Lexical Stability and Kinship Patterns in Australian Languages*

Claire Bowern
Amalia Skilton
Hannah Haynie
Yale University

ANU CRLC Seminar Series, March, 2014

1 Overview

- How stable are semi-closed class lexical categories?
- Does system stability exist independently of lexical form stability?
- Is there evidence for paradigmatic changes in these categories (Traugott and Dasher, 2002; Anttila, 2003)?
- How do semi-closed classes recruit new material?

⇒ Test with **kinship** data from **Pama-Nyungan** (Australian) languages, in particular, sibling terms.

⇒ Compare results from the comparative method (lexical reconstruction) with those derived statistically from system reconstructions using Bayesian Trait Analysis.

2 Why Kinship?

- Universal language category:
  - All languages have words for family members, though the systems vary across the world.
  - Variation in the systems, however, is defined; there are a limited number of attested systems (see further Murdock 1968)
- Claimed to be **both** 'stable' phylogenetically and etymologically conservative (Dumont, 1953; Smith, 1963; Friedrich, 1966). This is important for a family like Pama-Nyungan, where there is extensive lexical replacement (Bowern and Atkinson, 2012).
- Allows investigation of system vs. lexical stability. Unlike some other closed class items (such as pronouns), kin terms are not generally grammatically peculiar.[1]

3 Data and Methods

3.1 Data

- For the current study, we use **191** Pama-Nyungan languages (see map), coded for sibling system type (Murdock, 1968; Jordan, 2011).
- We restrict our analysis to Pama-Nyungan languages because we need to conduct analyses with an established phylogenetic tree. Such a tree does not exist for higher levels of putative relationships amongst Australian languages.[2]

*This work was funded by NSF grant BCS-0844550. Thanks to: Fiona Jordan; Yale's Historical Linguistics Lab; The Austkin Project (Australian National University)

[1]This is not to say that kinship cannot be marked in grammar. See, for example, Evans 2003 for discussion of 'kintax', where kinship marking is found on grammatical items such as pronouns.

[2]These analyses do not tend to produce reliable results for very small trees because of the limited possibilities for inferring transition rates across very small data sets. See further below.

- The lexical data come from Bowern's comparative files and the Austkin project;[3] We recorded the kinship terms and derived information about the sibling system, such as whether the system marks a sex of referent distinction and/or a relative age distinction (see further below).
- The languages in the sample were those for which the sibling nomenclature system could be inferred.
  - System was inferred based on the attested forms and their meanings given in the data.
  - The Austkin database has 337 languages, but not all have female sibling terms attested. It is unclear why terms for female siblings should be relatively undersampled.
  - Others have data which was ambiguous in other ways and could therefore not be included.

    (1) Darkinyung: *pingay* 'brother' ; *paping* 'elder brother' ; *ngaRin* 'sister, elder sister' (Wafer and Lissarrague, 2008)

    It's unclear here whether *ngaRin* means *both* younger sister and elder sister, or whether it is "sister, specifically, elder sister" and a term for younger sister is not recorded.[4]
- Lexical reconstructions were completed using the comparative method (Rankin, 2003; Hock and Joseph, 1996; Hock, 1991).
- In the Austkin dataset there is evidence for terms which vary based on the sex of the speaker (for example, a man's sister vs a woman's sister); however in each case for the languages in our dataset, these terms coexist alongside terms which are not differentiated by speaker.

  (2) Purduna: *tyuyu* eZ (elder sister); *kayana, katya, kurta* eB (elder brother); *marrka* yB, yZ (younger sibling); *kurta* B (brother), *kuntyantyu* mZ (man's sister) (fZ or mB, mZ not recorded) (Austkin).

  (3) Yir Yoront: *pam-pothawl* feZ (woman's older sister), *pam-keperr* meZ (man's older sister) vs *lu'anvng, puthlun, alun* eZ (elder sister) vs *ya'ar* Z 'sister' (Austkin)

  (4) Mangarrayi: *papa* mZ, Z, eZ, (cf *wawa* eB, *yapa* B, yB, yZ); fZ not recorded (Austkin)
- The types of system attested in our sample are summarized in Figure 1 below.[5]
  - Six states are attested in the 191 languages used for this sample, though with unequal frequency.
  - These states are the 'trait values' and form the input to the trait reconstruction.
  - Hereafter 'three-term' system means eB, eZ, yB=yZ (i.e., elder brother, elder sister, younger sibling)

4 Bayesian Ancestral State Reconstruction

Somewhat different type of reasoning from that with which linguists are familiar.

- Bayesian trait correlation and reconstruction analysis (with BayesTraits v2 (Pagel et al., 2004))
- Aim:
  - ⇒ Find the most likely values for the parameters of an evolutionary model (given assumptions about trait evolution) and use those parameters to reconstruct trait values probabilistically.
- Evolutionary model:

[3] See `austkin.net` and Dousset et al. (2010) for further information. Details of Bowern's comparative database can be found in Bowern and Atkinson (2012) and Bowern (2012).

