).

In contemporary French, the two traditional morphological processes, derivation and composition, are highly lexically productive. Derivation is by far the most frequent process used to create a new form (about 60% of all neologisms so far), competing with composition (about 20%). We observe that some prefixes appear to be overused (ultra-, ex-) whereas they were not that productive a few decades ago. Another aspect is the emergence of new formants (such as bio-, eco-, e-, etc.).

We will also detail the diastratic variation of derivation and composition, notably in women's magazines.

The data provided by the web platform shed also light on loanwords, which are another highly productive way to create words (about 15%). Among them, French words coined with material borrowed to foreign languages, also called "allogenisms"(Humbley, 2015), are worthy to be mentioned (slashing, cashico, hijabista). The English pattern N/ADJ-Ving is also disseminating. This is also the case for anglicisms which have been adapted in French through prefixation and/or suffixation, like the new french infinitive downvoter, with an usage linked to social networks.

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Simple event nominals do (not) exist in Serbian: Theoretical and empirical evidence

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Simple event nominals (SENs) in English fall into a category in between complex event nominals (CENs) and result nominals (RNs), as they share features of both. Crucially, unlike CENs, SENs do not take arguments (e.g. Grimshaw, 1990). In Serbian, however, CENs can appear with no arguments at all when they are formed out of detransitivized verbs (Zlatić, 1997), patterning thus with SENs rather than CENs in English. To the best of our knowledge, there are no previous studies addressing the differences between SENs and CENs in Serbian from either theoretical or empirical perspective. In this study, we investigate the notion and relevance of the category of SENs in Serbian from both perspectives. The used stimuli were based on the existing tests (Roy & Soare, 2012) focusing on the morpho-syntactic differences between these two categories, such as the presence of PP- modification, the use of adverbs 'frequent'and 'constant', and the presence of an obligatory argument. The stimuli were pairs of sentences with deverbal nominals divided into CENs and SENs, but also the presence and absence of the obligatory argument was varied. The stimuli were presented in a self-paced reading task. Linear Mixed-Effects Regression model showed that there are no significant differences in the processing of SENs and CENs, and that the presence of the obligatory argument does not significantly affect sentence processing. The results obtained in this study suggest that the distinction between SENs and CENs is not relevant in Serbian, but further research is needed for a more concrete conclusion about that distinction.

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Dissociating derivational and inflectional priming: Evidence from older bilinguals

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Unusual populations sometimes provide evidence for theoretically relevant contrasts that are more difficult to get from fit young native speakers. One case in point is derivational vs. inflectional morphology which in a number of masked priming studies (e.g., Jacob et al., in press; Kırkıcı & Clahsen, 2013; Veríssimo et al., 2016) yielded a dissociation for late bilinguals (L2) but not for native controls (L1). While bilinguals showed efficient priming for derivation (*walker –walk*), but not for inflection (*walked –walk*), the L1 controls showed similar magnitudes of priming for both. The sources of the selective derivational priming effect in bilinguals are, however, controversial.

This study contributes new evidence to this topic, from a study of older individuals (mean age = 62, range: 50-83): 36 L2 speakers of German (L1: English) and a control group of 36 L1 German speakers. We compared masked-priming effects (SOA=50ms) for derivational and inflectional primes to the same target (e.g., *Warnung –warnen* vs. *gewarnt –warnen* '(the) warning –warn'vs. 'warned –warn'). Appropriate orthographic and semantic control conditions were also included.

While there were no orthographic or semantic priming effects in any group, the morphologically related conditions yielded significant Group X Prime Type interactions (all *p* < .05). These interactions were due to reliable derivational (but no inflectional) priming for the bilinguals, and no corresponding contrast (with similar inflectional and derivational priming magnitudes) for the L1 controls.

Our findings replicate the L1/L2 contrast obtained for younger individuals with new groups of older individuals. We argue that combinatorial processing (viz. affix stripping) is preserved in aging (hence intact derivational priming) but that the processing of morpho-syntactic features is impeded in a late-learned L2 (yielding no or reduced inflectional priming for both younger and older bilinguals).

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Implicit and explicit morphological awareness: Insight from developmental trajectories and implications for future research

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Children with language difficulties very commonly have additional literacy difficulties (MacArthur et al., 2000). However, most of the research investigating this comorbidity has focused on phonological awareness. The current project is a systematic investigation of the morphological skills of language impaired children, with and without additional literacy difficulties. Researchers have argued that, in order to further develop our understanding of language and literacy impairment, it is important to consider the demands posed by different measures of language ability (Duncan et al., 2013; Ramus et al., 2013). These can vary greatly and tasks often require multiple skills for successful completion. Some research has been conducted to try to unpick such differences in task requirements, particularly for measures of phonological awareness. For example, phonological awareness tasks have been contrasted on the basis of stimulus and response type (Cunningham et al., 2015), general processing demands (e.g. memory load: Ramus et al., 2013), and the extent to which they require

children to demonstrate explicit knowledge (Roberts & McDougall, 2003). In contrast, measures of morphological awareness have received much less attention, with studies focusing on differences in stimulus type, e.g., nonwords vs. real words (Nithart et al., 2009), and differences between transparent and opaque derivations (Carlisle, 2000). The current research aims to extend this literature by systematically contrasting various existing measures of morphological awareness. Guided by previous research and drawing upon the theoretical framework outlined in the Representational Redescription Model (Karmiloff-Smith, 1992), a continuum has been developed which classifies existing morphological processing tasks according to a number of different characteristics and processing demands, including the extent to which they require children to demonstrate explicit knowledge. The current talk will outline the morphological awareness continuum and its development and discuss the usefulness of this in clarifying the complex relationship between language and literacy difficulties.

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Do all complex words have the same degree of complexity?

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We may find several studies claiming that morphological structure plays an important role in word processing. In this paper, supported by the observation of written derived words processing, we intend to demonstrate that complex words display different degrees of complexity, depending on morphological and semantic features. We've performed two experiments, on adults and 4th grade children. Our hypothesis is that word processing is sensitive to the morphological status of the word,although not necessarily in the same way.
In the first experiment, we've used a lexical decision with four conditions:
1) SW- simple words (janela 'window');
2) CDW- compositional derived words (desejoso 'willing');
3) nCDW~suf - non-compositional derived words (suffix allomorphy)(luxuoso 'luxurious');
4) nCDW~base - non-compositional derived words (base allomorphy) (padeiro 'baker');
Results confirm that both groups recognize CDW faster than nCDW. Furthermore, for children, processing nCDW~suf is significantly different from all the other conditions, whereas for adults, the relevant condition is CDW.
In the second experiment, we've used priming with three different times of exposure: 50, 100 and 150 ms. We've tested 3 conditions of prime/target pairs (the base word is always the prime):
1) CDW (desejo 'desire'/desejoso desirous');
2) nCDW~suf (luxo 'luxury'/luxuoso 'luxurious');
3) nCDW~base (água 'water'/aquoso 'watery').
Results indicate that CDW processing brings lower costs and nCDW~suf bring higher costs to word processing. These results are consistent in all exposure times. By crossing the data with the lexical decision experiment, we've also noticed that: for adults, there was a facilitation with the prime presentation at 50 ms; for children this facilitation occurs at 100 or 150 ms.
These experiments suggest that derived words aren't all processed in the same way - different degrees of complexity affect visual word processing.

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Does working memory have an impact on second language processing of inflection: The case of English past tense morphology

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In this study, proficient second language (L2) speakers'processing of past tense morphology was investigated in order to understand whether their processing routes (i.e., decomposition, storage or a dual-route) were comparable with native (L1) speakers of English. By means of a masked priming task (MPT), the reaction times (RT) for regular and irregular verbs were measured. The study also sought to explore whether working memory (WM), as measured by the Automated Reading Span Task (ARSPAN) and Operation Span Tasks (AOSPAN) has any relationship with L2 morphological processing.

A total of 66 L2 learners with L1-Turkish were tested in comparison to 66 native speakers of English. The MPT findings revealed that L2 speakers had slower RTs than native speakers. In addition, the regular verbs were responded to more slowly than irregular verbs in both groups. Further analyses revealed a partial priming pattern (i.e., reduced decomposition) for regular verbs and full priming pattern (i.e., decomposition) for the irregular verbs in both groups. The correlation analyses did not point to any relationship between WM and MPT results in either group. Furthermore, the extreme-groups analysis (comparison of higher and lower WM subgroups) did not result in between-group differences.

Comparable processing patterns in native and nonnative groups obtained in the present study oppose to earlier views that L2 learners are less sensitive to the morphological structure of the target language compared to native speakers. It seems that proficient L2 English speakers can employ the decompositional route in accessing inflected forms in the L2. Our findings suggest that real-time processing of morphologically complex words can ultimately be native-like. Only quantitative differences were found in the form of slower RTs in the L2 English group. Nevertheless, these RT differences cannot reliably be accounted for by WM capacity.

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The interference of animacy in the processing of morphological number

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Morphological Number is widespread throughout natural languages and it is mostly marked on nouns denoting animate entities (Haspelmath, 2013). This trend may mirror the salience of number and animacy, whose conceiving relies on a core knowledge system, early available in development and phylogenetically ancient, dedicated to representing significant aspects of the environment such as numerosity or motion (Spelke 2000). In three experiments, we explored the morphological Number encoding with respect to the animacy of nouns and its interaction with linguistic as well as visual cues related to motion.

In all experiments, participants were presented with phrases made up of a demonstrative and of a noun which missed the inflectional morpheme. The task required to insert it by pressing a button

for −o (masculine singular) or another one for -i (masculine plural).The conditions were: *Number* (singular vs. plural) and *Animacynoun*, (40 animate nouns vs. 40 inanimate nouns). In experiment 1 no prime was used. In experiments 2 and 3, trials were preceded by a prime (*Motion* condition), that was a verb denoting either movement (animate) or stillness (inanimate) in experiment 2, and a point light display giving the impression of a human either walking (animate) or rotating (inanimate) in experiment 3.

Response times were analysed by means of linear mixed effect models. *Animacynoun* was significant in all experiments; *Number* in experiment 1 and 3; *Motion* in experiment 3. A trend for *Animacy-nounxMotion* is observed in experiment 2, but it was significant only in experiment 3, suggesting that semantic and visual features related to animacy interfere with Number inflection. *Animacy-nounxNumber* were statistically significant in all experiments, showing that it is easier to inflect animate nouns for Number.

These data suggest that Number morphology may reflect the salience of animacy in counting, and more generally that morphology easily expresses core cognitive information.

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Reading complex words in Hebrew as a non-concatenative language

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This study investigates decomposition of affixed vs unaffixed and templatic vs concatenative words in Hebrew using the ERP paradigm.

