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Inheritance hierarchies and historical reconstruction: towards a history of Slavonic colour terms

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Inheritance Hierarchies and Historical Reconstruction: Towards a History of Slavonic Colour Terms[1]

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0. Introduction

The last decade has witnessed an interest in inheritance hierarchies for the representation of linguistic knowledge. An obvious application is to historical reconstruction of a language family, but this is largely unexplored territory. We demonstrate the merits of such an approach with a default inheritance treatment of the colour terms of Slavonic: Slavonic because it is uncontroversially a genetic unit, and colour terms both because of their universality and because of the tight constraints on a language's colour term inventory (Berlin & Kay 1969, and subsequent work). In section 1 we discuss the colour terms of Slavonic and introduce Berlin and Kay's typology and the notion of basic colour term. Section 2 describes our methodology and in section 3 we show how it is applied to Slavonic. The main results are discussed in section 4.

1. Slavonic colour terms

Our interest is the colour terms of Slavonic, specifically the basic colour terms. We will be using Berlin and Kay's evolutionary hypothesis, and their notion of basic colour term, to check against our analysis.

1.1 The notion of basic colour term

It has been claimed that colour terms map onto "biologically based semantic universals" (Kay & McDaniel 1978:611). Further, Berlin and Kay (1969) propose that terms for basic colours are universally highly constrained and that as languages develop, they acquire colour terms in a set order. The original colour hierarchy is shown in Figure 1 (modified recently in Kay, Berlin & Merrifield 1991). An evolutionary stage I language will have terms for BLACK and WHITE, and an evolutionary stage II language will have terms for BLACK, WHITE and RED. At stage III either YELLOW or GREEN emerge; if it is GREEN then YELLOW will appear at stage IV, and vice versa. BLUE and BROWN are added at stages V and VI respectively, and at stage VII PURPLE, PINK and ORANGE are added, but no prediction is made as to the order of the colours within this stage. GREY may emerge at stage VII, but it is given a special 'wildcard' status allowing it to develop at earlier stages in some languages.

$$\begin{bmatrix}\text{white}\\ \text{black}\end{bmatrix} < [\text{red}] < \begin{bmatrix}\text{green/}\\ \text{yellow}\end{bmatrix} < \begin{bmatrix}\text{yellow/}\\ \text{green}\end{bmatrix} < [\text{blue}] < [\text{brown}] < \begin{bmatrix}\text{purple}\\ \text{pink}\\ \text{orange}\\ \text{grey}\end{bmatrix}$$

Figure 1. The colour terms hierarchy.

Important for the colour term hierarchy is the notion of basic colour term. A candidate for basic colour term status must be shown to pass the Berlin and Kay (1969:6-7) criteria for basicness. First, the term must be shown to be monolexemic,

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i.e. the meaning is not derivable from the sum of its parts. This would rule out *bluish*. Second, the colour it signifies must not be included in the signification of another basic term. This rules out, for example *scarlet*. Third, it must apply generally, and not be restricted to a limited number of objects, as is the case with *blond* and *flaxen* which denote hair colour. A fourth test is whether or not it is psychologically salient. There is already a substantial literature on psychological salience as a technique for eliciting basic colour terms, and methodologies and their application to Russian, amongst other languages, can be found in Moss, Davies, Corbett, and Laws 1990 and Corbett and Davies 1997.

1.2 Slavonic languages

The genetic unit known as Slavonic comprises about fifteen languages. Two of these are no longer living: Polabian, a West Slavonic language which died out in the 18th century, and Old Church Slavonic (a South Slavonic language). The number of speakers of the languages varies enormously: Russian has the largest number of speakers, about 150 million (Timberlake 1993:827), whereas there are only about 70 thousand speakers of Upper and Lower Sorbian (Stone 1993:594-595). The common ancestor language Proto-Slavonic is a descendant of Indo-European. The languages are often organized into three main groups, East Slavonic (for example, Russian and Ukrainian), West Slavonic (for example, Czech and Polish) and South Slavonic (for example, Macedonian and Bulgarian).

