

# Introduction: Analogy in Grammar

Jim Blevins and Juliette Blevins

## 1. Analogy: The core of human cognition

The human mind is an inveterate pattern seeker. Once found, patterns are classified, related to other patterns, and used to predict yet further patterns and correlations. Although these tasks are performed automatically, they are far from trivial. The analogical reasoning that underlies them requires the discovery of structural similarities between perceptually dissimilar elements. Similarities may be highly abstract, involving functional and causal relationships. And while the recognition of analogical relations may seem like a passive process, it is in fact an aggressive process, driven by a search for predictability. A systematic structural similarity independent of perceptual similarity can be extended to yield novel inferences about the world.

There is mounting evidence from work in cognitive psychology that the talent for analogical reasoning constitutes the core of human cognition (Penn, Holyoak & Povinelli 2008, and references cited therein), and that analogy may be a highly domain-independent cognitive process (Halford & Andrews 2007). Analogy is part of what allows humans to evaluate cause and effect, to come up with new solutions to old problems, to imagine the world other than the way it is, and to use words evocatively (Gentner, Holyoak & Kokinov 2001). Other creatures create and use complex tools (Hunt 1996; Hunt & Gray 2004) and meta-tools (Taylor et al. 2007), recognize perceptual similarity and, after training, can perform better than chance on tests in which two objects must be judged as 'same' or 'different' (Premack 1983; Pepperberg 1987; Katz & Wright 2006). However, only humans, the symbolic species (Deacon 1997), effortlessly go beyond perceptual similarities, to recognize structural similarities that are independent of surface difference (Penn, Holyoak & Povinelli 2008). Children as young as one or two years of age show evidence of perceptual analogies, and by the age of 4 or 5, they can understand that *bird* is to *nest*, as *dog* is to *doghouse*, using functional analogies based on real-world knowledge (Goswami & Brown 1989, 1990; Goswami 2001).

As a central and pervasive property of human cognitive function and categorization, it is not surprising that analogy has been identified as a core component of linguistic competence from the earliest times to the present. In ancient Rome, Varro (116-127 B.C.) saw *analogia* as a central grammatical process (Law 2003), while ancient Arabic grammarians used the term *qiyaas* 'measuring' in a similar way: constructing a *qiyaas* involved 'exploring an unknown configuration of data and trying to recognize in it a patterning already met and which, in other situations, lent itself to analysis' (Bohas, Guillaume & Kouloughli 1990:23). A thousand years later, analogy was central to one of the most important discoveries in linguistic

history: the Neogrammarian insight that sound change was regular (Paul 1880/1920). Regular sound change, in contrast to analogy, was the foundation of the comparative method by which the world's major language families were firmly established (Campbell & Poser 2008). To this day, regular sound change and analogy are introduced together to students of historical linguistics as the primary internal mechanisms of change (Hock 1991; Campbell 1998; Deutscher 2005), as research on the nature of analogical change continues (e.g. Lahiri 2000; Garrett 2008; Albright 2008). From its central role in historical linguistics, analogy became a cornerstone of analysis in the 20th century American descriptivist tradition (Whitney 1875/1979; Bloomfield 1933:275; Sturtevant 1947:96-109; Hockett 1966:94) and, despite generative neglect, remains central to our understanding of synchronic grammars to this day (Antilla & Brewer 1977; Skousen 1989, 1992; Skousen, Lonsdale & Parkinson 2002; Itkonen 2005; Kraska-Szlenk 2007).

The notion of analogy discussed above refers to a general cognitive process that transfers specific information or knowledge from one instance or domain (the analogue, base, or source) to another (the target). Sets of percepts, whether visual images, auditory signals, experiences, or dreams, are compared, and higher-order generalizations are extracted and carried over to new sets. This knowledge transfer is often schematized in terms of classical 'proportional' or 'four-part' analogies. In a proportional analogy, the relationship R between a pair of items A:B provides a basis for identifying an unknown item, given an item that matches A or B. Knowing R and knowing that C is similar to A permits one to identify D as the counterpart of B. The analogical deduction that 'C is to D' as 'A is to B' is standardly represented as in (1). The initial recognition of similarity and difference between percepts is the basis of analogy, but this is only the first step. Humans show great creativity in classifying different ways objects can be similar and different, and in organizing these similarities and differences into complex schemata, which can then be extended to classify and understand new stimuli (Penn, Holyoak & Povinelli 2008, and references cited therein).