Background: In languages with concatenative morphologies (e.g. Indo-European), words are composed of lexical stems and affixes; these complex (affixed) words are decomposed during reading (Taft 2004). ERP and MEG studies revealed costs for decomposition and for inflectional at ~400ms (N400)(Leionen et al. 2009). In templatic Semitic languages, words (excluding borrowings) are inherently complex, consisting of a root and template (e.g. Hebrew root K.T.V. *writing* + verb template HiTR1aR2eR3, yields HiTKaTeV *correspond*). Furthermore, in concatenative languages, transposed stem letters (TL) words act as primes (e.g. Duñabeitia et al. 2007 [Spanish, Basque]), while in templatic languages, words with TL of two root letters don't prime
(Velan & Frost [Hebrew] 2011). The lack of flexibility is in line with templatic words being decomposed into roots and templates during reading. The goal of this study is to investigate decomposition in Hebrew as a templatic language for both affixation and templatic structure.

Methods: In an ERP experiment, subjects (12 native Hebrew speakers 22-54 years, further data collection in progress) performed a lexical decision task, reading words one at a time. Half of the words were Semitic-templatic and half concatenative borrowings; half were affixed with inflectional plural and definite affixes and half were not. Words are controlled for length, frequency. Affixes are counterbalanced between lists.

Results: Affixed templatic words elicited a larger N400 amplitude than did unaffixed templatic words.

Conclusion: The N400 affect in Hebrew mirrors finding in other languages for affixed vs unaffixed words and implies similar decomposition mechanisms for inflectional affixes. The null effects with comparisons involving borrowings may reflect a more variable time-course by trials or subjects when reading these less typical words.

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Grammatical category in the neural representation of derived forms: Evidence from Italian.

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Grammatical category plays an important role in word formation processes, which typically modify both meaning and grammatical properties of existing words by combining them with derivational affixes. Here we investigate how grammatical category affects the neurocognitive representations of derivationally complex forms focusing on the distributional contrast in Italian between denominal and deverbal derivational mechanisms. Denominal derivation combines independent lexemes (e.g. pin-o "pine") with suffixes (e.g., pin-eta "pine forest"), triggering cohort competition between the derived form and its embedded stem. Conversely, deverbal derivation employs verbal roots, abstract morphemes which surface as separate lexemes only when combined with suffixes (e.g.: par-latore, "talker", from verbal root: parl-, "to speak"plus thematic vowel -a-, agentive suffix -tor- and inflectional ending -e]). These combinatorial differences predict reduced cohort competition effects for deverbal forms, typically reflected by bilateral temporal lobe activations, and higher demand of grammatical decomposition engaging the left-lateralised language system.
We recorded fMRI responses to 320 Italian denominal and deverbal derived words (auditorily presented in a listening task), co-varying semantic transparency and morphological productivity across four conditions.
Combined univariate and multivariate pattern analyses revealed that, in semantically opaque productive forms, increased semantic relatedness produced stronger bilateral temporal activation to denominal forms, but weaker activation to deverbal forms. This dissociation suggests that semantic relatedness between derived words and their embedded stems differentially modulates cohort-based perceptual conflict within the denominal and deverbal sets. Increased semantic relatedness in opaque denominal forms would add to the processing complexity of discriminating the two lexemes involved. In contrast, increased semantic relatedness between the verbal root and the deverbal derived word may increase representational overlap between the two forms, reducing cohort competition.
These results suggest that the neural representation of derived forms in the language system is highly sensitive to grammatical category.

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Do morphological features of different deverbal nominals affect their reading?

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According to theoretical studies deverbal nominals in Serbian can be divided into process and result nominals. Furthermore, there are three subtypes of process and result nominals, which differ in certain morphological characteristics: (i) process and result nominals that differ in the presence of the –va infix (e.g. rešenje/rešavanje) (ii) result nominals have the zero-suffix and process have

the additional deverbal suffix (e.g. let/letenje) (iii) deverbal nominals have different deverbal suffixes (e.g. rotacija/rotiranje). To the best of our knowledge, this study is the first one interested in the examination of the processing of deverbal nominals in the sentence context, with the focus on the investigation of reading time of deverbal nominals that differ in certain morphological features. Three self-paced reading tasks were conducted. The stimuli in the first experiment were pairs of the sentences with process and result nominals that differ in the presence of the infix. In the second experiment, the stimuli were pairs of the sentences with deverbal nominals where result nominals ended in the zero-suffix and process ended in the additional deverbal suffix. Pairs of the sentences used as the stimuli in the third experiment included two types of nominals with different deverbal suffixes. Three refitted LMER models (each for each experiment) revealed that there are no differences in the processing of different types of process and result deverbal nominals (Experiment 1(β=.06; SEβ=.03, t=1.90; Pr($>$|t|)$>$.05);Experiment 2(β=.03; SEβ=.03, t=.98; Pr($>$|t|)$>$.05);Experiment 3(β=-.02; SEβ=.01, t=1.33; Pr($>$|t|)$>$.05)). The obtained results go in line with the amorphous perspective on lexical processing, which suggests that during the processing of morphologically complex words there is no obligatory segmentation into single morphemes.

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Morphological processing interacts with form priming

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Some evidence suggests that phonological transparency is used when processing morphologically complex words (c.f. Amenta & Crepaldi, 2012). However, in the form priming literature, the effect of phonological overlap is not conclusive (cf. Giraudo and Dal Maso, 2016). Priming experiments often show inhibition (Colombo, 1986) or null effects (Marslen-Wilson et al., 1994), rather than facilitation. We are interested in understanding form priming and how it interacts with morphological processing.

64 Bengali native speakers participated in four experiments using a cross-modal lexical decision paradigm: two with phonologically related prime-target pairs and two with morphologically related pairs. Bengali allows us to control experimental materials (a) to systematically manipulate segmental overlap between the prime/target pair and (b) to compare the results for word pairs that are phonologically or morphologically related with parallel segmental structures.

Segmental overlap was strictly controlled by increasing/decreasing one segment between prime and target. Two conditions were used: in the blocked condition (N = 32) critical prime-target pairs had the same type of relationship while in the mixed condition (N = 32) phonologically and morphologically related pairs were mixed.

In the blocked condition, morphologically related pairs showed robust priming effects, but not phonologically related pairs. In the mixed condition, a similar morphological priming effect was found. Additionally, a significant form priming effect emerged, suggesting that exposure to morphologically related word pairs altered the analyses for phonologically related words.

The form priming effect in the mixed condition was driven by pairs where targets increased by one segment rather than those which decreased by one segment. Hence, the form priming effect in the mixing condition results from a more activated phonologically related cohort, arguably because morphological processing draws on phonological relatedness. Thus participants rely more on phonological information than in a blocked condition. Methodological implications are discussed.

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Semantic transparency affects morphological priming⋯eventually

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Despite decades of psycholinguistic research on semantic transparency, researchers still disagree about whether morpho-semantic information is used in the earliest processing stages, resulting in stronger priming effects for transparent (*walker*) than for opaque (*corner*) forms (Beyersmann et al., 2015; Feldman et al., 2015). In two masked priming studies with English -*ness* and Russian -*ost'* nominalisations, we investigated how morphological priming effects are modulated by semantic transparency at short and long prime durations. In contrast to previous research, we used a transparency scale within our items rather than splitting them into dichotomous groups of transparent and opaque forms.

Forty-nine English and 60 Russian native speakers made lexical decisions for targets preceded by derived versus unrelated primes. The semantic transparency of the derived forms was established in a pretest, ranging from opaque (*business −busy*; *milost'* 'your highness'−*milyj* 'nice') to transparent (*paleness −pale*; *gordost'* 'pride'−*gordyj* 'proud'). Participants were assigned to one of two prime durations (~35 vs. ~70 ms).

Linear mixed-effects models revealed that semantic transparency modulated priming effects at the long prime duration in both English (t=2.45) and Russian (t=2.40), with priming effects increasing with transparency. At the short prime duration, however, priming effects were constant across the transparency scale (English: t=-1.22; Russian: t=-0.09). Three-way interactions showed that the effects in the two prime durations differed statistically (English: t=-2.10; Russian: t=-1.69).

Our results provide support for models that posit an initial phase of 'semantically blind' affix-stripping, with semantic transparency information reducing the facilitation effects for opaque forms only when there is sufficient time to process the prime. Crucially, we found this effect using a scale rather than distinct item sets, which indicates that the effect of semantic transparency is gradual rather than categorical.

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Comparison of sensitivity to case violations across native and nonnative speakers of Turkish

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This study examines the extent to which native speakers (NSs) and advanced nonnative speakers (NNSs) of a highly-inflected language, Turkish, are sensitive to case markers as morphosyntactic cues to detect syntactic complexity and case violations. Self-paced reading (SPR) and grammaticality judgment tasks (GJT) were employed to test the degree of sensitivity to the substitution of accusative or dative for one another on the embedded nominalized verb, or to the omission of genitive case, resulting in unmarked nominative, on the embedded subject (e.g., Loudly the auntie's snoring tolerated[I] during the bus trip, where auntie is inflected with genitive, while snoring is inflected with dative in Turkish, as determined by the matrix verb, tolerated). Participants were 36 NSs and 38 advanced NNSs of Turkish. Overall, NNSs were significantly slower than NSs in reading

complex sentences in SPR and were less accurate at detecting case violations in GJT. However, both groups were better at recognizing substitution than omission errors, although this trend was more pronounced in NNSs. In SPR, reaction times (RTs), measured on the matrix verb, did not differ across substitution vs. omission errors in either group, but a significant slowdown to ungrammatical sentences was observed only in NSs. Yet, NNSs demonstrated extremely long RTs to embedded subjects with genitive case relative to their ungrammatical counterparts in nominative case, and to the subsequent nominalized verb with dative case. This early sensitivity to syntactic complexity and to less frequent and marked dative case was not present in NSs. To conclude, advanced NNSs of Turkish displayed a nonnative pattern of sensitivity to case violations, along with greater processing effort than NSs, but they were still sensitive to case marking, albeit only at certain points, which flagged complex sentence structure, such as embedded subject and verb, rather than matrix verb.

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A reflection on psycholinguistics through its questions about morphology and the mental lexicon

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Psycholinguistics has tended to formulate its fundamental questions according to the pattern "What is the psychological implementation of a linguistic notion?", such as "What is the content of the mental lexicon?" or "How is morphology organized in the brain?". I will argue that questions like these presuppose the lexical and morphological modularity of traditional linguistics. By definition, answering these questions through experimental research or computational modeling will by definition result in answers that preserve the traditional linguistic modularity. This self-perpetuation is further strengthened by psycholinguistics' pervasive use of linguistic resources, which again reflects the traditional linguistic notions and linguistic modularity. I will discuss why these objections should not be confounded with objections to modularity or computationality. Finally, I will explore how computational and experimental research questions can be phrased in terms of psychologically-grounded notions of language and communication.