Slavonic is interesting with regard to the colour term hierarchy. It has been found that Russian has a unique set of terms: in addition to having the eleven basic colour terms that constitute a Stage VII language it has a second basic colour term for BLUE. Reference was made to this in Berlin and Kay (1969:36, 99) and later in Kay and McDaniel (1978:640-1) and it was questioned whether Russian constituted a further stage, i.e. whether Russian was a Stage VIII language. Using various psycholinguistic tests, Russian's unique status with twelve basic terms was confirmed by Davies and Corbett (1994). Information on the basic colour terms of the various Slavonic languages is provided in the individual language chapters in Comrie and Corbett (1993). This is presented in Table 1. It should be noted that for a number of the languages research still needs to be done into what constitutes a basic colour, according to the Berlin and Kay criteria outlined above. Where this is the case, the candidate colour term appears with a question mark. Languages may lack basic terms (indicated by a blank cell), and not all have two basic terms for BLUE.

	Black	White	Red	Green	Yellow	Blue		Brown	Purple	Pink	Orange	Grey
						Blue (dark)	Blue (light)					
Russian	čërn	bel	krasn	zelën	žëlt	sin	golub	koričnev	fioletov	rozov	oranžov	ser
Belorussian	čorn	bel	čyrvon	zjalën	žojt	sin	blakitn ?	bur ?	barvov ?	ružov	aranžav	šèr
Ukranian	čorn	bil	červon	zelen	žovt	sin	blakitn ?	brunatn ?	-	-	-	sir
Czech	čern	bil	červen	zelen	žlut	modr		hned	fialov ?	ružov	oranžov ?	šed
Slovak	čiern	biel	červen	zelen	žlt	modr ?	sin	hned ?	fialov	ružov	oranžov	siv
Sorbian (U)	čorn	bel	čerwjen	zelen	žołt	modr		brun	fijałkow ?	rožow	oranzow ?	šer
Sorbian (L)	čarn	bel	čerwjen	zelen	žołt	modr		brun	fijałkow ?	rožow	oranzow ?	šer
Polish	czarn	bial	czerwon	zielon	żołt	niebiesk		brązow	fioletow ?	ružow ?	pomaranczow	szar
Cassubian	czôrn	biôł	czerwon	zelon	żołt	modr		brun	lilew	ružow	pomerancow	sëw
Bulgarian	čeren	bjal	červen	zelen	žalt	sin		kafjav	morav	rozov	oranžev	siv
Macedonian	crn	bel	crven	zelen	žołt	sin		kafeav	violetov	rozov	portokalov	siv
Serbo-Croat	crn	bijel	crven	zelen	žut	modar ?		braon ?	ljubičast	ružičast	-	siv
Slovene	črn	bel	rdeč	zelen	rumen	moder	sinj	rjav	-	-	-	siv

Table 1: Slavonic basic colour terms from Comrie and Corbett (1993)
(Note: ? denotes uncertainty about term's basicness; Sorbian U/L = Upper/Lower Sorbian)

2. Methodology

We take the known synchronic facts about Slavonic colour terms, essentially the information in Comrie and Corbett (1993), together with conventional wisdom about the historical relations between the languages as the basis for inferring an inheritance hierarchy representation of Slavonic's history. Our approach to hierarchy construction is dynamic: as new facts become available, for example new evidence for a term's basic status, or new diachronic data, the inheritance hierarchy can be restructured to accommodate the findings. Moreover, gaps in the hierarchy are filled in by default. In this way speculation about the diachronic situation is well motivated, being expressed as a theorem of the model.

2.1 Default inheritance

A central concern of theoretical linguists is the identification of linguistic generalizations and, where necessary, the stating of exceptions to these generalizations. Default inheritance allows the structuring of information such that general information is encoded near the top of an inheritance hierarchy, while more specific information is located lower in the hierarchy. Information is retrieved from the bottom of the hierarchy upwards, with more specific information overriding more general. The notion of default inheritance is central to our approach. Shared linguistic facts and, by implication, a shared history, are captured by abstracting to a common node from which daughter language nodes inherit. Since the inheritance employed is nonmonotonic, inherited information may be overridden or augmented, thus allowing a language's unique identity to emerge. Figure 2 shows a default inheritance hierarchy of Slavonic. Generalizations about the Slavonic languages appear at abstraction nodes: East Slavonic will contain facts generalizable for Russian, Ukrainian and Belorussian. Facts general to Slavonic as a whole can be stated at the root node SHARED SLAVONIC. The individual languages are represented as leaf nodes, inheriting generalizations about Slavonic, as well as containing language specific material.

