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Accent in Thematic Nouns

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Abstract

In this paper I show that the columnar accent of the *o*-stems can be integrated into a simple accent grammar of PIE. After establishing the general pattern I demonstrate how the accented and unaccented thematic suffixes fit into the picture. The grammatical sketch leads to the conclusion that it is unnecessary to assume any break between a more ancient PIE stratum with consonant stems and a more recent one with vocalic stems, each with its own accent and ablaut patterns. In the second part a morphological network for deriving the accent patterns of internal derivation in *o*-stems is developed. In a short outlook I show that the simple mechanism of accent inversion developed here also accounts for internal derivation in consonant stems and for accent shifts in compounds.

Keywords

thematic stems – accent – ablaut – internal derivation – network morphology

1 Introduction

In current work on Indo-European accentology it is generally assumed that the thematic stems differ substantially from the athematic ones (see e.g. Schaffner (2001: 95), Kim (2002: 46), Olander (2009: 94, 96), Sukač (2010: 96–97), Kiparsky (2010: 161)). While the latter show all types of mobile and static paradigms, the former always have columnar accent. This difference is generally taken as further evidence for different diachronic strata, the *o*-stems being a later development. However, assuming a stratification is hardly a convincing explanation for the state attested in the early IE languages. Though there is overwhelming

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evidence for a scenario in which thematic stems started to supersede the athematic types in the course of prehistoric and early historical development, any theory of PIE accent has to deal with the fact that both types existed side by side in the parent language as well as in the early attested daughter languages. Since both the athematic and the thematic stems were very frequent and (at least in part) productive at those early stages, it follows that none of them can be counted as a mere lexical exception. In other words, the patterns of the various athematic stems and those of the thematic stems belong to one synchronic layer of linguistic competence, even if their origins go back to different time depths. Thus, any accentological grammar of late PIE (or for that matter of an early IE language like Vedic) has to account for all of them.

In this paper I demonstrate that such an account can actually be given. The accent pattern of the *o*-stems can be deduced from the same accentological grammar as the athematic stems. The only difference is the very obvious one: the endings of the weak cases.[1]

2 Analysis

2.1 *The Athematic Stems*

As has been shown in Keydana (2005; 2013; in print), the accent types of athematic primary derivatives in Proto-Indo-European can be explained in a very simple way by assuming morphological accent and an interplay of head dominance and the Basic Accentuation Principle. Under this view, inputs to the grammar without lexical accent always surface with word-initial stress—this is the BAP (see Kiparsky and Halle (1977: 209), Kiparsky (2010: 144)). Outputs of the grammar based on accented morphological heads show columnar stress, whereas accented non-heads are stressed only when the head is lexically unaccented. The desinences in the strong stems are inherently unaccented, those of the weak stems, on the other hand, are underlyingly accented.

In root nouns, where the root itself is the head of the morphological word, this leads to the following pattern:[2]

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1 I thank Tim Felix Aufderheide and Anna Bauer for stimulating discussions and two anonymous reviewers for valuable comments.

2 Lexical accent is indicated by ´, surface stress by ′. → indicates a synchronic relation between lexical input to the grammar and grammatical output, ⇒ marks internal derivation. In the surface representations given in the following tables possible phonotactic and/or morphophonological changes of the right word-edge are ignored.

	static	mobile
nom.sg.	**dóm-s → *′doms*	**pod-s → *′pods*
gen.sg.	**dém-és → *′dems*	**ped-ós → *pe′dos*

The head of a primary derivative is its derivational suffix. Thus, for words with a primary athematic suffix, the following picture emerges:

	static	mobile
nom.sg.	**suHn-ú-s → *suH′nus*	*deh_3*-ont-s* → *′deh_3*onts*
gen.sg.	**suHn-éu-és → *suH′neus*	*dh_3*-nt-és* → *dh_3*n′tes*

Words with accented derivational suffix show columnar accent on the second syllable, independently of the lexical accent of the root. As has been argued in Olander (2009: 96) and Keydana (2013: 47), this static pattern is attested both in the so-called proterokinetic and the so-called hysterokinetic stems, which are identical from an accentological point of view. At least in late PIE mobility is restricted to the so-called amphikinetic stems.[3]

2.2 *Integrating the Thematic Stems*

The thematic *o*-stems differ from the athematic stems in four respects. The most obvious one is the fact that the suffix consists minimally of a non-high vowel.[4]

The second one concerns ablaut and is an offshoot of the first: Thematic suffixes are of an extremely simple phonotactic structure. As the non-high vowels of PIE have no non-vocalic allophone, the suffix consists minimally of a syllable nucleus. Maximally, the nucleus is preceded by a proper and wellformed onset. Thus, the template for thematic suffixes is (C)(C)V, (C)(C) being a possible onset like /tr/ or /d^{h}l/.[5] This minimalistic structure has important and far-reaching corollaries: One is that the thematic suffixes themselves can never undergo quantitative ablaut. Deleting the vowel would either delete the suffix itself or, in case it contains one or more Cs, make it impossible to recover the

3 The model predicts that lexical accent on roots manifests itself in an akrostatic pattern if the derivational suffix is unaccented. However, the issue of accented roots has not yet been studied in detail.

4 I will not go into the distribution of **o* and **e* in this paper.

5 The only exception is the marker for middle participles -*m*h_1*no*-. In the attested languages, this suffix always undergoes repair. Either the laryngal is deleted (/mn/ being a proper onset), or it or the preceding nasal is vocalized (the result being a well-formed bisyllabic structure).

suffix from the phonological output. Loss of **o* in **-tro-*, for example, would conflate this suffix with froms of **-ter-*. Thus, rhythmic deletion, which seems to play an important role in athematic stems (see Keydana (2013: 52; in print)), is necessarily blocked in thematic ones.

