

Loss of color terms not demonstrated

Supporting details for Letter to *PNAS*

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Added: my response to B&H's reply (before References)

Abstract

Haynie and Bowern [Haynie HJ, Bowern C (2016) *PNAS* 113(48):13666–13671] matched Bayesian phylogenies for 189 Pama–Nyungan languages with the presence of color terms in each vocabulary. The inferred ancestral state reconstructions led to their striking claim of ‘extensive evidence for the loss (as well as gain) of color terms’, as well as the expected ‘broad support for the most influential theory of color term development’ based on the World Color Survey [Kay P, Berlin B, Maffi L, Merrifield WR, Cook R (2009) CSLI lecture notes 159, Stanford, CA]. However their inference is invalidated by the method for selecting the vocabulary data, its patchiness, and their method’s assumption that every unknown or missing datum is a true absence.

The naming of colors ‘has long been a topic of interest in the study of human culture and cognition’, and Haynie and Bowern (H&B) [60] employ promising computational phylogenetic methods to test the standard view of color terminology structure, epitomized in the World Color Survey (WCS) [77], that ‘the attested range of color-naming systems in language results from evolution along highly constrained pathways’.

H&B’s main finding was not surprising: ‘general support for the WCS model of color term development, but with more nuance’. What was unexpected was that H&B claimed to ‘find exceptions to their [WCS] predicted patterns, such as the loss of color terms in multiple subgroups’. It is notable that H&B cite no other investigation of loss of a basic color term distinction, or more to the point the dearth of any published instances elsewhere in the world (of which I am aware of only one, in Italian dialects [79], but see [76, 201n15]).

This note shows that H&B’s unexpected finding is unsound, because of flaws in the data H&B assembled, and an unacknowledged bias in their method. My examination concentrates on the three most commonly lexified colors usually glossed as ‘black’, ‘white’, and ‘red’, particularly where H&B code one of these colors as absent in a particular language. There is constant reference to H&B’s 2016 data table and their April 2017 revised data table, to both of which unfortunately *PNAS* gave the same file name <http://www.pnas.org/content/suppl/2016/11/10/1613666113.DCSupplemental/pnas.1613666113.st01.docx> (included now in my revision of it [93]). For further

details on a particular language see the Supporting Information (SI) (page 8 below), which has the languages in alphabetical order by name.

Languages coded as no ‘black’

H&B code three languages as lacking ‘black’. One of these (Yindjilandji) does have a ‘black’ term (also glossed as ‘dark’ as to be expected if the language distinguishes only three colors). H&B’s 2017 note 39 admits Kungadutyi ‘is most likely a case where a word for the color was present and not recorded’ and in any case its status as a language variety is questionable (see SI). The gap in Minjungbal is also most likely accidental (see SI).

Languages coded as no ‘white’

There are 11 languages coded in H&B Fig.3 and in the 2016 data table as lacking ‘white’. Three of these subsequently had a ‘white’ term added in the April 2017 revised data table (Batyala, Kuuk Thaayorre, and Western Arrarnte). Of the remaining eight languages, there are four each known from a relatively short wordlist recorded from last speakers (Kungkari, Mbakwithi, Nhirrpi, Yarluyandi), and four for which sources not used by H&B do provide a ‘white’ term (MathiMathi, Tharrgari, Uradhi, Wardandi).

Languages coded with ‘green’ (and with no ‘red’)

In the 2016 data table, and equivalently the presence/absence coding in `color_binary_189.txt`, 120 out of the 189 languages have a term for green. Of these, 13 (just under 11%) had no term for red: Bilinarra, **Dhangu**, **Djinang**, **Kukatj**, **Kurnu**, Kurrama, **Linngithigh**, Margany, **Mbabaram**, Ngarla, PittaPitta, **Wargamay**, and Western Arrarnte. This justified H&B’s conclusion that ‘we find no term for red in 11% of the Pama-Nyungan languages that have a term for green’ ([60, 13668]).

In the revised data table [61], in the light of further information the number of languages meeting the condition is reduced to seven (6%): the languages in bold in the list above (with a qualifying note added to the first three of these). When further information on these seven is considered (see SI), the number of languages meeting the condition is reduced to one (Linngithigh). This is because some of the languages do have ‘red’ (Dhangu, Djinang, Kukatj, and Kurnu), and because in some (Mbabaram and Wargamay) the purported ‘green’ word actually means ‘unripe, raw’ and is not a color term. H&B claim that ‘Proto-Pama-Nyungan *kurnka (“raw” or “unripe”) is used to refer to the *green* color category in a number of languages’ [60, 13671]. The unstated source for the reconstruction would be Alpher’s ***kunka** ‘alive’ [2, 442–3] where the reflexes are not colors. In H&B’s April 2017 data table, the reflexes of *kurnka are in Margany, Gunya, and Warungu, as well as Wargamay. Margany and Gunya *gunga* ‘raw, green (of fruit)’ [34, 355] is not a color term otherwise Breen would have listed it with the three colors [34, 371] in the topical vocabulary instead of only alongside other properties (‘raw, green (unripe)’ [34, 372]). So, of the 189 languages only one has a ‘green’ word but no recorded ‘red’ word, and that gap is probably not a true absence. Hence H&B’s conclusion on this point is unsustainable.

In five other languages coded with ‘red’ there are other spurious ‘green’ words: Dharawal (see SI), Kunjen (see SI), Kurtjar *maard* and *ghiyerk* (‘unripe, green (e.g. fruit, not color), raw, uncooked

(e.g. meat) (less commonly *ghiyerk*); alive (person or animal); smelly' [18]), Wardandi *bingelung* (see SI), and Western Arrarnta *anke* ('raw, green, unripe' [33]).

Languages coded no 'red' (and no 'green')

There are eight other languages coded as lacking 'red' (in H&B's revised data table). All of these languages are represented by fairly sparse sources. Two actually do have a recorded 'red' term (Dharumbal and Narungga, see SI; Dharumbal also has 'green' and other color terms). Four of the languages (Darkinyung, Jiwarliny, Mirniny, Ngadjuri) do have a 'red ochre' or 'red paint' word recorded, which suggests that the speakers were alert to redness. The same applies to Yirandali, which is coded as having a 'red' term actually glossed 'red ochre' in the source (see SI).

Finally, there are two languages with no 'red' or 'red ochre' term recorded. These languages have only a relatively small recorded vocabulary (both of them recorded in a salvage situation). Even so, there are clues in the limited material that the 'red' concept may have been lexicalized, or that its absence from the record is accidental: see SI for AghuTharnggala, and Ngawun.

Note that the seven languages lacking a recorded 'red' term are each the sole member of their subgroup.

H&B's data

H&B's study drew on the color terms in the useful Chirila database, a large assemblage of Pama–Nyungan wordlists [21], to which the authors kindly granted me access (through <http://pamanyungan.net/Chirila>; and now see <https://doi.org/10.5281/zenodo.848652>); I refer here to the version available in 2016. Chirila is a compilation of doculects (a term coined to denote 'the form of a language as presented in a particular data source' [21, 14]). H&B have understandably not used doculects with no (or only one) color term, such as number of the wordlists in Curr [42], but on the same grounds it would have been advisable to not rely solely on other doculects such as those with only two or three color terms (e.g. Minjungbal [82, 23-25 / PDF pages 168-170]). Some of the source documents are a compilation of the known sources of the particular language (e.g. [49, 75, 5]), while many others are a more primary source: a wordlist from one recorder at a particular place and time (such as [73, 82, 6] and wordlists in Curr [42]). Consequently at times H&B's analysis has not drawn on the best available information on the particular language.