(1) Four-part analogy: A is to B as C is to D

- |    |      |   |      |    |     |   |          |
|----|------|---|------|----|-----|---|----------|
|    | A    | : | B    | == | C   | : | D        |
| a. | ◐    | : | ◑    | == | ◒   | : | ◓        |
| b. | +*+  | : | *+*  | == | XOX | : | OXO      |
| c. | BIRD | : | NEST | == | DOG | : | DOGHOUSE |

In (1a), one can look at the two circles ◐:◑ and establish a structural relationship between the two which is more general than the concrete circle and black and white shadings of its halves. The relationship could be extremely general: one figure is the reflection of the other. This structural relationship can then be recognized in other pairs, like the two squares, ◒:◓, and, in this general form, could be further extended to images without shading, like d:b, or Xxx:xxX. In (1b), there is a recognizable pattern ABA:BAB, where 'A'

and 'B' can be replaced by any symbols, and where a more general statement of the pattern would allow reference to tones, melodies, or even conversational turn-taking. In (1c), where words in small capitals refer to concepts, the abstract structural relationship is a functional one relating an animal to its home or sleeping place. Again, the human mind is creative and flexible, and we can imagine the analogy extending to inanimate objects (CONTACT LENS: LENS CASE), musical traditions (JAZZ: NEW ORLEANS), or human emotions (ANGER: SPLEEN).

Before turning to the particular role that analogy plays in grammar, it is worth highlighting some general aspects of these relational patterns. First, although the analogues in (1) constitute paired objects, strings, and concepts, there is, in principle, no limit to how internally complex the analogue or base can be. We recognize human families, as well as language families, with mother tongues, daughter languages, and sister dialects. In language too, words can come in families, with complex kinship relations. These word families, often called **paradigms**, are a central locus of analogy in grammar. Inflectional paradigms can be extremely small, as in English {*dog, dogs*} or too large to list here, as in the approximately 1,000 inflected forms of a common Yupik (Eskimo) verb. The size of word families can also be highly item-specific within a language, as illustrated by the variation in the size of derivational paradigms in many languages, variation that is reflected in morphological family size effects (Bertram, Baayen, & Schreuder 2000; de Jong, Schreuder, & Baayen 2000). Although word-based analogies are often expressed as four-part analogies like those in (1), when large word-families are involved, analogy may be much more complex. The nature of these complex analogical patterns is explored in several papers in this volume (Finkel & Stump; Ackerman, Blevins & Malouf; and Milin et al.)

## 2. Analogy in grammar

In the domain of grammar, analogy is most strongly associated with language change (Antilla 1977; Hock 1991, 2003). Analogy is typically viewed as a process where one form of a language becomes more like another form due to an indirect association that is mediated by some higher-order generalization or pattern. While patterns can be observed across many linguistic categories, it is patterns between related words or word families that lead most often to analogical change. The short list of English singular and plural nouns in (2) exhibits a pattern that holds of the great majority of nouns in the language. Discounting compounds and derived forms, the families of these nouns are very small, consisting only of the two forms in (2).

(2) Some English singular and plural nouns

i. <u>Singular</u>	<u>Plural</u>	ii. <u>Singular</u>	<u>Plural</u>	iii. <u>Singular</u>	<u>Plural</u>
duck	ducks	kiss	kisses	baby	babies
cup	cups	dish	dishes	cookie	cookies

sock	socks	fox	foxes	spoon	spoons
pot	pots			apple	apples
sister	sisters			bed	beds

Once a child has heard even a small set of nouns in the singular and plural, a pattern will start to emerge. The pattern relates a singular noun to a plural noun, where the plural noun is typically identical to the singular, except that it includes a predictable ending: /s/ after voiceless non-strident sounds {p, t, k, f, θ} (2i); /əz/ after strident sounds {s, z, ʃ, ʒ, tʃ, dʒ} (2ii), and /z/ elsewhere (2iii). A proportional analogy like *sister:sisters = brother:X*, allows a child acquiring English to aggressively predict plurals not yet encountered on the basis of the singular form. Analogy yields *brothers*, the modern English plural, though similar analogical reasoning presumably led earlier to the replacement of *brethren* by *brothers*. Child language is full of analogical formations of this kind (*oxes, fishes, sheeps*, etc.) as well as others based on less robust patterns (e.g. *goose:geese = mongoose: mongeese*). The most salient examples are those that differ from adult forms, resulting in the strong association between analogy and language change.