The other corollary is the fact that in primary derivation thematic suffixes never induce phonotactically triggered quantitative ablaut in desinences or the base they are attached to.[6] This follows from the fact that concatenating the template to some base or combining any desinence with the template never leads to inadmissible phonotactic structures. The concatenation of a desinence to a thematic stem produces two possible configurations: if the desinence is vocalic, the suffix-vowel and the vowel of the ending are contracted (as in **-ōi*) in case the vowel in the ending is non-high. Otherwise, both vowels form a diphthong (as in **-oi*). If, on the other hand, the desinence is consonantal, the result is either a simple closed syllable (as in **-om*) or an open syllable followed by a second syllable with a well-formed onset (as in **-osi̯o*, for the syllabification see Keydana (2004: 170) and Byrd (2010: 128)). Either way, the result of the concatenation can always be parsed into well-formed syllabic structures. Attaching a thematic suffix to a base is similarly simple. The concatenation of a vocalic suffix to a root results in a parse where the root-final consonant becomes the onset of the second syllable (as in **u̯l̥kʷo-*). Attaching a suffix with one or two initial consonants followed by the thematic vowel leads to a word-internal cluster. This, however, is necessarily well-formed, as root-final consonants or consonant sequences are typically well-formed codas (Keydana 2004: 183–185), whereas all attested suffix-initial consonant-clusters are admissible onsets (trivially so if the suffix begins with a single consonant, but see e.g. **-tro-* in words like **deh$_3$-tro-*, ved. *dātrá-*). Roots with a final cluster consisting of an obstruent followed by a laryngeal, which against Keydana (2004: 184) violate the sonority sequencing principle, are nonetheless unproblematic, since repairs lead either to vowel insertion (`vocalization') or to deletion of the laryngeal: both strategies result in a well-formed phonotactic structure. Therefore, repair of illicit phonotactic structure, which is probably the second crucial factor triggering ablaut in athematic stems (Keydana (2013: 53; in print)), simply could not occur in thematic stems.

The attested root-ablaut in thematic stems is not due to phonotactic constraints, nor is it a function of the accent. The latter can be seen from forms with accented root in the zero grade such as gr. λύκος or ved. *-dúgʰa-* and the much

6 In rare cases of secondary derivatives like ved. *vatsá-* < **u̯et-s-ó-* or *rátʰa-* < **rót-h$_2$-o-*, the thematic suffix induces ablaut of the primary affix, probably due to rhythmic deletion.

more frequent pattern with root in the full grade and accent on the thematic vowel as in gr. λευκός and ved. *yod^hó-*. I conclude that root-ablaut is always morphological. It has not to be accounted for in the phonological grammar.

The third point concerns the endings. While the strong endings do not differ from those used in combination with athematic stems, the weak endings form a completely distinct set.

The final difference is accentological: *o*-stems never show mobile accent. They come in two varieties, as barytones and as oxytones, both with strictly columnar accent. This is confirmed by the Greek and the Vedic data. Only the Germanic data seem to hint at mobile patterns. However, this alleged mobility can be explained as an inner-Germanic development, see Olander (2009: 80) and Schaffner (2001: 100–105).

2.2.1 Accent in Thematic Stems

Ignoring for the moment the derivational relation between barytones and oxytones, how do the thematic stems fit into the picture of PIE accent outlined above?

The integration of the oxytone type is straightforward. From an accentological point of view, this type looks exactly like static athematic nouns. I therefore conclude that in oxytone *o*-stems the suffix is inherently accented. Being the head of the morphological word, it determines the stress of the grammatical output even if the root or the desinence are specified for lexical accent.

Except for the stress pattern, barytone *o*-stems behave exactly like their oxytone counterparts. Thus, it seems easiest to explain this difference by assuming a different lexical specification of the suffix. Trying to restrict the possible specifications as much as possible it is safe to propose that in barytone *o*-stems the suffix is inherently unaccented. I therefore distinguish two types of thematic suffixes, one inherently accented, the other unaccented. The pattern of the *o*-stems, then, is comparable to that of the primary athematic suffixes: accented heads are opposed to unaccented ones.

However, *o*-stems with unaccented suffix differ substantially from athematic nouns with unaccented suffix. In the latter, the unaccented suffix results in a mobile paradigm, whereas in *o*-stems the accent is columnar. In the strong stem both athematic and thematic stems with unaccented suffix behave exactly alike. Both draw from an identical set of endings and both show stress on the initial syllable. This follows directly from the interplay of unaccented endings and the BAP. The difference in the weak stems, however, is twofold. Not only does it affect the accent, it also extends to the segmental setup of the desinences. As a result, it seems plausible to tie the accentological difference to the desinences themselves: I conclude that it is the weak thematic desinences which induce the altered stress pattern. It is a well-established fact (see Keydana (2005: 31, 44)) that the weak endings used with athematic stems are lexically accented. If we assume that the set of weak thematic endings is lexically unaccented, the theory correctly predicts that the weak forms behave exactly like the strong ones, with stress on the first syllable due to the BAP throughout:

	oxytone	barytone
nom.sg.	**priH-ó-s* → **pri'Hos*	**u̯l̥kʷ-o-s* → **'u̯l̥kʷos*
gen.sg.	**priH-ó-si̯o* → **pri'Hosi̯o*	**u̯l̥kʷ-o-si̯o* → **'u̯l̥kʷosi̯o*

In other words, the accentological difference between athematic and thematic stems actually boils down to the most obvious difference, i.e. the different set of endings in the weak cases. Consequently, it cannot be interpreted as a manifestation of some fundamental change in the accentological grammar during the PIE period. Rather, the accentological patterns of all attested noun stems can be described in a unified way.

