

In: K. Brown (ed.), (2006), *Encyclopedia of language and linguistics*. Elsevier: Oxford, Vol. 4, pp.1-5.

Dual-mechanism morphology

Harald Clahsen

June 2004

Keywords: morphological processing, regular and irregular inflection, the past-tense debate, storage versus computation, psycholinguistics, words and rules, morphological decomposition, child morphology

Harald Clahsen
Department of Linguistics
University of Essex
Colchester, C04 3SQ, UK
Tel: +44/1206/87-2228
Fax: +44/1206/87-2198
email: harald@essex.ac.uk

Abstract

Dual-mechanism morphology refers to a family of psycholinguistic models which hold that morphologically complex word forms can be processed both associatively, i.e. through stored full-form representations and by rules that decompose or parse inflected or derived word forms into morphological constituents. We present a brief overview of some relevant experimental results on English and other languages and of different variants of dual-mechanism models that are currently discussed in the literature. Finally, we briefly outline how dual-mechanism morphology can be implemented into morphological theory.

Our understanding of how an adult native speaker/hearer processes inflected word forms in real time has increased considerably over the last decade. Experimental studies using a range of different psycholinguistic methods and techniques, e.g. lexical decision, priming, event-related potentials (ERPs), have led to a number of consistent and replicable results, e.g. frequency effects for inflected word forms in lexical decision tasks, priming effects for inflected word forms in different kinds of priming experiments, and left-anterior negativities for incorrectly inflected word forms in ERP violation studies; see Clahsen (1999) and Pinker (1999), for review. The theoretical interpretation of these and other results on morphological processing in adult native speakers is controversial; basically, three different approaches can be distinguished. On one side are different kinds of *associative single-mechanism models* claiming that all inflected words are stored and processed within a single associative system using distributed representations (see e.g. Bybee 1995, Sereno & Jongman 1997, among others). The morphological structure of an inflected word is not explicitly represented in these models; instead, these models implement networks that represent the mapping relationship between different word forms through associatively linked orthographic, phonological and semantic codes. A radical

alternative to these models are *rule-based single-mechanism accounts* in which all inflected words are formed by morphophonological rules, and memorization of inflected words is avoided as much as possible. Halle & Mohanan (1985) and related work in Generative Phonology in which minor rules are proposed, for example 'Lowering Ablaut' deriving the past-tense form *sang* from the stem *sing*, are representative of this approach; see Yang (2000) for a recent treatment of the English past tense in this framework. The third theoretical viewpoint is represented by a family of *dual-mechanism models* which hold that morphologically complex word forms can be processed both associatively, i.e. through stored full-form representations and by rules that decompose or parse inflected word forms into morphological constituents (Chialant & Caramazza 1995, Schreuder & Baayen 1995, Clahsen 1999, Pinker 1999, among others). Here, we will provide a brief overview of different variants of dual-mechanism models that are currently discussed in the literature.

There is a class of so-called *dual-route models* that is specifically concerned with the kinds of mental representation readers and listeners consult in recognizing morphologically complex words. As is common in word-recognition research, modality-specific access representations are assumed to mediate the mapping from the orthographic or spoken input onto lexical representations in the central lexicon. Dual-route models posit that morphologically complex words can be recognized either via prelexical morphological parsing which decomposes the orthographic or spoken input into its morphological components or via a direct access route which is based on stored full-form representations for morphologically complex words. Different proposals have been made as to how these two access routes interact. For example, according to Caramazza and collaborators, full-form based lexical access is preferred

