Morphological Structure in Native and Nonnative Language Processing

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This article presents a selective overview of studies that have investigated how advanced adult second language (L2) learners process morphologically complex words. The studies reported here have used different kinds of experimental tasks (including speeded grammaticality judgments, lexical decision, and priming) to examine three domains of morphological processing (regular and irregular inflection, derived word forms, and morphosyntactic phenomena) in L2 learners from typologically different first language (L1) backgrounds. The results from these studies demonstrate clear differences between native and nonnative processing in all three domains, indicating that adult L2 learners are less sensitive to morphological structure than native speakers and rely more on lexical storage than on morphological parsing during processing.

Keywords morphological processing; event-related potentials; priming; inflection; derivation; morphosyntax; German; English

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Previous second language (L2) acquisition research has relied mainly on speech production and other offline data to describe nonnative speakers' linguistic knowledge and how it develops over time. In the domain of morphology, most L2 research has focused on inflectional morphology and morphosyntax, which many studies have found to be areas of specific difficulty for adult L2 learners. L2 learners have been reported to omit inflectional morphemes or to use them in an unsystematic fashion (see White, 2003, for review). Whereas some researchers have claimed that L2 learners' poor performance in some grammatical domains reflects incomplete or unstable grammars (e.g., Johnson, Shenkman, Newport, & Medin, 1996), others have speculated that adult L2 learners' difficulties with inflectional morphology and morphosyntax might be due to "processing" problems rather than reflecting any underlying grammatical deficits (e.g., Prévost & White, 2000).

More recently, researchers have begun to investigate the L2 processing of sentences and morphologically complex words by using a variety of time-sensitive or "online" psycholinguistic methods, including the measurement of comprehension or production latencies and physiological measures such as event-related brain potentials (ERPs) or eye movements. These methods can provide a window on how linguistic representations are constructed in real time during language comprehension and production and reduce the possibility of participants relying on their explicit or metalinguistic knowledge, compared to the more commonly used offline tasks. Psycholinguistic L2 processing research has led to a growing number of empirical findings and some theoretical attempts to explain how and why adult nonnative speakers perform differently from child and adult native speakers. Current opinions on this question vary (see Clahsen & Felser, 2006a, 2006b, for review). Some have argued that L1 and L2 processing share the same processing system and mechanisms and that first language (L1)/L2 differences in linguistic performance are due to the influence of the learners' native language (compare, e.g., Chen, Shu, Liu, Zhao, & Li, 2007; Sabourin & Haverkort, 2003) or are explainable in terms of domain-general processes (memory, attention, etc.), such as L2 processing being slower and more memory-demanding than L1 processing (e.g., McDonald, 2006). There is evidence from several studies that L2 processing is affected by L1 transfer, notably with respect to phonological and lexical-semantic phenomena (see, e.g., Hernandez, Li, & MacWhinney, 2005; Weber & Cutler, 2003). L2 processing has also been found to be less automatic and slower than L1 processing. Studies measuring ERPs, for example, found that the so-called left anterior negativity (LAN), which is indicative of early automatic processes of sentence comprehension (Friederici, 2002), is absent or reduced in L2 learners

and that other ERP components (such as the N400 and P600) have a later onset in L2 processing relative to native speakers (see Mueller, 2005, for review).

That L1 transfer and cognitive resource limitations may affect L2 processing has not been disputed, but whether these factors are sufficient to explain L1/L2 processing differences across different domains of language remains controversial. For example, several sentence processing studies have found that L2 learners rely less on hierarchical phrase structure, or abstract syntactic elements such as movement traces, than native speakers during comprehension (see Clahsen & Felser, 2006a, for review). These and other findings have given rise to the shallow-structure hypothesis, according to which the L2 grammar does not provide the kind of information required to process complex syntax in nativelike ways, forcing L2 learners to fall back on "shallow" parsing strategies. These provide a less detailed representation of the structure of a sentence or a morphologically complex word and are largely based on lexical-semantic and other nonsyntactic cues to interpretation.

A related account is Ullman's (2005) application of the declarative/procedural model to L2 acquisition and processing. The declarative/procedural model (Ullman, 2004) claims that processing one's native language involves two different brain memory systems: a lexical store of memorized words that depends on declarative memory and is rooted in a network of specific brain structures including medial temporal and prefrontal cortical regions and a mental grammar that includes combinatorial rules and is rooted in a network including frontal/basal-ganglia circuits. Given these assumptions, Ullman (2005) argued that maturational changes occurring during childhood/adolescence lead to the attenuation of the procedural and enhancement of the declarative system, so that L2 learning and processing are largely dependent on the lexical memory system and invoke grammatical computation to a much lesser extent than L1 processing. This account leads to an interesting prediction as to how morphological processing in a late-learned L2 differs from L1 processing of morphology—namely, that morphological decomposition (which engages the procedural memory system) should be underused in the L2 and that, instead, L2 processing should mainly rely on lexical storage of morphologically complex words (which involves the declarative memory system).