[4] One possible line of logic would be to use the semantics of sibling terms in closely related languages; however, doing this would lead to circularity in our case, so we prefer to leave such languages excluded.

[5] Map 1 shows all languages for which we have data, not just those from Pama-Nyungan languages.

			eB	eZ	yB	yZ	
1	Relative Age	n=5	A		B		
2	Sex of referent	n=18	A	B	A	B	(Yellow)
3	Rel. Age and sex of referent	n=88	A	B	C	D	(Red)
4	Sex distinction for older sibs	n=67	A	B	C		(Blue)
5	Age distinction for male sibs	n=12	A	B	C	B	(Green)
6	Sex of speaker	n=1					
	Unreconstructible		??	??	??	??	(Grey)
	Ambiguous	n=3	A	B	C	B/C/D	(Purple)

Table 1: Types of Sibling System

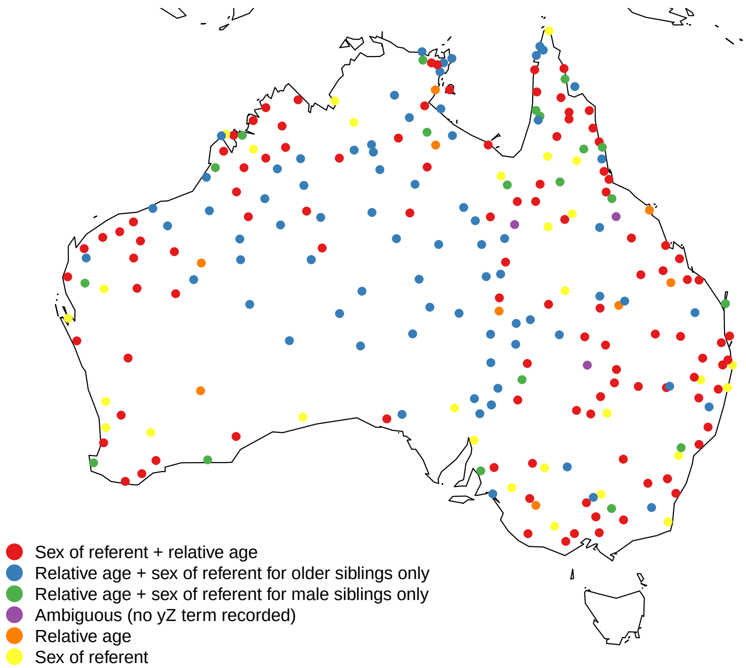

Figure 1: Map of languages in sample

  - Here: stochastic, neutral model (any trait can change into any other trait, at a certain rate)

- Parameters (see below)
- Reconstruction
  - Use our model and estimated parameters to reconstruct the most likely trait values for different nodes.
  - These are expressed as probabilities.

- Procedure (cf. Dunn et al. 2011; Jordan 2011; Mace and Jordan 2011):
  - Map traits onto a phylogeny (derived from other data); see Figure 2.
  - Assume trait values change (stochastically) over time;
  - Estimate transition rates between individual traits;
  - Evaluate possible parameter values by calculating the model likelihood (allows us to find an optimal model);
  - Probabilistic reconstruction of traits to proto-languages (both root and intermediate nodes);
  - → Can use reconstructions to subsequently measure features such as the level of phylogenetic signal (e.g. are the trait values strongly correlated with phylogenetic splitting?)

- The phylogeny used for the analysis is from Bowern and Atkinson (2012), recompiled with additional languages;
- We used Maximum Likelihood methods, with 200 iterations (that is, each ML calculation was performed 200 times, in order to reduce the chances of finding local maxima); these calculations were also repeated several times;
- We also performed a comparison of evolutionary models (evaluated with Likelihood Ratio tests).

4.1 Model Parameters

- Since each character state is presumed to be able to change into any other, we have to estimate the transition rates for all combinations of states.

State	0	1	2	3
0	–	q_{01}	q_{02}	q_{03}
1	q_{10}	–	q_{12}	q_{13}
2	q_{20}	q_{21}	–	q_{23}
3	q_{30}	q_{31}	q_{32}	–

Table 2: Matrix of state transitions

- Each transition rate is a parameter in the model; multistate data with many states have too many parameters to estimate reliably (here, for example, 6 states give 30 parameters).
- Transition rates can be constrained to reduce the number of parameters, allowing us to avoid model overfitting as well as increasing the tractability of the calculations.
- However, we have no a priori information about how many parameters are likely to be needed, or which transitions should be restricted. We therefore test this by running models with different potential parameter settings, and using the model which scores best using likelihood ratio tests.[6]
  - Number of parameters [1, 2, 3, 4, 12].