2.3 *Thematic Suffixes*

The analysis given above for simple **o*-stems can easily be extended to stems with more complex thematic suffixes. However, one trait common to many thematic suffixes deserves further attention, i.e. a significant number of them occur in oxytones and barytones alike. Typically, the different accentual specifications go hand in hand with differences in meaning, and in simple thematic verbal nouns, for instance, two types can be discerned: barytones with an event meaning like gr. τόμος, and oxytones with an agentive meaning like gr. τομός. See e.g. (Debrunner 1954: 98–99), Schwyzer (1939: 457) and the data in Lubotsky (1988: 59–100) and Schaffner (2001: 114 ff.). The pattern is obvious, although not without exceptions. Note especially that oxytone nomina agentis without a barytone counterpart do exist, such as ved. *ajá-* or *veśá-*. A similar pattern can be found with stems in **-mo-* (Debrunner 1954: 749) and with stems in **-tro-*. Here, barytones are typically nomina instrumenti or nomina loci (Debrunner (1954: 701–703), Lubotsky (1988: 82–83)). The few exceptions can be understood as “mittelbar Werkzeugbezeichnungen” (Debrunner 1954: 703). Oxytones are nomina abstracta or denominal nouns derived from *r*-stems. Finally, this pattern is very productive in compound formation. In a possibly old stratum of bahuvrīhis, the second member of the compound shows an accent which is opposed to that of the simplex; see especially Wackernagel (1909) and Widmer (2013: 191).

In the following I limit my analysis to deverbal thematic nouns as a prime example of opposite accentual patterns connected to functional or semantic differences. Because of its wide-spread attestation (see Brugmann (1906: 148–153)) and word pairs like ved. *bʰára-* : *bʰará-* besides gr. φόρος : φορός, this mechanism can be reconstructed for PIE, even if the oxytone pattern arose from a reanalysis of second members of compounds. In the remainder of this paper a transposition derived from the Greek will be used, i.e. **tómh₁o-* as an event nominalization based on the root **temh₁* and **tomh₁ó-* as an agentive noun. According to the accentological grammar developed above, the underlying representation for the event nominalization is unaccented /tomh₁o-/, the UR of the agentive noun is /tomh₁ó-/ with lexically accented suffix.

How can the opposing pattern be accounted for? The null hypothesis is to simply assume no derivational relation at all between both types. In this scenario, barytones and oxytones alike derive directly from the verb. Barytones consist of the root plus a lexically unaccented **-o-*, oxytones of the root plus lexically accented **-ó-*. Straightforward as it may be, this approach cannot account for the similarity between the two types and at the same time for the fact that the same patterns are attested with athematic nouns like ved. *ápas-* : *apás-* or *bráhmaṇ-* : *brahmáṇ-*. As it seems desirable to capture these patterns in an appropriate generalization, the communis opinio has it that one type is derived from the other by internal derivation.

However, it is difficult if not impossible to determine the direction of this relation. In analogy with the pattern observed in PIE **s-* and **n-*stems it is tempting to assume that oxytone nomina agentis are derived internally from barytone event nouns. This is the position taken by Schaffner (2001: 98–99), who credits Schindler for this assumption. Giving a more detailed account, Lubotsky (1988: 65) argues that the oxytone nomina agentis are based on event nouns used as heads in bahuvrīhi compounds, as the latter typically show oxytonesis. He sees evidence for this hypothesis in the fact that there are hardly any exceptions to oxytonesis in nomina agentis, whereas barytonesis in event nouns is less pervasive (Lubotsky 1988: 65). This scenario rests on the assumption that the accent shift in bahuvrīhi compounds—which typically take on an agentive meaning—was reanalyzed as a marker of nomina agentis. However, in light of the fact that accent shift is a far more general (and not necessarily unidirectional) device in compounding, Lubotsky's presupposed functional reanalysis of oxytonesis cannot be proven. It may well be that internal derivation in **o-*stems and accent shift in compounds are simply based on one and the same mechanism (on which see below). The opposite derivational relation (with oxytones as the base) is likewise possible. Tim Felix Aufderheide (p.c.) drew my attention to the fact that thematic nouns based on root nouns (typically without semantic or functional difference) are mostly oxytone in Vedic. Thus, if thematization is in origin a simplification of athematic stems, oxytonesis may well be the initial state.

The directionality of the shift is of minor importance for an account of how the mechanism of internal derivation worked. In this paper, I will follow the communis opinio by assuming that oxytones were derived from barytones. The opposite scenario could be treated along the same lines.

An explicit model of internal derivation in thematic stems has to address at least two issues. Firstly, It should give a formal account of how exactly the mechanism of accent shift works. In this context, a crucial observation given inter alios by Wackernagel (1914: 22) should be accounted for: "Wie man längst beobachtet hat [...] herrschte die Tendenz, die Ableitung anders zu betonen als das Grundwort". Secondly, the model should be able to handle the fact that nomina agentis are oxytone even in those cases when their derivational base is not barytone.