for all known words, and the parsing route is only employed for novel or extremely rare words that are morphologically regular (Chialant & Caramazza 1995). By contrast, according to the morphological race model proposed by Baayen, Schreuder and collaborators both the parsing route and the direct route operate in parallel. Which of these two routes turns out to be more efficient is claimed to depend on a number of factors, including the frequency of an inflected word and its constituents, the lexical neighborhood, the phonological and semantic transparency (vs. opacity) of a morphologically complex word, and the degree of homonymy of an affix (see e.g. Baayen et al. 2003, Bertram et al. 2000). Much of the empirical evidence in the context of dual-route models comes from just one experimental task, namely so-called lexical decision, in which subjects have to discriminate between existing words (that have been encountered before) and nonce words (that have never been encountered before), e.g. *houses* vs. *nouses*. Lexical decision is a rather odd task, and it is hard to tell what response times to this task actually mean; see Balota (1994) and Deutsch & Müller (1999) for discussion. It seems clear, however, that due to the task demands, lexical decision encourages subjects to strongly rely on memory, in order to determine whether or not they have encountered a stimulus word before. Thus, it could be that results from lexical decision have led us to overestimate the role of full-form access (as opposed to morphological parsing) in recognizing inflected and derived words.

Another variant of dual-mechanism morphology is the *words-and-rules* model of Pinker and collaborators (see e.g. Pinker 1999, Pinker & Ullman 2002). The basic claim of the words-and-rules account is that two complementary systems coexist in how our mind/brain processes and learns language: a combinatorial (rule-based) system that generalizes over symbolic categories such as N(oun), V(erb), etc. and treats all members of a given category equally, and an associative system that extracts

probabilistic contingencies, e.g. frequency distributions, similarity clusters, etc. from the input data. These two systems can be implemented as neural circuits or subroutines which do not just underlie linguistic generalization, but are claimed to be used in other domains of cognition as well, for learning, and comparing in general. The key property of the combinatorial system is that it suppresses differences between individual examples and treats all members of a group or class equally. By contrast, the associative system generalizes on the basis of resemblance to stored examples. Extending Pinker's model, Ullman (2001) has argued that the distinction between words and rules can be linked to two different brain memory systems, according to which the associative system ('words') depends upon *declarative* memory and is rooted in temporal lobe structures of the brain, whereas the combinatorial system ('rules') is rooted in frontal brain structures. However, the evidence currently available for such a strong localist interpretation of the words-and-rules distinction has not yet convinced everybody.

Much of the empirical research on the words-and-rules model comes from the study of a rather simple inflectional system, the English past tense. Pinker argues that the two different systems of his model directly correspond to the linguistic distinction between regular and irregular past-tense formation. Regular *-ed* inflection is predictable in form, readily applies to novel items, and invokes a combinatory rule (Add *-ed*) that may operate on the outputs of other morphological processes (derivation, compounding). Irregular past-tense inflection (e.g. *sing-sang*) on the other hand, is based on stored forms that cannot be perfectly predicted by the form of the stem or root, and only tentatively extends to new forms. There is indeed a considerable body of psycholinguistic evidence for the distinctions posited by the words-and-rules model from studies of the English past tense, investigating child

language acquisition (Marcus et al. 1992), adult language processing (Alegre & Gordon 1999), brain-imaging and event-related potentials (Jaeger et al. 1996, Münte et al. 1999), and language disorders (Marslen-Wilson & Tyler 1997, Clahsen et al. 2004).

However, despite all the evidence that has been accumulated on the English past tense, there are many reasons to extend research on dual-mechanism morphology to a wider range of languages. Note, for example, that the English past tense has only one productive form (*-ed*) and that regularity is confounded with both the presence of an overt affix and with type frequency. Regular verbs in English are much more frequent (= 95%) than irregular ones (= 5%), see Marcus et al. (1995), and regular past tense forms contain a segmentable affix, whereas irregular forms typically do not have affixes. These two confounding features leave room for several alternative interpretations of the same set of facts. Potential differences, for example, between forms such as *walk-ed* and *came* in acquisition and processing could be effects of frequency differences and/or effects of the presence or absence of an overt affix, rather than the result of different mental representations.