Some instances are where doculects can be combined to give a better account of a language's color terms: see the details for Coonambella and Wulguru, Dharawal, Dharuk and Iyora, and Injinoo and Uradhi. Further, see the details on Wangkajunga and Wangkatja (which are confused), and on Ngarla.

Apart from the hazard for H&B's study of dealing with doculects rather than languages, H&B have not used the best published color term research for six Pama–Nyungan languages: Hill's study of Umpila color terms [68], three languages in the WCS [77] (H&B's [8]): Kuku Yalanji pp327-8, Martu Wangka pp363-4, and Warlpiri pp549-57 (also [57]), and Rivers' two studies [101, 87-89] quoted by Berlin & Kay [12, 30-31, 58-59, 70] (see SI on Dharumbal, and Injinoo and Uradhi). Curiously, Kuku Yalanji was not included in H&B's survey, even though as well as the WCS study the language has a sizable modern dictionary [95], and was included in Bower & Atkinson's phylogeny [22].

When a data source has the one word glossed with more than one color (colexification), H&B would have confronted another coding decision, and it is unclear how it was dealt with. There are at least ten instances in the 2017 data table where the same word occurs in two color columns:

Arabana *miRaka* ‘red, yellow’, *ngaljuRu* ‘green, blue’

Dharuk *ngana* ‘black’ ~ *nga-nda* ‘blue’ (see SI on Iyora and Dharuk)

Gamilaraay *gawarrawarr* ‘green’, *gawarawa* ‘blue’ (see SI)

Kaurna *karalta* ‘green, blue’, *purnkipurnki* ‘red, brown’

Mabuiag *bolad-gamul* ‘white, blue’

WathiWathi *nganda* ‘black’ ~ *ngandar* ‘brown’ to which H&B’s 2017 note 65 ‘Probably the same as the word for black.’

Watjuk *jital* ‘white, grey’

Yandruwandha *impa* ‘black, brown’

Yindjibarndi *warru* ‘black, brown’

Note also Golpa *milkuminy* ‘green’ and *mulkuminy* ‘blue’ (synonymous variants in [122]); and Guwamu *gudhigudhi* ‘red’, *gudhirdgudgird* (sc. *gudhirdgudhird*) ‘yellow’ (see SI).

Without consulting the sources, we cannot tell if other terms in the table may have a wider range than indicated by the single gloss in H&B’s data table, or whether a superordinate color term has been overlooked. One example is in Yanyuwa: besides *naka* ‘red’ as used by H&B, there is *dankurrdankurr* ‘1. red 2. yellow’ [24, 147]; another is the YirYoront color term *kam+kam+w* ‘red, yellow’, which H&B do not provide (see SI).

Data sourcing

PNAS has published H&B’s replacement data table [61] which repairs many of the errors in their original table that I had alerted them to by February 2017. Some errors persisted in H&B’s revised table of April 2017, and I have subsequently noticed some more. Note that I have checked the data systematically for black, white, and red, and partially for other colors.

My checking of the data has been somewhat hampered by the gaps in referencing. H&B’s Chirila database includes a sources spreadsheet *Chirila-SourceList.xlsx*¹ but it does not provide the source of all the language data in their compilation. Here are some of the difficulties I have encountered in sourcing.

For some languages Chirila <http://www.pamanyungan.net/chirila-downloads-all-datasets/> does not provide the data source. Instances include Darkinyung ([75]), Dhangu (apparently [104]), Golpa, Kukatj, Kunjen (sc. Ogunyjan [3, 41]), Mabuiag, Malngin, Narunga (apparently [91]), Ngaiawang (apparently [90]), Panyjima (actually from Dench’s grammar [45] whereas Bovern & Atkinson cite his grammar of another language [46]), Purduna, Thalanyji [117], Thaynakwith ([113, 114] with slightly different orthography), Wangkatya [118], Warungu, WikNgatharr, Yanyuwa [24], Yindjibarndi, Yinhawangka (from [51] except ‘black’ is *kurluwa* not *warru* ~ *waru*), and YirYoront [1].

There are further source issues for Arabana, Barrow Point, Birrpayi, Dharumbal, Gamilaraay, Gunggari, Injinoo, Ikarranggal, Jiwarli, Jiwarliny, Kungadutyi, Mithaka, Nyamal, Tharrgari, Wardandi, Wailwan, Wajarri, Wangkajunga, Yandruwandha, Yindjilandji, and Yirandali: see SI.

¹Also, while ‘Many of the sources are also listed in the Zotero25 bibliography management system’ at <https://www.zotero.org/groups/pamanyungan>, Home > Groups > PamaNyungan > Library > Chirila Sources has been empty. Chirila sources and other metadata is now available at <https://doi.org/10.5281/zenodo.848775> (since 25 August 2017).

It is relevant at this point to also mention two discrepancies where H&B's data table has a term but their Fig. 3 and `color_binary_189.txt` codes the term as absent: Batyala *kak'kal* 'white' and WathiWathi *ngandar* 'blue'. From the pattern of terms in the relevant subgroup (Waka Kabi and Kulin respectively), it seems both these discrepancies will have contributed a little to an overestimation of loss.

It could be observed that many of the discrepancies I have noticed in H&B's data table do not affect the coding of the presence/absence of a color term in the particular language. While this may be true, the errors and omissions vitiate some other uses which H&B's color term compilation might be put to (such as study of the role of reduplication, or of phonosemantic effects, just to name two possibilities). Also, errors in language identification and in the wider comparative vocabularies will have degraded the full phylogeny of Pama–Nyungan (H&B Fig. S1).

Bias in the method

H&B's method does not distinguish between absence and missing: whenever the sources for a language do not provide a particular color term, that color is taken as unlexified in the language. This is barely discussed by H&B: it is adverted to in their note on Yindjilandji: 'No word for black is recorded but the source wordlist is very short. We therefore assume that this is a data omission rather than a genuine gap (though we have coded it as absent to avoid inconsistency in coding).' (n54 in 2016, n74 in 2017 version). The note is misleading in that H&B's method provides no alternative to coding a data omission as absent.

H&B observe that 'the general trend suggested by ancestral node reconstruction probabilities is consistent with WCS evolutionary pathways' [60, 13670], and indeed the non-terminal nodes of Fig.3 show hardly any loss between pairs. Where loss is apparent in Fig.3 is overwhelmingly in the last step of descent to terminal nodes. I see this as indicative of gaps in the terminal node data.

To uniformly code a missing color term as the absence of any term in the relevant language for that color must have some effect on ancestral state reconstruction, but it is not clear in general whether this might contribute an overall bias in the estimation of loss and gain. There is a scenario where loss would be overestimated: consider a particular subgroup G of languages descended from Proto-G where the majority of modern languages are coded as having a particular color C, but a few lack C. The ancestral state reconstruction will likely prefer Proto-G with C, and so some losses will be inferred. Hence, to the extent that a missing C is coded as a (false) absence, the model will imply a false loss in the history of G.

