

# Morphology as an adaptive discriminative system

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The past decade has witnessed a productive convergence of a number of historically separate research strands. One strand explores the implicational models that grew out of classical WP approaches to inflection (e.g., Wurzel 1984; Maiden 2005; Blevins 2006; Ackerman et al. 2009). A second strand extends the information-theoretic perspectives on ‘morphological information’ developed originally in the processing models of Kostić et al. (2003), Moscoso del Prado Martín et al. (2004), and Milin et al. (2009a, b). A third strand investigates a ‘complex systems’ approach to grammatical organization (Ackerman & Blevins 2008; Ackerman et al. 2008; Beckner et al. 2009). The fourth strand develops a cohesive discriminative perspective on language learning and use (Ramscar & Yarlett 2007; Ramscar & Dye 2010; Ramscar et al. 2010, 2013; Ramscar 2013; Arnon & Ramscar 2012; Baayen et al. 2011). This chapter considers how the interaction of these distinct components has produced a general conception of the structure and function of morphological systems which opens significant points of contact with research in other domains.

## 1. Introduction

In accordance with the theme of this volume, the present chapter presents some meta-theoretical remarks on the nature of morphological analysis and on the largely tacit assumptions that determine the implementational details of particular theories. The remarks reflect a general perspective on grammatical analysis that has taken shape as a number of historically separate research strands have converged over the past decade. This convergence is summarized concisely below. In the strand most directly connected to morphological theory, recent implicational approaches have provided a formal reconstruction of the general morphological model underlying the classical WP tradition (e.g., Wurzel 1984; Maiden 2005; Blevins 2006). The information-theoretic notions proposed to measure ‘morphological information’ in studies of morphological processing (Kostić et al. 2003; Moscoso del Prado Martín et al. 2004; Milin et al. 2009b,a) and for calculating systemic cohesiveness in analyses of complex

inflectional morphology (Blevins 2008; Ackerman et al. 2009; Bonami & Henri 2010; Ackerman & Malouf 2013; Cable 2014; Stump & Finkel 2013; Sims 2015) have supplied a means of measuring implicational structure and relations. Discriminative learning models (Baayen et al. 2011; Arnon & Ramscar 2012; Ramscar et al. 2010, 2013a) offer an interpretation of information-theoretic notions as measuring discriminability within a morphological system. The interaction of these components is seen as reflecting a complex systems view of grammatical organization (Ackerman & Blevins 2008; Ackerman et al. 2008; Beckner et al. 2009), opening significant points of contact with other domains (Michel & Moore 1995; Bateson & Gluckman 2011; Capra & Luisi 2014, among others).

Some of the implications of this convergence for cognitive models of morphological systems are explored in the discussion of Implicit Morphology in Baayen (this volume). The present chapter aims to take a slightly more expansive perspective by locating these developments within a larger intellectual setting, and drawing some broader conclusions about morphological analysis in general.<sup>1</sup>

### 1.1 The constructionist fallacy in morphology

The publication of this volume testifies to the timeliness of this reappraisal of morphological approaches, and its value is reinforced by the fertile reappraisal of analytical approaches currently transforming research in the developmental sciences. In particular, over the past decade there has been growing recognition of the importance of understanding the principles shaping systemic organization within the developmental sciences (see Gottlieb 1997; Oyama et al. 2001; Jablonka & Lamb 2006; Gilbert & Epel 2008; Overton 2010; Bateson & Gluckman 2011, among others), represented by the family of developmental dynamic systems approaches within both biology and psychology. There is an emerging cross-disciplinary consensus that familiar analyses which reduce complex wholes to their constitutive parts and formulate associated procedures to reconstruct wholes from these parts has led to inevitable gaps in our understanding of the targeted phenomena: it has been observed that the most ordinary, and often most puzzling objects, display properties that are not explicable in this way. Hence, the revived currency of the mysterious sounding dictum “The whole is more/different than the sum of its parts”. In line with this, Anderson (1972), arguing for a complex dynamic systems approach to the analysis of complex objects in contrast to the then-prevalent reductionism, writes the following:

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1. The reader should consult the references for detailed analyses of morphological data sets within this evolving tradition.

The main fallacy in this kind of thinking is that the reductionist hypothesis does not by any means imply a “constructionist” one: The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe. In fact, the more the elementary particle physicists tell us about the nature of the fundamental laws the less relevance they seem to have to the very real problems of the rest of science, much less to those of society. The constructionist hypothesis breaks down when confronted with the twin difficulties of scale and complexity. The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear, and the understanding of the new behaviors requires research which I think is as fundamental in its nature as any other.

Modern generative models of morphology that regard both words and paradigms as epiphenomena rather than first-class theoretical objects, simply reducible to their parts (if abstracted correctly) and combinatoric rules (if formulated correctly), make this same constructionist error (see Blevins 2016 and Bochner 1993). In contrast, from a contemporary perspective the foundational hypotheses guiding Word and Paradigm proposals have a natural affinity to much recent research in the complexity sciences and their efforts to explicate and explain systemic organization in different domains.

The Word and Paradigm or Word-based model of morphology has its origins, of course, in classical Graeco-Roman tradition: it has developed in parallel with structuralist and generativist hypotheses concerning the segmentation of words into morphemes (Matthews 1974; Hockett 1987; Anderson 1992; Bochner 1993, among others). The WP tradition can be conceptualized in terms of part-whole relations at two levels of analysis, as suggested in Matthews (1991: 204):

...words are not merely wholes made up of parts, but are themselves construable as parts with respect to systems of forms in which they participate.

Morphological analysis looked at in this way permits a perspicuous contrast between familiar assumptions guiding most generativist approaches and the less familiar assumptions associated with the WP perspective. In particular, the distinctive properties of these approaches can be identified by distinguishing between two different domains over which part-whole relations are definable.

In the domain of word structure, questions arise concerning the internal composition of (complex) words, especially concerning the relevant units of analysis, their appropriate representation and their manner of composition. In the domain of relations between words questions arise concerning sets and subsets of patterns that constitute the organization of morphological systems: this is the domain of paradigm structure which, of course, presupposes that words are construed as parts of patterns.

The clear and central focus of structuralist and generative morphology has been on the internal structure of words. Additionally, a prevailing assumption with the Chomskyan generative tradition has been that that internal structure consists of morphemes, interpreted in an increasingly abstract fashion over the years.