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Finding structure in form and time: Discriminative explorations in quantitative morphology

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Traditional studies of language assume an atomistic model in which linguistic signals comprise discrete, minimal form elements associated with discrete, minimal elements of meaning. Since linguistic production has been seen to involve the composition of messages from an inventory of form elements, and linguistic comprehension the subsequent decomposition of these messages, researchers in linguistic morphology have focused on attempting to identify and classify these elements, along with the lossless processes of composition and decomposition they support, a program that has raised more questions than answers, especially when it comes to the nature of form-meaning associations.

By contrast, behavioral and neuroscience research based on human and animal models has revealed that "associative learning"is a lossy, discriminative process. Learners acquire predictive understandings of their environments through competitive mechanisms that tune systems of internal cue representations to eliminate or reduce any uncertainty they promote. Critically, models of this process better fit empirical data when these cue representations do not map discretely onto the aspects of the environment learners come to discriminate. In this talk, I will briefly describe the basic principles of learning, along with the empirical basis for the belief that human communication is subject to the constraints these principles impose, and describe how, from this perspective, languages should be seen as probabilistic communication systems that exhibit continuous variation within a multidimensional space of form-meaning contrasts.

This systematic picture of communication indicates that discrete descriptions of languages at an individual (psychological) or community (linguistic) level must necessarily be idealizations. Idealizations inevitably lose information, and I will then describe how the development of a discriminative, information theoretic approach to language leads in turn to the appreciation of the vast array of socially evolved structure that serves to underpin human communication.

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Storage vs. Processing in Models of Word Inflection. A Neuro-computational Hebbian Perspective

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The advent of connectionism in the 80's popularised the idea that the lexical processor consists of a network of parallel processing units selectively firing in response to sensory stimuli. In the light of these assumptions, the most important contribution of connectionism to the theoretical debate on lexical modelling at the time was the utter rejection of the widely accepted idea that word recognition and production require a dichotomous choice between storage and processing. However, in spite of the prima facie psycho-computational allure of this view of the lexicon, early connectionist models also embraced a number of unsatisfactory assumptions about word learning and processing.

More recently, a growing number of approaches to inflection in both Psycholinguistics and Theoretical Linguistics developed the view that surface word relations represent a fundamental domain of morphological competence. Learning the morphology of a language amounts to acquiring relations between fully stored lexical forms, which are concurrently available in the speaker's mental lexicon and jointly facilitate processing of morphologically related forms through patterns of emergent self-organisation. This novel view presupposes an integrative language architecture, where storage and processing, far from being conceived of as insulated and poorly interacting modules, are the short-term and the long-term dynamics of the same underlying process of adaptive specialisation of synaptic connections. This view, upheld by recent evidence of the neuro-anatomical bases of short-term and long-term memory processes, crucially hinges on Hebbian principles of synaptic plasticity, which are, in

turn, in keeping with mathematical models of discriminative learning. I contend that

integrative computer models of Hebbian language learning represent an exciting way forward

in current neuro-computational research on word processing, and a persistently fertile legacy

of the connectionist revolution.

Symposium 1 – Quantitative Morphology / 75

Are baboons learning "orthographic" representations? Probably not.

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The ability of Baboons (Papio papio) to distinguish between English words and nonwords [1] has been modeled using a deep learning convolutional network model that simulates a ventral pathway in which lexical representations of different granularity develop [2]. However, given that pigeons (Columba livia), whose brain morphology is drastically different, can also be trained to distinguish between English words and nonwords [3], it appears that a less species-specific learning algorithm may be required to explain this behavior. Accordingly, we examined whether the learning model of [4],which has proved to be amazingly fruitful in understanding animal and human learning [5– 7] could account for these data. We show that a discrimination learning network using gradient orientation features as input units and word and nonword units as outputs succeeds in predicting baboon lexical decision behavior –including key lexical similarity effects and the ups and downs in accuracy as learning unfolds —with surprising accuracy. The performance of this model, in which words are not explicitly represented, is remarkable because it is generally assumed that lexicality decisions, including the decisions made by baboons and pigeons [2, 3] are mediated by explicit lexical representations. Our results suggest that in learning to perform lexical decision tasks, baboons and pigeons do not construct a hierarchy of lexical units, but rather they make optimal use of low-level information obtained through the massively parallel processing of gradient orientation features. Accordingly, we suggest that skilled fluent reading of both simple and morphologically complex words in humans may involve a transition from a high-level system building on letter representations acquired during explicit instruction in literacy to the use of a similar strategy of exploiting massively parallel processing from low-level visual features to semantics. Methodological implications of these results for theories of lexical access will be discussed.

Contributed papers 4 / 32

The neural bases and distributional factors underlying learning and generalization of morphological inflections

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We examined the neurocognitive basis of distributional factors underlying learning and generalization of affixal inflectional morphology in a novel language. Our behavioral study examined effects of three factors in adults acquiring plural suffixation in an artificial language, over six sessions: affix type frequency (number of words receiving an affix), phonological predictability (degree that phonological cues predict an affix), and affixal phonological diversity (number of different rime cues predicting the affix). Our results suggest that all three factors contributed to both learning and generalization, though with different time courses. Notably, both higher affix type frequency and higher affixal diversity led to default-like affixation of untrained words without phonological cues, explaining emergence of minority default inflections.

In our fMRI study adults were trained on the same artificial language for three sessions, and scanned after the first and last sessions while inflecting trained and untrained words. Inflecting trained items yielded activation in the caudate head bilaterally, only in the first session, consistent with a role for procedural memory in learning grammatical regularities. Untrained words yielded more activation than trained words in medial frontal (including preSMA) and left inferior frontal cortices, previously implicated in compositional grammatical processing. A reliance on phonological cues for untrained word inflection correlated positively with preSMA activation, but negatively with activation in pars triangularis, suggesting these regions underlie alternative linguistic processes. Activation in these regions was also affected by affix type frequency in trained items, with the weakest activation for trained items with high frequency affixes. This suggests less involvement of compositional processes for inflecting trained items, in particular those with high frequency affixes, consistent with storage of such forms.

Overall, these findings elucidate the role of domain general distributional factors (frequency, predictability, diversity) and procedural learning mechanisms underlying learning and generalization of morphological knowledge in a novel language.

Contributed papers 4 / 13

Reading derived words in Italian children with and without dyslexia: The effect of root length

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Italian children with dyslexia are extremely slow at reading long words. However, they read faster stimuli composed of roots and derivational suffixes (e.g., CASSIERE, 'cashier') than stimuli not decomposable in morphemes (e.g., CAMMELLO, 'camel'). The present study assessed whether root length modulates morphological processing. For skilled readers, reliance on the root might depend on its perceptual salience within the word, being greater for longer than shorter roots. In contrast, readers with dyslexia might be facilitated by the presence of a root irrespective of its length because of their difficulty in processing the word as a whole. Two groups of 6th graders, with and without dyslexia, participated in the study. They read aloud low-frequency derived words, with familiar roots and productive suffixes. Word length ranged from 6- to 12-letters; root length from 3- to 6-letters. Word naming times (RTs) and mispronunciations were recorded. Linear mixed-effects regression analyses on RTs showed inhibitory effects of word length, no effect of word frequency, and facilitatory effects of root frequency for both children with dyslexia and skilled readers. Root

length predicted RTs of skilled readers only, with faster RTs for longer roots, over and above the inhibitory effect of word length. Mixed-effects regression analyses on accuracy showed only a group effect. The large word length effect on latencies for both groups confirms laborious whole-word processing. The absence of a word frequency effect along with facilitatory root frequency indicate morphemic processing in all readers. The reversed root length effect for skilled readers indicates that root activation is more likely for longer roots. For readers with dyslexia the facilitation of root frequency irrespective of root length suggests a pervasive benefit of root activation because most words are for them too large units to be processed within a single fixation.

Contributed papers 4 / 33

Development of morphological processing in spelling

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Morphological awareness is demonstrated to be a key contributor to literacy development. Nonetheless, little is known about how children actually use morphological information as they read and write. To address this, we examine children's use of root morphemes in spelling. We use newly developed online measurement to study the processes involved in generating correct spellings in addition to errors. 25 children aged 6-8 and 24 aged 8-11 spelled root words (e.g., rock), inflections (rocks), derivations (rocky) and unrelated controls (rocket). In addition to traditional offline measures of spelling accuracy and root constancy, children's handwriting was digitally recorded to examine preparation time, word and root morpheme writing speed and the location of pauses. Preliminary analyses of correct spellings indicate that spelling preparation time was shorter for inflected and derived words than for unrelated controls. However, word writing time was longer in these comparisons. Further analyses will examine root morpheme writing time and the location of intraword pauses. We will also examine developmental effects, relationships between spelling measures, morphological awareness and overall literacy skill. Evidence from correct spellings is consistent with offline measures of spelling errors –children use root constancy to support spelling. In addition, we argue that our findings show that when writing a morphologically complex word, children initially prepare to spell the root morpheme and begin to spell it before preparing the second morpheme.

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A longitudinal perspective on masked morphological priming in children

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Masked priming studies comparing morpho-orthographic and morpho-semantic processing in children have seen an increase in recent years. However, the exact developmental trajectory of morphological priming effects remains unclear. It has been suggested that, for adults, the effects are

modulated by reading, spelling, and vocabulary skills. This is of special relevance when studying children for whom these skills are still undergoing changes. In order to take this developmental aspect into account, we examined masked morphological priming longitudinally in a large group of elementary school children from second to fourth grade.

A masked priming lexical decision task with suffixed words (kleidchen-kleid, like farmer-farm), suffixed nonwords (kleidtum-kleid, like farm-farmity), nonsuffixed nonwords (kleidekt-kleid, like farm-farmach), and unrelated control words as primes was administered to 100 children in grade 2, and again in grade 3 and 4. Growth curve analysis shows that facilitation from suffixed words and suffixed nonwords emerge simultaneously in grade 4, but no effects can be observed before. The findings shed new light on the mechanisms involved in the development of morphological processing from a longitudinal perspective. Additional analyses will explore how specific person and item characteristics influence the developmental trajectory.

Contributed papers 5 / 47

Taking morphology a level higher: A lemma-extended interactive activation model

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Much psycholinguistic research has provided evidence for the surface-form segmentation of complex words, but comparatively less attention has been paid to the organisation of morphology at 'higher levels'(but see Marelli & Baroni, 2015). Although several models of morphological processing make use of a lemma level interacting with morpho-orthographic representations, such proposals are not detailed enough to generate quantitative predictions. At the same time, explicit computational models of word recognition have not yet incorporated these theoretical developments.

Here, we mitigate these gaps by proposing a novel, implemented computational model of morphological processing, which extends the original Interactive Activation framework of visual word recognition (McClelland & Rumelhart, 1981) with a (structured) layer of lemmas. The main tenets of the Lemma-Extended Interactive Activation (LEIA) model are: obligatory decomposition into stems and affixes; separate (underspecified) lemma representations for marked and unmarked stems; and between-lemma excitatory and inhibitory links.