Of course, there are other scenarios wherein false gains will be imputed, though this is not relevant to the main issue of the extent of color term loss. And there are yet other scenarios of uncertainty wherein an actual loss would be masked. In general, it may well prove difficult to incorporate in the analysis the distinction between 'absent' and 'missing' data, and the reconstruction of some ancestral states could be indeterminate. H&B do not discuss this, nor the possible application of computational phylogenetic techniques which do allow for missing data. For instance, the `phytools` package <https://cran.r-project.org/web/packages/phytools/phytools.pdf> can be applied, according to 'Primer on estimating ancestral states (& tip values) when some tips are unknown' <http://blog.phytools.org/2015/09/primer-on-estimating-ancestral-states.html>. Note also a recent survey of 'The impact of missing data on species tree estimation', which concludes 'These results underscore the importance of understanding the influence of missing data in the phylogenomics era.' [121]

Interpreting wordlist data

There is some degree of bias involved when using wordlist data to study color terminology in Australian languages. H&B ‘acknowledge that this dataset falls short of the desiderata for meticulous language-internal analysis of color terms, because the referential, semantic, and grammatical detail available to us for these words is limited to what has been provided by lexicographers’.[60, S1] The situation is not quite as H&B describe: a large number of the sources are from amateur collectors who were hardly lexicographers, and some other sources are interim documents by linguists who are still available for consultation.

There is a bias in wordlists elicited from checklists in that the checklists contained few if any color meanings. Curr’s questionnaire [42] contained only ‘Dark’ and ‘Light’ though sometimes other color words were provided. John Mathew’s comparative table of 42 Australian wordlists included three colors (‘black’, ‘white’, and ‘red’ [84, 235-236]); Daisy Bates’ questionnaire, and Tindale’s checklist [116] had no colors; Tindale added ‘red ochre’ from list 83 onwards, and ‘yellow’ ochre from list 144. Davidson’s checklist [43] contained black, white, red, yellow, and green, though H&B’s Chirila does not include his wordlists. Hale’s Cape York Peninsula checklist [56] had only one color (‘black’). The wordlist template for the *Sourcebook for central Australian languages* [89] had black, white, red, yellow. The limitations of these checklists is partly the reason I have not examined H&B’s ‘blue’ and ‘brown’, and to some extent ‘yellow’ and ‘green’; and why I propose that no weight be placed on apparent loss of terms for these colors in H&B’s data.

Another factor affecting elicited wordlists is that many Australian languages were recorded only after the language was no longer in daily use, and ‘Many of the languages included in the sample are severely endangered or no longer spoken’ [60, S1]. In this ‘salvage interview’ situation speakers understandably are sometimes unable to recall particular words. This is relevant to H&B’s second (after Wailan) particular proposed locus of loss, the Kanyara–Mantharta subgroup.

We also find a reasonably high probability for a green category in Western Pama–Nyungan nodes ancestral to the Kanyara–Mantharta subgroup, although the probability of green in Kanyara–Mantharta itself is very low (0.01). This decrease in the probability of a green category along the branches leading to the Kanyara–Mantharta subgroup can reasonably be interpreted as a likely loss of that color. [60, 13671]

The Kanyara–Mantharta languages in H&B’s study are Payungu and Warriyanga (with recorded ‘green’), and, without ‘green’, Jiwarli, Purduna, Thalanyji, Tharrgari, and the next closest relative Yingkarta. However Davidson [43] recorded ‘green’ terms in Thalanyji (*warnguru*²) and Tharrgari (*pidarda*), and the Wangka Maya dictionary of Purduna [37] has *yuungu* ‘green’, so the proportion with recorded ‘green’ is 5/7 rather than 2/7. The remaining two languages, Jiwarli and Yingkarta, like the rest, were recorded from last speakers.

In salvage recording, the interviewer may elicit an English-based term, which is recognized as such and not recorded. This can mask a situation where there was a vernacular term which the informant could not remember (or avoided for some reason). This would lead to the language being coded as lacking a term for the particular color. In a few instances an English loan has made it into H&B’s table:

Dhuwala and Djapu *gurinyguriny* ‘green’ “=Eng green [with reduplication]” [122, 145]

²Davidson also has Thalanyji *wan’ga* ‘alive’, and his ‘green’ terms are with other colors (between ‘yellow’ and ‘white’), so it seems his *warnguru* does not comprise the ‘alive, unripe’ sense. The word is not in the modern Thalanyji dictionary [117].

Gunggari *yala* ‘yellow’ “(from English ? Gun NM)” [69, 249]
 Muruwari *puluw* ‘blue (Eng.)’,³
 Pitjantjatjara *rituwanaringanyi* ‘red’ sc. ‘go red’ from *rituwana* “(from English ‘red one’)” [52, 154]
 Wangkajunga (sc. Wangkatja) *arantji* ‘orange’ (sc. the fruit not the color: see SI)
 Yindjibarndi *arinji* ‘orange’ (sc. the fruit not the color [119, 286]).

These cases could instance in each language the replacement (for various reasons) of an older word, or perhaps the recent gain of a color distinction.

The hazards involved in applying the definition of basic color term (BCT) have long been discussed, and H&B justify how they identified BCTs in wordlist data [60, S1]. One difficulty is determining the range to which the term applies; H&B discuss this around Gupapuyngu and Yan-nhaŋu ‘blue’ and ‘green’ [60, S1]; see also the discussion of Gamilaraay ‘green’ and ‘blue’ in the data sourcing section above. This difficulty could provide a bias towards the WCS evolutionary pathways, insofar as linguists have been aware of them and would gloss a term as ‘red’ (say) despite evidence of coverage of ‘yellow’ and wider. A debatable criterion in the Australian context is the requirement the term be ‘monolexemic’ and that it not be derived from a term for a substance. Australian languages often use reduplication to derive a color term from a substance with that characteristic color; some examples are evident in H&B’s data table. I would support the inclusion of reduplicated terms given that reduplication generally has a high functional load in Australian languages; and note that the WCS accepts reduplicated terms in their Australian sample [77, 364, 550–1].

Conclusion

H&B’s striking finding of ‘extensive evidence for the loss (as well as gain) of color terms’ is invalidated by the method for selecting the vocabulary data, its patchiness, and their method’s assumption that every unknown or missing datum is a true absence. Further investigation of available vocabulary sources has supplied ‘black’, ‘white’, and ‘red’ terms overlooked by H&B, eliminated some ‘green’ terms, and shown that language records lacking terms for these colors are most likely deficient rather than evidence for true absence of a term. In this light, H&B have not demonstrated loss of these color terms, nor of evolutionary pathways contrary to those advanced by the World Color Survey (WCS).

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³H&B’s table note 50 applies here: ‘It is possible that this is a borrowing from English blue; alternatively, it is derived from subgroup-internal words for black.’ Cf. Ngiyambaa *pulawi* ‘blue’, and Wailwan, Gamilaraay and Yuwaalaraay *buluwuy* ‘black’.

Supporting Information (SI)

Details are arranged by language (in alphabetical order). The amendments justified here are also show in my revision of of H&B's data table (converted to an Excel spreadsheet) available since 6 October 2017 at <http://doi.org/10.5281/zenodo.1032450> [93].

AghuTharnggala

Hale elicited just 'black' and 'white' in the midst of verbs of speaking [74, 146] in an hour's tape-recording of the last-known fluent speaker of the language [74, 3].

Arabana

Chirila data on Arabana is from Curr wordlists, which lack color terms. The Arabana in H&B's data table matches entries in Hercus' dictionary [64], except that H&B's data table has for Arabana *pitjirrinha* 'white', whereas the term is actually *waru* 'white' [66, 49,213], and *pitjirrinha* is 'red, yellowish red, bright coloured' (a synonymy of *miRaka*). It seems H&B have misinterpreted the entry *midla-pitjiRinha* " 'red nose', a white person, a missionary" (*midla* 'nose'). Note that another Karnic language, Yarluyandi, also has *pitjirina* 'red' recorded by Hercus [65].