Against this background, the remainder of this article presents an overview of previous studies that have used online experimental techniques to investigate the processing of morphologically complex words in adult L2 learners. We will summarize the results of recent L2 processing studies on three core phenomena in this domain: (a) inflectional morphology, specifically contrasts between

regular and irregular inflection; (b) derivational morphology and how it differs from inflectional processes; and (c) morphosyntactic phenomena, specifically the processing of agreement and case in an L2. We will discuss the implications of the results from these studies for current models of L2 processing and the question of how and why L1 and L2 processing differ.

Part I: Regular and Irregular Inflection

L1 Studies

The processing of regular versus irregular inflection has been extensively studied in the psycholinguistic literature. Experimental studies using a range of different psycholinguistic methods and techniques have led to a number of consistent and replicable results on how regular and irregular forms are processed in one's native language. Consider, for example, results from so-called "priming" experiments, in which participants are presented with pairs of stimulus words (or letter strings). Depending on the nature of the relationship between the words in each pair, prior presentation of one may facilitate recognition of the other. Many studies have found priming differences between regular and irregular inflection in different languages (see Marslen-Wilson, 2007, for review). Sonnenstuhl, Eisenbeiss, and Clahsen (1999), for example, investigated priming effects in German past participles in a cross-modal priming experiment in which subjects heard a spoken prime immediately followed by a visually presented target form. The baseline condition was an Identity condition, with the same (first-person singular) form being presented as both prime and target (*kaufe-kaufe* "buy-buy"). In this condition, access to the lexical entry of the target is maximally facilitated by the prime, and this was reflected in faster response times to the target word relative to a Control condition in which the target word was preceded by an unrelated prime (*lobe-kaufe* "praise-buy"). Interestingly, in the morphological Test condition, regular and irregular participles behaved differently. Prime-target pairs containing regular participles (*gekauft-kaufe*) yielded a full stem-priming effect (i.e., the same amount of facilitation on the recognition of the target as in the Identity condition). Irregular participles (*geschlafen-schlafe* "slept-sleep"), however, only yielded a partial or reduced effect, with less priming in the Test than in the Identity condition.

The study of regular and irregular inflection has also been an important test case for the controversy between associative and symbolic models of language. In associative models, all inflected words are stored and processed within a single associative system in which the morphological structure of an inflected word is not explicitly represented. Instead, these models attempt to account

for differences between regular and irregular inflection that have been found, for example, in priming experiments, in terms of nonmorphological properties such as orthographic, phonological, semantic, or frequency contrasts between regulars and irregulars (see, e.g., Gonnerman, Seidenberg, & Andersen, 2007). Whereas orthographic and phonological factors may account for priming differences between regular and irregular past tense forms in English due, for example, to the larger overlap for regular than for irregular forms (compare *walked-walk* vs. *taught-teach*), the findings on German reported earlier are hard to explain in these terms, because the regular and irregular participles that were tested in this study exhibit the same formal overlap between primes and targets. Instead, Sonnenstuhl et al. (1999) interpreted the observed priming differences from the perspective of dual-mechanism models (see, e.g., Pinker, 1999) that posit morphologically structured (rule-based) representations for regularly inflected words and associatively represented whole-word forms for irregulars. Assuming that regular (but not irregular) participles are morphologically decomposed (e.g., [ge-kauf-t] "bought"), they can directly access the root, yielding a full stem-priming effect. By contrast, irregularly inflected participle forms (being stored as wholes) cannot directly access the root and thus only produce reduced priming effects.

L2 Studies

Inflectional processes have also been studied in nonnative language processing, but the number of studies that have used online methods is small and the interpretation of the results is controversial. Some studies did not find any L1/L2 differences in the production latencies (Beck, 1997) or priming patterns of regularly inflected word forms (Basnight-Brown, Chen, Hua, Kostić, & Feldman, 2007). From these findings, one may conclude that even though L2 processing may be slower and less automatized than L1 processing, adult L2 learners process morphologically complex words in the same way as native speakers.

Other studies, however, found L1/L2 differences, particularly with respect to regular inflection, and argued that L2 processing differs in more fundamental ways from L1 processing (e.g., Babcock, Stowe, Maloof, Brovetto, & Ullman, 2008; Neubauer & Clahsen, 2009; Silva, 2008; Silva & Clahsen, 2008). Using a speeded production task of regular and irregular past tense forms of English verbs (matched on stem, lemma, and past tense frequencies), Babcock et al. (2008) found that frequency effects, in the shape of shorter production latencies for high-frequency than for low-frequency past tense forms, showed a different pattern between regulars and irregulars in native speakers of English and in

Chinese and Spanish learners of English (who had been living in an English-speaking country for the 3 consecutive years prior to testing). A regression model revealed significantly larger frequency effects for irregulars than for regulars in native speakers but equally large frequency effects for regulars and irregulars in the L2 data (from both the Chinese and the Spanish learners). Silva (2008), examining regular past tense forms of English in a lexical decision experiment, also obtained significantly larger frequency effects in her L2 groups than in the L1 control group. Shorter production latencies or lexical decision times for high-frequency forms are generally interpreted as effects of memory storage, in that memory traces for word forms tend to get stronger with additional exposure or use. That there were larger frequency effects for regulars in the L2 than in the L1 data indicates a greater reliance on memorization of regularly inflected forms in L2 than in L1 processing. In addition, Silva and Clahsen (2008) observed morphological priming effects for regular past tense forms in L1 speakers of English but not in advanced L2 learners, suggesting that L2 learners do not decompose regular past tense forms in nativelike ways during processing. Taken together, these results are consistent with Ullman's (2005) view that L2 learners are more dependent on declarative than on procedural processing. In the following, we will consider two studies on the processing of German inflection in some detail.