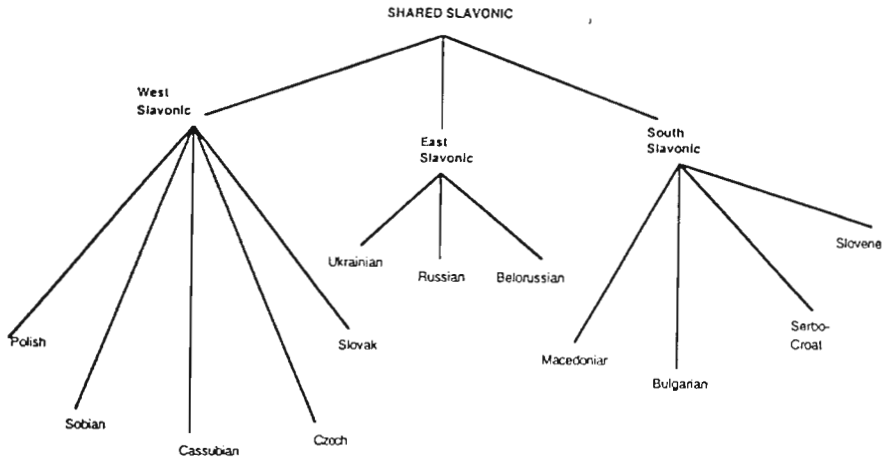


Figure 2: Slavonic hierarchy

2.2 Generaliziation locating tool

The facts about Slavonic colour terms are taken from the language chapters in Comrie and Corbett (1993). They are expressed in DATR (Evans & Gazdar 1996), a computer language for expressing default inheritance structures. The known colour facts serve as the input to a computer program that serves as a generalization locating tool (or 'discovery procedure'). The output is a compact abstraction of the facts in the form of a nonmonotonic inheritance tree.

The generalization locating tool operates in two stages. Firstly, it induces a monotonic inheritance tree. Secondly, it maps this monotonic inheritance tree to a nonmonotonic one. The first stage evaluates all possible attribute-value set intersections on an information-theoretic basis. One of the highest scoring intersections is chosen on tree geometry grounds and replaces its component attribute-value sets in the cohort. This 'construct, evaluate and replace' step is repeated until (non-empty) intersection is no longer possible. This process implicitly defines a monotonic inheritance tree (with a possibly empty root).

The second stage takes the monotonic tree and, for each attribute, finds the most common attribute-value pair. These commonly found attribute-value pairs are then added to the root of the tree and consequently redundant pairs are stripped from lower nodes. Empty nodes are then purged from the tree. This process leaves one with a nonmonotonic inheritance tree that is descriptively equivalent to the monotonic tree from which it derives.

3. Applying the methodology to Slavonic

We first build an inheritance hierarchy of Slavonic colour terms based solely on the synchronic data available. This forms an initial hypothesis of Slavonic colour terms in the absence of any diachronic data. The procedure is as follows. Each of the language groupings, East, West and South Slavonic, is treated in turn. Colour facts from the East Slavonic group of languages, for example, are recorded and provided as input to the hierarchy generating tool, as in (1). Note that an abstract orthography is required so that what are agreed to be phonological similarities can be incorporated.

(1)
```
Russian:
        <black> = _C_Orn
        <white> = b_El
        <red> = krasn
        <green> = z_E_L_On
        <yellow> = zh_O_L_t
        <blue_dark> = si_N
        <blue_light> = golub
        <brown> = korichnov
        <purple> = _Fioleto_V
        <pink> = r_U_Zo_V
        <orange> = _Oranzho_V
        <grey> = _S_Er.
```

```
Belorussian:
      <black> = _C_Orn
      <white> = b_El
      <red> = _C_Er_V_On
      <green> = z_E_L_On
      <yellow> = zh_O_L_t
      <blue_dark> = si_N
      <blue_light> = blakitn
      <brown> = bur
      <purple> = barvov
      <pink> = r_U_Zo_V
      <orange> = _Oranzho_V
      <grey> = _S_Er.

Ukrainian:
      <black> = _C_Orn
      <white> = b_El
      <red> = _C_Er_V_On
      <green> = z_E_L_On
      <yellow> = zh_O_L_t
      <blue_dark> = si_N
      <blue_light> = blakitn
      <brown> = brunatn
      <purple> = undefined
      <pink> = undefined
      <orange> = undefined
      <grey> = _S_Er.
```

The output is an inheritance tree expressed in DATR consisting of abstraction nodes, language leaf nodes, and the inheritance relations between the nodes as follows:

(2)

```
EAST_SLAVONIC:
      <blue_light> == blakitn
      <red> == _C_Er_V_On
      <black> == _C_Orn
      <white> == b_El
      <green> == z_E_L_On
      <yellow> == zh_O_L_t
      <blue_dark> == si_N
      <pink> == r_U_Zo_V
      <orange> == _Oranzho_V
      <grey> == _S_Er.

Russian:
      <> == EAST_SLAVONIC
      <red> == krasn
      <blue_light> == golub
      <brown> == korichnov
      <purple> == _Fioleto_V.

Belorussian:
      <> == EAST_SLAVONIC
      <brown> == bur
      <purple> == barvov.
```



```
Ukrainian:
      <> == EAST_SLAVONIC
      <brown> == brunatn
      <purple> == undefined
      <pink> == undefined
      <orange> == undefined.
```

Hierarchies representing West and South Slavonic are produced in the same fashion. Figures 3 and 4 show the West and South Slavonic hierarchies respectively. A good number of colour facts are common to the West Slavonic languages, and these are situated at the root node, as shown in Figure 3. Note the emergence of three sub-groupings: Sorbian and Cassubian, defined by BROWN, Czech and Slovak, defined by BROWN, PURPLE and ORANGE, and Polish. It is interesting to note that Cassubian is not grouped together with Polish, given the fact that it is sometimes taken to be a Polish dialect.

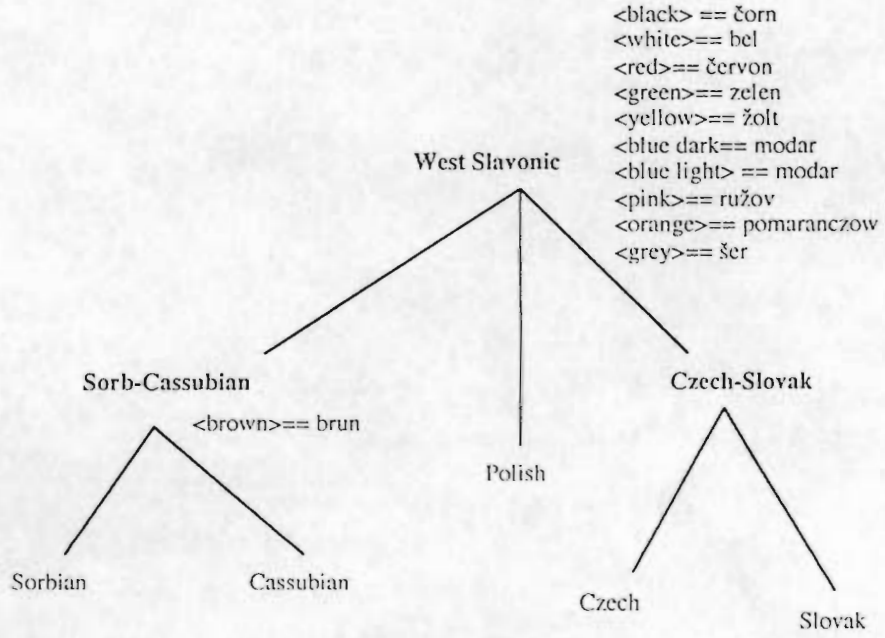
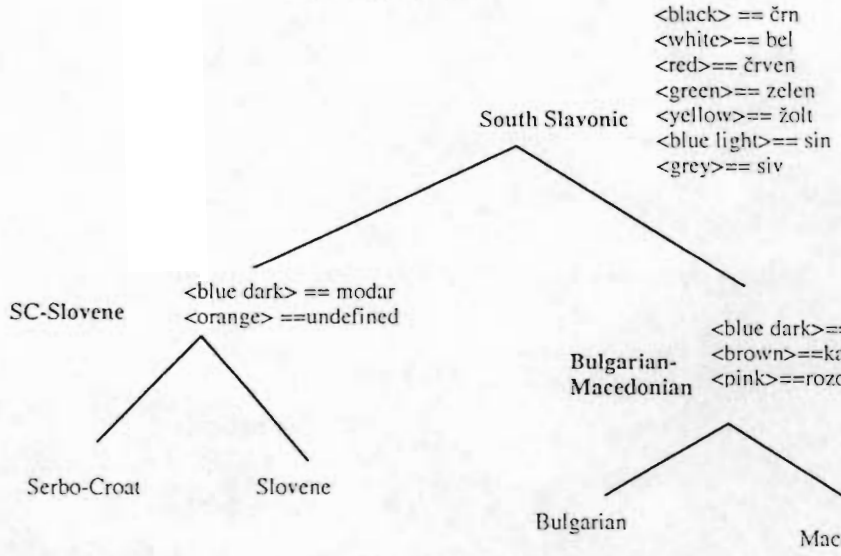


Figure 3. West Slavonic hierarchy

In Figure 4, Serbo-Croat is grouped together with Slovene based on a shared term for BLUE (dark) and the fact that the term for ORANGE is lacking, and Macedonian and Bulgarian form another group, based on shared terms for BLUE (dark), BROWN and PINK.