Barrow Point

The forms in H&B's data table are the same as those in Haviland's version of the lexicon [59], with some additional information: *ngulnggu:nh* ~ *ngulnggun* ~ *ulnggun* 'black', *urrggu:nh* 'blue?', *urra:lnganh* 'grey color, same color as native companion' (*-nganh* is an Ablative suffix). Haviland also has *warrba:rr* 'whitish color, color of *girrbadhi* [dugong -DGN] underwater'.

The Chirila source is given as 'sutton.ms' [110], which however has slightly different spellings from H&B's data table, and a couple of additional potential color terms: *ngulngkun* ~ *ulngkun* 'black', and reduplicated as *ngulngkungulngkun* ~ *ululngkun* 'blue, green' (also *wanhina* 'black, dark', cf. *anhinpay* 'tonight, night-time'); *warrparr* 'copper-coloured, brown, yellow'; *urra(a)l* 'brolga, native companion'.

Birrpai

Chirila-Varieties.xlsx VarietyID 1982 points VarietyName 'BB' (with 4356 DataPoints) to Birrpai, but BB is Jeremy Steele's Biyal Biyal <http://bayaladatabases.blogspot.com.au/> (his code for the Sydney Language). This must be the reason why the Birrpai row (*ngana dyirra mudjil yara-gal bulga-ga*) is unexpectedly so similar to the Dharuk row (*ngana dyirra mudjil yarra-gal bulgaga nga-nda*), whereas Birrpai is closely related to Gadhang ('of the Birrpai/Guringay/Warrimay' [81]) which has: black *butjung*, *guraa*, *gurrul*; white *barang*, *bura*, *watuun*; red *baril*, *barang*, *ganggarr*, *naruburabu*; yellow *baril*, *bilin*, *bukaruraru*; green *marang warang*; blue —; brown *duurung*; grey *dhinggarr*; orange —. Note that these Birrpai words are almost the same as H&B's Katthang. The error with Birrpai must be have been made across the vocabulary because Birrpai is unexpectedly grouped as the closest to Iyora in Fig.S1, and in Bower & Atkinson's Figure 1 [22, S8].

Coonambella and Wulguru

H&B's Coonambella source is the one included as Pr in Donohue's compilation of the dialects grouped under the name Wulguru [49]: Charles Price 1885 (AIATSIS MS330). It isn't apparent that Coonambella is a subset of Wulguru because this is obscured in three ways in the H&B data table:

1. Donohue respelled into a normalized orthography and does not provide original spellings. In particular, Donohue defensibly respelled Price's *Y* 'blue' as *way* [49, 48]. H&B seem unaware of that because they note at *Y* 'Sic; the transcriber of the wordlist did not finish the word, *y* is given as the entry. Alternatively (given the rest of the manuscript is only partially consistent in transcription), the entry *y* could represent a word *wayi*.' (H&B's table note 9). Looking at MS330 (sheet 93), the *Y* in context appears to be complete and the interpretation as *way* (or *wayi*) is quite likely.
2. Donohue unaccountably does not include in his compilation *bubba laballa* Pr 'green' (MS330 sheet 17) and *coo'ree* Pr 'green' (MS330 sheet 27).
3. H&B chose from Price (Pr) different synonyms from what was chosen for the Wulguru row:
H&B Coonambella *coor'gool ma'ra dil'goor'a'ry bubba laballa y*
H&B Wulguru *ngumbi gunggamu ulba gunbili way*
For convenience, here are the other Price Coonambella (MS330) original spellings:
'black': *coor'gool, mith'er, n'goom by*
'red': *dil'goor'a'ry, ma'gay'ra, ool'ba*
'green': *bubba laballa, coo'ree*

In short, H&B's Wulguru includes H&B's (Price's) Coonambella and so the two records are not independent.

Darkinyung

Darkinyung is not in Chirila. The language was last recorded in the late 19th century. Jones' compilation of all known information includes *minig* (not H&B's *mining*) 'dark, black, night' [75, 165], *naru* 'black' [75, 166], and *barag* 'white, white paint' [75, 149]. There is also *wirug* 'red paint' (*wirrook* RHM Tilly Clarke (Hawkesbury)) [75, 173].

Dhangu

H&B's 2017 data table added note 10 stating 'Schebeck's Dhangu manuscript records *miku*' in the meaning (red) ochre. This word is related to words denoting color terms in other Yolŋu languages, but on the gloss given in the vocabulary, does not meet Berlin & Kay's definition of a color word.' However in that source [104] the second occurrence (numbered 804) of *miku?* is glossed 'red; (red) ochre' (and with '(var.: yellow)' added by hand). Further, the Yolŋu languages comprise a dialect web and in most other dialects *miku*(') is recorded with gloss 'red—dark (ochre, used as paint)', and also *miku'mirr(i)* '(Adj) red, (Ext) pink' http://yolnguindictionary.cdu.edu.au/word_details.php?id=5305.

Dharawal

H&B's Dharawal combines two sources (per Steele's database [109]): (a) *ṇunda* 'black', *tibiūra* 'white', *kūbur* 'red or yellow' [99, 100 in 'Turuwul' pp.99–101] (b) *gudya* 'green, as a tree' (also 'unripe'), as well as *ngunda* 'black' *jillawaraura* 'white' *ngurung-ngurung* 'red' [85, 278]. The best Dharawal wordlist compilation now is in Jutta Besold's 2013 PhD [15, Part B] which has these color terms: **burawara** Black, **ngurnda** Black (very likely **ṇanda** in the light of the Sydney Language word), **ban** White, blanc, **warrawarra** White, **munja munja** Red, **ngurung ngurung** Red, **gubar** n. Red ochre, **gudja** Unripe, "green as a tree". (Forms in **bold** are reconstituted.) So it looks like H&B's *gabar* 'red' and *gubar* 'yellow' are the one word and there isn't a separate 'yellow' word recorded for Dharawal; and *gudya* is not a color term.

Dharuk

See Iyora below.

Dharumbal

H&B's Dharumbal color terms are not in Chirila. Bown & Atkinson's [22] source is Terrill [111, 93,94] who sourced *gururu* 'black' and *dharidhi* 'white' respectively from *gururu* and *DaṛiDi* in [69, 472]. The latter was apparently inferred from the expression *giṅgil DaṛiDi* 'white woman' (*giṅgil* 'woman'); however this is poor evidence that *DaṛiDi* is a color term or means 'white': it might be cognate with *tarir* 'red' (see below), and *Dabun* 'white man' (*gatar* 'man') [69, 462,471] is formed differently.

While there is no 'red' word in Terrill's compilation, there is *gutunu* 'ochre' [111, 86,102] sourced to Roth's *ko-to-no* [103], which is there actually glossed 'red ochre' (compare Yugarabul *kutchin*, *godjeen* 'red' in another member of the Durubulic group), alongside *ta-ré-ra* 'red'. Terrill unaccountably omits most of Roth's 'Ta-rum-bal, Rockhampton' color terms: *ku-ro* 'black', *pu-ra* 'white', *ta-ré-ra* 'red', *kal-mo* 'blue, green' [103]. Note also that these words are a match for *guru* 'black, blue', *bura* 'white', *kiran* and *tarir* 'red', *kalmur* ~ *kalmurkalmur* 'yellow (and green)', *moalmoal* and *wuralwural* 'green', as elicited 'with Holmgren's wools' by WHR Rivers from Fitzroy River people at Rockhampton in 1898 [101, 87-89]. Rivers' record was quoted by Berlin & Kay [12, 30-31,70] (and classified as Stage IIIb).