1 parameter: A single rate for all state transitions;

2 parameter: One rate for increasing the complexity of the system, another for decreasing it;

3 parameter: Rare states are treated differently from common states (1 parameter for entering a common state, one for leaving it, one for being within a common state);

4 parameter: Rates initially inferred using 30-parameter model in BayesTraits v1, then re-run with close values combined.

12 parameter: One rate each for transition between each other for the 4 most common states in the data [other states omitted and languages pruned from the tree].

  - 2 parameter models performed better than the other models and so are reported here.[7]

- In addition to estimating reconstructions at the root, we tested support for lexical reconstructions by ‘fossilizing’ nodes in the tree.
  - We set a subgroup or root node to a particular value and compare likelihood values of the models with and without the fossilized node.
  - We compared estimates with the root node set at all possible parameter states.

[6] This can also be tested by using RJ-MCMC; that is, using MCMC rather than Maximum Likelihood, and simultaneously inferring the parameter model and its values. An analysis using this method is still in progress; because of the complexity of the model, the chain needs to run for weeks in order to visit models more than once.

[7] The 12-parameter model did significantly worse than other models (BF>-10) for all other models on that dataset. For the 1, 2, 3, and 4 parameter models on the full dataset, the 1- and 3-parameter models fared worse than the 2- and 4-parameter ones (BF>5). There was no significant difference between the 2- and 4- parameter models.

5 Results : Trait Inference

- 2-parameter model (increasing complexity vs. decreasing) significantly outperforms 1-parameter model [log BF=7].[8]
- Root node fossilization provides positive (but not strong) evidence for a four-term reconstruction [log BF=3]; this tallies with root node reconstruction in the 2-parameter model, which favors four-term reconstruction over three-term (with single term for younger siblings), but not strongly (probability of 49% vs 30%).
- Lower level subgroups show differing degrees of support (clades with decisive support are colored in Figure 2).
- Three-term systems (with undifferentiated 'younger sibling' term) predominate in the West, while four-term systems characterize Eastern/Central groups.
- Evidence is equivocal for reconstruction in Yuin-Kuri, Lower Murray, Kalkatungic and Yolŋu, where trait reconstruction does not provide decisive support for either three- or four- term systems.
  - Yolŋu: (see reconstructions for forms)
    - 4 languages: 4 term system
    - 5 languages: 3 term system
  - Kalkatungic:
    - Kalkatungu: 3 terms (no differentiated 'younger sibling' term)
    - Yalarnnga: 4 terms
- Other proto-subgroups show support for either three- or four-term systems, except for Mayi, which has an age-graded distinction for male siblings only (that is, older, younger brother, but a single 'sister' term).
- Potential problem: Because 3- and 4- term systems are relatively more numerous, transition rates are higher and therefore reconstructions of those systems are likely to be preferred even when there is some evidence for other systems.

Interim conclusions:

- Lower-level subgroups are quite consistent in their forms.
- Where there is ambiguity, this is reflected in the language data.
- However, given the preponderance of 3- and 4- term systems, we should be mindful of the potential for 'over-reconstruction'.

6 Results : Comparative Method

The second part of the reconstruction involves using the comparative method to simultaneously infer system type and term semantics.

- There is extensive heterogeneity in words for siblings; few terms are reconstructible beyond the low-level groups.
- There is especially severe instability in 'sister' terms (particularly yZ) which leads to difficulties in system reconstructions using lexicon alone.
- Other difficulties come from term heterosemy over the subgroup:

[8] Note that because of the frequency of three-term and four-term systems, this model should probably be interpreted not as one which captures increasing or decreasing complexity, but one that has a rate for q34 and another for q43 (that is, different rates for entering and leaving the two most common states in the dataset).

– Yolŋu:

	eB	eZ	yB	yZ
Gupapuyŋu	*wäwa*	*yapa*	*yukuyuku*	*gutha'*
Djambarrpuyŋu	*wäwa*	*yapa*	*gutha'*	*yukuyuku*
Ritharrŋu	*wäwa*	*yapa*	*gutha'*	
Yan-nhaŋu	*wäwa*	*yapa*	*yukuyuku*	
Djinang	*wuwi*	*wamiri*	*yukuyuku*	*wamiri*

(Djinang *yukuyuku* is a loan.)

6.1 Etymologies

- A few widespread terms:
  - *yapa:
    - Paman: eB (see also below)
    - Yolŋu: eZ
    - Waka-Kabi: *yapun eZ (though *tyatya also reconstructible)
    - (Guwa *yapa* eB)
  - *tyatya:
    - Central NSW: eB
    - Karnic: eB
    - Waka-Kabi: eB, eZ
    - Yuin-Kuri: eB (also *piŋkayi)
  - *katha
    - Dyirbalic: eB, yB
    - Ngayarta: eB
    - Kanyara-Mantharta: eB
    - Nyungic: eB
    - Arandic: yB=yZ (tentative)

NB: All reconstructible as eB terms: indicative of relative stability within the system or chance, because of data quality?