Viewed from a WP perspective, this analytic approach builds upon a mistaken and empirically problematic assumption. Both WP and generative approaches agree that complex inflected and derived words consist of, e.g., morphosyntactic and lexeme-forming information. Where they differ is that the latter assumes that attention to word-internal structure entails this information is decomposable into morphemes that are arrayed in binary branching hierarchical structures, reminiscent of the phrasal representations favored within this tradition for syntactic phenomena.<sup>2</sup>

The former, in contrast, eschews such representations as basic, universal constructs of linguistic morphology: there is no requirement that all complex words be interpreted in terms of universal abstract morphemic composition facilitated by tree-theoretic representations and operations. The more or less concrete notion of

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2. Marantz (2013), but see Baayen et al. (2011); Hockett (1987). For example, Marantz (2013) defines the morpheme notion so capaciously that it accommodates traditional WP conceptions about the morphosyntactic word and exponence in terms of segmental and suprasegmental formatives, rather than in terms of traditional morphemes (see Matthews (1993) and Anderson (2015) for a substantive discussion of the morpheme concept). He adopts the distinction between lexeme and morpheme advanced by Beard & Volpe (2005: 189):

The definitions of the two categories are simple: Lexemes are noun, verb, and adjective stems. These items in all languages are manifested without exception as sound-meaning pairings that refer to something in the real world. Any other meaningful linguistic phenomenon is a Morpheme and hence must refer to a grammatical category; it cannot be used in reference to anything in the extralinguistic world. Morphemes refer exclusively to universally available closed-class grammatical categories like Tense, Aspect, and Number and may consist of independent phonemic strings (usually unaccented), affixes, infixes, changes in accent or tone, or even predictable omissions (zero morphemes).

This view, antedated by Baudouin de Courtenay [1895] 1972, as discussed by Stankiewicz (1972: 36), defines the morpheme as anything that has to do with complex word structure and morphology, therefore, as essentially morphemic: on this view, the morpheme is a primitive associated with positions in a phrasal representation. This elastic definition of the morpheme construct, i.e., as an abstract morphosyntactic property that gets realized in various language particular ways, makes the goal of morphological theory to identify the principles that relate these underlying representations to observed surface expression. This view about the appropriate representation of e.g., morphosyntactic information and its relation to surface exponence obscures a much more significant difference these two approaches. This concerns the theoretical status of words and their role in morphological organization, as discussed below.

a morpheme as a sign can be viewed as one type of strategy among many that all serve to discriminate related words from one another.<sup>3</sup> The important unifying phenomenon across the morphological systems of different languages is, accordingly, not abstract morphemic structure (see footnote 2 above for a more nuanced discussion), but the nature of the strategies used to establish networks of related words. Recent WP proposals focus on exploring the part-whole relations constitutive of the internal structure words, identifying the inventories of elements (re)deployed in the patterned organization (of classes of) whole words. This is in the service of a very different goal than that targeted by generative approaches. WP proposals develop evidence for the usefulness of assuming that the word is a fundamental and instructive unit of analysis in morphological theory. This latter assumption differs from the claim that words are epiphenomenal, in approaches that posit abstract morphemes.

Cross-linguistic empirical research suggests that morphological systems are organized in terms of a word's participation in discriminably different patterns of shape.<sup>4</sup> This is instructive about an issue in morphology where generativist and WP approaches most differ: in addition to identifying the patterns that words participate in, WP approaches are concerned with understanding the domain of paradigmatic organization, where whole words constitute parts of patterns which themselves are constitutive of larger systems of word patterns. Studies within the generative tradition which examine the nature of paradigms tend to presuppose the explanatory value of morphemic internal structure.

As proposed in Ackerman & Malouf (2013), there are two types of complexity considerations that seem useful for analyzing morphology.<sup>5</sup> The first, E(-numerative) complexity is essentially taxonomic. It relates to the sets of morphosyntactic properties distinguished in particular languages as well as the strategies attested for encoding them in the languages of the world. Results in this dimension of complexity have been a resource for morphological speculation in both morpheme-based and stem-based constructionist frameworks and descriptivist typological research. For the former,

3. See Hay & Baayen (2005), Blevins (2016) for a relevant review of the literature.

4. In this connection it is worth recalling Matthews' arguments that Bloomfield (1914:141) argues in a "word-based mode" when he posits that inflection can be seen as,

...variation between words to express relational differences which involve appurtenance to different categories.

This can be interpreted in a more modern fashion as claiming that morphology is the study of the covariation between meanings and form variation among words, however the pieces of these words may be labelled.

5. See Dahl (2004), Sampson et al. (2009), and Baerman et al. (2015) for different characterizations of complexity.

represented by the morpheme-based proponents of Distributed Morphology, a focus on morphosyntactic distinctions and their encoding within words has led to claims concerning universal inventories of morphosyntactic features and universal structural configurations that instantiate them: universal structural configurations are hypothesized to underlie and derive obvious surface variation in encoding strategies. For the latter, following a tradition typified by Sapir (1921) and Evans & Levinson (2009), among others, cross-linguistic research makes evident what sorts of distinctions are attested, the nature of their variation and what sorts of strategies languages utilize to encode them: in this tradition there is no necessary assumption concerning grammatical limits on the inventory of distinctions nor the need to posit a common representational strategy concerning the composition of elements obscured by language particular effects.

In both of these approaches, the paradigmatic dimension, the centrality of pattern-based principles of organization, and its relational core are largely absent: while both are taxonomic, the former attempts to make notional and formal generalizations on the basis of its findings, while the latter generally compiles inventories of these notional and formal distinctions, attempting to explain them in terms of functional and diachronic effects on formal expression. But, beyond the importance of cataloging morphosyntactic distinctions and their formal expression there is an equally important empirical issue: it inquires about how these twin dimensions of morphology get integrated within a particular morphological system and more broadly, about the nature of the generalizations concerning crosslinguistic systemic morphological organization. This latter was referred to as Integrative complexity in Ackerman & Malouf (2013).<sup>6</sup> It is a dimension of analysis that exploits the differences and similarities between individual (types of) words in terms of their internal composition: it attends to the discriminable differences among related words and the manner in which these are organized into patterns within a grammar system. Attention to this aspect of complexity encourages serious quantitative and experimental consideration of the conceptual issues and insights concerning Word and Paradigm models.

So, what are the essential characteristics of a morphological system? We hypothesize that it is not abstract morphemes, their (universal) hierarchical arrangement or the rules of composition responsible for realizing the language particular surface shapes of words, despite this being a standard hypothesis in modern morphology. From a WP perspective such an analytic bet is construable as the linguistic analogue of a reductive strategy which decomposes complicated elements into smaller and smaller parts and then posits rules to reconstitute them without remainder. This perspective, accordingly, participates in the popular, and often productive, reductive

6. One can consider this a question of explaining the dynamics underlying Wurzel's (1989) Paradigm Structure constraints.

assumption of a **continuity hypothesis** in analysis: the reconstituted object does not possess any empirically consequential or theoretically important property that does not exist antecedently in its component parts when combined via the appropriate rules. Adapting this strategy to morphological analysis, it becomes clear why regularly formed complex words, in morpheme-based proposals, are regarded as epiphenomena, and why, any purported organization of these entities into paradigms must be, consequently, epiphenomenal.<sup>7</sup>