In a classical structuralist concatenative approach to morphology, internal derivation must be due to the interplay of accentological specifications of morphemes. However, since the number of overt morphs in the derived oxytone remains the same as in the barytone base, the only way to deal with internal derivation is to assume a null-morpheme to account for the difference. Taking a barytone as input, the null-morpheme would simply have to be specified for lexical accent, which would then surface on the adjacent stem-vowel:

(1) n.sg. *tomh*$_1$*o-* + ǿ + *s* → */tomh*$_1$*ós/*, *tom'h*$_1$*os*

With inverse directionality, the null-morpheme would have to delete underlying lexical accent. Due to the BAP, the result would be barytonesis. Since overt affixes which delete the lexical specification of the stem they are attached to are well-attested in a variety of languages (as e.g. in Russian), this process is equally possible:

(2) n.sg. *tomh*$_1$*ó-* + ø + *s* → */tomh*$_1$*os/*, *'tomh*$_1$*os*

If I understand him correctly, the null-morpheme approach to internal derivation has been advocated by Widmer (2013: 191). However, there are a number of serious drawbacks to this analysis of internal derivation. Per definitionem null-morphemes are invisible and are thus stipulative. Besides, null-morphemes cannot account for Wackernagel's elegant generalization quoted above. The first problem could be addressed by a simple extension of the model allowing for substitution. However, substitution still cannot handle accent inversion in the internally derived word. Besides, it cannot cope with the fact that the inversion pattern is not restricted to *o-stems.

A more promising account for Wackernagel's observation within a grammar can be given in a framework developed in Alderete (2001). His system is able to address inversion and can—in principle—cope with the fact that internal derivation is not restricted to *o*-stems. Working in optimality theory, Alderete introduced Output-Output relations constrained by anti-faithfulness constraints (¬FAITH). Alderete (2001: 177) sees three possible ways of dealing with what he calls "mutation without affixation", all of which rely on the existence of this constraint family.

However, there are several reasons why I will not explore this prospect any further. One is that OO relations make optimality theoretical grammars extremely powerful and increase their computational load massively (Potts & Pullum 2002), which is hardly desirable. Apart from these theoretical concerns there are more technical ones which challenge this approach in a rather fundamental way. As Wackernagel already observed, accent shift is not directional. Thus, depending on the base, it may lead either to the deletion of a lexical accent or to its introduction. To cover both types with ¬FAITH, however, two different types of anti-faithfulness constraints are necessary, ¬OO-MAX triggering deletion and ¬OO-DEP triggering insertion (see Alderete (2001: 178)). Again, Wackernagel's generalization is missed. Another problem lies in the fact that only derivatives built by internal derivation undergo accentual changes relative to their base. To account for this in a model relying on ¬FAITH, this constraint (or family of constraints) has to be specified in such a way that it is actuated only by certain morphological diacritics (e.g. an index $_i$). Thus, internally derived nouns have to be marked for such a diacritic, and the constraints have to be defined in such a way as to apply only on coming across the diacritic. Alderete (2001) does not address this problem. However, he cites literature which deals with the second part of it by distinguishing different types of OO-constraints (OO_1 and OO_2) for different affixes. Far from being an elegant solution, such constraints can indeed be defined. But how can we account for the diacritic in the input? This problem is not addressed in the literature. The only solution I see is some concatenative morphological operation adding the diacritic. **tomh₁os*, thus, would be changed to something like **tomh₁os*$_i$, which in turn is evaluated by ¬OO-DEP$_i$(accent). This, however, amounts to once again assuming a ø-morpheme (now in the disguise of a diacritic). In addition to that, the whole mechanism is highly redundant. Assuming on the one hand a diacritic which triggers the whole process, and on the other a grammar sensitive to that diacritic has a strong flavour of duplication. If the lexical entry has to be specified anyway, why not simply specify it for accent shift; and get rid of

¬FAITH? This seems to be the best option since the accent shift is not a mere by-product of some other morphological process, but in fact the sole morphological marker.

Because of these severe problems, I want to push the consequences of Wackernagel's generalization a bit further. At its heart lies the idea that morphology is not so much a mechanism generating structure. Rather, it is a relation (Wackernagel's being 'anders') between words in a lexicon. A convenient device to capture such relations between morphological structures in a strictly declarative way is a network. Networks for representing lexical knowledge have been studied in Computational Linguistics for quite a while. In recent years, they have become prominent as tools for morphological descriptions outside of Computational Linguistics in the work of *inter alios* Bybee (e.g. Bybee and Beckner (2010)), who advocates a spreading activation lexical network inspired by connectionism (for a formalization see Baayen (2003: 253–256)), and Corbett (e.g. Corbett and Fraser (1993)), who opts for a less ambitious approach using a discreet network without weighting. As probabilities are irrelevant for the accentological patterns under discussion here, I follow Corbett in developing a simplified discreet lexical network represented in the formal language DATR. A detailed description of DATR can be found in Evans and Gazdar (1996) and Evans et al. (1998), an (unfortunately, quite sketchy) introduction to network morphology in DATR in Brown and Hippisley (2012).

DATR is a language defining an inheritance-based network which consists of nodes representing lexical knowledge. Nodes correspond to lexemes or classes of lexemes. While the first point seems obvious, the second is worth dwelling upon: In a DATR network, morphemes have no existence as lexical entries. Instead, derivational morphemes like the thematic vowel are accounted for by nodes which define the class of words consisting of a base and the derivational morpheme. These nodes are similar to Word Formation Rules in the sense of Anderson (1992). They define sets of words with a common morphological trait. For example, the node `der_suffix_o` introduced below defines the set of all words derived from roots by concatenating an unaccented *-o-*.

Each node is associated with a sentence containing statements, each statement being a path/value pair. Thus, we get the following syntax for definitional statements in DATR:

```
Node:Path == Def.
```

The left-hand side of this so-called value descriptor gives a path. The right-hand side gives the value for this path. The operator == indicates that the equation is a defining one (as opposed to an extensional equation marked by a simple =).