- Few **loans** appear in the system (27/885 items: 3%).

(5) a. Bularnu (Warluwarric, Pama-Nyungan) *gawityi* 'older sister', a loan from Garrwa (Garrwan)
b. Mirniny *marlangu* 'younger sister', which is a likely loan from a language of the Wati subgroup.

- Much **semantic shift**, from several distinct sources.
  - Other **kin terms**:

(6) a. Karnic *kaku eZ ~ FF ~ SC;
b. Maric *kami eZ < FM;
c. Arandic *katya yB < eB
d. Yolŋu younger sibling terms (see above)

NB: Most shift of this type is *not* between sibling terms; it's from grandparent terms.

  - From other nouns referring to **humans**:

(7) Thura-Yura *nhungar '< man';

(8) *yapa 'eB ~ man' (cf. Warlpiri *yapa* 'person')

– From **body parts** *katha* 'eB < head' in several subgroups; these terms are probably sourced from the auxiliary sign language terms for kinship terms.

  * cf. Kendon (1988, 330ff) for a detailed description of kinship sign language and the way in which body parts are used to refer to kin.
  * Body parts itching when kin do something

– Other lexical items:

(9) a. Yolŋu *wakinŋu* 'rubbish'[9] is used as a way for men to refer to their younger sisters;
b. Wangkayutyuru *kupa* 'yB < small';

– Some evidence for derivation by affixation: Paman *yapa-

(10)

	eB	eZ	yB	yZ
Proto-Paman (?)	*yapa	*yapun	*yaputyu	??

(11)

	eB	eZ	yB	yZ
Kugu Nganhcara	ngathunye	ngathepe	ngathake	ngathule

BUT how reconstructible is this system?

  * No other languages or subgroups show such a system; all others have unrelated lexical items for each category.
  * More likely (?) – isolated independent derivation that gives the appearance of archaism because the root is old?

– Some Eastern languages include the feminine suffix -*kan* on sister terms.

(12) Maric: **wapu* yB, **wapu-kan* yZ

This pattern is also isolated, and potentially problematic;

  * *wapu* is solidly attested only for Central Maric.
  * Reflexes of **yaputyu* are also found in Maric, as in Paman. Therefore, is **yaputyu* old (Pama-Maric proto-language?) or is it a loan?

	eB	eZ	yB	yZ
Proto-Maric	**mukina*	**kuta, *kami*	**yaputyu, wapu-*	**wapu(kan)*
Gugu-Badhun	*mugina*	*tana*	*yabu*	*pulku?*
Warungu	*mugina*	*pulku?*	*yabujana*	*barrina, kurramara*
Biri	*gadya*	*gudhana*	*wuba*	*"warbimmera"*
Yambina	*katyana*	*woongoobaya*	*wapu*	*wapu*
Guwamu	*dhaguna*	*bayina*	*waburdu*	*mangana*
Dharawala	*dhakunu*	*yaku*	*wabu*	*wabukan*
Bidyara	*dhagu*	*bari*	*wabu*	*wabuwandila*
Yiningay	*dhakuna*	*kami(na)*	*bamana*	*Nayilu*
Margany	*mugidoo*	*kaminu*	*waburdu*	*mayada*

Table 3: Maric sibling terms: selected languages

[9] The term is also used for items which aren't classified as Dhuwa or Yirritja. Opposite sex sibling taboos are strong in this area.

Interim Conclusions:

- While there is a lot of doubt in reconstruction, and few clearly reconstructible terms, the cause of this is lexical replacement and semantic shift, not borrowing.
- Some languages show shift within the sibling system (e.g. Yolŋu), but most of the terms come from outside the sibling and kin domains.

6.2 System and Lexical Reconstructions Compared

Three conflicts (Central NSW, Mayi, Bandjalangic) between lexical and trait reconstructions.

- **Central NSW:**
  - Lexical evidence points to three-term system with age distinction for male siblings only.
  - The trait reconstruction, however, finds evidence for a three-term system with gender distinction for older siblings, but not for younger.
  - This is possibly an artifact of the relative frequency of the systems.
  - There are difficulties with the lexical reconstruction, however; the 'older brother' terms are reconstructed mostly on the basis of *tyatya's widespread occurrence outside the subgroup.
  - *galuma:ny is straightforward for 'younger brother';
  - Gamilaraay and closely related varieties have a single term *bagaan* 'sister', but all other languages have distinct terms.[10]

	eB	eZ	yB	yZ
Gamilaraay	*dhaya*	*baawaa, bagaan, dhawurran*	*galumaay*	*bagaan, bariyan*
Yuwaalaraay	*dhaya*	*baawaa, bagaan, dhawurran*	*galumaay*	*bagan*
Wailwan	*moen*	*bubba*	*galuma:y*	*kityurray*
Ngiyambaa	*kaathii*	*kaakaa*	*kaathii*	*kaakaa*
Wiradjuri	*gaagang*	*boree*	*galama:ny*	*muugan*