Figure 4. South Slavonic hierarchy



The three hierarchies are subsequently combined to form a major hierarchy, representing Slavonic. The abstraction nodes of each hierarchy are taken together and are used as input to a further hierarchy-generating operation.

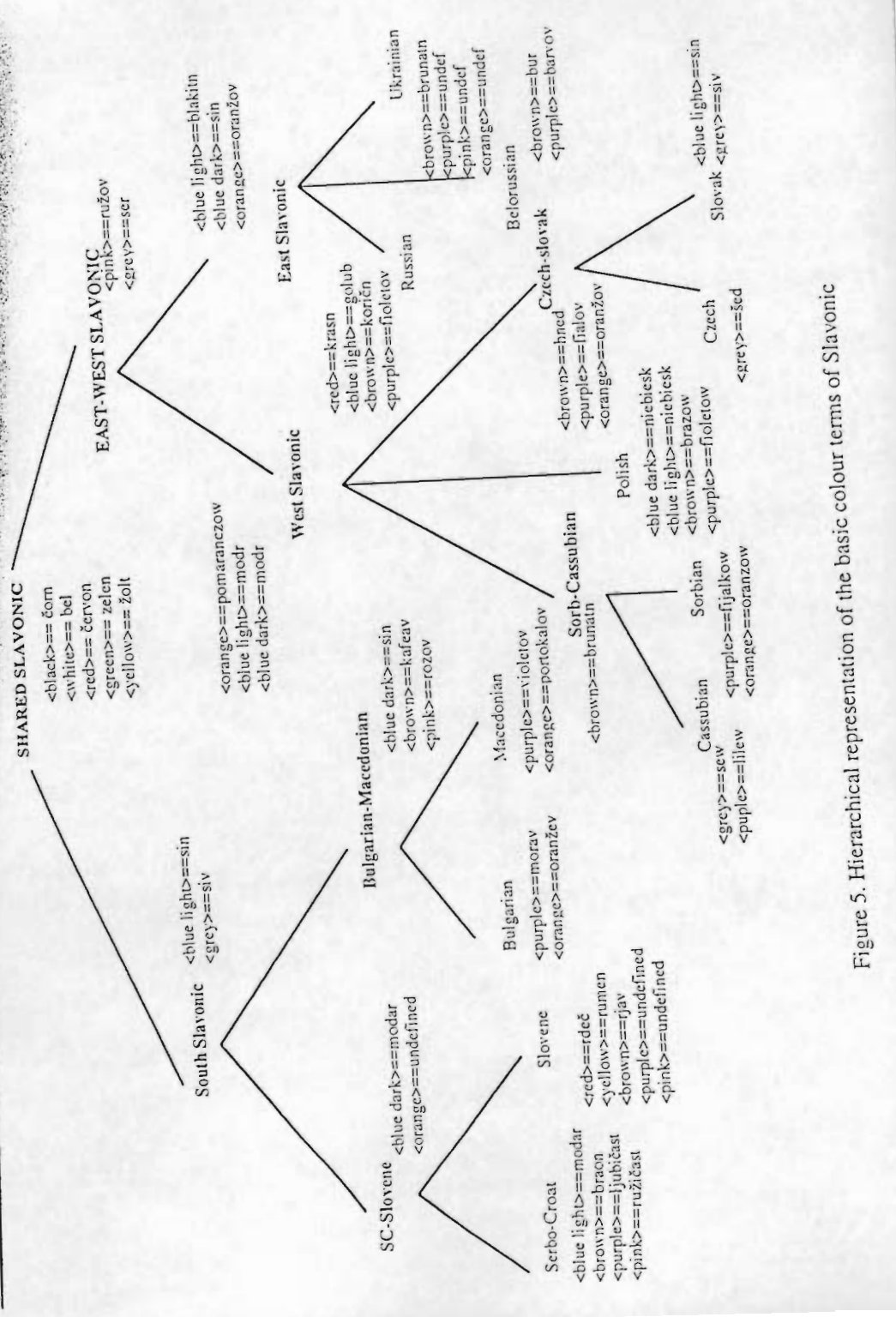


Figure 5. Hierarchical representation of the basic colour terms of Slavonic

The results, after node relabelling and minor adjustments, are shown in Figure 5. All the colour facts in Table 1 are distributed across the various nodes in the hierarchy. The overall shape of the hierarchy is interesting. The initial branching divides South Slavonic languages from East and West Slavonic languages. This is based (partly) on the different terms for GREY. As we discussed above, there are further divisions within the West Slavonic and South Slavonic groups.