Djinang

H&B's note 18 states 'A word for 'red' is not recorded for this language in Waters' *Interim Djinang Dictionary*. However, <http://ausil.org/Dictionary/Djinang/lexicon/index.htm> gives *burdiburdigili* 'bright red' (derived from *burdi* 'blood'). I think this can count as Djinang having a 'red' word.

Gamilaraay

On Gamilaraay 'yellow', H&B 2017 note 24 states 'The Gamilaraay dictionary gives *gidjirrgidjirr* for 'yellow', but we excluded it because it is a recent coinage.' However it isn't a coinage, but possibly borrowed from closely related Yuwaalaraay *gidjiirr* which H&B's data table accepts (although Chirila has *gidjirrgidjirr* for the form, with comment 'From 'gidjiirr' (gidgee tree) because of its

yellow flowers.’) The word was recorded in Gamilaraay in the 19th century [98, 25]; also “*ger̄r* or *gūnagūna* ‘yellow’” [99, 32]. Another flaw in H&B’s Gamilaraay is their two terms *gawarrawarr* ‘green’ and *gawarawa* ‘blue’, which however must be the same word: the modern compilation has *gawarrawarr* “green. Also recorded as ‘blue.’” [5, 82]. In an early source the equivalent is *kaoraoa* ‘blue (light)’, where contrasting words are *gān* ‘green’ (compare Wailwan *giidjan* and Ngiyambaa *kiityan* ‘green’), and the ‘black’ word *būlui* is glossed as ‘black or dark blue or brown’ [98, 24], from which my tentative conclusion is that Gamilaraay actually did have separate terms for ‘green’ and ‘blue’.

Gunggari

The Chirila source for Gunggari is given as [70] (also in [22, S3]) rather than, correctly, an earlier book by the same author [69].

Guwamu

Guwamu in H&B’s 2017 data table includes both *gudhigudhi* ‘red’, and *gudhirdgudgird* ‘yellow’ with note 29 ‘note that yellow appears to be based on the term for red.’ The ‘Chirila-FullData’ spreadsheet has GeneralNote to the *gudhirdgudgird* form: ‘in the English-Guwamu section of the word list, this word is given as “gudhirdgudhird.” it is unclear which is the correct form.’ H&B’s source is presumably Austin’s digital Guwamu vocabulary, and the third *g* is presumably a typing error: in Austin manuscript version of Wurm’s field recording the forms are *guḏiguḏi* ‘red’ and *guḏiḏguḏiḏ* ‘yellow’ [6, 43]; a curious contrast. Compare *gudhigudhi* ‘red’ in the closely related language Gunya (cf. *gudhi* (Margany) and *gudhin* (Gunya) ‘red ochre’ [34, 354]).

Another small discrepancy is that the Austin manuscript has *buja* ‘white’ [6, 43] (corresponding to *buya* in ‘Chirila-FullData’ spreadsheet), whereas H&B’s table has *budhabudha* (a form I did not find in the Austin manuscript, but it is ‘white’ in Gunya, cf. *budha* ‘ashes’ [34, 351]).

Ikarranggal

Ikarranggal is not in Chirila. It is located on the upper Palmer River and classified by Alpher in the central bloc of the Alaya–Athima clade of Paman languages [3, 42]. Sommer’s salvage sketch of Ikarranggal has just three color terms: *oltjoR* ‘black’, *etjelwetjen* ‘red’ and *olpo* ‘grey’ [108, 5,6,21], the last two of which are in H&B’s data table. The other four of H&B’s six terms match Palmer’s ‘Gilbert River’ list [97]: *boolpah* ‘black’, *poteerah* ‘white’ (sc. *poerah*), *kooina* ‘green’, *boolpol* ‘blue’. Palmer has a blank for ‘red’, and no entry for ‘grey’. Ikarranggal cannot be equated with Palmer’s ‘Gilbert River’ vocabulary, which Black has identified as Walangama [17, 216–8][19], a language not otherwise in H&B’s survey.

Injinoo and Uradhi

H&B’s Injinoo data is from the Injinoo Ikya vocabulary [58], which relates to the modern language at the town of Injinoo, and its compilation has ‘drawn heavily on’ [58, 4] Crowley’s earlier compilation of three dialects under the name Uradhi [41]. Indeed all the seven color words of Injinoo Ikya [58, 27] are virtually identical to Crowley’s [41, 425] and cover three colors (black-white-red). (The only difference is that Harper uses a practical orthography, and has *uchurrin* for *utij* ‘red’.) Although Crowley adopted Uradhi as a name for the erstwhile unnamed language comprising ‘almost a dozen

attested dialects' [41, 309], from the name of the southwesternmost dialect, his compilation is of three other dialects [41]. The Uradhi dialect proper was recorded briefly by Hale, who had only one color term on his Paman test list ('black', Uradhi *onma*) [56].

Note that H&B's Injinoo entry has for 'white' *wunawanthinhu* ~ *wunawanthu* (At), *akarri* which however are words for the 'white ibis' bird [58, 18], whereas 'white' is *rupal* (At), *yupah* (Ang), *yupwal* (Y) [58, 27].

It was this language that was recorded by Rivers [101, 87-88] as 'from the district of Seven Rivers on the east coast of the Gulf of Carpentaria', with terms *unma*, *manara* 'black'; *yōpa*, *wăpōk* 'white, yellow, green'; *ōti*, *owang* 'red, purple, orange'; and then under the name 'Queensland' Berlin & Kay analysed it as a black-white-red system [12, 58-9].

H&B's Uradhi data (*uuma* ~ *unma* 'black' and *rebano* 'red') is referable to the southeasternmost Wuthathi dialect, from a single primary source [105], which has just these two color terms. So if the pan-Uradhi data is disaggregated into the constituent dialects, the recorded color terms would vary from none (in the most poorly attested dialects) to three (black-white-red), or more (the c1889 source [88] of the mideastern Y (Yadhaykenu) dialect had in addition *Umpum-bay* 'green'). The likely situation is that all dialects would have had words for at least black-white-red, and that a missing black, white, or red term in the record of a particular dialect is an accidental gap in the record.

Iyora and Dharuk

The Sydney Language has two dialects, coastal (H&B's Iyora [73]) and inland (H&B's Dharuk [80] per Steele's Bayala Databases [109]). There are several other sources for each dialect, including the more reliable Dawes [44] and Mathews [86, 87]. In H&B's revised data table a note 31 is added to Iyora quoting Dawes' words, and adding 'If using this data (which are not in Chirila at this point), Iyora is identical to Dharuk', where 'identical' must be intended to mean 'the same range of color terms'. However H&B's inland (Dharuk) data has an extra color: *nga-nda* 'blue', which is Steele's respelling of *Gnundah* which occurs twice in Lang [80], the other occurrence being glossed 'Dark, black'. Lang has no other 'black' word; so it is unlikely this was a separate 'blue' word. Secondly, Iyora *nand* from Hunter's book [73] looks to be a misprint of handwritten *Nana* 'black': see King's MS [78, 404 line 11], a reading supported by the coastal dialect's general lack of homorganic clusters and word-final clusters, and Entry 11 in Table 10.1 in my account of Dawes' Law has the 'black' forms: *ḡana* Coastal, *ḡanda* Inland [92, 170].

Jiwarli

Chirila does not indicate a source for Jiwarli, a Kanyara-Mantharta language. Bown & Atkinson's [22, S2] source is Austin's salvage compilation [7], which has *kurdu* 'black', *jirnda* 'white', which H&B's data table has as Jiwarliny. H&B's *martamarta* 'red' is indeed Jiwarli.