Table 4: Central NSW

- **Mayi:** Only terms for 'older brother' and 'younger brother' are reconstructible; other terms are different and untraceable in each language. The lexical evidence therefore is unrevealing.
- **Bandjalangic:**
  - A single term *pana:m* 'brother (eB=yB)' is possibly reconstructible, along with *nanaŋ* 'older sister'.
  - no term for younger sister is reconstructible with certainty, though **yilga:ŋ* is a possible candidate).
  - Yugambeh and Bandjalang also have *kaku:ŋ* as eB, casting doubt on the eB=yB reconstruction.
  - The system is reconstructed as four term in the structural trait analysis, probably because of the rarity of systems other than the four-term or three-term with sex distinction for older siblings. A three-term system with age distinction for sisters is otherwise unattested.

[10] Ash et al. (2003) gives *baawaa* as the 'recommended' word for sister. Further information about possible differences in meaning is not available at present.

	eB	eZ	yB	yZ
Bandjalang	*bunum*	*nanung*	*bana:m*	*wabunj*
	bana:m	*nana:ŋ*	*bana:m*	*wapuny*
Githabul	*banahm*	*nanahŋ*	*banahm*	*yirgaŋ*
	bana:m	*nana:ŋ*	*bana:m*	*yirgaŋ*
Minjungbal	*punnam*	*nunung*		
Yugambeh	*kagohn*	*nanang*	*banam*	*yilgahn*
	kaku:ŋ	*nana:ŋ*	*bana:m*	*yilka:n*

Table 5: Bandjalangic

7 Discussion

- How stable are semi-closed class lexical categories?
  - The categories are fairly stable, in that they are reconstructible across large parts of the family.
  - There is also, however, evidence for change.
  - The preponderance of 3-term and 4-term systems, along with the general difficulty in reconstructing younger sibling terms, points to reconstructing one of these systems to Proto-Pama-Nyungan.
- Does system stability exist independently of lexical form stability?
  - Yes; the lexical stability is very low, with very little reconstructibility beyond low-level subgroups.
  - The system stability, however, is relatively high.
  - With both methods, systems are fairly readily reconstructible, though with uncertainty at the highest level of the tree.
- Is there evidence for paradigmatic changes in these categories (Traugott and Dasher, 2002; Anttila, 2003)?
  - Not at this stage; we did not find any evidence for any such changes in either the lexical or the system data.
  - Instead, we find some local, low-level change, but in several directions. Four-term to three-term, and probably vice versa.
- How do semi-closed classes recruit new material?
  - By semantic shift, largely from outside the system.
  - A substantial number of items are unique to the language and (at this point) untraceable.

8 Conclusions

- Sibling **systems** show greater stability than the lexicon marking them;
- We do see, however, shifts between three-term and four-term systems (in both directions).
- The domain of sibling terms thus provides evidence for an interesting case of mismatch between lexical stability and system stability and reveals evidence for system stability even in the absence of lexical stability.
- It also provides us with an insight into how lexical replacement proceeds, as a mapping onto an existing lexical structures and oppositions.
- It shows that kinship patterns can be conservative even when the lexical material used to express the forms is subject to frequent lexical replacement and semantic shift.
- Finally, this research provides insight into the lexical sources for sibling terms, in particular, other kinship terms, human terms, and body parts.

References

Anttila, R. (2003). Analogy: the warp and woof of cognition. In Joseph and Janda (2003), chapter 10, pages 426–439.

Ash, A., Lissarrague, A., and Giacon, J. (2003). *Gamilaraay, Yuwaalaraay & Yuwaalayaay Dictionary.* Alice Springs: IAD Press.

Bowern, C. (2012). The Pama-Nyungan comparative lexical database. MS, Yale University.

Bowern, C. and Atkinson, Q. (2012). Computational phylogenetics and the internal structure of Pama-Nyungan. *Language*, 88(4):817–845.

Dousset, L., Hendery, R., Bowern, C., Koch, H., and McConvell, P. (2010). Developing a database for australian indigenous kinship terminology: the AustKin project. *Australian Aboriginal Studies*, 1:42–56.

Dumont, L. (1953). The Dravidian kinship terminology as an expression of marriage. *Man*, 53:34–39.

Dunn, M., Greenhill, S. J., Levinson, S. C., and Gray, R. D. (2011). Evolved structure of language shows lineage-specific trends in word-order universals. *Nature*, 473(7345):79–82.

Evans, N. (2003). Context, culture, and structuration in the languages of Australia. *Annual review of anthropology*, 32:13–40.