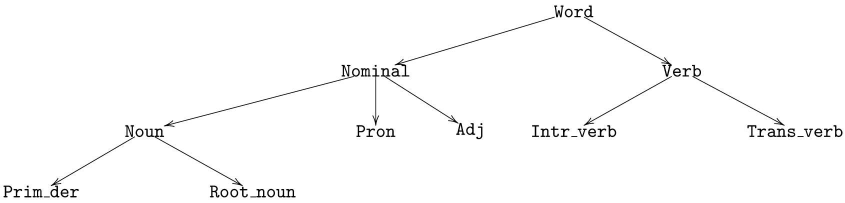

FIGURE 1 *Fragment of a lexical network with local inheritance*

Values can be introduced at a given node. However, they can also be inherited from other nodes. Thematic event nominalizations, for example, inherit their concatenative structure from a more general node `Prim_der` comprising the set of all formations consisting of a root and an affix. In DATR, two types of inheritance are defined, local inheritance and global inheritance. Local inheritance simply specifies a node or a path to inherit from. Inheritance is stated in a so-called inheritance descriptor. Local inheritance is expressed in statements like

```
Node1:Path1 == Node2:Path2.
```

Thus, a local inheritance descriptor states that if the value for `Path2` in `Node2` is defined, then the value of `Path1` in `Node1` is defined and equal to it (Evans et al. 1998). In DATR descriptions, the path on the right-hand side is omitted if it is identical to the path on the left-hand side. Local inheritance is useful for stating relations between entries and classes of entries in the network. An example for a fragment of a simple network with local inheritance relations is given in figure 1. In this network a primary derivative inherits part of its specification from the `Noun`-node, which inherits from `Nominal` and ultimately from `Word`. The `Word`-node contains information about word structure common to all PIE words, e.g. the fact that they are made up of sequences of phonemes. `Nominal` encodes morphosyntactic features shared by adjectives, pronouns, and nouns. The `Noun`-node gives all the morphological and syntactic information common to nouns but not shared by adjectives and pronouns. `Prim_der`, which is discussed in detail below, defines the specific structure of primary derivatives. Each node in this network defines a set, such that every node `a` dominated by another node `b` comprises a subset of `b`.

Inheritance constitutes such a powerful mechanism in a DATR-network because it allows for definition by default. Definition by default means that a "definitional statement [is] applicable not only for the path specified in its left-hand side, but also for any rightward extension of that path for which no more specific definitional statement exists" (Evans et al. 1998). It is therefore a useful tool for capturing generalizations across lexical entries. Additionally, DATR allows for multiple inheritance. Thematic event nominalizations, for instance, share different traits (root vocalism, accent etc.) with different sets of words. This can be captured by assuming abstract nodes for each of these traits, which all contribute to the make-up of event nominalizations. In the DATR language multiple inheritance is conceived of as being orthogonal, which means that the properties a node inherits from each node higher up in the hierarchy must be disjoint.

Whereas local inheritance uses values from a local context, global inheritance uses values from a global context. The format is

```
Node1:Path1 == "Node2:Path2".
```

The global context is typically the original node whose value shall be determined. Take as an example the event nominalization PIE _*tómh$_1$os_, which will be dealt with in greater detail below. Like other event nominalizations, _*tómh$_1$os_ inherits its structure locally from a node `Nom_ac` (which itself inherits locally from `Prim_der`). That the word is derived from the root _*temh$_1$_, however, is a parochial fact about _*tómh$_1$os_ not shared by other event nominalizations. Thus, it cannot be captured by a local inheritance descriptor. Rather, this inheritance relation is defined specifically relative to the original query (or global context), _*tómh$_1$os_. Thus, the phonological make-up of the root and its lexical meaning are inherited globally from a node `Temh`$_1$ specifying the idiosyncratic properties of the root _*temh$_1$_.

For a more thorough introduction to DATR see the literature quoted above, especially Evans et al. (1998). Essential concepts necessary to follow the argument will be introduced along the way.

As it is not my intention to give the full network for nouns in PIE, I will start out by introducing a node defining primary derivatives, i.e. nouns consisting of a root and one derivational affix. A preliminary version of the node, called `Prim_der`, looks as follows:

```
Prim_der:
    < > == Noun
    <mor stem> == "<phn root>" "<mor der_suffix>"
    <phn root> == OR:<IF: <"<mor root_o>">
                       THEN: Root_o <"<phn root->">
                       IF: <"<mor root_0>">
                       THEN: Root_0 <"<phn root->">>
                       ELSE: "<phn root->">.
```

The first line of this definition states that primary derivatives inherit all information not given in the Prim_der-node itself from a node Noun (which for convenience' sake I will not dwell upon here). The second line gives the morphological structure of primary derivatives. They are defined as consisting of some root and a derivational suffix. The specifications for each morpheme are drawn from the lexical entry for the root and der_suffix, each by global inheritance. The last line, which draws on the analysis of German ablaut in Cahill and Gazdar (1999: 12), contains information concerning root ablaut. The statement discerns three cases, *o*-grade, zero-grade, and the default *e*-grade.[7] The conditional states that if some primary derivative is specified as <mor root_o> (either in its lexical entry or by a node specifying some type of derivative and being lower in the hierarchy than Prim_der), then it inherits its phonological shape from a node Root_o applied to the shape of a given root as defined in its lexical entry. This underlying representation is indicated by -. Root_o will be introduced immediately. If the derivative is specified as <mor root_0>, it inherits its phonological shape from Root_0. In all other cases, the phonological shape of the input root is passed on without alternations.