Hahne, Mueller, and Clahsen (2006)
This study examined ERPs to morphological violations in German participle and noun plural forms in a group of adult learners with Russian as the L1 and a control group of German native speakers. The L2 participants were highly proficient in German, using the language on a daily basis for interaction with native and nonnative speakers. A self-rating test revealed an average proficiency score of 5.0 on a 6-point scale. Hahne, Mueller, and Clahsen (2006) found that an incorrect participle form in which the irregular -*n* was exchanged with the regular -*t* (e.g., *gelauf-t* instead of *gelaufen* "run") produced an early LAN in the L1 and a less focal (bilateral) anterior negativity plus a later parietal positivity (P600) in the L2 group. For the corresponding incorrect plural forms, the L1 group again exhibited a focal left-lateralized anterior negativity (LAN) followed by a P600, whereas the L2 group only showed a P600 and no anterior negativity. P600/LAN effects are indicative of (early and late) processes involved in detecting morphosyntactic violations as, for example, in incorrect subject-verb agreement, gender, or tense marking (see Friederici, 2002, for a review). Hahne et al. thus interpreted their results along these lines. Note, however, that the anterior negativities, which are supposed to

Table 1 Summary of experimental findings on regular and irregular participles in German

	Lexical decision experiment		Priming experiment			
	-t participles	*-n* participles	*-t* participles		*-n* participles	
	Low Freq.-High Freq.	Low Freq-High Freq.	Test-Identity	Test-Control	Test-Identity	Test-Control
L1	17 ms	57 ms*	12 ms	−62 ms*	45 ms*	−27 ms*
L2	85 ms*	67 ms*	54 ms[(*)]	−11 ms	41 ms*	−44 ms[(*)]

Note. The table presents response time (RT) differences between the low- and the high-frequency conditions in the lexical decision experiment and between Test versus Identity and Test versus (unrelated) Control conditions in the priming experiment.
*Significant at $p < .05$ by subjects and items.
[(*)]Significant at $p < .05$ by subjects.
Source. Data from Neubauer & Clahsen (2009).

reflect *early* morphosyntactic processing, were more focal and consistent across experiments in the L1 than in the L2 speakers, suggesting that L2 learners are less sensitive to morphosyntactic violations than native speakers.

Neubauer and Clahsen (2009)

This study compared regular and irregular participle forms of German in a series of experiments investigating highly proficient L2 learners of German with Polish as the L1 who had acquired German after childhood and L1 speakers of German. The L2 learners achieved the highest level (C) of so-called "competent language users" in German according to the Goethe Institute proficiency test administered to all L2 participants at the time of testing. The results of the lexical decision and priming experiments are summarized in Table 1.

The lexical decision experiment examined potential frequency effects in the recognition of *-t* and *-n* participles (Clahsen, Eisenbeiss, & Sonnenstuhl, 1997). The two types of participles (none of which involved any vowel changes) were each divided into a high-frequency and a low-frequency group according to their participle frequency in the CELEX lexical database (Baayen, Piepenbrock, & van Rijn, 1993), with similar stem frequencies and similar length (in terms of mean number of letters) for *-t* and *-n* participles.

The results shown in Table 1 present the response times (RTs) of high-frequency forms subtracted from those of low-frequency ones. Whereas in the L2 group lexical decision times for high-frequency participles were

significantly shorter than for low-frequency ones, in the L1 group an advantage for high-frequency forms was only found for irregular but not for regular participles. Furthermore, it was found that the overall RTs across conditions were much longer for L2 learners than for L1 speakers. To examine whether the different frequency effects in the L1 and L2 were due to differences in speed of processing, Neubauer and Clahsen examined a subgroup of "fast" L2 responders who were matched to the L1 group in terms of overall response times across conditions. The results were parallel to those mentioned earlier. Again, the L2 learners had significantly shorter RTs for high- than for low-frequency items in both conditions, indicating that speed of processing cannot account for the observed L1/L2 contrast. Instead, the finding that the L2 learners exhibited a frequency effect for both regulars and irregulars, and the L1 group for irregulars only, suggests that L2 processing relies more on memory storage than L1 processing.

Neubauer and Clahsen also performed a masked visual priming experiment (Kinoshita & Lupker, 2003) with the same participant groups to investigate the role of morphological decomposition in the processing of regular and irregular participles. In masked priming, a prime word that is usually not consciously identified is briefly presented between a forward mask and a target word to which a word/nonword decision is made. Using this technique, significant facilitation effects for L1 speakers were obtained when the prime word was morphologically related to the target.