4. Discussion

After considering how the hierarchy compares with Berlin and Kay's evolutionary hypothesis, we discuss the implications of having two basic colour terms for BLUE in Slavonic, and see how this may be captured in our account.

4.1 Comparison with Berlin and Kay's evolutionary hypothesis

The first question we should ask is how far the analysis captures Berlin and Kay's insights into the evolution of colour terms. The root node SHARED SLAVONIC contains the highest level generalisations and represents an hypothesis about Proto Slavonic colour terms. If we compare the information at SHARED SLAVONIC with the Berlin and Kay typology in (Figure 1) we see that according to our account, based entirely on synchronic colour data and the identification of generalizations, the hypothetical Proto Slavonic does not contradict Berlin and Kay in that the five colour terms available are the exact five predicted by the typology. In terms of the proposed historical reconstruction methodology this is a highly positive outcome. Moreover, the result compares favourably to other hypotheses about Proto Slavonic colour terms. In our account Proto-Slavonic constitutes a stage IV language. This can be compared to Priestly's (1987) account who, using various phonological, semantic, genetic and geographical criteria, as well as referring to Berlin and Kay's notion of basicness, proposes that early Proto-Slavonic is certainly stage IV, and questionably stage V. Schenker (1993) concurs with this, and both agree that BLUE and GREY are a later innovation, with various competing roots. This last point is reflected in our account if we note that of the three terms appearing at the first branch, at the South Slavonic and East West Slavonic nodes, two of these are terms for BLUE and GREY. Recall from section 1.1 that GREY is a viewed as wildcard for Berlin and Kay, so its appearance at this point in the hierarchy does not contradict their typology.

At the same time a number of hypotheses have been generated by our methodology which are completely at odds with Berlin and Kay. Two of these concern PINK and ORANGE. Terms for these colours appear relatively high up the tree in our account, crucially in some cases higher than BLUE and BROWN. For example, PINK is one of the two facts at East West Slavonic, representing a development ahead of BLUE and BROWN, and ORANGE appears at West Slavonic, East Slavonic, and SC-Slovene, representing a development simultaneous with BLUE and ahead of BROWN.

We end our comparison with Berlin and Kay by considering areas where a term is simply unavailable, expressed in our account as 'undefined'. For example, of the four colour facts at Ukrainian three are undefined. Unavailability in the Slavonic data accords well with Berlin and Kay, occurring precisely towards the end of their hierarchy, in other words at the later evolutionary stages. We can capture this better in our account by a simple modification. A fact is introduced which expresses that colour terms additional to those already stated as being part of

Shared Slavonic are undefined by default. This fact is situated at the root node Shared Slavonic, and thus inherited throughout the hierarchy, and is represented in (3).

(3)
```
SHARED_SLAVONIC:
        <> == undefined
        <red> == _C_Er_V_On
        <black> == _C_Orn
        <white> == b_El
        <green> == z_E_L_On
        <yellow> == zh_O_L_t.
```

By specifying additional colours, daughter nodes will override this default. Some nodes, however, will inherit this fact. By so doing, the node generalising over Serbo-Croat and Slovene represented in (4) no longer needs a statement about ORANGE. We mark these no-longer -needed equations with '%' below. Similarly the Slovene node no longer needs to specify PURPLE and PINK (5), and Ukrainian no longer needs a statement about PURPLE (6). It should be noted that Ukrainian must still specify the unavailability of PINK and ORANGE, since these terms appear too high up the tree, as noted above.