However, there is a growing body of empirical evidence that linguistic change is continuous throughout the lifetime of an individual (Harrington, Palethorpe & Watson 2000; Sankoff & Blondeau 2007 and references cited therein). Patterns of change suggest that linguistic knowledge is acquired incrementally, and that there is a feeding relationship between the production and perception of speech, which results in an ongoing process of grammar development (Pierrehumbert 2006; Wedel 2006, 2007). If this perspective is broadly correct, it suggests that the modern dichotomy between synchrony and diachrony is misconceived and that analogy is panchronic, and integral to the constantly-evolving linguistic system of the individual. Recent simulations that use production/perception feedback loops have shown considerable promise in modelling the evolution of syntactic, morphological, phonological, and phonetic aspects of linguistic systems, and the success of these models is often enhanced by the introduction of analogy (see, e.g. Sproat 2008; Wedel this volume, and references cited therein.)

As suggested above, many of the most robust analogies in language involve word families as in (2), and can be referred to as **word-based analogy** or **morphological analogy**. In these cases, a recurrent **sound pattern and meaning** runs through a set of words, and forms the basis of the abstract pattern that newly-heard words are associated with. In many cases, these can be stated as four-part analogies, but, as recognized as early as Paul (1880/1920), and further supported by Finkel & Stump (this volume), and Ackerman, Blevins and Malouf (this volume), larger word sets may be necessary to discover patterns of predictability within complex inflectional systems. Furthermore, word families need not be limited to those defined by inflection or derivation. As shown by Krott (this volume), compounds define word families within which analogical formation is robust, and indeed the only explanation available for certain patterns.

There is evidence of word-based analogy in every language where analogical patterns have been investigated. The attraction of analogical patterns may be due in part to the fact that they impose a measure of order on the typically arbitrary sound-meaning correspondences in a language. But why should words play a distinguished role? In the cognitive psychology literature, it has been argued that the validity or strength of an analogy is partly determined by the number of distinct points at which one domain or entity can be aligned with another (Gentner 1983; Holyoak & Thagard 1989; Gentner & Markman 1997). This structural alignment will be very strong in word families, like the singulars and plurals in (2), since words can be aligned at phonetic, phonological, categorial, and inflectional feature points. In linguistic terms, the more shared features of different types a set of words has, the more likely the set will be used as the basis of analogical modelling (Skousen 1989). Evidence for a minimal degree of structural alignment in word-based analogy is presented in Gerken et al. (this volume).

Because it is so widespread, word-based analogy has given rise to the greatest number of descriptive generalizations and theoretical proposals. At the descriptive level, the bulk of analogical changes are analysed as instances of *extension* or *levelling*. Extension is the case where an alternating pattern is introduced to a historically non-alternating paradigm: e.g. English irregular *drive-drove* is extended in some dialects to *dive*, so that *dive-dived* > *dive-dove*. Under levelling, paradigmatic alternations are eliminated, as in the regularization of any historically strong verb, such as *cleave-cleaved* replacing the older *cleave-clove* in some varieties of English. More theoretical proposals attempt to define the most common directions of analogical change, taking into account phonological, morphological, syntactic, and semantic information. The best known of these are Kuryłowicz's laws of analogy (Kuryłowicz, 1945-49/1995) and Mańczak's tendencies in analogical change (Mańczak 1958). Both authors summarize recurrent aspects of word-based analogical change, from tendencies for transparent inflection to extend and replace synthetic forms, to generalizations governing which meanings are associated with old and new forms once analogy has taken place. However, as more morphological systems have been explored, few, if any, of these generalizations have survived. In their place, we see more general proposals. Deutscher (2001) divides internal word-based analogical change into 'extension' and 'reanalysis', in parallel with the typology of internal syntactic change (Campbell & Harris 1995). In a similar vein, Garrett (2008) suggests that pure levelling, in the sense outlined above, does not exist: instead, all cases of levelling are analysed as extensions of an existing uniform paradigm on a non-uniform paradigm. Baayen (2003) demonstrates the importance of probabilistic knowledge in modeling morphological productivity, while Albright (2008) emphasizes an association between analogues and general informativeness.