In contrast, one can hypothesize that in morphological analysis, it is the patterns of word internal structure associated with classes of related words and the organization of the grammar system constituted by these patterns that are the essential characteristics of morphology: words and paradigms constitute their own instructive level of grammar with their own significant properties. An important aspect of this system is the nature of the relations between classes of related words and the nature of the relations among the classes of patterns. In fact, this different level of morphological analysis utilizes and motivates the types of internal organization of words we find cross-linguistically. This becomes particularly apparent in the paradigmatic organization displayed by inflectional morphology, where relations between patterned information units assume an explanatory role different than the units that constitute them. There are essentially two types of patterns. The patterns represented by the shapes of (types of) words and the patterns of relations between related words of specific types. This means that the actual elements of e.g., words need not be intrinsically meaningful, as in the usual interpretation of morphemes, but that their meanings/functions arise as contrastive ensembles of elements within networks of related words. That is, distinct word patterns can be discriminated from one another. Moreover, morphological systems can be interpreted as ways of organizing patterns of discriminability so that they increase the predictability of relatedness among words by decreasing the uncertainty of interpretation between them. The recognition that there are distinctive properties distinguishing higher level units from their constitutive elements aligns morphological analysis with the **discontinuity hypothesis** assumed in systems analyses of complex phenomena across numerous disciplines.<sup>8</sup>

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7. Naturally, if combinatoric rules can be annotated with precisely the information known to be associated with the targeted complex object, then this diacritic strategy can account for those properties not directly derived from the internal parts themselves. However, this strategy deflects the recognition that the complex objects may participate in a system of organization that differs dramatically from the system represented by the pieces from which they are composed.

8. In this connection, see Thelen & Bates (2003) for an insightful exploration of differences and similarities between connectionist and dynamic systems approaches to complex

The preceding discussion suggests that the contrast between morpheme-based models and word and paradigm models does not come down to empirical adequacy. Indeed, it is well-known that the wordforms of a language constitute a regular language in the formal language sense (Langendon 1981; Koskeniemi 1983; Karttunen & Beesley 2003; Karttunen 2003; Sproat 2005). That being the case, all morphological theories are, in a sense, notational variants of each other. No theory has a basis to claim to be ‘right’ (or at least not righter than any other theory), and it is unlikely that any morphological phenomenon will allow us to distinguish among theories on empirical grounds. However, this is not to say that one’s choice of morphological theory has no consequences. On the contrary: any particular approach to the world will naturally lead one to examine certain questions and connections while at the same time foreclosing others. And while two models may be formally equivalent in their generative capacity, they may still be very different in their larger consequences. There are two simple areas of research that illustrate the importance of how different approaches lead to asking different questions: what facilitates the learning of complex inflectional systems? And, is the morphology of creoles simpler than their base languages? A focus on words, their organization into systems of relations, and the principles that integrate this organization may be crucial factors for learning complex morphological systems: this can only be investigated if all these elements are acknowledged as first-class objects of analysis (Seyfarth et al. 2014). Relatedly, defining appropriate measures for calculating morphological complexity over words has led to the surprising result that e.g. Mauritian creole verbal morphology can be interpreted as more complex than its lexifier language French (Bonami & Henri 2010).

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phenomena, and of both to competing proposals (see also Elman et al. 1996, and more generally Michel & Moore 1995; Bateson & Gluckman 2011). The article makes clear that, e.g., Chomskyan approaches to language analysis, as traditionally practiced, are incompatible with core assumptions of systems approaches in the developmental sciences. Some recent efforts in Biolinguistics (Boeckx et al. 2013), in this light, appear to be identifying connections between language and the developmental sciences that are familiar from several decades of criticism of the Chomskyan paradigm, even as it changes over time. This process recalls an early remark by Weinreich (1967) about the style of theory construction which he thought characteristic of generative grammar. Responding to Katz’s claim that the theory at that time could accommodate whatever semantic features might be required without “any change in the theory whatever”, Weinreich (1967:286) wrote:

By this mysterious power to change his theory without changing it, Katz seeks to guarantee the perennial correctness of his approach, abstracted from any particular formulation of it.

## 1.2 Overview

In the remainder of this chapter we provide a summary of certain key elements crucial to the type of theoretical approach to morphology construed as a complex discriminative system. We begin in Section 2 with an introduction to certain grounding assumptions found in classical WP models. This permits us to identify two central analytic assumptions in Sections 3 and 4: discriminability between types of words and sets of patterns is argued to be in the service of shaping morphological organization in terms of uncertainty reduction.

## 2. The classical WP model

Since at least Hockett (1954) it has been customary to classify morphological approaches in terms of their hypothesized units of analysis. As illustrated by Hockett's split between 'item and arrangement' (IA), 'item and process' (IP) and 'word and paradigm' (WP) models, unit-based classifications isolate a salient dimension of variation across approaches. Within this frame of reference, WP models are described, as in Table 1, as treating words as basic units that are organized into paradigms. In contrast, IA models treat morphemes as basic, and words as the structures that they are combined to form.

Table 1. Unit-based classification of WP and IA/IP

	'Word and Paradigm'	'Item and Arrangement'
Basic Unit	word	morpheme
Structure	paradigm	word

The idea that the specification of units is a primary design choice within a morphological approach is reflected in the standard dichotomy between 'word-based' and 'morpheme-based' models. The importance of a typology of units also underlies criticisms of the treatment of sub-word variation within classical WP models. For example, the emphasis on words within these models is often taken to have inhibited the development of what Robins (1997) terms below "a theory of the morpheme".

The framework of grammatical description in western Antiquity was the word and paradigm model. **Despite the richness of classical morphology, a theory of the morpheme was not achieved**, and classical grammatical statements exhibit the strengths and the weaknesses of a word-based model.

(Robins 1997: 31, emphasis added)

On this view, a classical WP model could have extended morphological analysis to the units comprising word internal structure without changing its basic character,

and thereby arrive at a more satisfactory account of “the richness of classical morphology”. Yet by assuming that decisions about the ‘granularity’ of units are independent of the ‘logic’ of a WP model, this view precludes principled answers to the questions in (1).

- (1) 1. Why do classical WP models treat words as basic morphological units?
2. Why do they treat paradigms as the locus of part-whole relations?
3. Why does the WP tradition “fail to achieve a theory of the morpheme”?

The contemporary revival of the classical WP model offers a different perspective on these questions. The primacy of words and paradigms within the classical WP model was among to be the first issues to be addressed. This focus reflects an implicational perspective on variation, structure and economy. The basic perspective can be summarized by three core assumptions. The first is that variation within a system corresponds to **uncertainty**. The second is that structure within the system corresponds to **uncertainty reduction**. The third is that **the economy of a model or analysis correlates with the amount of uncertainty that arises in the association of morphological units with grammatical properties**. While neither words nor paradigms have a privileged status *a priori* in a classical WP model, the abstraction of word-sized units and their assignment to larger paradigmatic structures is justified by the reduction in uncertainty that this achieves in a grammatical analysis.

A modern reappraisal of the function of sub-word alternations in WP models, in effect, suggests that classical models did not “fail to achieve a theory of the morpheme” but developed an implicitly **discriminative** conception of word structure. From this standpoint, minimal contrasts do not function as individually meaningful ‘signs’ or even as ‘realizations’. Rather, they serve to reduce uncertainty within a larger system of meaning (and, through learning, tune the topography of the discriminable meanings that are afforded by that system (Ramscar et al. 2013a)). The resulting perspective connects early intuitions guiding the classical conception of morphology with recent research in the developmental sciences which explores complex phenomena in terms of systemic organization. Reconsidering the role of units within the WP tradition, thus, suggests that the selection of units is neither a free nor even primary choice. Instead, the choice of units reflects the more fundamental analytic assumptions summarized in Table 2 below.