Friedrich, P. (1966). Proto-Indo-European kinship. *Ethnology*, 5(1):1–36.

Hock, H. H. (1991). *Principles of historical linguistics.* Mouton de Gruyter, Berlin, 2nd edition.

Hock, H. H. and Joseph, B. D. (1996). *Language History, Language Change, and Language Relationship: An Introduction to Historical and Comparative Linguistics.* Mouton de Gruyter, Berlin.

Jordan, F. M. (2011). A phylogenetic analysis of the evolution of Austronesian sibling terminologies. *Human Biology*, 83(2):297–321.

Joseph, B. and Janda, R., editors (2003). *The Handbook of historical linguistics.* Blackwell Publishers, London.

Kendon, A. (1988). *Sign languages of Aboriginal Australia: Cultural, semiotic and communicative perspectives.* Cambridge University Press, Cambridge.

Mace, R. and Jordan, F. (2011). Macro-evolutionary studies of cultural diversity: a review of empirical studies of cultural transmission and cultural adaptation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1563):402–411.

Murdock, G. P. (1968). Patterns of sibling terminology. *Ethnology*, 7(1):1–24.

Pagel, M., Meade, A., and Barker, D. (2004). Bayesian estimation of ancestral character states on phylogenies. *Systematic Biology*, 53(5):673–684.

Rankin, R. (2003). The comparative method. In Joseph and Janda (2003), pages 183–212.

Smith, R. J. (1963). Stability in Japanese kinship terminology: The historical evidence. *Japanese Culture: Its Development and Characteristics*, (34):25.

Traugott, E. and Dasher, R. (2002). *Regularity in Semantic Change.* Cambridge University Press, Cambridge.

Wafer, J. and Lissarrague, A. (2008). *A handbook of Aboriginal languages of New South Wales and the Australian Capital Territory.* Muurrbay Aboriginal Language and Culture Co-operative, Nambucca Heads, N.S.W.

	eB	eZ	yB	yZ
Arandic	*kaku	*Cuŋkara-?	Catyiya?	Catyiya?
Bandjalangic	*panam	*nana:ŋ	*panam	–
Central NSW	*thaya < *tyatya	*paka:n	*kaluma:y	*paka:n
Durubalic	*ŋapaŋ	*tatyiŋ	*tuwaŋal	*maŋaŋkal
Dyirbalic	*katha?	*tyampuwan	*katha?	*tyampuwan
Kalkatungic	–	–	–	–
Ngayarta	*katya	*tyurtu	*marrkara	*mari
Kanyara-Mantharta	*katya < *katha	–	*marrkartu	*marrkartu
Karnic	*tyatya	*kaku	*ngartharri	*ngartharri
Kartu	*kurta	–	*buwa?	*malyu?
Kulin	*wa:wi?	*tyatyi	–	–
Lower Murray	kiila-?	mingkan?	tarti?	prati?
Maric	*mukina	*kutha, *kami	yaputyu, wapu	wapu(kan)?
Marrngu	–	–	*marrkartu	*marrkartu
Mayi	*ŋapun	–	*patyamun	–
NgumpinYapa	*papa?	*kapurlu	–	–
Nyungic	*katha	tyintam/tyukan	–	*tyukan?
Paman	*yapa	*yapun	*yaputyu	–
Thura-Yura	*nhuŋa	*yaka	*panya?	*panya?
Waka-Kabi	*tyatya	*tyatyi	–	*kuntam
Warluwaric	*lalu	–	–	–
Wati	*kurta	*tyurtu	*marla	*marla
Yardli	*kaku	*karru	–	–
Yolngu	*wa:wa	*yapa	*kutha/yukuyuku	*kutha/yukuyuku
YuinKuri	*tyatya/*piŋkayi	*ŋarrinti/ŋamaŋ	*tuwaŋal	–