Word-based analogies are by far the most widely recognized and carefully studied type, and their effects on language change are most salient. Nevertheless, analogy in grammar need not be limited to word-based comparisons, and cases involving phonetic, phonological, syntactic, and semantic alignment have also been proposed. In the domain of sound patterns, **phonetic analogy** is the case where a phonetically based variant

of a particular segment is extended to another segment type or another context on the basis of phonetic similarity between segments or contexts (Bloomfield 1933:366; Vennemann 1972; Steriade 2000; Yu 2007; Mielke 2008:88-95). For example, in Tigrinya, velar stops /k/ and /g/ undergo spirantization to [x] and [ɣ] respectively between vowels. In one dialect, spirantization has been extended to /b/ and /p/ as well, but not to /t/ or /d/. One analysis of this pattern is that the original velar spirantization is extended to labials, but not coronals, on the basis of analogy: labials and velars are phonetically similar, both being grave, with greater acoustic energy in the lower frequencies (Mielke 2008:89-90). Though in some cases, alternative, purely phonetic, analyses are possible, and well supported (e.g. Barnes & Kavitskaya 2002, on French schwa deletion), it remains to be seen whether all cases can be dealt with in similar ways.

Direct sound-meaning or phonology-semantics alignments that are not mediated by the lexicon are usually characterized as systems of **sound symbolism** (Hinton, Nichols & Ohala 1994). Conventional sound symbolism, where sound-meaning correspondences are highly language-specific, and to some extent arbitrary, provide the best examples of **phonological analogy**, especially where **phonaesthemes** are involved. Phonaesthemes are recurring sound-meaning pairs that cannot be construed as words or as morphemes, like English word-initial *gl-* in *glitter*, *glisten*, *glow*, *gleam*, *glint* which evokes light or vision (Firth 1930; Bloomfield 1933; Bergen 2004). Though they may arise by accidental convergence, the statistically significant distribution of sound-meaning pairs are interesting, in that they, like other patterns, are seized upon by language learners, forming the basis of productive analogies. As Bloomfield (1895:409) observed colourfully: 'Every word, in so far as it is semantically expressive, may establish, by hap-hazard favoritism, a union between its meaning and any of its sounds, and then send forth this sound (or sounds) upon predatory expeditions into domains where the sound is at first a stranger and parasite...'. In the case of English phonaesthemes, the psychological reality of the sound-meaning correspondence is evident in priming experiments (Bergen 2004), as well as in neologisms, where the correspondence is extended analogically (Magnus 2000). Looking for a new dishwashing powder? 'Everything glistens with *Glist*', or so an advertising slogan would have us believe. Direct sound meaning alignments need not be mediated by discrete phonological units. Words may have their own 'gestalts', or wholistic patterns, and these may also be the basis of productive analogies (Hockett 1987).

**Semantic analogies** are usually classified as **metaphors**. In semantic analogies, relations between aspects of meaning of the analogue are mapped to those of the target (Gentner et al. 2001). Though words are used to express semantic analogies, it is clear that, in some cases, words are merely vehicles for deeper conceptual alignments. The use of space to talk about time is a clear example: *a long illness; a short recovery; two weeks in advance; one month behind schedule*, etc. Cross-linguistically the metaphorical relationship between space and time is asymmetrical: people talk about time in terms of space more often than they talk about space in terms of time (Lakoff & Johnson 1980; Alverson 1994). A range of psychophysical experiments supports a conceptual, non-linguistic basis for this asymmetry: subjects take

irrelevant spacial information into account when judging duration, but do not take special notice of irrelevant temporal information when judging space, providing evidence that semantic representations of time and space are inherently asymmetrical (Casasanto & Boroditsky 2007). Semantic analogies may also play a significant role in semantic change across time and space, and determine, in many cases, specific directions of grammaticalization, e.g. verbs > auxiliaries; verbs > adpositions; adpositions > case markers; ONE > indefinite markers; spacial adverbs > temporal adverbs (Traugott & Heine 1991; Heine 1993; Hopper & Traugott 2003).