**Table 2.** System-level contrasts between WP and IA/IP

	‘Word and Paradigm’	‘Item and Arrangement’
Metatheory	information theory	formal language theory
Economy	grammatical uncertainty	inventory/unit size
Contrasts	discriminative	associative

Sections 2.1 and 2.2 now outline the complex system perspective of a WP model, expanding on the role that uncertainty minimization and the discriminative interpretation of contrasts plays within this model. This discussion provides the basis for the subsequent evaluation of associative and discriminative approaches in Section 3.

## 2.1 Uncertainty

The traditional ‘defense’ of the WP model appeals to a notion of uncertainty minimization, though usually in more philological than information-theoretic terms. The central claim is that, in at least a significant class of languages as well as subsets of phenomena within many languages, isolating word-sized units minimizes the uncertainty of individual analyses. Segmentations into larger units often fail to express stable and recurrent form-meaning correspondences. Conversely, analyses into smaller units often increase uncertainty by rendering isolated units more ambiguous than their presence within (classes of) words actually warrants, i.e., the function of parts is often determined by the whole, rather than the other way around. This can arise via polyfunctionality: for example, in Tundra Nenets the same set of suffixes can indicate different pronominal roles, depending on morphological and syntactic context: subject-object on a finite transitive verb, subject on a non-finite verb, possessor on a possessed noun, and the subject of a relative clause (Ackerman et al. 2012). It can also be a result of gestalt exponence, as discussed below in Section 3.2.2. Hence, as Robins (1959) suggests, the uncertainty that arises in associating grammatical properties with a word is on average less than the cumulative uncertainty that arises in assigning properties to its parts.

The word is a more stable and solid focus of grammatical relations than the component morpheme by itself. Put another way, grammatical statements are abstractions, but they are more profitably abstracted from words as wholes than from individual morphemes. (Robins 1959: 128)

The association between words and paradigm cells (encoding property sets) then serves to ‘anchor’ a form within a grammatical system, facilitating the implicational deductions that further constrain uncertainty within the system. It is the affiliation between a word and these larger sets of forms that principally constrains uncertainty in the association between individual word forms and grammatical properties. For each cell in a paradigm, there is uncertainty about which inflectional variant realizes the cell. This uncertainty correlates with the amount of allomorphy exhibited by the realization and the distribution of allomorphic patterns. For each form, there is corresponding uncertainty that correlates with the number of cells that it realizes.

Yet, as expressed in “the insight ... that one inflection tends to predict another” (Matthews 1991: 197), the uncertainty associated with cells and forms is effectively constrained by the patterns of interdependence that define paradigms and classes.

As Matthews (1991: 197) goes on to remark, the recognition of these interdependencies provides “the basis for the method of exemplary paradigms” and underpins the economy of a paradigmatic analysis, since “if the alternations were independent, these would have to be numerous”. In the classical WP tradition, patterns of variation and interdependency tend to be exhibited by the forms of exemplary items, or encapsulated in the classes represented by these items. The key notions of ‘uncertainty’ and ‘interdependency’ can be expressed directly in terms of information-theoretic notions such as entropy and conditional entropy, as outlined in Ackerman et al. (2009), Ackerman & Malouf (2013) and Blevins (2013a), among others.

The role attributable to uncertainty and interdependency in WP models helps to account for the primacy of words and inflectional paradigms. But these factors do not account for the absence of a systematic treatment of sub-word patterns. As Robins (1997) notes, criteria such as ‘indivisibility’ and ‘grammatical stability’, appear, in at least in some cases, to be satisfied by units smaller than the word.

Aristotle additionally gave a formal definition of the word as a linguistic unit: a component of the sentence, *méros lógou* (μέρος λόγου), having a meaning of its own but not further divisible into meaningful units.

Aristotle’s definition is remarkably like Meillet’s ‘association of a given meaning with a given group of sounds capable of grammatical employment’; in fact neither is wholly adequate, since both exclude the morpheme from consideration, which itself is always ‘capable of grammatical employment’ and often enough carries an isolable meaning.’ (Robins 1997: 33)

Typological factors, historical contingency and practical considerations all play a role in the development of the classical WP model. In particular, the flexional character of classical languages and the pedagogical goals of the classical tradition exerted a decisive influence, as outlined in Matthews (1991) and Robins (1997). Hence it is possible to construe the fact that classical grammarians “expressly denied any significance” to “morphemic analysis” as evidence that the classical WP model was merely tuned too closely to the properties of ancient Greek and Latin.

As with the rest of western Antiquity, Priscian’s grammatical model is word and paradigm and **he expressly denied any linguistic significance to divisions in what would now be called morphemic analysis below the word.**

(Robins 1997: 70, emphasis added)

## 2.2 Discriminability

However, a reappraisal of the **function** of sub-word alternations suggests a more coherent rationale for the structure of WP models. From the assumption that the word is the smallest meaningful unit, it follows that sub-word alternations need not be individually meaningful. But that is not to say that these patterns are functionless.

On the contrary, it is through sub-word variation that the larger meaningful configurations are distinguished in a classical WP model. More concisely, the **discriminative** function of sub-word variation is to distinguish words, permitting word patterns to represent distinctive configurations of parts without the need for morphemic composition. It is the discriminative interpretation of alternating patterns that, therefore, stands in the way of “a theory of the morpheme”, because morphemes have, traditionally, been thought to serve an intrinsically **associative** function.

In an associative model, the difference in form between two contrasting words,  $w_1$  and  $w_2$ , is associated with at least some difference in their grammatical properties,  $F_{w_1}$  and  $F_{w_2}$ .<sup>9</sup> This correspondence is expressed in (2). The nature of the association varies according to the model, ranging from a biunique correspondence in morphemic models, to looser ‘spell-out’ relations in realizational accounts.

$$(2) \quad \text{Associative} \quad \text{Correspondence} \\ w_1 \setminus w_2 \approx F_{w_1} \setminus F_{w_2}$$

In a discriminative model, contrasts in form serve solely to distinguish  $w_1$  and  $w_2$ . Speakers learn to discriminate words, paradigm cells (or grammatical property bundles) as a system of grammatical and semantic contrasts (Baayen et al. 2011; Ramscar et al. 2010, 2013a). The key point about this approach is that learning is not treated as a gradual accretion of associations between minimal contrasts in form and grammatical properties, but rather, learning proceeds in the opposite direction, as speakers begin by associating form gestalts with ‘chunks’ of meaning and gradually **unlearning** the features of the gestalts that are non-discriminative. Correspondences between sub-word units and properties will, in many cases, be useful in guiding the association between words and meanings. But the status of these correspondences is no different in principle from those involving theme vowels or phonesthemes (indeed, from a learning perspective, this is ultimately true of words themselves).