Root_o and Root_0 are straightforward. They make use of the fact that DATR can be used to define finite state transducers, i.e. automata relating an input to an output. By default the transducer carries over extensions of left-hand-side paths (the input) into extensions of right-hand-side paths (the outputs). Assuming that the variable $phn is defined over the phonemes of PIE in the phn path, the transducer accounting for the *o*-grade in roots looks as follows:

```
Root_o:
  <e> == o
  <$phn> == $phn.
```

This node transduces every item defined in $phn to an identical item in the output, the only exception being *e*, which becomes *o*.

The transducer accounting for the zero-grade is equally simple:

7 The lengthened grade is omitted here to reduce complexity. It can be introduced along the same lines as the *o*-grade and the zero-grade.

```
Root_0:
  <e> == <>
  <$phn> == $phn.
```

Here, the first line simply states that when coming upon an *e* in the input, the transducer is to give out zero in the output. Brute-force transducers like the ones introduced here are completely adequate in situations where ablaut is not (or no longer) phonologically motivated. For similar accounts for German umlaut and templatic morphology see Reinhard and Gibbon (1991) and Cahill and Gazdar (1999).

With `Root_o` and `Root_0` defined, `Prim_der` is the set of all types of primary derivatives. To define subsets like thematic event nominalizations, nodes have to be introduced which specify these stems further. One such node needed for event nominalizations specifies the thematic vowel as a suffix. As thematic vowels are not restricted to event nominalizations, this specification cannot be given in the node defining the nominalizations itself. The node contains the following set of axioms:

```
Der_suffix_o:
   <> == Affix
   <phn> == o
   <mor der_accent> == FALSE.
```

The first line points to a node `Affix` (not to be dealt with here) which groups together all types of affixes and at least contains the information that affixes are made from phonological segments—which, by the way, excludes null-morphemes. The next line simply gives the phonological information associated with the suffix, and the last line states that the affix is unaccented. This is done by treating accent on the affix as a boolean, i.e. two-valued, feature. Accounting for accent along these lines is very straightforward, since in the simple system of morphological accent advocated here, each morpheme is underlyingly either accented (`<mor der_accent> == TRUE`) or unaccented (`<mor der_accent> == FALSE`). Note, however, that although being superficially similar, this treatment of accent is fundamentally different from an SPE-style feature like [±accent], as the latter is a segmental feature, whereas accent in the model used here is a feature of morphemes.

Now we are able to define thematic event nominalizations, which inherite their general make-up from `Prim_der` by local inheritance and the specific affix used from `Der_suffix_o` by global inheritance:

```
Nom_ac:
   <> == Prim_der
   <sem struc> == λPλxλe. P(e) ∧ THEME(e, x) with P ==
                  <base lex_meaning>
   <mor root_o> == TRUE
   <mor der_suffix> == "Der_suffix_o".
```

To be able to finally derive the event nominalization PIE **tómh*$_1$*os*, I now introduce the lexical entry for the root **temh*$_1$:

```
Temh1:
   <> == TRANS_VERB
   <sem lex_meaning> == cut
   <sem sem_struc> == λyλx∃e. cut′(e) ∧AGENT(e, x) ∧THEME(e, y)
   <phn root> == temh1
   <mor prs_stem> == n_infix:<>
   <mor aor_stem> == <mor root>.
```

The first line states that information not defined in the Temh$_1$-node is drawn from a node TRANS_VERB by local inheritance. I will not address this node in detail. Suffice it to say that it contains syntactic information, an abstract semantic structure (on which see below) and—again by local inheritance—morphological information taken from a node VERB. The second line simply states the lexical meaning of **temh*$_1$. Line 3 is more complex. Since (most) transitive verbs have a common semantic structure, it must be inherited from the TRANS_VERB-node. This, therefore, includes the following axiom:

```
TRANS_VERB:
    <sem sem_struc> == λyλx∃e."<base lex_meaning>"
                       (e) ∧ AGENT(e, x) ∧THEME(e, y).
```

This axiom contains a global inheritance descriptor "<base lex_meaning>" pointing to the lexical meaning of the transitive verb which is the original query node. In the Temh$_1$-node, this inheritance is made explicit by inserting the value of <sem lex_meaning>, cut′, for the global inheritance descriptor. The 4th line of the Temh$_1$-node is a definitional statement giving the phonological structure of the root. To keep things simple I treat morphemes as sequences of unanalyzed phonological segments. As Cahill (1993) has shown, more complex representations can easily be incorporated. As for the last two lines of the Temh$_1$-node, both define tense stems, line 5 again by pointing

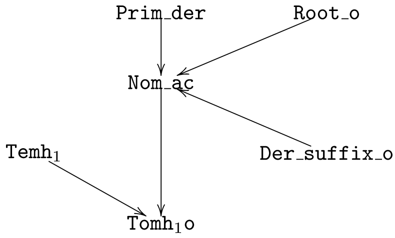

FIGURE 2 *Event nominalizations derived from roots*

via local inheritance to a node giving the morphological structure of infix stems.

We are now in a position to define _*tómh$_1$os_ as a theorem of the network simply by feeding `Nom_ac` with the information in `Temh`$_1$ by global inheritance:

```
Tomh1o:
   <> == Nom_ac
   <base> == "Temh1: <>".
```

Spelling this out, we get the following specification of _*tómh$_1$os_:

```
Tomh1o:
    < > == Noun
    <base> == "Temh1: <>"
    <sem sem_struc> == λPλxλe. cut′(e)∧THEME(e,x)
    <mor stem> == temh1 o
    <mor root_o> == TRUE
    <mor der_accent> == FALSE.
```

The network developed so far is captured in figure 2.