(4)
```
SC_SLOVENE:
        <> == SOUTH_SLAVONIC
        <blue dark> == mod_Ar.
      % <orange> == undefined.
```

(5)
```
Slovene:
        <> == SC_SLOVENE
        <red> == rdech
        <yellow> == rumen
        <brown> == rjav.
      % <purple> == undefined
      % <pink> == undefined.
```

(6)
```
Ukrainian:
        <> == EAST_SLAVONIC
        <brown> == brunatn
      % <purple> == undefined
        <pink> == undefined
        <orange> == undefined.
```

4.2 Capturing the two basic BLUE terms in Slavonic

As mentioned above, Slavonic, and in particular Russian, is known to contradict Berlin and Kay in one specific area, namely concerning the terms for BLUE. Russian has an additional basic term for BLUE, suggesting that it has evolved beyond the stages claimed by Berlin and Kay. These are *sin(ij)* translated as 'dark blue' and *golub(oj)* translated as 'light blue'. Extensive work has been carried out on BLUE in Russian, and the evidence points to two distinct terms (see Corbett & Morgan 1988, Davies & Corbett 1994 and Davies, Corbett, McGurk & McDermid 1998). Other Slavonic languages appear to have this phenomenon. We have accounted for this by having two separate paths for BLUE, `<blue dark>` and `<blue light>`, for each Slavonic language. However, this fails to capture the fact

that some Slavonic languages have only one BLUE term. For example, Figure 1 suggests the Polish has two basic BLUE terms which happen to share the same value. Slavonic is clearly divided between languages with two BLUE terms, and languages with one BLUE term. This can be more elegantly captured by viewing BLUE light as a more specific kind of BLUE.[3] By default, the term for BLUE will cover both the less specific and more specific cases. However, in some instances a separate term will be used for the more specific BLUE light, as in Russian. This can be captured by the longest-path-wins semantics of the DATR language. By default any extension of a path will return the same value as the unextended version, since the value is determined by the leading subpath. Note that this captures very satisfactorily the notion of basic colour term. The value for a path `<red light>` is the same value as that for the path `<red>`. In other words, in most cases the basic colour term will be used when various sorts of modification are made to the basic colour, such as light, dark, pale, etc. At the same time this allows for the extended path to be assigned a different value.

(7) is a partial representation of what is required at the Russian node which has two separate terms for BLUE,[4] and (8) is a partial representation of Polish which has a single BLUE term, and has been modified accordingly. In the case of Russian, the extended path `<blue light>` is assigned a value different to its leading subpath `<blue>`. When `<blue>` and `<blue light>` are queried, two different values will be returned expressing two basic terms for BLUE in Russian. In the case of Polish, when `<blue light>` is queried the value returned will be that of `<blue>`, just as `<red light>` will return the same value as `<red>`.

(7)
```
Russian:
      <> == EAST_SLAVONIC
      <blue> == sin
      <blue light> == golub
      ...
```

(8)
```
Polish:
      <> == WEST_SLAVONIC
      <blue> == niebiesk
   %  <blue light> == niebiesk
      ...
```

The result of this modification is that the number of colour facts in the Slavonic hierarchy are significantly reduced. Figure 6 represents the new analysis with the modifications made to capture BLUE in Slavonic. Bold type points to where the analyses differ. Square brackets represent the absence of those facts present in the pre-modified analysis. (Note that modifications made to capture the unavailability of certain colour terms are also represented in Figure 6) At the West Slavonic node we see two BLUE facts replaced by a single BLUE fact. This captures the fact that West Slavonic has only one term for BLUE, whereas East Slavonic has a second term for the more specific BLUE light. Polish, a West Slavonic language, now only needs to specify one fact about BLUE. Turning to South Slavonic, we see the generalization that there is only one term. A consequence of this is that the node generalising over Bulgarian and Macedonian no longer requires a statement about BLUE: the fact that there is a single term, and that it is *sin* is inherited by default. Slovene and Serbo-Croat also have the generalization that there is a single BLUE term, stated at the generalising node SC-Slovene. However, instead of *sin* the term

is *modar*. This allows us to remove the statement about BLUE at the Serbo-Croat node. It also allows us to capture the fact that Slovene is unusual in being the only South Slavonic language that has a second term for BLUE. Though this requires an extra statement at the Slovene node, the extra statement concerns the more specific BLUE term, which is what we would expect. In other words, it represents an innovation.