The difference between associative and discriminative perspectives ultimately reflects a more basic contrast between conceptions of morphological variation in terms of ‘simple’ or ‘complex’ systems. An associative interpretation of form variation contributes to a ‘simple’ conception in which the properties of a morphological system are wholly derivative of the properties of individual forms. The goal of an associative analysis is a static inventory of minimal elements (whether construed in terms of ‘items’, ‘processes’, or some combination of the two), each of which can be assigned a constant, context independent interpretation. Given an inventory of such

9. It is usually the case that similarity in form between  $w_1$  and  $w_2$  is also associated with shared features, though the nature of this correspondence depends on the treatment of ambiguity.

elements, together with combinatoric principles that describe their contextual variants, the analysis of a morphological system reduces to the analysis of its component forms. Each form is analyzed in isolation from the analysis of all other forms, and the ‘system’ consists of the cumulative output of these parallel analyses.

A discriminative interpretation of form variation is embedded within a classical conception of morphology as a ‘complex system’ (Blevins 2013a,b). From this perspective, a morphological system cannot be disassembled into a static inventory of elements, because the function of form variation is often intrinsically dynamic. In cases of what is termed ‘gestalt exponence’ in Ackerman et al. (2009), variation directly discriminates larger forms. Conversely, in cases of what are termed ‘resonances’ in Hockett (1987) and ‘morphomes’ in Aronoff (1994), variation directly relates larger forms. Both gestalt and morphomic patterns violate the Associative Correspondence in (2) because these patterns are irreducibly relational. The relational character of these patterns is implicit in the way they are described. All morphomic patterns involve variation that occurs more than one place in a system (i.e., there can be a single ‘cran morph’ but no unique morphome), and all cases of gestalt exponence involve elements that recombine in some other arrangement.

In sum, like the information-theoretic interpretation of word-level interdependencies, a discriminative construal of sub-word contrasts clarifies the treatment of form variation in the WP tradition. The primacy of words is due to their contribution to minimizing uncertainty (in a world in which many of the contrasts speakers wish to make relate to objects and events). The role of discriminative contrasts likewise reflects their usefulness in characterizing alternations that resist an associative analysis.

### 3. Associative and discriminative strategies of correspondence

Alternations that support a discriminative perspective are illustrated in Section 3.2. To provide a context for the interpretation of these patterns, Section 3.1 first reviews the types of patterns that are taken to provide motivation for associative models.

#### 3.1 The logic of associative decomposition

The two pillars of Post-Bloomfieldian models are the assumption that (i) recurrence entails redundancy and (ii) that structure implies decomposed representations. The goal of morphological analysis in this tradition is a distillation of variation into general symbolic statements, schemas or rules that describe the distribution and interpretation of isolable units of form. Descriptions that exhibit recurrent patterns are regarded as deficient on the grounds that they ‘miss linguistically significant generalizations’ or, in Bloomfield’s terms, “fall short of scientific compactness”.

The inflectional forms are relatively easy to describe, since they occur in parallel paradigmatic sets; the traditional grammar of familiar languages gives us a picture of their inflectional systems. It may be worth noticing, however, that **our traditional grammars fall short of scientific compactness by dealing with an identical feature over and over again as it occurs in different paradigmatic types.** Thus, in a Latin grammar, we find the nominative-singular sign *-s* noted separately for each of the types *amīcus* ‘friend’, *lapis* ‘stone’, *dux* ‘leader’, *tussis* ‘cough’, *manus* ‘hand’, *faciēs* ‘face’, **when, of course, it should be noted only once, with a full statement as to where it is and where it is not used.**

(Bloomfield 1933:238, emphasis added)

In the domain of morphology, scientific compactness is achieved by decomposing forms into recurrent parts. Apart from WP models, virtually all morphological approaches follow Bloomfield’s prescription by analyzing complex forms into lexical bases (stems or roots) and grammatical exponents (formatives or rules). Morphemic approaches carry this decomposition a step further by representing bases and exponents in morphotactic arrangements. But all ‘redundancy-free’ models of the lexicon are guided by the goal of ‘scientific compactness’, and the disassembly of forms into parts that are assigned to separate inventories of bases and exponents serves to ensure that “an identical feature ... is noted only once”.

An associative perspective is implicit in the procedures of morphemic analysis initially proposed by Harris (1942) and Hockett (1947), and assumed in some form in subsequent morphemic accounts. These procedures are summarized by Lounsbury (1953) in terms of ‘cuts’ that isolate individually meaningful sequences.

Following the method of morpheme alternants one divides or ‘cuts’ forms of actual utterances into minimal segments, or sequences of phonemes, to which it is possible to assign meanings. (Lounsbury 1953:172)

The application of these procedures of analysis can be illustrated with reference to the locative case forms of the Finnish noun TALO ‘house’ in Table 3 below.

**Table 3.** Decompositional case forms of Finnish TALO ‘house’

	Sing	Plu
Adessive	talolla	taloilla
Ablative	talolta	taloilta
Allative	talolle	taloille

The disassembly of these forms into minimal sequences yields the analysis in Table 4, in which each sequence is assigned a distinct meaning. In an orthodox morphemic account, the feature-form associations in in Table 4 would be biunique. In realizational

models that develop the programme outlined in Matthews (1965), the relations could be many-many. But both types of models, morphemic and realizational, make an association between sub-word units and grammatical properties.

**Table 4.** Associative analysis of case forms in Table 3

Feature	$\lambda$	Sing	Plu	Adessive	Ablative	Allative
Form	talo	Ø	-i	-lla	-lta	-lle

The appeal of the analysis in Table 4 derives largely from the economy it achieves. A decompositional analysis holds out the promise that classes of stems, derivational formatives and inflections can be “noted only once” in the lexicon. The association between meaning and form can also be expected to facilitate the acquisition and production of new forms. Moreover, a declensional system that can be disassembled into an inventory of minimal forms, together with combinatoric principles that describe their distribution, can be treated as a simple system. An analysis of such a system can then focus exclusively on the structure of forms in isolation, since the properties of the system are reducible to the properties of individual forms.

### 3.2 The limits of association

Even if one accepts “scientific compactness” as a relevant criterion for evaluating morphological analyses, the economy achieved by an associative analysis relies on the generality of the analysis. Generality depends in turn on three conditions. First, there should be some principled basis for deciding on the segmentation of forms. Second, it should be possible to associate segments with constant grammatical properties. Third, the units identified as ‘recurrent’ should, in fact, be identical.

From the outset of the morphemic tradition, the first two conditions were recognized as problematic. With the advent of techniques and methodologies for probing sub-phonemic properties has come the realization that the third condition is equally problematic. From a discriminative perspective, it is significant that problems arise in cases, as described in (3) below, where word forms are fully discriminated.

- (3)
1. Contrasts that discriminate a set of word forms do not always determine unique segmentations into minimally contrastive elements.
  2. Contrastive elements cannot always be associated with properties.
  3. Even in cases where a unique segmentation is possible and the elements can be associated with properties, an associative analysis may misrepresent a learning context as the structure of the system.