In three sets of (proof of principle) simulations, all with the same parameter values, we show that LEIA produces close quantitative fits to a variety of previously reported priming effects. **Study 1** examined priming between lemma-related forms. LEIA produces stronger priming for regular morphology, weaker facilitation for irregular morphology, and inhibition for orthographic relatives (Crepaldi et al., 2010). **Study 2** demonstrates stem priming asymmetries, with reduced priming from unmarked to marked stems, compared to the reverse (Bosch & Clahsen, 2015). In **Study 3**, we show that LEIA can account for the intricate pattern of stem homograph effects, producing facilitation or inhibition from stem homographs (and their allomorphs), depending on prime duration (Badecker & Allen, 2002).

We have taken the first steps towards a fully specified theory of morphological processing. Our results suggest that a lemma level, with properties like the ones outlined above, may be one of the assumptions indispensable in such a theory.

Contributed papers 5 / 40

Evaluating the impact of relations in compound processing: a simulation study in distributional semantics

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In most languages, words can be combined to create novel compounds that are readily understandable by speakers. Crucially, the compound meaning is not only determined by the two words, but also by the (unexpressed) relation that links them together: we have a clear intuition that *snow building* means *a building MADE OF snow*, even if we have never heard it before. In the present work, we propose a new data-driven model, CAOSS (Compounding as Abstract Operation in Semantic Space), to capture this process.

In CAOSS, word meanings are represented as vectors encoding lexical co-occurrences from a text corpus. A compositional procedure is applied to these vectors: given two constituent words u and v, their composed representation can be computed as $c=Mu+Hv$, where M and H are weight matrices estimated from corpus examples. The matrices are trained using least squares regression, having the vectors of the constituents as independent words (*car* and *wash*, *rail* and *way*) as inputs and the vectors of example compounds (*carwash*, *railway*) as outputs, so that the similarity between $Mu+Hv$ and c is maximized. Once the two weight matrices are estimated, they can be applied to any word pair in order to obtain meaning representations for untrained word combinations (i.e., productive usage of compounding).

We tested our models against behavioral results from the conceptual combination literature, and in particular the effects of relational priming and relational dominance in the processing of novel compounds. The impact of relational information, as well as its specific association with the initial constituent, are correctly predicted by the CAOSS representations.

The model simulations suggest that relational information can be learned from language experience and then applied to the processing of new word combinations. CAOSS representations are flexible and nuanced enough to emulate this procedure.

Contributed papers 5 / 22

The role of competition between conceptual relations during compound word recognition: Evidence from spoken and visual word recognition

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Research suggests that compound word recognition is guided by the activation of a relational structure that links the compound's constituents (e.g., *steamboat* is a 'boat that *uses* steam'; Gagné & Shoben, 1997). Schmidtke et al. (2016) demonstrated that part of this process is competitive in nature. They found that greater relative difficulty in converging on a compound's relational interpretation (i.e., greater Shannon entropy) leads to longer lexical decision latencies. However, it is not known whether this effect generalizes to different tasks or different modalities. We addressed these issues in a series of four studies.

In Study 1 we collected relation interpretation data for 604 English compound words using Amazon Mechanical Turk. Data from this study was used to compute the measure of entropy of conceptual

relations. In Study 2, across two visual lexical decision datasets (ELP and BLP; Balota et al., 2007; Keuleers et al., 2012), we replicated the finding that greater competition among conceptual relations slows down compound word recognition. In Study 3, we investigated the same effect on auditory lexical decision latencies in the MALD database (Tucker et al, submitted). We demonstrate the novel finding that competition among relational interpretations also occurs during spoken word recognition. Finally, moving beyond the recognition of isolated words, Study 4 reports the same inhibitory effects of entropy on eye movements to compounds that were read within sentence contexts.

In sum, across all studies we find that uncertainty in selecting a compound's relational interpretation creates a cognitive bottleneck, which increases cognitive effort during word recognition. This finding accords with the theory that conceptual combination is a competitive process (Spalding et al., 2010), and demonstrates that the underlying mechanism of selecting a single relational meaning from many is task independent, and is common to auditory and visual comprehension.

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The role of context in compound detection during reading of unspaced text

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In Chinese, efficient segmentation strategies are crucial for fluent reading, as word boundaries are not signaled by obvious segmentation cues like spaces. In alphabetic languages like English, word boundaries are clearly indicated by interword spaces and presenting these languages in the same way as Chinese, that is without interword spacing, slows down reading to a great extent (Rayner et al, 1998). In the current eye movement experiment Finnish sentences were presented without spaces and we investigated what segmentation cues are used to determine word boundaries under these circumstances. It was found that one of the cues is the co-occurrence of letter bigrams, with low co-occurence of letters (e.g., the rt-sequence in a phrase like 'itisclearthat') leading to swifter segmentation. Moreover, target word compounds (e.g., vuorileijona 'mountain lion') were processed more slowly when the first constituent (here mountain) fitted in with the preceding context as in 'hesawthemountainlionfromadistance'. Processing proceeded more smoothly when this was not the case (as in 'heheardthemountainlionfromadistance'). We argue that this finding is caused by more effortful segmentation in the first compared to the latter case.

Similar decisions have to be made in Chinese constantly, as in Chinese subsequent characters often but not always need to be unified to form compound words. To investigate this issue further, we conducted an eye movement experiment in Chinese in which subsequent character combinations were less or more likely to form compounds as a function of co-occurrence characteristics and preceding context. The data of this experiment are currently being analyzed.

Symposium 2 – The time course of morphological processing as revealed by analyses of distributions and of means / 15

Survival analysis: A tool for timing semantic and formal effects on derived and compound word recognition

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A critical point for many conflicting accounts of morphological processing is the relative time-course of formal (orthographic, phonological and morphological) and semantic effects during visual recognition of complex words. This talk address this question with the help of a nonparametric technique of survival analysis (Reingold & Sheridan, 2014, 2016), designed to estimate the temporal onset of an effect on behavioral response latencies. The technique considers distributions of response times to groups of words differing in a formal or semantic characteristic, and establishes the earliest timepoint at which the distributions reliably diverge and the effect of the target characteristic has its onset. We present worked examples for over 10 datasets of lexical decision and eye fixation latencies to derived words (Schmidtke & Kuperman, in press) and compounds in English and Dutch. We also discuss estimation of effect onsets for individual participants, as well as aggregated samples. The relative order of divergence points in response time distributions reveals that semantic effects are virtually simultaneous with formal ones. We also discuss how the absolute time signatures of behavioral effects in lexical decision latencies and especially the eye-movement record (120-250 ms) guide future research by constraining the expected timeframe of same effects in the brain activity.

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Novel insights in morphological processing from Dynamic Survival Analysis and Quantile Regression

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We present two statistical methods that make it possible to assess whether the effect of predictors on a response variable vary within the distribution of the response. Dynamic survival analysis is applicable to durational responses such as reaction times, fixation durations, and acoustic durations. Quantile regression can be applied to any kind of measurement, not only durations but also tongue positions or the amplitude of the brain's electrophysiological response to some stimulus. Dynamic survival analysis applied to auditory lexical decisions to English compounds revealed early effects of compound frequency and late effects of modifier frequency, replicating Schmidtke et al. (2017). The competing risks setting of dynamic survival analysis enabled a further analysis of the nonword responses, indicating that such error responses are likely to arise due to intrusion of the modifier.
A quantile regression applied to articulatory trajectories of the tongue as revealed by electromagnetic
articulography showed that regular present and past tense inflections of English verbs are
co-articulated more strongly when more frequent, and that this effect was especially prominent
when the general position of the tongue was higher. Both sets of results argue against decompositional
theories of morphology, and fit well with the discriminative perspective on lexical processing
as well as with Word and Paradigm morphology.

Symposium 2 – The time course of morphological processing as revealed by analyses of distributions and of means / 24

The time course of BOAT-FLOAT facilitation and its implication for morphological processing

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Accounts of morphological processing differ with respect to whether morphological effects fall out of learning-based principles (e.g., convergence, discrimination) or whether morphological structure is explicitly represented in our lexical knowledge. We examine how the contribution of meaning (and form) similarity differs across time with quantile regression and dynamic survival analysis. Data encompass three variants of primed lexical decision that differed by SOA and presence of a mask (48 ms forward masked, 116 ms, and 250 ms SOAs) as well as position of form overlap (rime, onset) between prime and target. Each target (e.g., FLOAT; SKATE with rime and onset overlap respectively) followed all types of primes, those related by form only (e.g., COAT, SKIP), meaning only (e.g., SWIM, GLIDE), both form and meaning (e.g., BOAT, SKI) or neither (e.g., SEED, HOOK). We contrast the results of a standard analysis of variance to those of the quantile regression and dynamic survival models for the instantaneous hazard and the cumulative incidence within the competing risks setting to track the primacy of semantic effects and their interaction with form throughout the full time course of primed word recognition.
Shared form in the absence of shared meaning led to delayed responses from the second decile onwards. Shared meaning in the absence of shared form led to shorter responses, but only in later deciles. Shared meaning and shared form also afforded shorter RTs, and this effect was present already at the first decile. Similar results were obtained with dynamic survival analysis. The emergence of the effect of sharing both form and meaning before any other effect, irrespective of SOA and the presence or absence of a mask or a linguistically-define morpheme, provides further evidence for the importance of semantics already at the earliest stages of lexical processing.

Symposium 3 – Theoretical linguistics / 85

Vague and vacuous morphological decomposition

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Empirical tests of productivity and decomposition use etymological, semantic, and distributional criteria to classify items into categories, such as transparently affixed, opaquely affixed, pseudoaffixed, or unaffixed. Such classifications require analysts, as well as language learners, to know semantic and syntactic properties of forms, identify potential base forms, and determine which (base, derived) pairs share the same relationship. Language learners often have sparse or incomplete information about semantic and syntactic properties of words and related bases; indeed, positing potential morphological decompositions is a useful first step in decoding the category and meaning of words. Numerous models of morphological segmentation have been developed using distributional techniques such as MDL or Bayesian inference; however, these models focus almost exclusively on segmenting words into morphemes, and very little on establishing productivity or selectional restrictions. Furthermore, segmentation in these models is all or nothing.

In this talk, I describe the application of a supervised morphological learning model (the Minimal Generalization Learner; Albright and Hayes 2003) to data with incomplete or missing information about pairs, with the goal of discovering the pairs and their decomposition simultaneously. Given no information about syntactic or semantic properties, the model resembles other distributional learners, discovering recurring pieces. However, the model can also identify potential morphological relations with varying degrees of semantic specificity and predictive power. Thus, the grammar

may simultaneously contain semantically vague or vacuous rules encoding frequently recurring formal relations, alongside rules for narrow prescribed morphosyntactic functions. The model makes several interesting predictions. The first concerns gradient decomposition: pseudoaffixed forms may be decomposed with varying probabilities. The model also favors "vague" decomposition, in which the base and derived form share some morphosyntactic properties with transparently related pairs, over "vacuous" decomposition, in which the relation is purely formal. Finally, the model favors decomposition for strings that represent multiple homophonous affixes.