To address these concerns, psycholinguistic studies have examined a range of typologically different languages from the perspective of dual-mechanism morphology (e.g. German: Clahsen (1999); Hebrew: Berent et al. (1999); Italian: Say & Clahsen (2002); Spanish: Clahsen et al. (2002a), Rodriguez-Fornells et al. (2002); Catalan: Rodriguez-Fornells et al. (2001)) focusing on the question of whether and how the fundamental distinction between lexical storage and combinatory rules extends to linguistic systems other than the English past tense (see Pinker 1999, chapter 8 for review). The results of these studies revealed contrasts that were similar to those obtained for regular and irregular inflection in English despite the fact that

the vocabulary distribution, the surface morphology, and other properties of the language were different from those of English past-tense formation. For example, psycholinguistic examination of the German noun plural system revealed that even though the *-s* plural is the least frequent plural allomorph in German, it exhibits the same experimental effects as the regular past-tense *-ed* in English (Marcus et al. 1995). The same is true for past participle formation in German despite the fact that (unlike English) German has two segmentable participle endings, the regular *-t* and the irregular *-n*, and that the vocabulary distribution for regulars and irregulars is different from that of the English past tense (Clahsen 1999). Priming experiments revealed regular/irregular differences for German participles despite the fact that the phonological and orthographical distance between the participle forms and their corresponding stem forms tested was identical for both regular and irregular verbs (Sonnenstuhl et al. 1999). For example, an irregular participle such as *geschlafen* ‘slept’ is as similar to its base form (*schlaf*) as a regular participle (e.g. *geöffnet* ‘opened’) is to its base stem (*öffn-*), and despite these formal similarities the regular form produced full priming, and the irregular one did not, just like in corresponding experiments on the English past tense (Stanners et al. 1979). These results do not only show that the words-and-rules model extends to morphological systems other than the English past tense, but also that alternative non-morphological factors (e.g. the frequency distribution and the surface properties of inflected word forms) that may hold for the English past tense cannot explain the observed contrasts between lexically-based (‘frozen’) and rule-based (‘built’) inflected word forms.

There are different ways of how dual-mechanism morphology can be implemented into an explicit linguistic theory. One direct implementation is Wunderlich and colleagues’ morpheme-based model (Wunderlich 1996) according to which

irregularly inflected forms are lexically represented, as subnodes of structured lexical entries, while regular inflection involves combinatorial rules that concatenate an affix with a lexical entry. An alternative implementation within realization-based models of morphology reconstructs this contrast in terms of the distinction between rules that contain variables and those that have a constant output, see e.g. Blevins (2004). Irregular inflection, e.g. the form *is* of the verb *to be*, is encoded as a realization rule that has a constant formal spell-out ($\langle [V, 3\text{sg}, \text{pres}, \text{ind}, \text{BE}], \text{is} \rangle$), whereas combinatorial (regular) inflection, e.g. the regular 3sg present tense *-s* in English, is based on a realization rule ($\langle [V, 3\text{sg}, \text{pres}, \text{ind}], X+s \rangle$) that adds the exponent ‘s’ to the base form represented by a variable (‘X’) yielding inflected word forms for any verb that is not blocked by a more specific rule. Thus, although dual-mechanism morphology can be construed in terms of an opposition between rules and entries, the basic distinction between built and stored elements can also be expressed in alternative all-rules models of morphology.

From a linguistic perspective, dual-mechanism morphology and the accompanying empirical studies suggest that structural differences between built and frozen forms correspond to differences in the way they are mentally represented and processed by the speaker-hearer and acquired by children. This raises the question of whether there is any psycholinguistic evidence for more complex morphological concepts and operations that go beyond the simple opposition between built and frozen forms, a question that my colleagues and I have investigated in a number of recent studies using psycholinguistic experiments and other sources of evidence. We have studied, for example, the mental representation of stem allomorphy (Clahsen et al. 2001a, 2002b), the role of inflectional paradigms in language processing and disorders (Clahsen et al. 2001a, 2001b), and effects of the split between derivation and

inflection on morphological processing (Clahsen et al. 2003). Even though further study is required to see whether the results obtained generalize to other morphological systems, the findings from these studies suggest that morphological distinctions (beyond ‘words-and-rules’) do indeed play an important role in the organization of the mental lexicon and that morphological notions and concepts are not only useful descriptive tools for linguists, but also contribute to a better understanding of how the speaker/hearer processes morphologically complex words.