In Neubauer and Clahsen's experiment, *-t* and *-n* participles without stem changes were shown as primes (for 60 ms) immediately followed by corresponding stem-based forms presented as targets for lexical decision. The experimental conditions and materials were similar to those of the priming experiment from Sonnenstuhl et al. (1999) reported earlier. The results shown in Table 1 present the size of the priming effects for regulars and irregulars in the morphological Test condition relative to an Identity condition and an unrelated Control condition. These data show that both participant groups produced the same priming pattern for irregulars—that is, a partial priming effect with shorter RTs in the Test than in the Control condition and longer RTs in the Test than in the Identity condition. For regulars, however, different priming patterns were found: a full stem-priming effect in the L1 group (i.e., the same amount of priming in the Test and the Identity condition) but no significant priming in the L2 group.

Again, as in the lexical decision experiment, the L2 learners had slower overall RTs than the L1 group across all conditions. To determine whether the observed L1/L2 differences in morphological priming can be accounted for by L1/L2 differences in processing speed, Neubauer and Clahsen examined

a subgroup of fast L2 learners that was closely matched with the L1 group on overall RTs across conditions. The results were parallel to those reported in Table 1. The fast L2 learners showed partial priming for irregulars and no priming for regulars, in contrast to the L1 group.

The priming differences between -*t* and -*n* participles seen in the L1 group replicate earlier findings from Sonnenstuhl et al. (1999) indicating that regular participles are pure combinatorial forms for native speakers and are fully decomposed. Full decomposition ensures that the base stem is isolated and directly primes the target stem. By contrast, irregular participles, despite having a segmentable ending (-*n*), only yielded a partial priming effect, suggesting that irregular participles activate separate whole-word representations that prevent any direct reactivation of the base stem. It should be noted, however, that in a recent visual priming study, Smolka, Zwitserlood, and Rösler (2007) failed to obtain the priming differences between regular and irregular participles in native speakers of German that were found by Sonnenstuhl et al. (1999) in cross-modal and by Neubauer & Clahsen (2009) in masked priming. One reason for this could be that Smolka et al.'s visual experiment did not include an Identity condition, making it impossible to identify the contrast between full priming (for regular) and partial priming (for irregular participles) that was seen in both the cross-modal and the masked priming experiments.

Assuming that full stem-priming is indicative of morphological decomposition, the lack of full priming in the L2 group suggests that L2 processing relies less on morphological decomposition than L1 processing. Furthermore, the same contrast between full priming in native speakers and no priming in nonnative speakers that Neubauer and Clahsen obtained for -*t* participles in Polish L2 learners of German was also found for -*ed* past tense forms in three groups of L2 learners of English with Chinese, German, or Japanese as the L1 (Silva & Clahsen, 2008), demonstrating the robustness of the priming patterns and L1/L2 contrasts across different target languages and a heterogeneous set of L1 backgrounds.

How can the findings on L2 processing of regular and irregular inflection be interpreted with respect to current views on nonnative language processing? Whereas there are still only few experimental studies on this topic and the results are not fully conclusive, most findings indicate that adult L2 learners process (regularly) inflected word forms differently from native speakers. Factors such as slower processing speed, cognitive resource limitations, and L1 influence appear to be insufficient to explain these differences. Instead, the findings currently available are more in line with the proposal (Ullman, 2005) that L2 processing is more dependent on the lexical

memory system and invokes grammatical computation to a lesser extent than L1 processing.

Part II: Derived Word Forms

Derivational processes are distinct from, and prior to, inflectional ones. Typically, derivation creates new lexemes, whereas regular inflection creates complete word forms that cannot undergo any further word formation processes. A derived form such as *affordable*, for example, can feed further derivational processes (*unaffordable*, *unaffordability*), but a regularly inflected form such as *walked* cannot undergo any further word formation. To account for this contrast, morphologists (Anderson, 1992, among others) proposed that both the input and the output of a derivational rule are listed in lexical entries that are either internally structured (for productive derivations such as [afford[able]]) or internally unanalyzed (for frozen forms such as [strength]), whereas the outputs of regular inflectional rules do not constitute lexical entries and thus cannot participate in any further word formation. These differences yield a three-way distinction between (a) pure combinatorial processes (for regular inflection), (b) combinatorial entries (for productive derivation), and (c) unanalyzed entries (for frozen inflected and derived forms).

L1 Studies

Results from experiments on L1 processing are consistent with this threefold distinction. Consider, for example, the results of a series of priming and lexical decision experiments on inflectional and derivational processes in German (Clahsen, Sonnenstuhl & Blevins, 2003). Nonproductive derivational processes such as *in*−adjective formations (e.g., *instabil* "unstable") yielded results parallel to those of irregular inflection—that is, significantly reduced stem-priming (relative to an Identity condition) and whole-word frequency effects in unprimed lexical decision. By contrast, productive derived forms such as *-ung* nominalizations (e.g., *Stiftung* "foundation") and diminutives (e.g., *Kindchen* "small child") produced a pattern of experimental effects that differed from both the one for regular inflection and the one for irregulars—namely, a full stem-priming effect and, in lexical decision, a whole-word frequency effect. This pattern of results for productive derivational processes corresponds to their representation as combinatorial entries. Productive derivational processes share with irregular inflection the fact that their output yields stems (i.e., lexical entries) and, hence, the whole-word frequency effect in lexical decision. Their internal morphological structure, however, is parallel to regular inflection, in

that productive derivations are decomposable (stem + affix) forms and, hence, the full stem-priming effect. More generally, these results, along with other findings (see Marslen-Wilson, 2007, for review), indicate that a considerable proportion of derived words, across a variety of languages, are stored in the mental lexicon, albeit in a morphologically structured format.