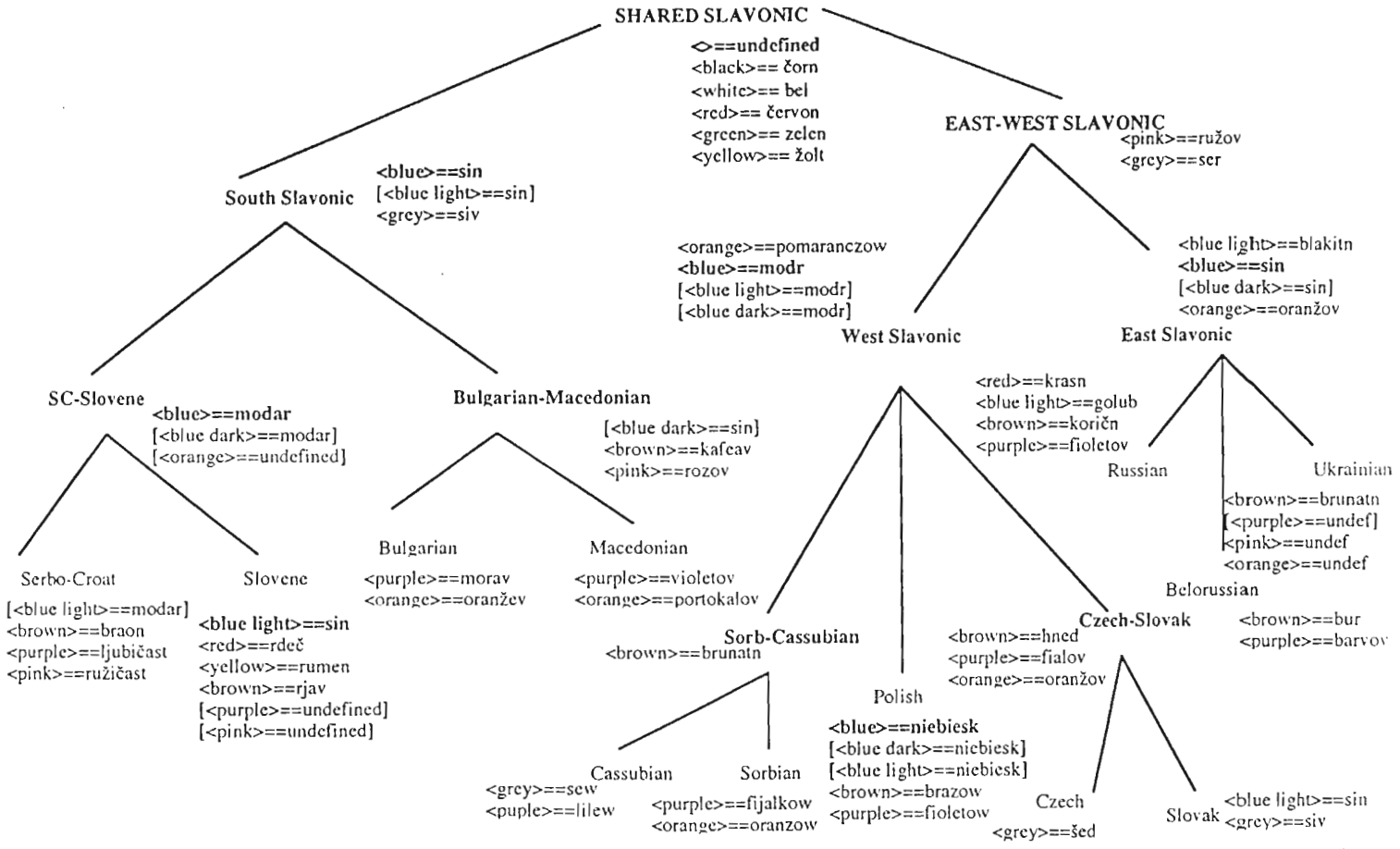


Figure 6. Modified Slavonic colour terms hierarchy.

5. Conclusions

We have demonstrated that the methodology proposed provides an effective and efficient way of organising data as it becomes available, and forming hypotheses about a language family's history. We provided exclusively synchronic data, specifically on colour terms. We were therefore able to use the Berlin and Kay colour terms typology as a measure of the hypotheses generated. Though there were some inconsistencies with the typology, the general picture of Slavonic that emerged was one where Proto-Slavonic was seen as a Berlin and Kay stage IV language. Modifications of the initial analysis allowed us to capture the unavailability of certain colour terms, as predicted by the typology, as well as Slavonic's unique treatment of BLUE. Finally, it should be noted that since the hypotheses that are developed are default inheritance hierarchies, gaps in the data will be filled in by default, such that each analysis represents a full set of hypotheses about the historical facts, in our case all the facts about Slavonic colour terms.

Notes

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[2]Andrew Hippisley is from the Department of Linguistic and International Studies at the University of Surrey, and Gerald Gazdar is from the School of Cognitive and Computing Sciences at the University of Sussex

[3]This suggestion emerged from discussion with Roger Evans and Greville Corbett.

[4]In fact one of these values is inherited from the East Slavonic node.

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