Although highly intricate proposals have been advanced to account for syntactic knowledge, there is little counter-evidence to a very simple proposal. This classic model, which dominated language science until the rise of generative grammar, posits two basic mechanisms of human sentence production and comprehension (see, e.g. Sturtevant 1947:104-07). The first mechanism is memorization: people memorize utterances they have heard. These can range from very short phrases and simple sentences, to complex sentences, whole songs, poems or stories (Jackendoff 2002:152-54; 167-82). The second way in which people produce and understand phrases and sentences is by analogy with those they have memorized. In order to make use of **syntactic analogy**, a language learner must perform some segmentation of the utterance into smaller chunks (phrases or words) on the basis of sound/meaning correspondences. Based on this parsing, analogous bits or chunks of sentences can replace each other in different sentence frames (Tomasello 2003:163-69). Two models that incorporate syntactic analogy have proved highly successful in accounting for syntactic acquisition and form. In language acquisition research, the 'traceback' method analyses dense corpora of child language in its natural context (Lieven et al. 2003; Dąbrowska & Lieven 2005). In the earliest stages of acquisition, one third of all children's utterances are exact imitations of adult speech, while over 80% of their speech is made up of exact copies of earlier utterances with only one analogically-based operation (substitution, addition, deletion, insertion, or reordering). From utterances like *more milk*, *more juice*, the child is able to identify a frame 'more N', and extend it: *more jelly*, *more popsicle*, *more swimming*, etc. A similar perspective emerges from some of the models of construction grammar (Kay & Fillmore 1999; Croft 2001; Goldberg & Jackendoff 2005; Goldberg 2006), where syntactic productivity is viewed as the extension of learned constructions. Constructions are the syntactic analogue of words: they typically embody arbitrary relations between form and meaning. The internal complexity of a construction, whose form may include phonological, morphological, syntactic and pragmatic components, results in multiple anchor points for analogical extension.

A number of factors have contributed to the diminished role that analogy plays in generative accounts. The marginalization of morphology in general, and the neglect of complex inflectional systems in particular, shifted attention away from many of the patterns that traditional accounts had regarded in analogical terms. A primary focus on synchronic description likewise eliminated much of the traditional evidence for the influence of analogical pressures on the development of grammatical systems. A model of grammar that

conceives of the mental lexicon as a largely redundancy-free collection of minimal units also lacks the word stock that provided the traditional base for analogical extensions of word-based patterns. In addition, the use of symbolic 'rules' to provide a discrete description of a linguistic system imposes a strict separation between 'data' and 'program' which departs from the more exemplar-based conception of approaches that treat analogy as the principal creative mechanism in language, and recognize the probabilistic nature of linguistic generalizations (Bod, Hay & Jannedy 2003; Gahl & Yu 2006). Hence, while Chomsky's early remarks on grammar discovery echo some aspects of the descriptivist tradition (which retained a role for analogy), they also assume the notion of a 'structural pattern' that corresponds to item-independent rules, not individual constructions or instances of any type of expression:

A primary motivation for this study is the remarkable ability of any speaker of a language to produce utterances which are new both to him and to other speakers, but which are immediately recognizable as sentences of the language. We would like to reconstruct this ability within linguistic theory by developing a method of analysis that will enable us to abstract from a corpus of sentences a certain structural pattern, and to construct, from the old materials, new sentences conforming to this pattern, just as the speaker does. (Chomsky 1955/1975:131).

In later writings, Chomsky is dismissive of analogy on the few occasions that he mentions it at all (Itkonen 2005: 67-76), and his general position seems to be that 'analogy is simply an inappropriate concept in the first place' (Chomsky 1986:32). Work within the generative tradition has tended likewise to think of rules as the basis of broad generalizations, reserving analogy for local, lexically-restricted patterns. A particularly clear and accessible exposition of this perspective is *Words and Rules* (Pinker 1999), . However, from a traditional perspective, a rule can be understood as a highly general analogy. There is no need for any qualitative difference between general and restricted analogies, and it is entirely plausible to assume that their differences reside solely in the specificity of the pattern that must be matched to sanction an analogical deduction. A number of psycholinguistic studies provide a measure of support for this more uniform view of grammatical devices by showing that there is no stable behavioural correlate of posited differences between irregular items (stored 'words') and productive formations (outputs of 'rules'). Instead, different types of frequency information appear to be of central importance in conditioning variation in speakers' responses in the lexical access and recognition tasks that are used to probe the structure of the mental lexicon (Stemberger & MacWhinney 1986, Hay & Baayen 2001, Baayen et al. 2003). One further virtue of a unified notion of analogy that subsumes general and restricted cases is that it can account for the competition between candidate analogies in terms of the natural trade-off between the specificity of an analogical pattern and the number of encountered instances that match the pattern. It may even be possible to model or measure the attraction exerted by competing analogies given the advances in psycholinguistic methods for probing the structure of the mental lexicon (Milin et al., this volume) and advances in techniques for modelling the effects of lexical neighbourhoods (Wedel, this volume).