L2 Studies

Second language processing of derivational morphology has only been examined in a small number of studies. In one of the experiments reported by Koda (2000), Chinese and Korean L2 learners of English were tested in a timed separability judgment task in which they had to decide whether a given word could be divided into smaller meaningful units. Koda used existing and novel derived word forms with one of four prefixes (*con*, *de*, *in*, *re*) and as controls the monomorphemic words that shared the same initial orthographic sequence as the prefixed words (e.g., *re*gime and *in*fant). If L1 background had an influence on L2 processing in this task, one would have expected more sensitivity and faster decision times in Korean than in Chinese L2 learners, due to the fact that, unlike Chinese, Korean has a rich system of derivational processes. The results, however, showed that both groups of L2 learners exhibited significantly shorter RTs in the prefixed than in the monomorphemic conditions, suggesting that, in this task, the L2 learners were sensitive to the internal structure of the derived words regardless of their L1 backgrounds. Note, however, that this task does not tap into automatic unconscious processes of language comprehension, leaving open the question of whether L2 learners rely on the morphological structure of derived word forms during online processing. In the following, we will summarize the results of Silva (2008) on the processing of derived word forms in L2 English.

Silva (2008) investigated deadjectival nominalizations with -*ness* and -*ity* in a series of masked priming and visual lexical decision experiments (see also Silva and Clahsen, 2008). Participants were two groups of adult L2 learners of English with either Chinese or German as the L1 who achieved proficiency scores of 83% or above in the Oxford Placement Test (Allan, 1992), which represents an "advanced/proficient user" level. Results from the priming and lexical decision experiments are shown in Table 2.

Consider first the results of the lexical decision experiments. The means shown in Table 2 present the RTs of high-frequency forms subtracted from those of the low-frequency ones. The results for all participant groups were parallel, exhibiting significantly shorter RTs for high-frequency than for low-frequency derived words. For the L1 group, this result replicates earlier

Table 2 Summary of experimental findings on derivational word forms in English

| | Lexical decision experiment | | Priming experiment | | | |
| | *-ness* forms | *-ity* forms | *-ness* forms | | *-ity* forms | |
	Low Freq.-High Freq.	Low Freq.-High Freq.	Test-Identity	Test-Control	Test-Identity	Test-Control
L1	66 ms*	25 ms*	6 ms	−44 ms*	−15 ms	−57 ms*
German L2	118 ms*	67 ms*	69 ms*	−52 ms*	31 ms(*)	−83 ms*
Chinese L2	112 ms*	43 ms*	103 ms*	−97 ms*	72 ms*	−115 ms*

Note. The table presents RT differences between the low- and the high-frequency conditions in the lexical decision experiment and between Test versus Identity and Test versus (unrelated) Control conditions in the priming experiment.
*Significant at $p < .05$ by subjects and items.
(*)Significant at $p < .05$ by subjects.
Source. Data from Silva and Clahsen (2008) and Silva (2008).

findings of full-form frequency effects for productive derived forms in lexical decision experiments (e.g., Clahsen et al., 2003), indicating that even highly productive forms such as *-ness* nominalizations in English are stored in the mental lexicon. Silva's findings show that this is also the case for L2 learners.

Differences between the L1 and the L2 groups were found in the priming experiments, however. As can be seen from Table 2, the L1 group demonstrated full stem-priming effects for both *-ness* and *-ity* forms—that is, the same significant facilitation on the recognition of the target in the Test (*bitterness* → *bitter*) as in the Identity condition (*bitter* → *bitter*), replicating previous findings, for example on *-ung* nominalizations and diminutives in native speakers of German (Clahsen et al., 2003). The full stem-priming effect corresponds to the combinatorial structure of these derived word forms. In L2 learners, derivational processes with *-ness* and *-ity* forms also yielded a priming effect, albeit a reduced one. Thus, unlike in the L1 group, the Test conditions for *-ness* and *-ity* produced significantly less facilitation than the Identity conditions in both L2 groups, yielding a reduced or partial priming effect. Silva showed that this priming effect cannot be explained in terms of the semantic, orthographic, or phonological relatedness between primes and targets but instead argued that it is morphological in nature. With respect to semantic priming, they pointed out that if the partial priming effect for derived word forms was due to the semantic relatedness of, for example, *bitterness* and *bitter*, then there should also be a semantic priming effect for regular past tense primes, due to the semantic

relatedness of the past tense form (*walked*) and its corresponding base form (*walk*). This, however, was not the case. Instead, as mentioned in the previous section, there was no priming effect for regular past-tense forms in any of the L2 groups tested. To assess the role of orthographic relatedness, Silva reported the results of a control experiment that showed no priming effects in either the L1 or the L2 groups for prime-target pairs that exhibited the same degree of orthographic overlap (e.g., *dragon* → *drag*) as did the prime-target pairs in the morphological Test conditions of the main experiments. Hence, the full priming effect for derived forms in the L1 and the partial one in the L2 cannot be explained in terms of orthographic overlap.