Table 6: Subgroup Reconstructions

Root P(1)	Root P(2)	Root P(3)	Root P(4)	Root P(5)	Root P(9)
0.115583	0.053332	0.489401	0.293362	0.041478	0.006844
West P(1)	West P(2)	West P(3)	West P(4)	West P(5)	West P(9)
0.086868	0.044149	0.182015	0.658493	0.024459	0.004016
East P(1)	East P(2)	East P(3)	East P(4)	East P(5)	East P(9)
0.064785	0.028589	0.835348	0.058836	0.009266	0.003177
Central P(1)	Central P(2)	Central P(3)	Central P(4)	Central P(5)	Central P(9)
0.106012	0.047524	0.34981	0.434608	0.056925	0.005121
North P(1)	North P(2)	North P(3)	North P(4)	North P(5)	North P(9)
0.083941	0.03917	0.536109	0.091527	0.241519	0.007735
South P(1)	South P(2)	South P(3)	South P(4)	South P(5)	South P(9)
0.088406	0.044203	0.64445	0.180256	0.037774	0.004911
Arandic P(1)	Arandic P(2)	Arandic P(3)	Arandic P(4)	Arandic P(5)	Arandic P(9)
0.036729	0.018364	0.044523	0.892401	0.005942	0.00204
Bandjalangic P(1)	Bandjalangic P(2)	Bandjalangic P(3)	Bandjalangic P(4)	Bandjalangic P(5)	Bandjalangic P(9)
0.030549	0.015275	0.92741	0.021162	0.003907	0.001697
CentralNSW P(1)	CentralNSW P(2)	CentralNSW P(3)	CentralNSW P(4)	CentralNSW P(5)	CentralNSW P(9)
0.106095	0.025593	0.776987	0.074693	0.013789	0.002844
Durubalic P(1)	Durubalic P(2)	Durubalic P(3)	Durubalic P(4)	Durubalic P(5)	Durubalic P(9)
0.060667	0.030334	0.816842	0.07495	0.013837	0.00337
Dyirbalic P(1)	Dyirbalic P(2)	Dyirbalic P(3)	Dyirbalic P(4)	Dyirbalic P(5)	Dyirbalic P(9)
0.083024	0.041512	0.35863	0.138798	0.373424	0.004612
Karnic P(1)	Karnic P(2)	Karnic P(3)	Karnic P(4)	Karnic P(5)	Karnic P(9)
0.083341	0.040673	0.195417	0.656734	0.019735	0.0041
Kalkatungic P(1)	Kalkatungic P(2)	Kalkatungic P(3)	Kalkatungic P(4)	Kalkatungic P(5)	Kalkatungic P(9)
0.092591	0.046295	0.435739	0.399554	0.020677	0.005144
Kartu P(1)	Kartu P(2)	Kartu P(3)	Kartu P(4)	Kartu P(5)	Kartu P(9)
0.108766	0.022757	0.791758	0.062629	0.011562	0.002529
LowerMurray P(1)	LowerMurray P(2)	LowerMurray P(3)	LowerMurray P(4)	LowerMurray P(5)	LowerMurray P(9)
0.095544	0.047772	0.438422	0.378995	0.033959	0.005308
Kulin P(1)	Kulin P(2)	Kulin P(3)	Kulin P(4)	Kulin P(5)	Kulin P(9)
0.062345	0.031172	0.817081	0.074133	0.011805	0.003464
Maric P(1)	Maric P(2)	Maric P(3)	Maric P(4)	Maric P(5)	Maric P(9)
0.135841	0.044606	0.675339	0.124449	0.017023	0.002742
Marrngu P(1)	Marrngu P(2)	Marrngu P(3)	Marrngu P(4)	Marrngu P(5)	Marrngu P(9)
0.035584	0.216072	0.105605	0.626026	0.014736	0.001977
Mayi P(1)	Mayi P(2)	Mayi P(3)	Mayi P(4)	Mayi P(5)	Mayi P(9)
0.231292	0.007731	0.047901	0.036204	0.676013	0.000859
Nyungic P(1)	Nyungic P(2)	Nyungic P(3)	Nyungic P(4)	Nyungic P(5)	Nyungic P(9)
0.170247	0.033292	0.531161	0.157687	0.103914	0.003699
NgumpinYapa P(1)	NgumpinYapa P(2)	NgumpinYapa P(3)	NgumpinYapa P(4)	NgumpinYapa P(5)	NgumpinYapa P(9)
0.028621	0.014311	0.027027	0.925508	0.002943	0.00159
Paman P(1)	Paman P(2)	Paman P(3)	Paman P(4)	Paman P(5)	Paman P(9)
0.112034	0.058429	0.44708	0.194292	0.183503	0.004662
ThuraYura P(1)	ThuraYura P(2)	ThuraYura P(3)	ThuraYura P(4)	ThuraYura P(5)	ThuraYura P(9)
0.093386	0.040453	0.23107	0.610612	0.019983	0.004495
WakaKabi P(1)	WakaKabi P(2)	WakaKabi P(3)	WakaKabi P(4)	WakaKabi P(5)	WakaKabi P(9)
0.145787	0.038794	0.41715	0.363037	0.030922	0.00431
Warluwaric P(1)	Warluwaric P(2)	Warluwaric P(3)	Warluwaric P(4)	Warluwaric P(5)	Warluwaric P(9)
0.066388	0.033194	0.128744	0.750021	0.017964	0.003688
Wati P(1)	Wati P(2)	Wati P(3)	Wati P(4)	Wati P(5)	Wati P(9)
0.059385	0.094381	0.178484	0.653694	0.010756	0.003299
Yolngu P(1)	Yolngu P(2)	Yolngu P(3)	Yolngu P(4)	Yolngu P(5)	Yolngu P(9)
0.133292	0.046625	0.291596	0.354816	0.168491	0.005181
YuinKuri P(1)	YuinKuri P(2)	YuinKuri P(3)	YuinKuri P(4)	YuinKuri P(5)	YuinKuri P(9)
0.078931	0.030756	0.789347	0.087754	0.009794	0.003417
Victoria P(1)	Victoria P(2)	Victoria P(3)	Victoria P(4)	Victoria P(5)	Victoria P(9)
0.096819	0.04841	0.464703	0.251193	0.133497	0.005379
Yidinyic P(1)	Yidinyic P(2)	Yidinyic P(3)	Yidinyic P(4)	Yidinyic P(5)	Yidinyic P(9)
0.099825	0.035802	0.701647	0.134008	0.02474	0.003978