Symposium 3 – Theoretical linguistics / 86

From grammar induction to learning and processing

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The automation of analysis allows to make the comparison between competing hypotheses in theoretical morphology more explicit: Implementing learning algorithms that break down unanalyzed inflectional paradigms into form-meaning pairs and possibly a full grammar allows to investigate the empirical consequences of hypotheses or frameworks in detail (e.g Anderson 1992, Halle & Marantz 1993, Stump 2001). This talk highlights different principle problems of inflectional analysis such as selecting possible forms to consider, pairing them with (possibly default) meanings, introducing and representing the linear order between markers/rules as well as their paradigmatic suppression (blocking). It presents algorithmic solutions to those problems and shows how map to empirical predictions for language acquisition and processing.

Symposium 3 – Theoretical linguistics / 88

Storing morphologically complex forms: convergent evidence from grammar and psycholinguistics

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Linguistic theory affords several ways of using grammatical evidence in support of the lexical storage of morphologically complex forms. These theoretical lines of argument are particularly persuasive when they converge with the results of independent psycholinguistic experiments.

One type of evidence comes from allomorphic locality. Assume that allomorphy involves competition between lexically stored exponents and that exponence proceeds cyclically. If so, one can infer the size of listed allomorphs from the size of the cyclic domain in which they compete for selection. Bermúdez-Otero (2013, 2016) applies this method to Spanish, where most stems can be decomposed into a root and a theme vowel: e.g. am-a 'love-th', beb-e 'drink-th'. Since the choice of theme vowel is syntactically and phonologically unpredictable, this raises the question whether the Spanish lexicon stores bare roots specified with class features or full stems complete with their theme vowels.

Allomorphic patterns such as the diphthongal and raising alternations support the option of stem storage. In the diphthongal alternation, for example, allomorphs containing stressed [jé] and [wé] alternate with allomorphs containing unstressed [e] and [o]: e.g. cuént-a-Æ 'count-th-3sg'~ cont-á-mos 'count-th-1pl'. Now consider a derivative like the deverbal adjective [A [V contá] ble] 'countable'. Assuming competition between two root allomorphs /kont-/ and /kwent-/ in the first

cycle, when stress is on the initial syllable, yields ungrammatical *cuentable. This instance of allomorphy must therefore involve competition between two stems /kont-a-/ and /kwent-a-/. These are listed exponents of the lexeme contar 'count'and compete in the second cycle, in which stress moves to the second syllable.

Psycholinguistic evidence confirms this conclusion. Domínguez et al. (1999, 2000) studied lexemes like ciego 'blind', which has two stems (cieg-o m and cieg-a f) and four fully inflected forms. Recognition latencies were found to depend on the token frequency of each stem, rather than on the frequency of the lexeme or of individual wordforms.

Symposium 3 – Theoretical linguistics / 87

Beyond affix-stripping: Generalisation and processing of 'pure morphology'

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The 'classical'approach to morphology ascribes productivity to knowledge of rules: categorical, context-free operations which create structured representations. Alternatively, within analogical, connectionist, and stochastic approaches, it has been proposed that the mechanisms that generalise and process complex forms are inherently graded, as well as frequency- and similarity-sensitive. In this talk, I will review work conducted in Romance languages aimed at adjudicating between these two broad theoretical positions.

We have made use of a number of experimental techniques (elicited production and judgement tasks, masked and cross-modal priming, and computational simulations) to examine the generalisation and processing of conjugation classes in Portuguese and Italian. Conjugation classes are instances of 'pure morphology', abstract features that do not express meaning or syntax beyond their morphological properties. With these properties, such phenomenona may be particularly suited to examine speaker's knowledge of morphology beyond the phonological-to-semantic mappings that necessarily characterise inflectional and derivational morphemes.

The results from these studies indicate that speakers partition the space of conjugation classes by distinguishing between: i) a default class, which generalises in a context-free manner and forms structured stems (i.e., [root + class marker] representations); and ii) 'exceptional'classes, which are generalised in a graded manner on the basis of phonological similarity and comprise stems that display no internal structure.

We conclude that the investigation of more abstract phenomenon than the more commonly studied processes of morpheme decomposition holds promise for illuminating long-standing theoretical controversies. In particular, the results have implications for the debate between rule-based and associative approaches to language, as well as for the status of morphological classes in the theory of morphology.

Poster 2 (with coffee) / **48**

Executive function deficit affects online morphological processing: evidence from Mild Cognitive Impairment.

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Pseudo-words of the type re-happy present with a conflict in terms of stem-suffix combinability. Apart from knowledge of grammar, processing this type of pseudo-words demands the involvement of executive functions which allow the processor to evaluate the conflicting information (re- + adj) and detect the violation. We explored the relationship between executive control and morphological processing through the performance of MCI individuals, a population with a manifested executive dysfunction.
*Method: 23 Slovenian-speaking MCIs and 21 age-matched controls performed a grammaticality judgment task and an on-line lexical decision task on complex pseudo-words with three types of mismatches, in terms of: [a] lexical category of the base (*črkilec 'letter-er'*), [b]* argument structure properties of the base (*trpelec ꞌsufferer*Ꞌ*), [c] aspectual properties of the base (*preplavalec ꞌswimmer-perfective*ꞋꞋ).
Results: No differences between MCI and controls in the grammaticality task. Both populations successfully rejected inappropriate pseudo-words and they could tell them apart by yielding different acceptance rates for each type ([a]<[b]<[c]). In the on-line task, MCIs were slower than controls (p < 0.001). Also, while the control group produced distinct RTs for each type ([a]<[b]<[c]), no significant difference was found among them in the MCI group. Finally, Pearson's r correlations showed a correlation between RTs of the MCI group and their performance on executive function tests.
Discussion: The ceiling performance in detecting violations in grammaticality judgment suggests preservation of morphological rules. However, under time pressure, patients are slower than controls and fail to tell apart the different kinds of mismatches. The evidence suggests that while morphological rule knowledge is preserved in MCI, the processing times of these violations are indicative of a deficit which appears to rely on the extra-linguistic cognitive system and correlates with executive dysfunction.

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Morphological processing impairments in Parkinson's disease: effects of regularity, disease progression, and sex

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Substantial research has examined the neural bases of morphology, and how morphological processing is affected in brain disorders. Parkinson's disease (PD), in which frontal/basal-ganglia circuits undergo degeneration, may elucidate these issues. Ullman et al. (1997) reported that higher right-side hypokinesia, which reflects left frontal/basal-ganglia degeneration, predicted worse performance at producing regular but not irregular English past-tense forms. The paper suggested that rule-governed computation of regular forms depends on frontal/basal-ganglia circuits underlying procedural memory, whereas irregular forms are stored in declarative memory. Subsequently, several studies of regular/irregular inflection in PD reported different patterns, challenging the paper's conclusions. However, these studies differed from the original study, including by examining patients at lower levels of disease progression (rule-governed deficits may only arise at higher levels), and by including high percentages of females (who may depend less on procedural memory for rule-governed computation, due to compensation by declarative memory, which shows female advantages). Experiment 1 tested English past-tense production in male and female PD patients with a wide range of disease progression. In mixed-effects regressions, right-side hypokinesia predicted accuracy at regulars in males but not females, and not irregulars in either sex, with interactions between hypokinesia and sex for regulars but not irregulars. Experiment 2 examined Farsi past-tense production in male and female PD patients at advanced stages. Male patients showed deficits (relative to healthy controls) at regulars compared to irregulars, while female patients did not show this pattern, and were least impaired at regulars. Overall, the findings suggest that PD, and degeneration of left frontal/basal-ganglia circuits in particular, is indeed associated with a particular impairment at producing rule-governed inflectional forms, but that factors such as disease progression and sex modulate this deficit.

Poster 2 (with coffee) / 60

Stem allomorphy effects in word recognition in individuals with Alzheimer's disease and mild cognitive impairment.

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This study discusses the recognition of Finnish nominal base forms in relation to their paradigmatic complexity (stem allomorphy). As has previously been shown by Nikolaev et al. (2014), response latencies to monomorphemic nouns differ depending on the number of their possible stem allomorphs. Using the single word lexical decision experiment, we presented monomorphemic nouns from three different inflectional types to 22 individuals with Alzheimer's disease (AD), 24 individuals with mild cognitive impairment, 17 cognitively healthy elderlies, and 31 young adults. The three *i*-paradigms we used can be exemplified by words like *vesi* 'water' (unproductive; three or more allomorphs, sg. *vede-*, *vet-*, *vete-*, pl. *ves-*), *savi* 'clay'(unproductive; two allomorphs, sg. *save-*, pl. *savi-*), and *lasi* 'glass'(productive; two allomorphs, sg. *lasi-*, pl. *lase-*). Only the *lasi* paradigm has no allomorphy in its singular forms. Thus, by including three types of noun classes that vary in terms of the richness of their stem allomorphy, we aimed to identify how rich the stem allomorphy must be before a facilitatory effect on lexical processing is observed (cf. Nikolaev et al., 2014).

We analyzed the data using a mixed effects model. Our model included participants, items, and trial numbers as random intercepts and a variety of other explanatory variables as fixed-effect factors.

We observed a facilitation effect for word recognition only for unproductive words with three or more stem allomorphs (*vesi*-type), but not for unproductive words with two allomorphs (*savi*-type). The findings suggest that high stem allomorphy, rather than productivity of the inflectional class, is driving the facilitation effect in word recognition. However, in one group, individuals with AD, responses to unproductive *savi*-type nouns did not significantly differ from *vesi*-type, suggesting that in AD, inflectional class productivity may drive word recognition facilitation.

Poster 2 (with coffee) / 63

Time-course of auditory repetition vs. morphological priming

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A major issue in lexical processing concerns the interplay between episodic (e.g., voice) and abstract components (e.g., morphological identity) of spoken words. Some research (Goldinger 1996) highlights episodic components while others advocate hybrid models combining both types (Pierrehumbert 2006).

Kouider & Dupoux 2009 (K&D) examine the time-course of abstract versus episodic effects. Their experiments compare long-distance repetition (*dog → dog*) and morphological (*dogs → dog*) auditory

priming using French gender-inflected words. Repetition was stronger than morphological priming at mean distances of 18 and 72 intervening words. This difference collapsed at a distance of mean 144 words and with a voice switch between prime and target. K&D conclude that with increased distance and diminished token similarity, episodic components of priming are eliminated, leaving only the abstract components.

We investigate priming decay of four conditions over exact distances of 5, 10, & 20 intervening words. Repetition/morphological condition targets were identical, allowing for direct comparisons between conditions. Focusing on the time-course, we removed the voice switch component. Our repetition condition varied tokens between prime and target to remove the confound of low-level phonetic facilitation.