Clearly, further experimental study of derived word forms in L2 processing is required before any strong conclusions can be drawn. What the evidence currently available suggests, however, is that effects of morphological structure on processing are weaker in the L2 than in the L1. This difference is hard to explain in terms of L1 transfer, as the German and the Chinese L2 groups demonstrated the same reduced priming pattern irrespective of differences in their L1s. Likewise, speed of processing cannot account for the results, either. In the lexical decision and priming experiments reported in Table 2, the Chinese L2 learners had substantially longer RTs than the German L2 learners in all conditions, and yet the response patterns were parallel for the two L2 groups. Instead, the finding that stem-priming effects were reduced in the L2 groups is more consistent with the idea that L2 processing of morphologically complex words is less affected by their internal combinatorial structure than L1 processing (Ullman, 2004, 2005).

Part III: Morphosyntax

Morphosyntax is concerned with inflectional morphemes and their phrase-level or sentence-level functions. Some aspects of morphosyntax are notoriously difficult for late L2 learners to master, and researchers have long been trying to identify the factors that make a particular grammatical category harder to acquire than others (see, e.g., DeKeyser, 2005). These may include factors as diverse as the formal and semantic complexity of the grammatical category to be acquired and the transparency of the form-meaning relationship, cognitive factors such as individual differences in learners' working memory resources or processing speed, age of acquisition, and influence from the learners' native language.

The majority of studies that have examined L2 morphosyntactic development have been informed by naturalistic or elicited production data. These

have shown that late learners may continue to have difficulty producing, for example, bound verbal inflections such as English third-person agreement -*s* even after many years of immersion (Lardiere, 1998). The correct use of pronominal case, on the other hand, has been argued to be comparatively unproblematic for late L2 learners of English. The frequently observed optionality in the production of certain inflectional morphemes has led some researchers to hypothesize that this might reflect a production-specific "mapping" problem rather than a competence deficit (e.g., Prévost & White, 2000), possibly due to prosodic constraints operative in the learners' L1 (Goad & White, 2006).

Although only relatively few studies have investigated learners' ability to process morphosyntactic information during L2 listening or reading, there is growing evidence that learners' problems with inflectional morphology also extend to comprehension, thus calling into question any purely production-specific accounts. Experimental evidence showing that late learners are less sensitive to morphosyntactic information than native speakers during L2 processing comes from a number of studies using ERPs (e.g., Chen et al., 2007; Sabourin & Haverkort, 2003), self-paced reading (Jiang, 2004, 2007), eye-movement monitoring (Keating, 2009; Lew-Williams & Fernald, 2007), or timed grammaticality judgments (McDonald, 2000; Sato, 2007).

Morphosyntactic agreement dependencies appear to be particularly difficult for learners to establish during L2 processing. Using an auditory grammaticality judgment task investigating a variety of grammatical phenomena, McDonald (2000), for example, found that both Spanish- and Vietnamese-speaking learners of English had most difficulty with subject-verb (SV) agreement. Other L2 processing studies have shown that learners' sensitivity to SV agreement markers is also reduced in reading-based tasks (e.g., Chen et al., 2007; Jiang, 2004, 2007) as well as in late-acquired American Sign Language (Emmorey, Bellugi, Friederici, & Horn, 1995). Much less is known, in contrast, about L2 learners' processing of case morphology. Whereas Johnson and Newport (1989) found that postpuberty learners of English had more difficulty identifying incorrect pronoun forms than third-person agreement errors in an auditory grammaticality judgment task, the reverse pattern was seen in earlier learners, as well as in McDonald's (2000) study. The results from a reading-based grammaticality judgment task in L2 German (Hopp, 2006), in contrast, showed that participants had more difficulty recognizing case errors than SV number agreement errors under time pressure.

Although the possibility of L1 transfer in morphosyntactic processing has rarely been investigated systematically, several researchers have claimed that

learners' sensitivity to morphosyntactic information in L2 processing may be affected by properties of their native language (see, e.g., Chen et al., 2007; Sabourin & Haverkort, 2003). Chen et al., for example, have speculated that L1 Chinese speakers' nonnativelike ERP responses to SV agreement errors in L2 English may result from the absence of number marking in Chinese (but see Jiang, 2007, for some arguments against L1 influence). In the following, we will summarize results from a series of experiments investigating learners' sensitivity to SV number agreement and pronominal case in L2 English.

To investigate L2 learners' sensitivity to SV number agreement and pronominal case and to assess the possible influence of the presence versus absence of these grammatical categories in the learners' L1, Sato examined three groups of learners from typologically different L1 backgrounds (German, Japanese, and Chinese) in a series of speeded grammaticality judgment tasks. Note that German is similar to English in that it marks both case and SV agreement, Japanese has a morphological case but lacks SV agreement marking, whereas Chinese lacks both. All L2 learners scored 70% or above in the Oxford Placement Test, placing them within the intermediate to advanced proficiency range. Furthermore, all three learner groups scored at or close to ceiling level on both case and agreement in a complementary offline questionnaire task, confirming that they were aware of the relevant grammatical distinctions.