Jiwarliny

Chirila does not indicate a source for Jiwarliny, a Ngumpin language. Bown & Atkinson's [22, S4] source is the short record made by Ken Hale one day in 1960, which has *maru* 'black', *wirntikirli* 'white' [55]. As H&B's note 34 states "No word for 'red' is recorded. The word for red ochre is *pilji*," but the closely related Walmajarra has *pirljipirli* 'red, colour of *pirli*', *pirli* 'red ochre' [72,

235]. There is also *karntawarra* ‘yellow ochre’ [55]. H&B’s data table has *kurdu* ‘black’, *jirnda* ‘white’, which are actually Jiwari words.

Kukatj

H&B’s note 38 states ‘There is no separate word for red, as far as we can tell (from dictionary materials); however, there is a word *kunemurruk* ‘red paint’ which may also be used to refer to red colors.’ However Kukatj also has *yirmperrimper* ‘red, chestnut (horse)’, presumably derived from *yirmp* ‘blood’ [28].

Kungadutyi

As H&B’s note 2017 note 39 (2016 note 33) states, ‘No translation equivalent for black is given in the sources (Schebeck fieldnotes) for this language. However, given that other color words are recorded, and that words for black are found in all closely related varieties, this is most likely a case where a word for the color was present and not recorded.’ I do not know the Schebeck source. The Chirila source, Heagney in Curr [62], has no color word among its 148 items. Breen [29, 64] found that the Heagney vocabulary is a composite of Kungkari and Pirriya (a language included in Bowern & Atkinson’s phylogeny [22] but not in this color study), that the word Kungadutyi means ‘circumcised’, and that ‘it seems likely that [Kungarditchi] is not a genuine language name at all’.

Kungkari

The source [29, 22–64] is a vocabulary of a 454 words recorded in a salvage situation.

Kunjen

Kunjen is not in Chirila. The Kunjen in H&B’s data table is Ogunyjan, in the southwestern bloc of the Alaya–Athima clade of Paman languages [3, 41]. H&B’s *alukariy* ‘red’ and *eral* ‘grey’ occur in an earlier Oykangand word list of Sommer’s [107], whereas Ogunyjan ‘red’ is *ecelbhecen* [4]. H&B’s ‘green’ word, *olmbor*, is ‘green, unripe’ “Contrast *anhdhenh* ‘ripe’” [4].

Kurnu

The Kurnu dialect of Paakantyi does have a ‘red’ word recorded: *Nähllkeekä* ‘red’ [112, 217] cf. *yalgirga* ‘red’ [63, 295].

Linngithigh

Linngithigh ‘*olan* n. Red paint (made by burning yellow ochre with heat from ironwood fire).’ [54] (Note that the ‘green’ word’s entry is ‘*ayam*, adj., Green (as of leaf). *thondh ayam*, n., Green leaf.’ [54], and the vocabulary doesn’t record a word glossed ‘raw’ or ‘unripe’.) Hale recorded this information from last-known fluent speaker of the language in the course of a fortnight’s fieldwork on many languages at Aurukun and Weipa. Note also the potential cognate in another Paman language, Kuku Thaypan: *alolon* ‘red’ [100].

MathiMathi

H&B's 2017 note 44 states "There is no adjective 'white' in the dictionary, but there is a verb *wirlerrma* 'be white'." This verb should count as a color term.

Mbabaram

The extant Mbabaram vocabulary lacks a 'red' word, but H&B count it as having a 'green' word *anup*. The source has *anub* 'raw (meat), green (fruit)' [48, 399] and it is not in the list by semantic fields under 'Colour' [48, 395] (which has just black, white, and grey). The Mbabaram data points to the language lacking both 'red' and 'green' color terms. It must be noted that the extant Mbabaram vocabulary of about 300 words was recorded from one of the last speakers.

Mbakwithi

Crowley recorded *rwa* 'white paint' [40, 193] in salvage work from a single rememberer. (Note that Crowley has *adhiki* 'yellow' (not H&B's *anhdhiki*), and additionally *roga* 'grey'.)

Minjungbal

The Chirila data is from Livingstone's 1870s vocabulary [82, 23-25 / PDF pages 168-170], the sole source for this language. The approximately thirty lexemes includes 'white' and 'red'; this is insufficient evidence that the language lacked other color terms. Also, Livingstone remarks "*Guru* in some dialects means 'dark' or 'night'" [82, 24 / PDF page 169]; compare *guuru* 'black' in Gumbaynggir, a language on the south of the Minjungbal's Bandjalangic subgroup.

Mirniny

Mirniny is known from Curr and Bates vocabularies, and salvage study in the 1950s–60s records of which include *pilhirr* 'red ochre', *pulyirr* 'blood' [96].

Mithaka

There are 291 words of Mithaka in Chirila <http://chirila.yale.edu/languages/Mithaka>, sourced to Gavan Breen (presumably [26]). These include two words not in H&B's data table: *tyimpa* 'black', and *kingginggi* 'red', whereas H&B's 'black' word, *wityipaka(r)ni*, is actually glossed 'black shag' (a type of bird; *wityipaka(r)ni* applies to the black shag, and the black and white shag [26]). H&B's *kurkiRi* 'green' is not in the Chirila list. However *kingginggi* 'red' is correctly omitted as it is Ngulupulu rather than Mithaka [26].

Narungga

H&B's two Narungga terms ('black' and 'white') are from a recent compilation [91] which does not consider as a 'red' term *dilali* 'red, fair, fair-haired' [115, 66] (and in *kaka 'tilali* 'red-headed person' [115, 61]) in vocabulary recorded from the last speaker in the 1930s.

Ngadjuri

Ngadjuri *jumbura* (red ochre), *mildi* (red ochre) [14, 13]

Ngaiawang

Ngaiawang was recorded by Moorhouse [90]. As well as *kantukanturangko* ‘red, blood like’ (derived from *kantur* ‘blood’) there is another term *rumrum* ‘red’ [90, 54] (apparently underived) which H&B do not use. Note that *komkomko* ‘green or blue’ [90, 32] H&B assign to their ‘green’ column; and H&B’s ‘brown’ term *kaintyarru* is actually not a color: ‘nankeen bird, of a beautiful brown colour, with a tuft of white feathers on the head’.

Ngarla

H&B’s data is apparently from the Wangka Maya compilation [35]. H&B’s April 2017 data table added *miki* ‘blood, blood colour, red’ (from *Michi* ‘sanguine, color sanguigno, rosso’) from Salvado [114]. Salvado also has another ‘red’ term *pilyari* ~ *pilari* (from *Pigliari* ~ *pillari* ‘rosso’; and two ‘yellow’ terms: *kakul* (from *Cacòl* ‘giallo’), *tùnù* (from *Tunnò* ‘color giallo’), and *pútùngùrrù* (from *Pútòngòrrò* ‘giallo, terra gialla’). Davidson recorded *waru* ‘black’, *bilungba* ‘white’, *bilyara* ‘red’, and *midji-midji* ‘yellow’ [43]. Hence Ngarla is not anomalous in appearing to lack a ‘yellow’ term alongside ‘red’, ‘green’, ‘blue’ and ‘grey’.

Ngawun

The main (probably sole) source is Turnbull 1911 via Breen [27]. Ngawun is close to Mayi-Kulan (79% shared basic vocabulary) and Mayi-Yapa (68%) which both have ‘red’ as do all other Mayi languages.