At this particular point in the development of the field of linguistics, it is useful to be reminded of the pivotal role that analogy has played in earlier grammatical models and to appreciate its renewed importance in the emerging quantitative and data-driven methodologies that feature in many of the papers in this volume. Nearly all grammatical traditions have regarded analogy as a central determinant of the form and evolution of linguistic subsystems, though it is only with the advent of better modelling techniques that it has become possible to investigate the psycholinguistic reality of analogical patterns and to represent and even measure the analogical pressures on a system. From this standpoint, it is perhaps the generative attitudes toward analogy that appear anomalous, a point that adds a further dimension to the reappraisal of generative approaches that is currently underway in phonology (Bybee 2001; J. Blevins 2004, 2006; Mielke 2008), morphology (Anderson 2004; Deutscher 2005; J. P. Blevins 2006); and syntax (Goldberg 2006; Matthews 2007; J. P. Blevins 2008). However one reconciles generative scepticism about analogy with more traditional perspectives, it would seem that this is an auspicious time to reconsider the role of analogy in grammar. In the chapters that follow, authors seek to understand better the ways in which analogical reasoning, the core of human cognition, shapes the form and acquisition of linguistic knowledge.

### **3. Organization of this Volume**

The papers in this volume are organized thematically into three parts. The papers in each part address a group related or overlapping issues, usually from slightly different or complementary perspectives.

The papers in Part 1 consider aspects of the organization of linguistic systems and the levels at which analogy operates in these systems. The central role attributed to analogy in morphological analysis is clear in the practice of matching principal parts against cells of exemplary paradigms to deduce unencountered forms. Yet although the deductions themselves can be represented by proportional analogies, many other aspects of this analysis remain imprecise, notably the criteria that guide the selection of principal parts. In Chapter 2, Finkel & Stump address this issue by proposing a typology of principal part systems, and by developing a notion of 'paradigmatic transparency' that measures the degree of predictability between principal parts and paradigm cells. The information-theoretic approach outlined by Ackerman, Blevins & Malouf in Chapter 3 offers a complementary perspective on this issue by representing implicational structure in terms of uncertainty reduction. In Chapter 4, Wedel sets out some of the ways that the organization of linguistic systems can evolve, reflecting different initial biases in a system or different ways of resolving conflicts between analogical pressures that operate at phonological and morphological levels.

The papers in Part 2 turn to the role that analogy plays in language learning, by humans but also by machines. In Chapter 5, Gerken et al. suggest that analogical reasoning about 'secondary cues' accounts for the facilitatory effect that these cues apparently exert in the learning of lexical categories on the basis of

paradigm-completion tasks. In Chapter 6, Krott reviews the pervasive influence of analogy on the form of compound structures in a range of languages. In Chapter 7, Goldsmith summarizes a body of research that has been devoted to building a general model of automatic morphological analysis and examines the contribution that analogy can make to the learning algorithm of this model.

Goldsmith's paper provides a natural transition to the papers in Part 3, which take up the challenge of modelling analogy formally. In Chapter 8, Skousen offers a concise synopsis of the theory of Analogical Modeling, and presents analyses that motivate particular extensions of this theory. In Chapter 9, Albright considers three restrictions on analogical inference that he argues can be attributed to limitations of context-sensitive rules. In the final chapter, Milin et al. return to issues concerning the organization of linguistic systems and present a range of studies that indicate the predictive value of information theoretic measures, and also suggest the psychological relevance of traditional notions of paradigms and inflection classes.

Taken together, these papers reflect a resurgence of interest in traditional approaches to the representation and extension of grammatical patterns. It is hoped that collecting these papers together in the present volume will help to highlight significant points of contact across different domains and encourage further investigation of the role of analogy in language structure and use.

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