Sections 3.2.1–3.2.3 now present examples that illustrate each of these patterns.

### 3.2.1 *The challenge of segmentation*

In the continuation of the passage on p. 16 above, Lounsbury acknowledges that the segmentation of forms is not always straightforward. In some cases, more than one segmentation is motivated and in others no segmentation appears to be available.

In a fusional language, if one seeks to arrive at constant segments in such a manner, conflicts arise in the placing of the cuts. One comparison of forms suggests one placement, while another comparison suggests another. Often, in fact, no constant segment can be isolated at all which corresponds to a given constant meaning. Situations of this kind often permit of more than one solution according to different manners of selecting and grouping environments.

(Lounsbury 1953:172)

The grammatical case forms of the Estonian nouns in Table 5 provide a simple case in which “one comparison of forms suggests one placement, while another comparison suggests another”. For nouns of the class containing *õpik* (e.g., second declension in Blevins (2008), or *käändsõa* 2 in Erelt et al. (2013)), comparing genitive plurals against other forms of its paradigm motivates a segmentation into a consonant-final base *õpiku* and a genitive plural marker *-e*. This analysis is proposed by (Mürk 1997) below (though the implication is unidirectional, given partitive singular/genitive plural pairs like *kõnet/kõnede* ‘speech’ in the ‘fourth’ declension).

If the partitive singular ends in *-d* or *-t* (variants of the same sound) then only an *-e* needs to be added to the partitive to form the genitive plural. (Mürk 1997: 13).

**Table 5.** Competing motivation for Genitive Plural forms in *-te*

	Sing	Plu	Sing	Plu	Sing	Plu
Nominative	nokk	nokad	õpik	õpikud	seminar	seminarid
Genitive	noka	<i>nokade</i>	õpiku	õpikute	seminari	<i>seminaride</i>
Partitive	nokka	nokkasid	õpikut	õpikuid	seminari	seminarisid
		‘beak’		‘workbook’		‘seminar’

Alternatively, comparing *õpikute* against the genitive plural forms of other classes motivates a segmentation into a vowel-final base *õpiku* and a genitive plural marker *-te* that alternates with *-de*. This analysis is proposed by (Tuldava 1994) below.

If the partitive singular ends in a vowel, the genitive plural has the ending *-de*, which is added to the partitive singular form.

If the partitive singular ends in *-d*, the genitive plural has a *-de* ending in place of this *-d*. (Tuldava 1994:195)

The two competing analyses of *õpikute* are summarized in Table 6.

**Table 6.** Alternative segmentations of Gen Plu *ōpikute*

Base	Ending	Alternation	Motivation
ōpikut	-e	Part Sing in -t	same class
ōpiku	-te	Gen Plu in -de	other classes

The alternatives in Table 6 illustrate two general problems. The first is that the competing motivation comes from different parts of the morphological system. It is possible to assign priority to one source of motivation by fiat, but there is no principled basis for this choice. The second, and more fundamental problem, is that an associative analysis forces a choice between two complementary analyses. In fact, the form of *ōpikute* contrasts **simultaneously** with the partitive singular in its own class and with the genitive plurals in other classes. Yet the segmentation forced by an associative analysis must treat one pattern as significant and the other as accidental. An obvious and practicable alternative is to simply identify how patterns of structure serve to discriminate (classes of) words from each other.

In this respect, the difficulties that arise in partitioning forms into the correct “minimal segments” appear to be artifacts of associative models, reflected in the inconclusive discussions of the division of *children* in Harris (1942) and Hockett (1947) to the more recent summary in Spencer (2012). In other words, the theoretical need to arrive at definitive segmentations in order to proceed with analysis entails arbitrary choices which divert attention from understanding the internal structure of words and their organization into discriminable patterns of relatedness.

### 3.2.2 *Gestalt exponence*

Moreover, even in cases where a unique segmentation is possible, it may not be possible to establish a stable association between minimal segments and grammatical properties. For example, the forms of the first declension noun *NOKK* in Table 5 can be divided into two stems, *nok* and *nokk*, the theme vowel *-a*, and case endings *-d*, *-de* and *-sid*. These divisions are motivated by class-internal as well as by cross-class comparisons. The combination of these elements determines a fully distinctive set of six grammatical case forms. However, the discriminative function of these elements is not mediated by an association with properties. Hence, in contrast to the locative forms of *TALO* in Table 4, decomposition achieves no economy.

The three forms defined by the stems and theme vowel are exhibited in Table 7, in which ‘Ø’ indicates the absence of a theme vowel rather than a ‘zero’ element. The declensional system makes efficient use of the two binary choices, ‘strong’ vs ‘weak’ stems and presence vs absence of theme vowels, defining three distinctive singular forms. The fourth potential form, a weak stem in isolation, violates the minimum word constraint of the language (which requires monosyllables to be overlong).

**Table 7.** Decomposition of singular grammatical case forms of *wo* 'beak'

	Ø	-a
<i>nok</i>	-	Gen Sing
<i>nokk</i>	Nom Sing	Part Sing

In the plural forms, stem alternations and endings also define a three-way contrast. In this case, it is possible to associate features with the endings. However, this analysis is achieved at the cost of treating stems as grammatically meaningless and thereby depriving stem selection of any role in discriminating plural case forms.

**Table 8.** Decomposition of plural grammatical case forms of *NOKK* 'beak'

	-d	-de	-sid
<i>noka</i>	Nom Plu	-	-
<i>nokka</i>	-	Gen Plu	Part Plu

A parallel pattern recurs in the semantic case forms of *NOKK*. Counterparts of the locative forms of Finnish *TALO* are shown in Table 9. The locative endings can all be assigned a determinate case value. But this requires that the stems, which are identical to the genitive forms of *NOKK*, are associated with a number value.

**Table 9.** Decomposition of locative case forms of *NOKK* 'beak'

	-l	-lt	-le
<i>noka</i>	Adessive Sing	Ablative Sing	Allative Sing
<i>nokkade</i>	Adessive Plu	Ablative Plu	Allative Plu

An associative analysis could classify *noka* as a case-neutral singular stem, *-de* as a plural marker, and treat genitive as a zero-marked case. However, this analysis would effectively disrupt the regular pattern of contrasts in the declensional system. In particular, it would shift the expression of grammatical properties largely to zero markers and deprive the system of stem alternations of any discriminative function.

Some of the salient consequences of an associative analysis are listed in (4).

- (4)
1. Nominative and partitive are expressed by zero in the singular.
  2. Genitive case is expressed by zero in the singular and plural.
  3. The stems *nok*, *nokk* and *nokka* express no grammatical properties.

4. The stem *noka* expresses no grammatical properties in nominative plural *nokad*, but expresses singular in singular semantic case forms.
5. The stem *nokkade* expresses plural in plural semantic case forms.

The treatment of form variation as ‘meaningless’ is a common feature of associative analyses. In the most extreme case, ‘zero’ markers are associated with grammatical properties, and ‘allomorphs’ are treated as concomitants of the distribution of these zeros.<sup>10</sup> As Hockett (1987) notes below, this extension of an associative analysis, completely dissociates grammatical meaning from form variation.