References

- Alegre, M. & Gordon, P. (1999). Rule-based versus associative processes in derivational morphology. *Brain & Language* 68: 347-354.
- Baayen, H., Dijkstra, T. R. (2003). Frequency effects in regular inflectional morphology: revisiting Dutch plurals. In: H. Baayen & R. Schreuder, (eds.), *Morphological structure in language processing*. Berlin: Mouton de Gruyter. 355-390
- Balota, D. A. (1994). Visual word recognition: The journey from features to meaning. In: M. A. Gernsbacher (ed.), *Handbook of psycholinguistics*. San Diego, CA: Academic Press. 303-349
- Berent, I., Pinker, S. & Shimron, J. (1999). Default nominal inflection in Hebrew: evidence for mental variables. *Cognition* 72: 1-44.
- Bertram, R., Schreuder, R. & Baayen, H. (2000). The balance of storage and computation in morphological processing: The role of word formation type, affixal homonymy, and productivity. *Journal of Experimental Psychology: Memory, Learning, and Cognition* 26: 419-511.

- Blevins, J. P. (2004). Stems and paradigms. *Language* 79: 737–767.
- Bybee, J. L. (1995). Regular morphology and the lexicon. *Language and Cognitive Processes* 10: 425-455.
- Chialant, D. & Caramazza, A. (1995). Where is morphology and how is it processed? The case of written word recognition. In: L. Feldman (ed.), *Morphological aspects of language processing*. Hillsdale, NJ: Erlbaum Press. 55-76
- Clahsen, H. (1999). Lexical entries and rules of language: a multi-disciplinary study of German inflection. *Behavioral and Brain Sciences* 22: 991-1060.
- Clahsen, H., Eisenbeiss, S., Hadler, M. & Sonnenstuhl, I. (2001a). The mental representation of inflected words: an experimental study of adjectives and verbs in German. *Language* 77: 510-543.
- Clahsen, H., Sonnenstuhl, I., Hadler, M. & Eisenbeiss, S. (2001b). Morphological paradigms in language processing and language disorders. *Transactions of the Philological Society* 99: 247-277.
- Clahsen, H., Aveledo, F. & Roca, I. (2002a). The development of regular and irregular verb inflection in Spanish child language. *Journal of Child Language* 29: 591-622.
- Clahsen, H., Prüfert, P., Eisenbeiss, S. & Cholin, J. (2002b). Strong stems in the German mental lexicon: evidence from child language acquisition and adult processing. In: I. Kaufmann & B. Stiebels (eds.), *More than words: a festschrift for Dieter Wunderlich*. Berlin: Akademie-Verlag. 91-112.
- Clahsen, H., Sonnenstuhl, I. & Blevins, J.P. (2003). Derivational morphology in the German mental lexicon: a dual mechanism account. In: H. Baayen & R. Schreuder (eds.), *Morphological structure in language processing*. Berlin: Mouton de Gruyter. 125-155

- Clahsen, H., Ring, M. & Temple, C. (2004). Lexical and morphological skills in English-speaking children with Williams Syndrome. In: S. Bartke & J. Siegmüller (eds.), *Williams Syndrome across languages*. Amsterdam: Benjamins. 221-244.
- Deutsch, W. & Müller, O. (1999). Chomsky's new clothes. [Commentary to Clahsen 1999]. *Behavioral and Brain Sciences* 22: 1020.
- Halle M. & Mohanan, K. (1985). Segmental phonology of modern English. *Linguistic Inquiry* 16: 57-116.
- Jaeger, J., Lockwood, A., Kemmerer, D., Van Valin, R., Murphy, B., & Khalak, H. (1996). A positron emission tomographic study of regular and irregular verb morphology in English. *Language* 72: 451-497.
- Marcus, G. F., Pinker, S., Ullman, M., Hollander, M., Rosen, T. & Xu, F. (1992). *Overregularization in Language Acquisition. (Monographs of the Society for Research in Child Development)*. 57 (4, Serial No. 228).
- Marcus, G. F., Brinkmann, U., Clahsen, H., Wiese, R. & Pinker, S. (1995). German inflection: the exception that proves the rule. *Cognitive Psychology* 29: 189-256.
- Marslen-Wilson, W. & Tyler, L. (1997). Dissociating types of mental computation. *Nature* 387: 592-594.
- Münte, T.F., Say, T., Schiltz, K., Clahsen, H., & Kutas, M. (1999). Decomposition of morphologically complex words in English: Evidence from event-related brain potentials. *Cognitive Brain Research* 7: 241-253.
- Pinker, S. (1999). *Words and rules*. New York, NY: Basic Books.
- Pinker, S. & Ullman, M (2002). The past and future of the past tense. *Trends in Cognitive Sciences* 6: 456-462.