Nhirrpi

Wurm made a salvage record of this language, and ‘all we know about Nhirrpi is from Professor Wurm’s 25 pages of field notes and one tape that he made (about 10 minutes long)’ <http://www.pamanyungan.net/papers/nhirrpi/> Breen [31] used that and other information to place Nhirrpi as one of the dialects under the cover term Yandruwandha (which does have a ‘white’ word).

Nyamal

Chirila does not indicate a source for Nyamal. Bown & Atkinson’s source is ‘Klokeid, Terry. n.d. Nyamarl wordlist. ASEDA 0075’ but that wordlist has no color words. The best available source for Nyamal [38] has these color terms: *walukurra* ~ *warrukurla* ‘black’, *mirtamirta* ‘white’, *mijimiji* ‘red’, *martajarri* ‘green’, *patalyi* ‘1 • noun. grass. 2 • descriptor. green’ *pataljali* ‘green’, *warrulywarruly* ‘green’. H&B’s Nyamarl words are from a source wrongly titled Nyamal which actually contains Nyangumarta (note the similarity with H&B’s Nyangumarta). However H&B’s Fig.3 coding as black-white-red-green is unaffected.

Tharrgari

For Tharrgari color terms H&B have just *kurdu* ‘black’, *kulhuwi* ‘red’, which apparently mixes the d-dialect and the l-dialect. Austin’s 1992 dictionary, incorporating Klokeid & O’Grady records from the 1960s and his own subsequent salvage work, listed *kurluwa* ‘black’, *kulhuwi* ‘red’, and *yugarda* ‘white ochre’ [8, 28]; ‘In this dictionary words are given in their l-dialect form — you can make the d-dialect form by just changing any l in the word to d.’ [8, viii] However in the 1930s Davidson had recorded *kurdu* ‘black’, *yirdi* ‘white’, *kutjuwi* ‘red’, and *pidarda* ‘green’ [43].

Uradhi

See the discussion of Injinoo and Uradhi above. Crowley’s compilation, repeated by Harper, has three ‘white’ words (in three other dialects): *rupal* (AT), *yupa*: (AN), *yupwal* (Y) [41, 58, 425]. The likely situation is that all dialects would have had words for at least black-white-red, and that a gap for a particular dialect, and in particular in Wuthathi (H&B’s Uradhi) [105], is an accidental gap in the record.

Wailwan

Wailwan (Fig.3) ~ Wayilwan [60, 13670] is not in Chirila nor Bowern & Atkinson [22]; inquiries have revealed the source is a file compiled by John Giacon from Janet Mathews’ recordings. Wayilwan is said to be ‘with only *black*, *white*, *green*’ [60, 13670] whereas the data table and `color_binary_189.txt` has ‘red’ also. A 19th century source [71, 248] has seven color terms with the further addition of ‘yellow’, ‘blue’, and ‘brown’.

Wajarri

Wajarri is not in Chirila. Bowern & Atkinson [22] used AILEC 0446, which was a 1994 draft (superseded by AILEC 0576, then in 1996 by AILEC 0618) of the dictionary published in 2011 [83]. Its color terminology is: *wirri* ~ *widi* ‘black, dark’, *marurdu* ~ *mawurdu* ‘black’; white: *birluny* ‘white, shiny, white person; white ochre’, *bilyarra* ‘1. white; white quartz; white quartz with red parts’ (but not *bilyani*); *bilyara* ‘red’, *biliyarra* ‘red’, *bilyini* ~ *bilyinyi* ‘red’ (but not *biliyarr*); *barala* ‘green, green plants, grass’. There is no separate ‘yellow’, ‘blue’, or ‘brown’ term.

Wangkajunga and Wangkatja

These two varieties are around a thousand kilometres apart, at the north and south extremes of the Wati subgroup dialect web. The words given for Wangkajunga in H&B’s data table are identical to those given for Wangkatja, with the addition of *arantji* ‘orange’. Orthographic tj is not used in Wangkajunga and so the spelling *ngintji* ‘white’ does not fit, and one Wangkajunga source [120] has different words for ‘white’ (*mawuntu*), ‘red’ (*yilkuyilku*, *karrku*). Actually, the words are Wangkatja [20], and *arantji* is found only in the Wangkatja source, in the entry ‘*arantji* n. fruit : orange : (eng.) “orange”’ [20] indicating that it is not a color term. Wangkajunga needs to be eliminated from H&B’s study, at least until its data can be provided.

Wardandi

Wardandi is part of the extensive Nyungar dialect web. H&B's Wardandi is not apparent in Chirila; the data appears to be from Ednie Hassell's unpublished 19th century word list, repeated in Bindon & Chadwick's compilation [16]: *muwan* respelled from *mooarn*, *wildji-munj* from *wilgie mughn*, *wildja-ga* from *wilgerka*; and the 'green' word *bindjilang* is from *bingelung* 'silveryeye, or greeny' [16, 15] which denotes a bird species, and is not a color term.

As H&B 2017 note 57 to 'white' states "No word recorded in Chirila sources, but Hester (in Curr 1886:360-361) gives *bennak* 'light'; other varieties in the dialect chain have a word for white recorded." Note that the following item in Hester's list is *moordang* 'dark' [67, 361].

Another 19th century wordlist referable to Wardandi with a 'white' word is vocabulary in Curr [9, 357] with adjacent entries 'light *kittalgup* / dark —'. Wardandi was part of the extensive Nyungar dialect web; two others used by H&B (Watjuk and Nyungar) have a 'white' word; and also, e.g. *wil - ban* 'white' at King George Sound [25, 45] (which source by the way has other color terms *mo - an* 'black', *welgilam* 'red', *yundo* 'yellow', *tdur - dang* 'green').

Wargamay

H&B's April 2017 note 58 to Warramay (sc. Wargamay) *gun.ga* 'green' states 'This is glossed as 'unripe, green (vegetables), raw (meat), alive (person)'; it is thus unclear whether it is a true color term.' However the semantic fields list of colors in the source [47, 131] has words just for black-white-grey, and in the alphabetical vocabulary *gun.ga* is glossed 'unripe, green (vegetables), raw (meat), alive (person)' [47, 117]. If only because raw meat isn't green, this can't be a color term.

Wulguru

See Coonambella above.

Yandruwandha

For Yandruwandha Chirila provides the Curr sources (which lack color terms) whereas H&B's data table draws on an equivalent of Breen's compilation [31]. Instead of H&B's *impa* 'black, brown' (with 2017 note 70 'Regularly from *tyimpa.') Breen has *tjimpa* 'black, brown' ~ *yimpa* 'black'. For H&B's *parruparruldra* 'yellow' Breen has *parruparru* ~ *padupadu* derived from *parru* 'yellow ochre, yellow'; *-ldra* is "added to a word to show that there is a contrast with something else; 'on the other hand', or 'contrary to expectation' or just 'but'" [31, 8] [30, 236–7]. See also Nhirrpi.

Yindjilandji

H&B's note 54 (2017 note 74) states, 'No word for black is recorded but the source wordlist is very short. We therefore assume that this is a data omission rather than a genuine gap ...' However there is a 'black' word in Breen's Yindjilandji transcripts: dark *wudungu*, black *wuthungu*: ~ *wuthunngaÖ*, white *bunangga* ~ *burnáנגgar*, red *wumanggu*. See also the discussion of Yindjilandji 'white' in the data sourcing section.

Instead of Osborne & Breen's word (*burnáנגgar*), H&B have *moo-rah* 'white' which in Chirila is only as from F. Bennett 'The Vocabulary of the Mt. Spencer Blacks' [10], located 'about 50 miles south-west of Rockhampton', a long way from Yindjilandji. 'White=*moo-rah*' is the only color

term in Bennett’s word list. (That language may be Gayiri <http://austlang.aiatsis.gov.au/main.php?code=E44>, not included in H&B’s survey.)