The node for each nomen agentis inherits everything except its semantic structure from the event nominalization the nomen agentis is derived from. However, to account for the fact that the accent of the derivational affix is not simply inherited, but inverted, a node `Inv_aff` is needed to account for this inversion. Since accent was defined above as a boolean value, this shift is very straightforward. All that is needed is an operator `not`. Since boolean logic is implemented in DATR, this operator comes for free.

```
Inv_aff:
   <mor der_accent> == <not "<base der_accent>">.
```

If a word belongs to the set characterized by this node, the accent of its derivational suffix is always the opposite of the accent of the suffix in the base. To allow primary derivatives to undergo inversion, `Prim_der` has to be amended by a line including inversion:

```
Prim_der:
    < > == Noun
    <mor stem> == "<phn root>" "<mor der_suffix>"
    <phn root> == OR:<IF: <"<mor root_o>">
                  THEN: Root_o <"<phn root->">
                  IF: <"<mor root_0>">
                  THEN: Root_0 <"<phn root->">>
                  ELSE: "<phn root->">
     <mor der_accent> == IF: <"<mor inv_aff>"
                           THEN: Inf_aff <"<mor der_
                           accent->">
                           ELSE: "<mor der_accent->">.
```

The `Inf_aff`-node is the key to the accent shift patterns discussed above. Because of its generality it can feed any type of accent switch, be it the one attested in **tro*-stems or the switch in second members of bahuvrīhi compounds.

The node defining thematic oxytone nomina agentis, `Nom_ag`, is defined in the following way:

```
Nom_ag:
   <sem sem_struc> == λPλx∃e. P(e) ∧AGENT(e, x) with P ==
                      <base lex_meaning>
   <mor inv_aff> == True.
```

By this definition, nomina agentis inherit all information from the event nominalization they are derived from except for the semantic structure. The accent is inverted due to the fact that the feature `<mor inv_aff>` is instantiated.

Thus, **tomh₁ós* is defined by the following node:

```
Tomh1ó:
   <> == Nom_ag
   <base> == "Tomh1o"
   <sem_struc> == λx∃e.cut′(e) ∧AGENT(e, x).
```

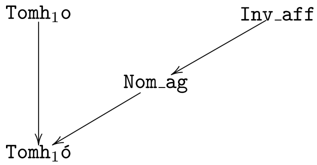

FIGURE 3 *Internally derived nomina agentis*

Figure 3 is the addendum to the network given in figure 2 necessary for deriving nomina agentis.

The network thus accounts for the internal derivation of oxytone nomina agentis from event nominalizations. However, as mentioned above, not every nomen agentis can be derived this way. Rather, some seem to be built directly on verbal roots. This observation can be accounted for in a straightforward way in the current framework. A necessary prerequisite is the assumption of a node deriving primary nouns with accented thematic vowel. Its introduction actually comes for free, as other oxytone primary derivatives exist in the language and have to be accounted for at any rate. See e.g. the thematizations of root-nouns like ved. *padá-* (Debrunner (1954: 141–142), Schindler (1972: *passim*)).

```
Der_suffix_ó:
    <> == Der_suffix_o
    <mor der_accent> == TRUE.
```

This node is identical to Der_suffix_o except for the value of <mor der_accent>. All that is needed now is a reanalysis of nomina agentis. Originally derived from event nominalizations via accent inversion, they can also be analyzed as primary derivatives based directly on verbs. This reanalysis is reflected by the introduction of a new node Nom_ag2, which inherits the *o*-grade of the root through instantiation of the feature root_o and the accented thematic vowel from Der_suffix_ó:

```
Nom_ag2:
    <> == Prim_der
    <sem struc> == λPλx∃e.P(e)∧AGENT(e,x) with P ==
                   <base lex_meaning>
    <mor root_o> == TRUE
    <mor der_suffix> == "Der_suffix_ó".
```

This node connects directly to the lexical entries of the roots. Thus, the reanalysis leading to Nom_ag2 builds entirely on already existing mechanisms. The network for nomina agentis derived from roots is given in figure 4.

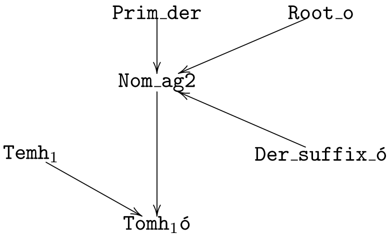

FIGURE 4 *nomina agentis derived from roots*

In a stage of PIE when the reanalysis was already taking place, nomina agentis could inherit their morphological structure and their semantics from `Nom_ag` and `Nom_ag2` alike. Both derivational paths were, therefore, in competition. This is again a case of multiple inheritance, albeit not of the orthogonal type, as both paths define the same values. However, this problem is vacuous, as both nodes not only define the same values, but they define them in an identical way. In a lexicon containing both nodes, inferential distance in the sense of Touretzky (1986: 70) determines that whenever the lexicon contains an event nominalization, the nomen agentis inherits from it, since the derivational path for the internal derivation is shorter than the one for direct deverbal derivation. `Nom_ag2` only becomes relevant when no event nominalization is available.

2.4 *Extending the Analysis*

The analysis of accent shift given here relies crucially on the node `Inv_aff`, which inverts the boolean accent specification of affixes. It accounts neatly for the pattern observed in *o*-stems. However, `Inv_aff` is more powerful, as it actually covers accent shift in all types of internal derivation as well as in compounds.