48 participants completed an auditory lexical decision task. Compared to the phonological condition, mixed-effects models reveal that repetition and morphological targets were faster at all distances (p<0.001, p=0.004). A separate model of just repetition & morphological conditions showed morphological targets were significantly slower than repetition targets across all distances (p=0.047).

At all distances, morphological priming is reduced compared to repetition priming. Careful comparisons reveal that differences between repetition and morphological conditions did not interact with distance. Further work will investigate whether an interaction between condition and distance is found at additional distances.

Poster 2 (with coffee) / 65

Substitution letter effects in Russian nouns: implications for morphological decomposition

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We present a masked priming lexical decision experiment on Russian with substitution orthographic neighbors. All primes were real nouns, half of the targets were nonce nouns. Four factors were manipulated: whether the prime was a neighbor of the target (experimental vs. control conditions); whether the prime was a nominative singular (primary) form or an oblique form (Russian has six cases); whether the prime was more or less frequent than the target (we took lemma and form frequency into account); whether the substituted letter was word-final or word-medial. Target nouns were in nominative singular. Examples of prime and target pairs: *ritma* 'rhythm.GEN.SG'(from *ritm*) –*rifma* 'rhyme.NOM.SG', *golod* 'hunger.NOM.SG'–*golos* 'voice.NOM.SG', *prutom* 'stick.INS.SG'(from *prut*) –*prutol* (a nonce word).

We aimed to study the relative timing of morphological decomposition and letter position assignment in reading (several experiments addressed this problem, but mostly for derivation rather than for inflection, and only using transposition neighbors); the role of letter position for neighborhood effects (previous experiments compared substituting initial vs. non-initial letters) and the role of relative neighbor frequency (how it interacts with other factors).

Primes were presented for 500 ms (a pilot study presenting primes for 200 ms did not yield any significant effects). Neighbor primes that were more frequent than targets increased response latencies compared to control conditions, less frequent neighbor primes had the opposite effect. The priming effect was modulated by the prime form (being significant only in primary form conditions, which points to a very early morphological decomposition) and by the substituted letter position (being more pronounced for word-final letters). The latter result shows that, although word-final letters are known to be more salient, they might be less important for candidate activation during lexical processing.

Poster 2 (with coffee) / 25

Morphological awareness and visual processing of derivational morphology in high functioning adults with dyslexia: An avenue to compensation?

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This study examined processing of derivational morphology and its association with measures of morphological awareness and literacy outcomes in 30 Dutch speaking high-functioning dyslexics, defined as university students with a past diagnosis of dyslexia with age appropriate reading comprehension skills, and 30 age-matched Dutch speaking controls, matched for reading comprehension. A masked priming experiment was conducted where semantic overlap between morphologically related pairs was manipulated as part of a lexical decision task. Measures of morphological awareness were assessed with a sentence completion task, specifically designed for this study. Significant priming effects were found in each group, yet adults with dyslexia were found to benefit more from the morphological structure than controls. Results suggest that morphological processing is intact in high-functioning dyslexics and also a strength compared to controls matched on reading comprehension and age. Furthermore, dyslexics were found to be influenced by both form and meaning properties of morphemes while controls were mainly influenced by morpho-semantic properties. Moreover, adults with dyslexia were found to perform significantly poorer than controls on morphological awareness measures. Morpho-semantic priming effects were found to correlate with the performance on time sensitive literacy measures in adults with dyslexia, a similar pattern was not observed in controls.

Poster 2 (with coffee) / 26

The role of orthography in the L2 processing of complex words: An overt priming study.

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Several masked priming experiments have investigated native (L1) and non-native (L2) processing of complex words. While studies on L1 have consistently shown priming effects for morphologically related, but not for orthographically related pairs (for a review, see Amenta & Crepaldi 2012), those on L2 have found effects for both (Heyer & Clahsen 2015). This suggests that while masked morphological priming effects in L1 are genuinely morphological, effects in L2 might be orthographically mediated.

The present study investigated whether the orthographic effects found in L2 are specific to the early, pre-lexical processing stage addressed by masked priming. 40 native and 48 non-native speakers of German participated in an overt priming experiment (SOA: 200ms), which included morphologically (Störung-STÖREN 'disturbance-DISTURB') and orthographically related (Wache-WACHSEN 'guard-GROW') pairs, plus a semantic control set (Wolke-HIMMEL 'cloud-SKY').

In the morphological set, both L1 and L2 speakers showed significant priming effects. In contrast, only the L2 group showed significant priming effects in the orthographic set. Analyses with linear-mixed effects models revealed a significant interaction between group (L1/L2) and prime type (re-

lated/unrelated) in the orthographic set, while no interaction between group and prime type was found in the morphological set. In line with the 200ms SOA, both groups additionally showed semantic priming effects.

Our findings suggest that, unlike native speakers, non-native speakers rely on low-level orthographic cues during the processing of complex words, in both the earlier and the later stages of visual word recognition (masked and overt priming). As a result, morphological priming effects in L2 speakers are not genuinely morphological, but instead driven by orthographic similarity between prime and target.

Amenta, S., & Crepaldi, D. (2012). Frontiers in Psychology, 3, 232.

Heyer, V., & Clahsen, H. (2015). Bilingualism: Language and Cognition, 18(03), 543-550.

Poster 2 (with coffee) / 27

White matter correlates of morphological processing in word reading

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Morphological processing is an essential component in reading, but the white matter underpinnings of this skill are largely unknown. We analyzed the relationship between morphological measures, assessed behaviorally in adult English readers, and microstructural properties of white matter pathways identified using diffusion MRI (dMRI). Morphological processing was assessed using the morpheme interference paradigm (e.g., Crepaldi et al., 2010). For each subject, morphemic cost was calculated as the difference in accuracy for pseudowords constructed from real morphemes, compared with pseudowords containing an invented morpheme. We hypothesized that morphological processing relies primarily on ventral-stream reading pathways, as morphemes provide prominent cues for mapping between print and meaning. Accordingly, we targeted major ventral pathways: inferior fronto-occipital fasciculus (IFOF), inferior longitudinal fasciculus (ILF) and uncinate fasciculus (UF). For comparison, we analyzed two dorsal pathways: the long and anterior segments of the arcuate fasciculus. 49 adults completed dMRI scans at Royal Holloway and a behavioral battery that included the morpheme interference task and measures of phonological and orthographic processing. The tracts of interest were identified bilaterally using deterministic tractography. Fractional anisotropy (FA) and mean diffusivity (MD) profiles were calculated along each pathway, and Spearman's correlations were calculated between these profiles and morphemic costs. Significant negative correlations were found between morphemic cost and FA in the bilateral IFOF. Additionally, significant positive correlations were found between morphemic cost and MD in the left UF and left ILF. Post-hoc analyses revealed that these effects all stemmed from positive associations with radial diffusivity. The correlations remained significant after partialling out nonword repetition scores, suggesting some level of specificity. Morphological processing thus appears to rely on ventral pathways, primarily in the left hemisphere. The results support the contribution of morphological processing to lexical access and comprehension of complex words.

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Four attemps to find morphological effects using complex and simple stimuli as primes: a matter of orthography

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Whether morphological decomposition of complex words occurs independently of semantics and orthography is a matter of intense debate. In this study, morphological processing is examined by presenting complex words (brujería -> brujo –witchcraft -> witch), as well as simple (brujaña ->brujo) and complex pseudowords (brujanza ->brujo), as primes in four masked lexical decision tasks. In the first experiment, the three experimental conditions facilitated word recognition in comparison to the control condition, but no differences emerged between them. Given the importance of the surface frequency effect observed, a second experiment was conducted. The results fully replicate those observed in the first one, but this time with low frequency targets. In the third experiment, word ending frequencies were manipulated so that non-morphemic ending frequencies of simple stimuli were lower than the suffix frequencies of complex stimuli. Despite this manipulation, the results once again showed similar facilitation effects for the three experimental conditions, which were different from those for the control condition. In the fourth experiment, vowels were removed from the stems of primes to reduce the orthographic overlap between primes and targets. The results show facilitative effects only for complex words. However, paired comparisons showed no differences between experimental conditions. The overall results show the main role played by the processing of stems in visual word recognition and are explained in terms of current models of morphological processing.

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Encoding numerosity into number morphology: An ERP study

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Morphological Number usually encodes the referential numerosity, denoting one entity (singular) or more than one (plural). However, also quantifiers encode information about the numerosity. The Italian quantification expressions for 'some', *qualche+nounSG* and *alcuni+nounPL*, refer to a plural numerosity; however nouns agree in the plural with *alcuni* but in the singular with *qualche*. Since both conditions are grammatical, they allow to test the mismatch between referential numerosity as encoded by morphological Number and by quantifiers without exploiting a violation paradigm.

We designed an ERP study exploiting a newly developed picture–phrase matching paradigm. We chose 30 nouns referring to countable, concrete objects and created two pictures for each one: the object was represented either once or four times. Each picture was displayed once with *qualche+nounSG* and once with *alcuni+nounPL*, for a total of 120 experimental stimuli in 4 conditions. 180 filler stimuli were added to counterbalance each experimental condition; 120 of them presented a semantic violation. The 26 participants were asked to press one key if the phrase matched with the picture, another key in the opposite case.

We tested whether the quantification expressions elicit ERP components associated with violations in response to the numerosity represented in the picture. The aim is to disentangle whether the

information of numerosity encoded in the Number morpheme is accessed even when the noun is embedded in a phrase with a quantifier. We analyzed ERPs time locked to the presentation of the noun. After a picture presenting one object, nouns following both *qualche* and *alcuni* elicited a larger Left Anterior Negativity (LAN), as compared to the conditions involving a picture displaying a plural numerosity. Considering the LAN as an index of morphosyntactic incongruence, this result seems to suggest that the reference to a numerosity could be incrementally encoded.

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Semantic transparency and semantic compositionality in compound words: Evidence from lexical decision latencies and fixation times in reading

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While some compounds, such as shorebird, are semantically transparent, others, such as ladybird, are semantically opaque. Typically, this semantic transparency (ST) has been operationalized from a relatedness perspective, where ST depends on the relation between a compound meaning and the meanings of its constituents as independent units. However, such an approach falls short in capturing the compositional side of compounding, a morphological process whose main purpose is generating new meanings. We argue that compositionality, which describes how accurately an actual compound meaning can be predicted from its constituents and the way they are combined, is a crucial determining component of ST. In the work presented here, we demonstrate that compositionality plays an important role in compound processing. We use the CAOSS model, a compositional model for distributional semantics, to compute compositional distributed representations for compounds. Compositionality is then operationalized as the similarity between these compositional representations and the observed distributed representations for the same compounds, as induced from a large corpus of natural language. We further compute the similarity between the compound constituents and the compositional compound representations as measures of the constituent contribution to the compositional meaning. We test the impact of these variables on lexical-decision latencies and fixation-durations in reading. For both lexical-decision times and first-fixation durations, we find facilitated processing if the contributions of both constituents are high, indicating an early effect of constituent semantics. On the other hand, the effect of compositionality dissociates across tasks: in lexical-decision times, a facilitating effect is observed for low values of compound compositionality; conversely, gaze durations are shorter for high values of compound compositionality. These findings show that compositionality is crucial to the understanding of ST effects in compound processing. However, the associated variables can have different effects depending on task requirements.