- Rodríguez-Fornells, A., Clahsen, H., Lleo, C., Zaake, W. & Münte, T.F. (2001). Event-related brain responses to morphological violations in Catalan. *Cognitive Brain Research 11*: 47-58.
- Rodríguez-Fornells, A., Münte, T.F. & Clahsen, H. (2002). Morphological priming in Spanish verb forms: An ERP repetition priming study. *Journal of Cognitive Neuroscience 14*: 443-454.
- Say, T. & Clahsen, H. (2002). Words, rules and stems in the Italian mental lexicon. In S. Nootboom, F. Weerman & F. Wijnen (eds.), *Storage and computation in the language faculty*. Dordrecht: Kluwer. 93-129.
- Schreuder, R. & Baayen, H. (1995). Modeling morphological processing. In: L. Feldman (ed.), *Morphological aspects of language processing*. Hillsdale, NJ: Erlbaum Press. 131-154.
- Sereno, J.A., & Jongman, A. (1997). Processing of English inflectional morphology. *Memory & Cognition 25*: 425-437.
- Sonnenstuhl, I., Eisenbeiss, S. & Clahsen, H. (1999). Morphological priming and the mental lexicon: evidence from German. *Cognition 72*: 203-236.
- Stanners, R. F., Neiser, J.J., Hernon, W.P. & Hall, R. 1979. Memory representation for morphologically related words. *Journal of Verbal Learning and Verbal Behavior 18*: 399-412.
- Ullman, M. (2001). A neurocognitive perspective on language: the declarative/procedural model. *Nature Reviews Neuroscience 2*: 717-727.
- Wunderlich, D. (1996). Minimalist Morphology: the role of paradigms. *Yearbook of Morphology 1995*: 93-114.
- Yang, C. D. (2000). Knowledge and learning in natural language. Unpublished doctoral dissertation. Cambridge, MA: MIT.

Dual Mechanism. Isometric Morphology. F Minor. Key. The following tracks will sound good when mixed with Dual Mechanism - Isometric Morphology, because they have similar tempos, adjacent Camelot values, and complementary styles. Camelot. BPM. Dual Mechanism - Isometric Morphology. Listen. Download MP3. Dual Mechanism. Element: Arsenic. 04:23 10.34 DæD± 320 ĐšĐ±/Ñ. Watch music video "Dual Mechanism - Isometric Morphology" online. Update music video. Send lyrics Send translation. However, the dual-mechanism account he supports predicts a crisp distinction; the empirical data instead suggest a fuzzy one, more in line with single-mechanism connectionist models. Export citation Request permission. Copyright. © 1999 Cambridge University Press. Recommend this journal. Email your librarian or administrator to recommend adding this journal to your organisation's collection. Behavioral and Brain Sciences. Morphology is in some ways both the most ancient and one of the youngest sub-disciplines of linguistics and grammar. It is said to be an ancient study because there is much evidence that the first linguists were mainly morphologists (Haspelmath, 2002).[2] The term morphology is attributed to Johann Wolfgang von Goethe who coined it in the biological context during the nineteenth century. The dual-mechanism model postulates that regularly inflected words have a morphological...