Yirandali

The Yirandali (Dalleburra) in Chirila is from Curr [42] and does not have color terms. H&B’s data table has for Yirandali three terms, which match three words in the best available but ‘fragmentary’ source, from the 19th century [11, 271–6]. However, the source’s entry for *boronya* is ‘OCHRE, red *Boronya*’ and so the gloss is actually ‘red ochre’ (fitting a pattern with other phrasal glosses), and there is no ‘red’ term. Note that Bowern & Atkinson’s source ‘Bennett (1927)’ [22, S3,S13] has only a few words of vocabulary, and presumably [11] was meant. Breen has collated all available information on this language (Yirandhali) [32, 242–3].

YirYoront

H&B’s data table has for YirYoront *kolpikolon* ‘black’, *larrl* ‘white’, *kolvlh* ‘red’, and *muw* ‘grey’. The comprehensive Yir-Yoront dictionary [1] has entries for a set of four color terms; each has a note to contrast it with the three others.

The closest form to H&B’s *kolpikolon* in the Yir-Yoront dictionary is *kolp+kol+lh* ‘black’. The dictionary glosses *larrl* ‘1. white 2. clean, clear’, and *kolvlh* ‘1. (as for *warr-kolvlh* ‘*Sorghum* [spp.]’ [*warr* reduced form of *warrq* ‘grass’ –DGN]) 2. reddish, whitish-red’. The latter lacks the contrast note, and so the lexicographer did not consider it on a par with the four color words. Instead the dictionary has *kam+kam+w* ‘red, yellow’ (under *kam* ‘blood’). The dictionary glosses *muw* ‘1. grey 2. smoke’; if *muw* is considered a basic color term then it goes against the usual WCS pathways by occurring in a language with only three other basic color terms.

Update (30 October 2017): response to B&H’s reply

My Letter to *PNAS* [94] was published on 14 September 2017 simultaneously with ‘REPLY TO NASH: Color terms are lost, despite missing data’ [23] (here, B&H). Here I respond to the reply, which does not detract from my title ‘Loss of color terms not demonstrated’.

B&H summarise my critique as

citing questions about the semantics of certain lexical items, treatment of unattested items, and, crucially, problems with missing (vs. absent) data in Bayesian phylogenetic models.

Actually rather than asking questions on these points, my critique makes claims. Further, my discussion of H&B’s neutralisation of missing (vs. absent) data is not confined to treatment in Bayesian phylogenetic models. By coding all ‘missing’ as ‘absent’ H&B did not carry out their own advice that ‘the solution is not to introduce arbitrary coding biases’.

Now B&H say that they ‘reran all analyses with five alternative datasets’; the reader is not provided with any of these alternative datasets.

First, B&H ‘corrected errors resulting from data missing from Chirila’. If they mean here the errors repaired by their April 2017 revised data table, then they have not taken account of the corrections I have indicated above for their revised data table. Second, B&H say they ‘applied Nash’s alternative judgments about color term presence/absence’: again we do not know what

effect this had on the input data; and further, I usually supplied straightforward corrections to H&B's data table, and hardly any of the amendments involved my judgment.

Third, 'The remaining conditions involved missing data' whereby absent codes variously replaced with "missing" codes' or 'ambiguous states'. This is allowed for in the BayesTraits software package, which H&B used, but again the alternative datasets are not available to the reader. However, those details are likely to be ultimately irrelevant, for reasons I now try to lay out.

Consider the data for the three most attested colors black, white and red. Of the 188 languages, 13 have a gap: 2 lack 'black', 4 lack 'white', and 7 lack 'red' (no language has more than a single gap for these colors). The likely phylogenetic trees will reconstruct with earlier stages lexicalising all three colors; no ancestral state will lack any of the three colors, as that would generally require more than one language with a particular gap to be in the same subgroup. So, if these gaps are regarded as true absences, then each of the 13 gaps must have involved a loss in the descent to the modern language. This is the basis for H&B's conclusion rejecting a gain-only model of the evolution of color term distinctions. It is readily seen that this is so even if some of the gaps are regarded as 'missing' rather than 'absent'; and indeed even if there were only a single absence, that scenario is not possible in a gain-only model (leaving aside the implausible tree wherein the language concerned were a direct descendant of Proto Pama-Nyungan and all other languages were grouped under its sister node).

As an aside, a parallel scenario can be based on the data used in the lexicostatistical classification of Indoeuropean (IE) [50]. The color meanings among the 200 in that study are black, white, red, yellow, and green. Among the words for these five colors in the 95 speech varieties there were three gaps in the source data:⁴ BLACK in Frisian, and Ossetic, and YELLOW in Albanian C. By H&B's method, the ancestral state reconstructions on the plausible phylogenetic trees for Indo-European, would conclude that Proto IE had terms for each of the five colors, and that each of these three languages would have lost the relevant term. That is, a gain-only model would not fit the data, and gain-and-loss model would be required. However, it seems likely that the three gaps are accidents of the sources: the second edition of their Frisian source supplies *swart* 'black' [39, 496]; an online Ossetic dictionary has *cay* 'black' <https://glosbe.com/en/os/black>; and 'yellow' in Albanian C (Arbëresh) is *xhall* <https://glosbe.com/pt/aae/amarelo> (the other four Albanian dialect sources all have *verdh(e)* 'yellow'). Of course it is known that the development of IE color terminology is much more complex (though nevertheless not evincing loss of a basic distinction); see for instance [36, 106]. I do not mean to suggest that it is useful to apply H&B's method to the IE wordlists; I just want to illustrate that the pitfalls in re-using lexical data assembled for another purpose.

Similarly, the large collection of Austronesian vocabulary [53] has some data gaps in the color domain, but it would be foolhardy to claim that this shows basic color distinctions have been lost; and the investigation of Proto-Oceanic color terms [102, 212-7] does not reveal loss.

Now, in the situation of Pama-Nyungan black-white-red, it is irrelevant to posit a scenario where even '90% of 0 values were replaced by ambiguous states', when really the dominant possibility is that none of the 13 gaps ('0 values') are true absences. And for the other colors H&B studied (yellow-green-blue-brown), in Pama-Nyungan the data is sufficiently patchy (as argued in previous sections) as to make too speculative the inferences about ancestral states.

Of course 'Color terms are like other areas of language: subject to change' (B&H): lexical replacement is commonplace. However the topic here is lexical loss (the loss of a lexicalised distinction), which is (or would be) striking in 'basic' vocabulary. I am open to the possibility that

⁴The IE-DATA1 file available at <http://web.archive.org/web/20070204095605/http://www.ntu.edu.au:80/education/langs/ielex/HEADPAGE.html>

there may be a language (or group of languages) whose lineage has lost (or neutralised) a basic color distinction. What I await is evidence that this has happened in a particular lineage. The instances adduced by H&B [60, 13671] were the purported loss of ‘red’ and ‘blue’ in Wailwan, and the posited loss of ‘green’ in the Kanyara–Mantharta languages, but neither of these is sustainable, as I showed above (see the ‘Interpreting wordlist data’ section).

Abbreviations

AIATSIS = Australian Institute of Aboriginal and Torres Strait Islander Studies <http://www.aiatsis.gov.au/>
 AILEC = AIATSIS Australian Indigenous Languages Collection, via <http://catalogue.aiatsis.gov.au>, which
 supersedes ASEDA <http://aseda.aiatsis.gov.au/>
 Backreferences after each item are to page numbers.

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