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The role of morphology in the processing of English-Turkish false cognates: Evidence from a backward lexical translation task

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False cognates are lexical items that display overlapping orthographic and/or phonological properties in two languages but little or no semantic similarity. Studies investigating the processing of false cognates have predominantly disregarded the effect of morphology (cf. Janke & Kolokonte, 2015). Additionally, studies on the processing of (false) cognates have almost exclusively dwelt on typologically-related language pairs like English-Italian and English-German, disregarding the processing of (false) cognates from typologically distant language pairs.

Against this background, the present study aimed to investigate the processing of real and false cognate word pairs from English and Turkish by examining the effect of morphological properties. 50 L1 Turkish learners of L2 English participated in a self-paced backward lexical translation task (Janke & Kolokonte, 2015), in which they had to provide Turkish translations for English words appearing on a computer screen.
The experiment employed Turkish-English word pairs in 6 different conditions:

1. False Cognate Simplex: monomorphemic false cognates (Turkish pasta –cake vs. English pasta)

2. False Cognate Mismatch: false cognates; monomorphemic in Turkish but polymorphemic in English (Turkish izolasyon –insulation vs. English isolation)

3. Real Cognate Simplex: monomorphemic real cognates (Turkish and English limit)

4. Real Cognate Mismatch: real cognates; monomorphemic in Turkish but polymorphemic in English (Turkish lider vs. English leader)

5. Control Simplex: non-cognate, monomorphemic equivalents (Turkish zehir vs. English poison)

6. Control Mismatch: non-cognate equivalents; monomorphemic in Turkish but polymorphemic in English (Turkish istisna vs. English exception)

The results revealed a significant cognate facilitation effect and a significant false cognate inhibition effect. Moreover, it was found that morphological mismatch played a significant role in the processing of cognates and false cognates, which was evident in longer reaction times to mismatch items compared to simplex items.

Poster 2 (with coffee) / 1

How do we decompose foreign words? Comparing masked priming effects in visual word recognition in a native and non-native language.

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Research suggests that letter strings are analysed in terms of their constituent morphemes early on during visual word identification, independently of their semantics—the brain sees DEAL and ER in DEALER, but also CORN and ER in CORNER (e.g, Rastle et al., 2004). Results are less clear as to whether non-native speakers carry out the same processing in the recognition of a foreign word (e.g., Heyer & Clahsen, 2015; Diependaele et al., 2011). This study takes up this issue by involving L1 Italian-L2 English speakers in a masked priming task where morphologically transparent, e.g. employer-EMPLOY, morphologically opaque, e.g. corner-CORN, and non-morphological pairs, e.g. brothel-BROTH, are contrasted. Participants took up the task in both their L1 and L2; and, critically, they underwent a thorough testing of their lexical, morphological, phonological, spelling and semantic proficiency in their second language.

Overall, results suggest markedly different priming between L1 and L2. L1 items with a transparent and opaque relationship showed significant priming, compared to the orthographic baseline. However, L2 items with an opaque relationship were indistinguishable from the orthographic baseline. This general pattern, however, is critically qualified by proficiency in L2—low scores were associated with similar priming in the three conditions, whereas highly proficient participants showed substantially more facilitation with transparent pairs than with either opaque or orthographic items. Despite we used a wide array of different proficiency tests, none of them seems particularly more important than the others, i.e., a general proficiency score explains individual variability with parsimony and effectiveness.

Diependaele et al. (2011). Journal of Memory and Language, 64, 344-358.

Heyer and Clahsen (2015). Bilingualism: Language and Cognition, 18, 543-550.

Rastle et al. (2004). Psychonomic Bulletin & Review, 11, 1090-1098.

Poster 2 (with coffee) / 5

Morphological encoding in bilingual children: Evidence from behavioural measures and ERPs

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Traditional wisdom has it that bilingual children's language acquisition is delayed relative to milestones of monolingual development. For vocabulary development, this has been shown to be incorrect, if a bilingual's combined vocabulary size is considered (1). But what about bilingual children's morphological skills?
We addressed this question by examining processes involved in producing regular and irregular past tense and participle forms in English and German using a silent-production-plus-delayed-vocalization ERP paradigm ([2], [3]). We tested 171 children (age range: 7-13), 79 early bilinguals plus 92 monolingual L1 controls (L1 English: 37; L1 German: 55).
Behavioural responses: Accuracy rates were higher for monolingual than for bilingual children in both languages. Particularly in forming irregular forms the bilingual children scored worse than the monolinguals. The proportion of overgeneralizations is also twice as high in the bilinguals than in the monolinguals.
ERPs: We found a significantly more negative-going waveform for regular (relative to irregular) verb forms from 300-550ms after silent-production-cue-onset for 11-to-13-year olds (English/German, mono-/bilinguals). This negativity was also found for the younger English bilinguals (7-10y), but not for the English monolinguals. For the younger German children (mono/bilingual) the negativity had a delayed onset (~800ms).
These results show that processes of morphological encoding (as measured by ERPs) are largely parallel for bilingual and monolingual children in both English and German. On the other hand, producing irregular verb forms is more error-prone in each of in the bilinguals, which we attribute to their reduced exposure to each of the two languages (relative to monolingual children).
[1] Patterson, (2004). J. Speech, Language, and Hearing Research 47.
[2] Budd, Paulmann, Barry, & Clahsen (2013). Brain&Language 127(3)
[3] Jessen, Fleischhauer, & Clahsen (2017). J Child Lang 44

Poster 2 (with coffee) / 7

Beyond decomposition: Processing zero-derivations in English visual word recognition

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Four experiments investigate the effects of covert morphological complexity during visual word recognition. Zero-derivations occur in English in which a change of grammatical class occurs without any change in surface form (e.g., a bridge-to bridge; to bump-a bump). Bridge is object-derived and is a basic noun (N), whereas bump is action-derived and is a basic verb (V). As the suffix {-ing} is only attached to verbs, deriving bridging from its base, requires two steps, bridge(N)>bridge(V)>bridging(V), while bumping can be derived in one step from bump(V). Experiments 1 to 3 used masked-priming at different prime durations, to test matched sets of one and two-step verbs for morphological (bumping-BUMP) and semantic priming (jolting-BUMP). Experiment 4, employed a delayed-priming paradigm in which the full verb forms (bumping and bridging) were primed by noun and verb phrases (a bump/to bump, a bridge/to bridge). In both paradigms, different morphological priming patterns were observed for one-step and two-step verbs that can be distinguished from purely semantic effects. Our results demonstrate that morphological processing cannot be reduced to surface form-based segmentation.

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Spatiotemporal dynamics of morphological processing in adults with dyslexia

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Developmental dyslexia is characterized by impairments in reading fluency and spelling that persist into adulthood. Here, we hypothesized that high-achieving adult dyslexics (i.e., university students with a history of dyslexia) possibly managed to cope with these deficits by relying to a greater extent on morphological information than do non-impaired adult readers. We used magnetoencephalography (MEG) in a primed lexical decision task, in which we contrasted orthographic, morphological and semantic processing. Behavioral results confirmed that adult dyslexics did indeed rely to a greater extent on the semantic properties of morphemes than controls. In line with this, MEG results showed early morphological effects (100-200ms) in a frontal network, which reflected the contribution of semantic processing. The same effects occurred much later in controls (~400ms). In contrast, whereas controls showed early orthographic priming effects in posterior left inferior temporal gyrus at around 130ms, dyslexics showed only late activation of semantic and orthographic information in the middle left fusiform gyrus. The present results thus clearly showed morphology effects on written word recognition that were stronger and occurred earlier in high achieving adult dyslexics than in normal readers. These findings suggest a spatiotemporal reorganization of the reading network, in which higher level morphological information located in frontal regions is supposedly used in a top-down fashion to facilitate the basic bottom-up reading processes.

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An fMRI study of morphological decomposition in the recognition of case-inflected nouns: Dissociation of inflection and case

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A study of Polish case-inflected nouns showed activation in the left perisylvian area, both for zero-inflected citation-form nouns and overtly inflected oblique-case nouns (Szlachta et al., 2012). However, because case and inflection were confounded, this made it impossible to separate the activation related to the processing of overt inflection and case. We report the results of an fMRI study that aims to dissociate the processing of inflection (overt: -a vs. zero: -ø) and case (citation form: the Nominative vs. oblique form: the Genitive) in Russian nouns. Word length was manipulated to explore its role independently from inflection and case. Eighteen adult native Russian participants without neurological disorders performed a visual lexical decision task, while their BOLD signal was recorded. Reaction times were significantly longer to oblique-case than citation-form nouns indicating additional costs for processing oblique cases. The whole-brain analyses of the changes to the BOLD signal established an increased activation for overtly compared to zero-inflected oblique-case nouns in several brain areas including the left perisylvian area (BA 44/45/47). Together with an interaction of inflection and case instantiated in an increased effect of overt inflection in the oblique case compared to the citation form, this suggests a greater involvement of morphological decomposition in the recognition of oblique-case inflected nouns. At the same time, faster reaction times and relatively small changes in the BOLD signal associated with inflection type and word length in citation forms compared to oblique-case nouns suggest that morphological decomposition may play a weaker role in the recognition of citation forms. Overall, the study supports morphological decomposition of oblique-case inflected nouns in visual word recognition by showing increased activation in the left perisylvian area for overtly inflected compared to zero-inflected nouns in the oblique case.

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How strongly are morphologically related words connected: evidence from Russian verbs

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It was shown that access to the base word depends on the properties of its derivatives, most notably on the morphological family size (e.g. Moscoso del Prado Martin 2004). Evidently, this effect is due to the fact that derivationally related words are connected in the mental lexicon. We explore the role of different factors in the relative strength of such connections.

In Russian, verbs can be derived from other verbs by prefixation (*tolkat'* 'to push'- *zatolkat'* 'to push into, to push too much (in a crowd)') and by suffixation (*tolkat'* - *tolknut'* 'to push once'). Prefixed verbs tend to preserve all inflectional properties of the base verb except for its aspect, but their semantics is often only partly predictable. Suffixation always changes the verb's inflectional class, but allows for a much lesser semantic variability than prefixation. We looked at the suffixes *-va-* used for secondary imperfectivation and *-nu-* deriving semelfactives.

To explore whether suffixed or prefixed verbs have a stronger connection to their base verb in the mental lexicon, we conducted a masked priming lexical decision experiment with three conditions: a suffixed prime, a prefixed prime and an orthographically and semantically unrelated prime (control).

We had 39 stimulus sets (three primes and a target verb), 13 pairs of unrelated primes and targets to counterbalance the number of morphologically related ones and 52 pairs with nonce verb targets (in half of them, primes were orthographically similar to targets). 47 native speakers took part in the study.