The concept of internal derivation was introduced as "innere veränderung des stammes" by Schmidt (1889: 92). It was taken up by Schindler (1975a), who used internal derivation to explain accent alternations between cognate words within the Erlangen model of PIE accent. His ideas were taken up inter alios by Nussbaum (1986) and Widmer (2004), who argued for a fully-fledged derivational circle from acrostatic to proterokinetic to hysterokinetic (see also Frazier (2006: 95)). To quote Widmer (2004: 62), "[d]ie Flexionsklassen lassen sich untereinander hierarchisch gliedern und zwar dergestalt, dass der schwache Stamm (idealiter und vorerst deskriptiv) der unmittelbar vorgeordneten Klasse dem starken Stamm der nachgeordneten entspricht". Impressive as this theory may be, it faces serious problems. One is the total lack of typological parallels in attested languages. The most important one, however, concerns the data used as evidence. Since Schindler (1975a) it has been common practice to stipulate that one word with one accent type in language A and a cognate word with the same morphological structure but another accent type in language B stand in a derivational relationship to one another (see e.g. Nussbaum (1986: 22), Rau (1998: 156), Widmer (2004: 79)). However, this stipulation is dubious at best since the words compared belong to distinct and discrete morphological systems, each with a long and intricate, albeit hardly ever traceable, prehistory. Thus, one might argue that their derivational connection is assumed simply because the prehistory of the respective words is unknown. What is known, though, are the data and—by stipulation—the underlying accentological system. The mechanism that seems to be operating here is what Tversky and Kahneman (1973) call the Availability Heuristic, viz. neglecting probability in favour of a bias towards what is known. The theory of internal derivation is weakened further by the fact that hardly any word used as evidence is actually attested in the accentual paradigm presupposed by the so-called derivational circle. The alleged shift from acrostatic to proterokinetic, for example, is often illustrated by ved. *krátu-* ⇒ ved. *kratú-* (Widmer 2004: 65), both with columnar accent. Even less convincing is ved. *ā́yu-* ⇒ *yóḥ/* (Nussbaum (1986: 143), Widmer (2004: 65)), since Occam's razor demands that the latter word be analyzed as a gen.sg. (attested in av. *yaoš*). Alleged examples for the shift from protero- to hysterokinetic stems were discussed in Keydana (2013: 54–55). Typical ones are gr. ψεῦδος ⇒ ψευδής and ved. *ápas-* ⇒ *apás-* (cf. Schindler (1975b: 263), Stüber (2002: 27), who note that this type may be recent), again with columnar accent in both members of the correlation. Another type mentioned in the literature (Stüber (2002: 26), see however Rau (2009: 51–58)) is the shift from alleged proterokinetic to amphikinetic stems as in ved. *bráhmaṇ-* ⇒ *brahmáṇ-* and gr. πεῖραρ ⇒ ἀπείρων. In all these examples, and certainly in those where both parts of the derivational relation belong to the same language (at the same time), the accentological pattern always boils down to a simple shift along the lines characterized by the quote from Wackernagel above. Thus, Fortson (2010: 122) can describe internal derivation adequately by the following simple statement: "The language could derive new nouns or adjectives simply by shifting the accent rightward." Fortson's simple generalization is further strengthened by the fact that all the indisputable cases of internal derivation show no quantitative ablaut alternation in connection with the accent shift. The qualitative ablaut attested in some of the pairs is also not induced by the shift. Rather, it seems to be purely morphological—at least in late PIE and the early daughter languages.[8] I thus conclude that the axiom given in `Inv_aff` is sufficient to

8 The mechanism of internal derivation is reminiscent of a special type of conversion in

account for the accent shift in all types of internal derivation, and that there is no valid evidence for a "Derivationskette" as assumed e.g. by Widmer (2004: 198).[9] The validity of `Inv_aff` is further corroborated by accent shifts in bahuvrīhi compounds. As shown by Wackernagel (1957: 298–299), the second part of a bahuvrīhi, if accented, has a tendency to be oxytone in spite of the fact that the simplex is typically barytone. Oxytone simplicia, on the other hand, become paroxytones in compounds. Thus we get *ardʰendrá-* (: *índra-*) and *puruvī́ra-* (: *vīrá-*). This pattern is again easily captured by `Inv_aff`. Due to its simple boolean nature, the axiom leaves the direction of the shift unspecified.[10]

3 Conclusions

PIE accent was morphological. The system can be explained fully by assuming that each morpheme was lexically specified for the presence or absence of accent. A simple accent grammar based on the interplay of lexical accent, head dominance, and the BAP generates the attested accentological patterns of athematic and thematic primary derivatives alike. Consequently, there is no need to assume different historical strata (and different grammars) for the different stem types. Differences in ablaut behaviour are due to the phonological make-up of the respective suffixes. They, too, do not corroborate diachronic stratification.

The accent grammar is fed by a lexical network containing words specified for accent. This network can also describe accent shift. A simple axiom turning the underlying accentual value of the base into its opposite accounts for all types of internal derivation, be it in thematic or athematic stems.

The grammar and the lexical network presented here are descriptively adequate for the patterns attested in the early IE languages and for a state of

English. Nouns can be derived from verbs by accent shift to the left, as in *to tormént* vs. *tórment* or *to blàck óut* vs. *bláckout*. See Plag (2003: 110).

9 A similarly simple mechanism for internal derivation was introduced by Kiparsky (2010: 169), who accounts for the shift by deaccentuation. For a critique of his model see Keydana (in print). A crucial difference to the account presented here is the directionality inherent to Kiparsky's rule. In light of the accent shifts in compounds discussed below, this is a serious drawback.

10 Contrary to Widmer (2013: 192) I see no necessity to assume that this pattern is late and based on original oxytones.

PIE accessible through external derivation. The proposed system has therefore some distinct advantages over reconstructions like the "Erlanger Modell" and others:

- the model is based on attested patterns,
- it can give a unified account for athematic and thematic stems alike,
- it is able to deal with the accent shift in all types of internal derivation in a very simple way,
- it is typologically plausible.

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