The extreme of this tendency, for me its *reductio ad absurdum*, was a proposed way of handling the English plural *men*. To recognize this as the plural of *man* is, of course, correct: that’s what users take it to be when they hear it. But the proposal went far beyond that: in order to make it conform to the agglutinative ideal we said that it was really a sequence of two morphs, the first one, /men-/, being an allomorph of the morpheme {man}, while the second, of phonemic shape zero, is an allomorph of the noun-plural morpheme. (Hockett 1987: 84)

A discriminative perspective clarifies the basis of Hockett’s unease. In cases that resist an associative analysis, a maximally nondiscriminative element is associated with properties and the discriminable variation is regarded as meaningless.

### 3.2.3 *Sub-phonemic discrimination*

Agglutinative treatments of stem alternations in Estonian or ablaut patterns in English raise an even more fundamental issue. The goal of these analyses is to assimilate seemingly ‘irregular’ formations to more regular patterns of affixal exponence. This goal in turn reflects the view that regular formations are normative and that suppletion and other irregularities are deviations from the uniform patterns that a system (or its speakers) strives to maintain. Although this view is largely taken for granted in models of morphological analysis, it again reflects an associative bias.

From a discriminative perspective, the situation is exactly reversed. To the extent that patterns like suppletion enhance the discriminability of forms, they contribute to the communicative function of a language. Indeed, in a discriminative model, such as that of Ramscar et al. (2013a), the only difference between overtly suppletive forms such as *mice/mouse* and more regular forms such as *rat/rats* is that the former serve to accelerate the rate at which a speakers’ underlying representation of a specific form/meaning contrast becomes discriminated from the form classes that express similar contrasts. In this model, all learning serves to increase the level of suppletion in

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10. Analyses of this kind have been proposed for patterns of stem ablaut in English from the early Bloomfieldian treatment in Bloch (1947) through to the account in Halle & Marantz (1993: 128).

form-meaning mappings. This perspective is supported by recent studies that have begun to probe sub-phonemic contrasts. In the domain of word formation, Davis et al. (2002) found suggestive differences in duration and fundamental frequency between a word like *captain* and a morphologically unrelated onset word such as *cap*. Of more direct relevance are studies of inflectional formations. The exploratory study of Baayen et al. (2003) found that a sample of speakers produced Dutch nouns with a longer mean duration when they occurred as singulars than as when they occurred as the stem of the corresponding plural. In a follow-up study, Kemps et al. (2005) tested speakers' sensitivity to prosodic differences, and concluded that "acoustic differences exist between uninflected and inflected forms and that listeners are sensitive to them" (Kemps et al. 2005:441).

In summarizing the four experiments they conducted to test speaker sensitivity to the prosodic differences between the phonemically 'same' form, in isolation and as the stem for a larger plural form, Kemps et al. (2005) conclude

The prosodic mismatch effect documented in this study has important consequences for our understanding of the morphological structure of complex words. The way words are written in languages such as Dutch and English suggests that they consist of stems and affixes that are strung together as beads on a string. Phonemic transcriptions convey the same impression. Our experiments show that this impression is wrong. **Plurals are not just singulars with an additional suffix. The precise acoustic realization of the stem provides crucial information to the listener about the morphological context in which the stem appears.** (Kemps et al. 2005: 441, emphasis added)<sup>11</sup>

### 3.3 Summary

The economy achieved by an associative account relies on the idealization that forms can be segmented into minimal parts and these parts can be assigned constant meanings. As outlined in Section 3.2, this idealization is challenged by patterns in which it is not possible to motivate a unique segmentation or assign properties to segments.

As reflected in Lounsbury's (1953) caveat about fusional languages, some language types have been acknowledged to be problematic for associative analyses. Nevertheless, decompositional accounts have maintained the assumption that, where segmentation is possible, forms can be disassembled into minimal meaningful parts **with no loss of information**. Even this assumption turns out to be questionable. It has long been known that information about the frequency of a form cannot be recovered from the frequencies of its parts. However, since many models treat frequency as a matter

11. See also Plag (2014) and Blazej & Cohen-Goldberg (2015).

of ‘usage’ rather than ‘structure’, this has not necessarily been regarded as a serious problem for decompositional analyses. Yet, from a learning perspective, frequency is a key determinant of structure itself, since it serves to determine an individual’s exposure to a given form, and therefore it serves to determine the suppletive status of that form within the overall system that the individual has learned (Ramscar et al. 2013b). Indeed, given that frequency, among other factors, influences the sub-phonemic properties of a form, and speakers appear to be sensitive to these properties, it would seem that a net effect of all is that seemingly ‘recurrent’ elements are not, in fact, identical. Instead, they are ‘tuned’ to the contexts in which they occur, precisely as a discriminative perspective would lead one to expect (Blevins et al. 2016).

#### 4. Some challenges for making sense of morphology

The previous two sections have suggested that morphology is an adaptive discriminative system organized according to uncertainty reduction and the discriminability among related words within (classes of) patterns. On such an approach much surface expressive “exuberance” is revealed, crucially, as explanatory signals in the system: as instructively ineliminable constitutive parts of larger wholes. Just as generative assumptions about morphology both reflect and guide how one interprets different domains of grammar and encourages the formulation of particular research questions associated with language, the present view suggests a different way of viewing (complex) morphology and its relations to other domains of grammar as well as for conceptualizing broad questions in the field. In the present section we briefly address some of these issues.

One obvious question that arises is the nature of the relationship between WP word-based morphology and phrasal syntax. There are a few simple observations that can be made in this connection. In his 1970 State of the Art article on morphology Matthews wrote:

The history of morphology since the 1930’s has led to a progressively complex and nonpatent relationship between the elements of grammar, on the one hand, and their phonological realization on the other: Is there any reason why the domain in which an element may be realized should be kept within traditional limits.  
(Matthews 1970: 12)

What he has specifically in mind is the question as to whether morphosyntactic properties (“grammar”) can receive either synthetic (“traditional limits”) or periphrastic, i.e., multiword expression, for their clause structure exponence. He hypothesizes that, “one can foresee a thorough re-examination of the morphology-syntax division in the coming decade.” Though it has taken somewhat longer than Matthews anti-

pated (approximately 40 years), it can be said that the interdependence of morphology and syntax has undergone a significant re-interpretation in the past decade. There is a large and growing literature that identifies criteria for distinguishing morphological periphrases from syntactic phrases (Börjars et al. 1996; Ackerman & Webelhuth 1998; Sadler & Spencer 2001; Ackerman & Stump 2004; Brown et al. 2012; Bonami & Samvelian 2015; Bonami 2015): given the independence of form and meaning mapping assumed in WP models, multi-word morphological expressions, both inflectional and derivational, are predicted to occur, as they do with impressive frequency crosslinguistically. For example, languages offer abundant displays of periphrastic encoding for tense, aspect, mood inflection and lexical relatedness constructions involving verbs with separable particles or preverbs.