We found that suffixed primes produced significantly shorter response latencies compared to the control condition than prefixed primes did (RM ANOVA by subjects and by items was used). Thus, regular and predictable semantic correspondences are more important than shared morphological features (the forms of prefixed and base verbs literally coincide except for the prefix).

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Position-specific productivity in compound word processing

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Models of compound processing differ in their assumptions concerning the role of the constituents in word recognition. Especially in languages with productive compounding, decomposition could facilitate the reading of new combinations. In German, some stems enter into compounds more often in first position (e.g., *Sandhügel, Sandburg, Sandkasten*) and only seldom in the second position (e.g., *Dünensand*), while it is vice versa for other stems. We termed this characteristic *position-specific productivity (PSP)* and examined its effect on compound processing.

We identified stems occurring more often in first position (PSP1) and stems occurring more often in second position (PSP2). We selected compounds in which those stems either appeared congruent with PSP (e.g., PSP1-position1: *Sandhügel*; PSP2-position2: *Notizheft*) or incongruent (e.g., PSP1-position 2: *Dünensand*; PSP2-position1: *Heftklammer*). Thirty participants conducted a masked priming LDT on these compounds, primed by either one of their constituents. Results indicate an effect of PSP congruency, but no effect of prime constituent: compounds with stems in their more productive position were identified faster, but PSP congruent constituent were not more efficient primes. We conclude that the reading system is sensitive to productivity of compound constituents, and this seems to be a morpho-semantic effect.

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Processing zero-derived and non-derived Forms in L1 and L2 English

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The process whereby a verb is derived from a noun (e.g., brush) or a noun is derived from a verb (e.g., taste) is called zero-derivation. Some theorists argue that this covert conversion results in greater degree of morphological complexity compared with non-derived forms (Marchand, 1969). Others assert that neither verbs nor nouns are derived from each other and that there is a semantic relationship between the two forms rather than a morphological one (Farrell, 2001). Recent studies

have shown that processing zero-derived forms may involve more processing load compared with non-derived complex forms and monomorphemic words (Pliatsikas et al., 2014).

The present study aimed to investigate whether this internal morphological operation of zero-derivation will result in differential processing patterns between zero-derived and non-derived nouns in L1 and L2 English. To this end, a masked priming task (SOA=50 ms) was administered to 32 L1-English and 35 L2-English participants with advanced proficiency. The zero-derived and non-derived noun targets matched in terms of mean frequency and word-length were preceded by identical forms (dream–DREAM; week–WEEK), identical forms with –s affix (dreams–DREAM; weeks–WEEK) or semantically and orthographically unrelated words (south–DREAM; plate–WEEK). The results of the linear mixed-effects analyses revealed similar processing patterns for the two word groups, i.e., derived forms and non-derived nouns in both participant groups. There was no difference in reaction times to the two forms. Both word forms were primed by their morphologically related inflected forms, which is indicative of decomposition. The findings challenge earlier research which reported a higher processing load in lexical decision to zero derived forms and also show evidence for comparable morphological processing routes, i.e., decomposition, in L1 and L2 speakers of English.

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Compound processing in semantic variant of Primary Progressive Aphasia

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We investigated the production and lexical access of compounds in the semantic variant of Primary Progressive Aphasia (PPA-s), a language impairment caused by neurodegenerative disease and characterized by word meaning breakdown in absence of grammatical difficulties (Mesulam, 2013). While inflectional & derivational morphology has been examined in PPA-s (e.g. Auclair-Ouellet, 2015), compounding has not been explored yet. Our goal is to present data of how the degraded semantic system in PPA-s affects compound processing.
Participants: Two patients diagnosed with PPA-s on the basis of neurological, neuropsychological and neuroimaging data and four healthy elderly controls.
Stimulus set: 130 Modern Greek compounds; 70 dependent (e.g., aɣrioɣata/ʿwild cat'), 45 coordinative (e.g., alatopipero/ʿsalt&pepper') and 15 exocentric compounds (e.g., kokkinomalis/ʿredhead') from all grammatical categories.
Procedure: a) Naming by definition task: participants were given the definition and they had to utter the actual compound. b) Online simple Lexical Decision task.
Results: Naming performance of both patients was significantly impaired compared to controls. Their errors were mostly substitutions (e.g., krifovlepo/ ʿsecretly see'instead of krifokitazo/ʿsecretely look') and misorderings (e.g., korfovuno/ʿtopmountain'instead of vunokorfi/ʿmountaintop'). Lexical decision task showed that PPA-s patients responded slower than controls in absence of significant differences in accuracy. Both tasks revealed more difficulties in dependent compounds.
Discussion: Compound naming is impaired in PPA-s due to semantic deterioration while knowledge of word structure appears to be relatively preserved. Results further suggest an impeded lexical access. This could be attributed either to a difficulty with processing complex semantic relationships within compounds or to factors related to the semantics of each constituent.

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Form overlap vs. morphological complexity in L1 and L2 processing

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Morphological complexity in Germanic may involve considerable form overlap. Non-native speakers not only appear to concentrate more on declarative knowledge than decomposition in morphological processing (e.g. Bowden et al. 2010) but they also appear to be guided more strongly by surface orthographic factors when processing complex words in masked priming studies (e.g. Heyer & Clahsen 2014).

We investigated L2 speakers of English using a visual delayed priming task where morphological processing usually shows different effects from form and semantic processing. We conducted a series of experiments with three conditions: form (fluently-influential), semantic (exceptional-remarkable) and morphological (natural-unnatural). Participants were native English speakers (n=32) and highly proficient native Bengali L2 speakers of English (n=54) in English-medium education in Kolkata.

Both groups show no facilitation for semantically related items but strong priming effects (p < .001) in morphological conditions. However, while L1 speakers predictably do not show facilitation in the form condition, L2 speakers show significant priming (p = .012). While these results support previous studies (e.g. Heyer & Clahsen 2014) regarding a form effect for L2 but not for L1 speakers, our data also shows significant differences in the degree of priming between form and morphological conditions (p = .024) with greater facilitation for the latter.

One possible explanation is that L2 speakers may also apply the structural analysis process required for the decomposition of complex items (resulting in a slower decay of activation and thus delayed priming) to items with pure form overlap. In a masked priming paradigm (employed by previous studies), L2 speakers may not have sufficient time to fully analyse the morphological structure as morphosyntactic processing, for example, has been shown to take longer in L2 speakers (Bosch et al. 2016) and thus display greater reliance on surface properties such as orthographic overlap.

Symposium 4 – Morphology and Neuroscience / 3

MRI and morphological processing: Where are we, and where to go next?

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Magnetic Resonance Imaging (MRI) provides a valuable window into how the brain functions, with the particular benefit of allowing us to localise the source of cognitive processes in the brain with millimetre precision. However, and despite its widespread use in cognitive neuroscience, the use of MRI (structural or functional) in neurolinguistics, and particularly in the study of morphology, remains limited, compared to other neuroimaging and behavioural methods. This talk reviews the available literature studying morphological processing with (f)MRI. Studies looking at the processing of inflection and derivation, by both native and non-native speakers of a given language, will be presented. Links to other neuroimaging (ERPs, MEG) techniques will also be provided, as well as to more common behavioural methods. Theoretical implications for the study of morphology will be discussed, as well as suggestions on how to make the most of the technique in future studies.

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Morphologically complex words in the brain: Neuromagnetic evidence

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Language-related processes in the brain are known to unfold within tens of milliseconds. Magnetoencephalography (MEG) directly registers the magnetic field created by electrical activity of masses of neurons. The magnetic field is measured on the millisecond scale, without being distorted by e.g., the skull as extensively as electroencephalography (EEG). In addition, the brain activity is recorded by approximately 300 sensors, covering the whole head. Hence, MEG provides the necessary temporal and spatial accuracy to measure the brain activity related to morphological processing.

This talk will review studies that have approached morphological processing using MEG. Most of the available MEG studies focus on the processing of inflected and derived words –with a few exceptions, investigating the recognition and production of compound words. The reviewed studies use both visual and auditory modalities, tapping attentive as well as non-attentive processing of morphologically complex words. Furthermore, the studies use a wide range of experimental paradigms, from visual masked priming to the auditory oddball paradigm.

Overall, the results of the studies suggest full or at least partial combinatorial processing of complex words, supporting many current models of morphological processing. In addition, recent MEG findings on affix acquisition suggest that cortical memory traces for newly learned affixes are formed even after a very short exposure to novel morphology. Thus, the reviewed MEG findings add valuable evidence on when and where in the brain morphologically complex words are processed and acquired.

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Morphological processing –the past and future of electrophysiological evidence

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Electroencephalography (EEG) and the derived event-related potentials (ERPs) provide an important means to study the time-course of brain functions in high temporal resolution without referring to overt behavioral responses.

This talk will review the available literature on morphological processing with EEG, including studies on the processing of inflections, derivations, and compounds. The overview will describe paradigms that are typically applied in studying morphological effects in the EEG, such as the violation paradigm and masked or overt priming paradigms. The overview will also compare some methods in the analyses of EEG-data. I will link the findings from EEG studies to other neuroimaging techniques (MEG, MRI) and to behavioral data that often provide the basis for models on morphological processing. I will then discuss the outlook for EEG studies in comparison to behavioral or other neuroimaging techniques for the study of morphology.

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Closing remarks

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Semantic entropy measures and semantic transparency in English compound nouns

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Recently, entropy measures based on the relational structure of English compounds have been used in studies of semantic transparency and lexical decision times. Pham & Baayen (2013) show that the entropy of semantic relations in the modifier family is negatively correlated with semantic transparency. Schmidtke et al. (2015) find that the relational entropy for individual compounds is correlated with lexical decision time. However, neither study takes the ambiguity of the compound constituents into account. Our contribution addresses this gap. In a model of semantic transparency, we show that the relational entropy of the head family interacts with synset entropy: uncertainty about the reading of a given constituent. Using the publically available compound dataset from Bell & Schäfer (2016), we calculated the entropy of the probability distributions of the synsets and semantic relations for all modifier and head constituent families and modelled the semantic transparency ratings collected by Reddy et al. (2011). Our final model of compound transparency shows an interaction between the two entropy measures based on the head constituent families. When the synset entropy is low, perceived transparency is unaffected by relational entropy; when the synset entropy is high, perceived transparency is negatively correlated with relational entropy, mirroring the finding by Pham & Baayen (2013) for modifier families. These findings suggest that relation entropy is not negatively correlated with semantic transparency across the board, but only when the reading of the head is uncertain. In these cases, the compound appears more transparent if the relation is easily predictable across all possible senses than if it is not. One interpretation is that in cases of high synset entropy, low relation entropy masks constituent ambiguity, while high relation entropy necessitates greater activation of different readings to arrive at even a 'gist' interpretation, thereby increasing processing effort and lowering perceived transparency.