Table 7: Subgroup Trait Reconstruction Probabilities

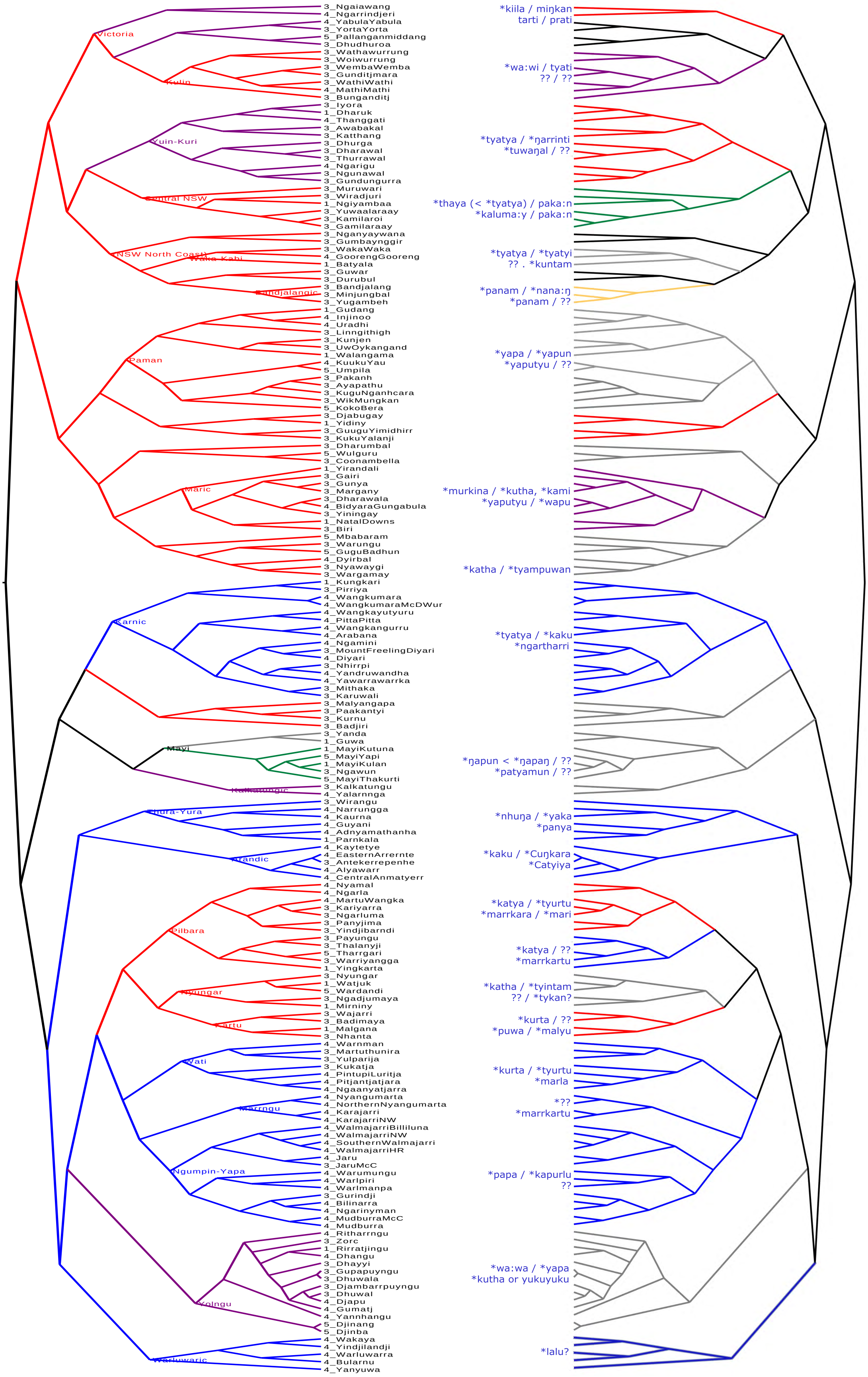

Figure 2: Ancestral state reconstructions (left) vs Comparative Method reconstructions (right); clades are colored by reconstructed system type.