The phenomenon of morphological periphrasis itself raises two challenging questions: the first is a conceptual and representational one concerning the nature of the relationship between morphological and syntactic constructions and the second is a related historical one concerning the role and nature of language change in morphological and syntactic systems.

Among some Russian linguists there was a theoretical intuition that certain word groups belong to the morphology, just like synthetic forms, and, accordingly, there was an effort to identify criteria that would distinguish such morphological word groups from superficially similar syntactic dependencies between independent wordforms. Gukhman (1955:337) states the task quite cogently:

Where is the border between complex wordforms and word combinations. And what are its criteria? In the section Verb [in Vinogradov's work] the formation *budu ...itat'* [will read] is included in the system of forms of verb alternations for the verb *...itat'* as complex future tense, but *stanu ...itat'* [begin to read], *na...nu ...itat'* [begin to read], is not included in the system of form alternations of the Russian verb. Where are the criteria which would confirm the correctness of such a treatment of these phenomena? And why should one not consider *xo...u ...itat'* [I want to read] as the complex form of the optative?

The recognition that, e.g., paradigm cells can be occupied by synthetic as well as multi-word expressions is regarded as a fundamental fact about morphological systems within WP approaches. Consequently, it is crucial to distinguish morphological from syntactic constructions, rather than assimilating one to the other. The logic motivating correspondence architectures (Kaplan & Bresnan 1982; Jackendoff 1997) is applicable here: morphology and syntax can be seen as interdependent, but distinctive domains of language, each with their own organizational principles and construction types. Accordingly, each domain can be interpreted as reflecting human pattern-making and pattern-identifying capacities, but neither is assimilable to the other. In effect, both morphology and syntax can be viewed as construction-theoretic, in the sense that they

study patterned phenomena and their systemic organizations within different, but interdependent grammar systems. Additionally, and this bears upon the second question mentioned above, the two domains are continually shaped by the dynamic temporal relations that effect language change both within each system and between them. This description, of course, recalls the insights of Herman Paul concerning “historical” approaches to language analysis. Paul’s broad conception of historical inquiry is well-described in Fertig (2013: 3):

Paul saw all aspects of language in historical terms. He had relatively little interest in synchronic snapshots that tried to capture the state of a language at a single moment in time because he regarded language as something inherently dynamic, in constant flux, both at the level of the speech community and that of each individual’s mental system. He felt that only an approach that took this fluid character of language fully into account could be explanatory rather than merely descriptive. So, in addition to what we think of today as historical linguistics, Paul and some of his contemporaries took a deep interest in the questions that we now associate with theoretical linguistics, psycholinguistics and sociolinguistics.<sup>12</sup>

Questions naturally arise concerning the sorts of processes and factors that lead to changes reflecting probability-based trajectories of observed patterns and systemic organization. This is a necessarily cross-linguistic venture that entails careful, detailed description and connects WP approaches tightly with the research of descriptive grammarians and typologists. The pattern-based nature of morphology on WP assumptions encourages the exploration of analogy as an explanatory resource for systemic organization. Analogically guided inferences can be seen as shaping morphological change (Morprugo Davies 1978; Fertig 2013) and facilitating language use and learning (Hofstadter & Sander 2014; Rácz et al. 2014).

## 5. Conclusions

A decompositional perspective is set out explicitly in Postulate 9 of Bloomfield (1926), which identifies the ‘morpheme’ as a minimal unit of form and the ‘sememe’ the corresponding unit of meaning. Bloomfield’s successors, notably Harris (1942) and Hockett (1947), developed his programmatic remarks into recognizable models of morphemic analysis. But the components of a decompositional approach are fully present, in something very close to their modern form, nearly a century ago. The ideas themselves

12. This basic approach is developed for diverse domains and phenomena in the contributions to *The Oxford Handbook of Language Emergence* as well as in Hay & Baayen (2005) for morphology.

are far older, reflecting the influence of the Sanskrit grammarians, in particular Panini, whose concise grammar Bloomfield famously regarded as “an indispensable model for the description of languages” (Bloomfield 1929).

Classical WP models and their contemporary descendants develop an ensemble of fundamentally different ideas. Economy is correlated with the degree of uncertainty that arises in the mapping between forms and the properties they express. The abstraction of word-sized units and their assignment to larger paradigmatic structures is justified by the reduction in uncertainty that this achieves in a grammatical analysis. The word is the basic unit of morphological analysis because it is a maximally discriminable “perceptual gestalt” Hockett (1987:52) that provides “a more stable and solid focus of grammatical relations than the component morpheme by itself” (Robins 1959: 128). The association between words and paradigm cells facilitates implicational deductions that further constrain uncertainty within the system.

In the context of a pattern-based model of grammatical analysis, sub-word contrasts perform a discriminative rather than an associative function. A discriminative interpretation of form variation fits in turn within a classical conception of morphology in terms of what would now be called a ‘complex system’ (Weaver 1948). This is the type of explanation of language phenomena anticipated by Paul and the Neogrammarians, as well as by Saussure, in their treatments of language as a system of relations among elements at different levels of analysis in constant dynamic interdependence with each other. These early insights required the types of formal and computational tools that are being deployed in recent analyses of complex systems in other domains such as biology and psychology.

Perhaps the most surprising conclusion that can be drawn from the reconstruction of WP models in terms of information theory and discriminative learning models is the classification it imposes on morphological approaches. From this perspective, the basic split is not between word-based and morpheme-based models: these can be interpreted as different discriminative ways for organizing (types of) words. Looked at this way, the existence of morphemes, when they occur, is a particularly transparent way of addressing the issues of discriminability and uncertainty reduction, i.e., a morpheme is a highly discriminable single unit that by definition provides a interpretation with certainty. A paradox arises, however: If it is assumed that all morphological organization is morphemic, contrary to WP assumptions, then this might be explained by the efficiencies of discriminability and uncertainty reduction. In other words, we would have an explanation for the purported universality of morphemic organization. But, if these are actually the factors responsible for morphological organization, then their useful effects can be straightforwardly achieved without morphemic decomposition and via many different strategies for organizing the internal structure of words into discriminable patterns. Consequently, to the degree that an explanation for (universal) morphemic organization can be provided by discrim-

inability and uncertainty reduction, these same factors can be used to account for all of the empirical evidence employed to argue against morphemic organization and for word based organization. Indeed, these two factors of morphological organization explain why morphemic organization is not even necessary, let alone universal: there are many ways to organize the information associated with morphological units that will produce the integrative complexity characteristic of morphological organization. Finally, it is worth observing that the present hypotheses about the degrees of discriminative WP models yields a more nuanced contrast between morphemic and nonmorphemic realizational approaches versus word-based approaches to morphology. In particular, the class of stem-based realizational models (e.g., Function Morphology; Stump (2001) or Network Morphology; Corbett & Fraser (1993)) are conventionally contrasted with morphemic models, even realizational ones, like Distributed Morphology. On the present account, however, both of these models, one dispensing with morphemes and the other embracing them, however different they may be in many respects, are alike in their contrast with the word-based assumptions relevant for analyzing morphology as a complex discriminative system.

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