The materials for the speeded judgment task included simple three-word sentences such as *We regularly sneezes* or *He admires she* that all became ill-formed at the final word. The experimental sentences were presented word-by-word at a rate of 350 ms per word to increase processing pressure, and participants were asked to judge whether a given sentence was well formed and meaningful immediately after reading the final word. Table 3 provides an

Table 3 Summary of experimental findings on English case and agreement inflections

	L1	German L2	Japanese L2	Chinese L2
Errors (Agreement-Case)	−0.7%	4.4%(*)	9.7%*	17.2%*
Response times (Agreement-Case)	3 ms	162 ms*	298 ms*	527 ms*

Note. The table presents error rate and RT differences between the ungrammatical Agreement and the ungrammatical Case conditions.
*Significant at $p < .05$ by subjects and items.
(*)Significant at $p < .05$ by items.
Source. Data from Sato (2007).

overview of the between-condition differences ("agreement" minus "case") in judgment accuracy and response times for all participant groups.

Statistical analyses were performed for ungrammatical items only, as only the incorrect acceptance of an ungrammatical sentence can be reliably attributed to a lack of sensitivity to a particular grammatical property (compare Johnson & Newport, 1989, p. 86). The analysis of the response accuracy data showed that whereas the native-speaker controls were equally successful at identifying case and agreement violations, all three learner groups had more difficulty recognizing agreement than case violations. This pattern of results was mirrored in the RT data, with all three learner groups—but not the native-speaker controls—taking significantly longer to reject sentences containing agreement violations than those containing case violations. In short, the German, Japanese, and Chinese groups patterned alike in showing reduced sensitivity to SV agreement compared to the pronominal case, irrespective of whether these categories are instantiated in their native language. The German group responded faster overall than did the Japanese and Chinese participants, which was most likely due to the latter having to read in a foreign script—in combination, perhaps, with the German groups' slightly higher level of general L2 proficiency. Additional analyses showed, however, that the learners' judgments were not influenced by differences between individual participants' average response speed.

So how are these results to be interpreted? Although domain-general factors such as poor decoding ability, slower processing speed, or computational resource limitations (McDonald, 2006) undeniably play a role in L2 processing, they do not by themselves provide a full explanation for the observed L1/L2 differences, and the differences between case and agreement, in Sato's study. The absence of any effects of response speed (which might be taken as an indicator of processing speed) on the learners' performance patterns also fails to support any general "performance"-based accounts. Several researchers have argued that morphosyntactic features, including those relevant for agreement and case marking, are only accessible to adult L2 learners if they are instantiated in their L1, but not if they are not present in their L1 (e.g., Hawkins & Casillas, 2008; Tsimpli & Dimitrakopoulou, 2007). In contrast to these claims, there was no evidence of any L1 transfer of morphosyntactic properties in Sato's results, with all three learner groups showing the same performance pattern across the two morphosyntactic conditions. As Table 3 shows, the Chinese group showed the largest between-condition differences of all three learner groups, both for RTs and response accuracy, whereas in the German group these differences were comparatively smaller, with the Japanese group falling in between. Neither the observed similarity (in terms of the direction of processing difficulty)

among the three learner groups nor the fact that the between-condition differences were largest for the Chinese group is expected from the perspective of morphosyntactic L1 transfer; that is, if relatedness of L1 morphosyntactic features to those of the L2 affected performance such that L2 categories that are absent in the learners' L1 are more difficult to process, the German group should have been nativelike and the Chinese group should have done equally poorly in both morphosyntactic conditions. This was clearly not the case.

Because Sato's results can neither be accounted for by slower processsing speed nor by L1 transfer, let us now take a closer look at the linguistic properties of the two grammatical phenomena under investigation. Note that both verbal agreement and pronominal case inflections are semantically redundant in present-day English and both paradigms are "weak" in that they involve very few morphological distinctions. Agreement inflections and pronouns are also similar in terms of their featural complexity, with the former expressing person, number, tense and (possibly) aspectual features, and pronouns carrying person, number, gender, and case features. One factor that may make certain morphemes harder to process than others is their perceptual salience (compare, e.g., Goldschneider & DeKeyser, 2001). However, the idea that the relatively low phonetic salience of agreement *-s* should make subject-verb agreement more difficult to process than case-marked pronouns fails to account for the observation that learners' sensitivity to agreement is also reduced for sentences containing the suppletive forms *was* or *were* (Chen et al., 2007; Jiang 2004, 2007), which are comparable in salience with case-marked pronouns. It is also difficult to reconcile with the fact that reduced sensitivity to subject-verb agreement has been reported for different modalities, including spoken, written, and sign language. Another difference between the two phenomena under investigation is that SV agreement dependencies span the entire clause (and thus require comparatively complex structural scaffolding), whereas the objective case is assigned locally within the verb phrase. Sato's results may thus reflect learners' relatively greater difficulty establishing clause-level morphosyntactic dependencies under processing pressure.

Implications and Future Perspectives

One common observation from the above-reported results was that domain-general factors such as the relatively slow speed of processing in an L2 were insufficient to explain the observed L1/L2 differences. With respect to inflectional and derivational processes, for example, it was found that even those L2

learners who performed a given task with the same speed as native speakers showed the same nonnativelike priming and lexical decision patterns as more slowly performing L2 learners. Another factor that failed to account for the reported L1/L2 contrasts was L1 transfer. In each of the three phenomena we examined, a characteristic L2 performance pattern was found across learner groups from typologically distinct L1 backgrounds.

These are somewhat surprising findings—at least for those who believe that L2 processing should benefit from properties in the L1 that are similar to those of the L2 (see, e.g., Sabourin & Haverkort, 2003). From this perspective, one would have expected, for example, that German-speaking L2 learners of English should perform more nativelike than Chinese-speaking learners with respect to regular inflectional and productive derivational processes, due to the greater similarities between English and German than between English and Chinese in these domains. This, however, was not the case, indicating a limited role of L1 transfer on L2 processing of morphology. Instead, the results suggest a deeper divide between native and nonnative language processing.

One promising account of the observed L1/L2 differences in the domain of morphology is that L2 learners rely more on the declarative memory system and less on the procedural system for processing morphologically complex words (Ullman, 2005). Most of the findings reported earlier are indeed consistent with this account. Whenever whole-word storage was involved (as, e.g., in irregularly inflected forms and in derived word forms), the L2 results were similar to those of native speakers. Effects indicative of morphological decomposition, on the other hand, were much weaker in L2 learners, notably for regular inflection. This contrast fits with Ullman's hypothesis of an attenuated procedural and enhanced declarative system in late L2 learners.

Future research in this domain needs to consider at least two additional perspectives on L2 morphological processing that go beyond the simple procedural versus declarative dissociation, however. For one thing, L2 morphological processing research needs to be explicitly linked to existing psycholinguistic models of language production and comprehension. Serial models of language processing, for example, typically assume a series of steps or levels with distinct representations. Many models of word recognition distinguish between *access representations*, which are modality-specific (e.g., specific to visual or auditory recognition) and encode form-level (such as orthographic or phonetic) information, and *central lexical entries*, which are modality independent and incorporate more abstract (e.g., syntactic and semantic) information (see, among others, Marslen-Wilson, Tyler, Waksler, & Older, 1994). Whereas masked priming is thought to tap access-level representations, cross-modal priming is

believed to tap central-level ones (Marslen-Wilson, 2007). Following this line of psycholinguistic research, we should also seek to investigate L2 morphological processing at different levels of representation. Compare, for example, the results on L2 processing of inflection from masked priming experiments (Neubauer & Clahsen, 2009; Silva & Clahsen, 2008) with those from cross-modal priming experiments (Basnight-Brown et al., 2007). In masked priming, the various L2 groups tested did not show any facilitation for regularly inflected prime words, whereas in cross-modal priming, late L2 learners showed similar amounts of facilitation for *-ed* primes as native speakers. These results might mean, then, that the observed L1/L2 differences are confined to early stages of form-level access and that central or lemma-level processing is similar in the L1 and L2. Although this possibility remains speculative at present, due to the small number of online studies, examining L2 morphological processing from this perspective could be a promising avenue for future research.

Second, there is evidence suggesting that more fine-grained linguistic distinctions are required to understand the nature of L2 morphological processing, beyond the basic procedural versus declarative difference. Consider, for example, the finding from Silva and Clahsen (2008) that for productive derivational processes (e.g., *-ness*), L2 learners exhibited more nativelike priming patterns than for regular inflection (e.g., *-ed*). According to the declarative/procedural model, there is no obvious difference between *-ness* and *-ed* affixation in English, and the question as to why L2 priming patterns on these forms should differ remains mysterious. From a linguistic perspective, however, there are clear differences between regular inflections and derivational processes in that the former, but not the latter, are pure combinatorial forms that do not constitute lexical entries of any kind. Instead, regular inflections are represented in the form of morphological paradigms (or equivalent) that are defined in terms of the values of formal features such as [+past] or [+plural], and are independent of the lexical host. Silva and Clahsen (2008) suggested limitations of L2 grammars in these representational mechanisms as a potential source of the L1/L2 processing differences for regular inflection.

Finally, in the domain of morphosyntax, a future challenge for L2 research will be to better understand the processing of agreement, case, and other aspects of morpshosyntax *in different modalities*. The findings from Sato (2007) reported earlier add to a growing body of evidence demonstrating that adult L2 learners' difficulties in the domain of morphosyntax extend to comprehension and judgment and are not limited to production. It is still unclear, however, whether "morphological variability" (White 2003, chap. 6), the occasional omission of morphosyntactic markers that is a striking characteristic of

L2 production particularly at the early stages of L2 development, has any direct equivalents in other modalities. More research on L2 morphosyntax in production, judgment, and comprehension using both offline and online experimental methods is needed to investigate this. Again, as for inflection and derivation, linking L2 research on morphosyntax to psycholinguistic models of production and comprehension is likely to be beneficial.

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