

# Are languages really independent from genes?

*Genetic biasing in language diversity, change and evolution*

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*Integrating Genetic and Cultural Approaches to Language*

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# Genes and Language

## *The Species/Evolutionary Level*

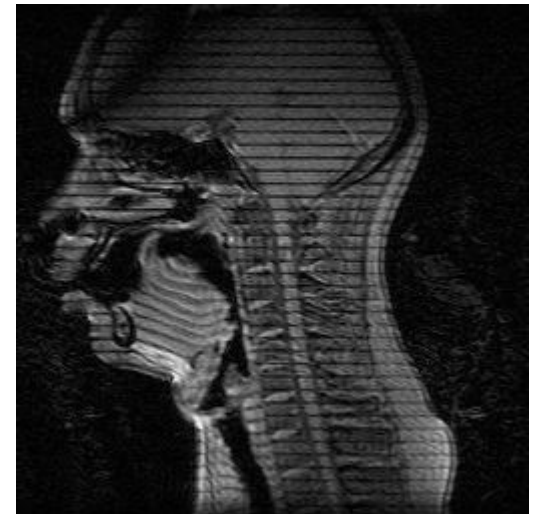
- Language & speech rest on “**species-specific**” genetic foundations

Not necessarily language-specific

Building on **existing structures & behaviors**

Probably **subtle changes**

Mostly in regulatory regions



Human vocal tract  
[www.llas.ac.uk](http://www.llas.ac.uk)

See, for example, T. Fitch & S. Fisher



# Genes and Language

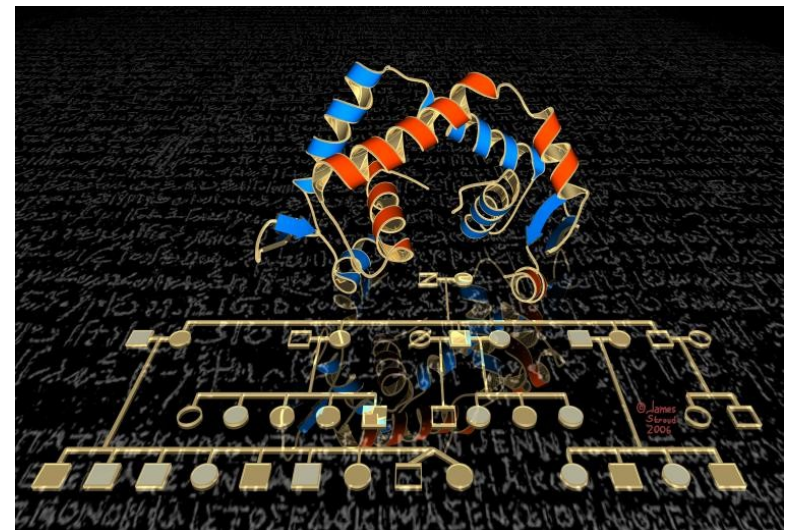
## *The Individual/Ontogenetic Level*

- Individual differences in speech & language have a **strong genetic component**

Normal & pathologic

**Heritability** and specific **genes**

*FOXP2, CNTNAP2*



*FOXP2* gene & KE pedigree  
[www.foxp2.org](http://www.foxp2.org)

See, for example, S. Fisher



# Genes and Language

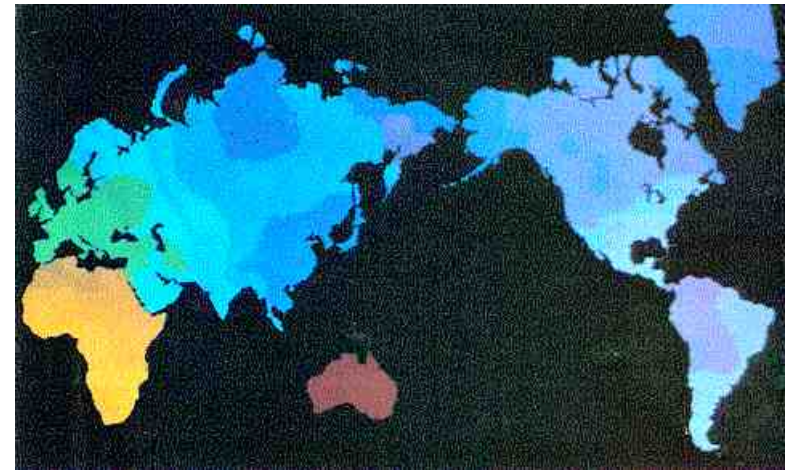
## *The Population/Glossogenetic Level*

- Languages and genes as “**travel companions**” through space & time

They are changing together

**Demographic processes** affect both in parallel ways

Produce **accidental correlations** between language relatedness and genetic similarity



Genetic gradients across the world  
*The History and Geography of Human Genes*



# Genetic Biasing of Language

## *The Idea*

### 1. Language is **shaped by** the

- **Production** and **perception** systems
- **Brain/cognition**
- **Social & cultural** factors and processes

→ some have genetic components

- **Adaptation** to these through **cultural evolution**

⇒ *genetic biases can affect language*

*But no “gene for Chinese”!*

See, for example, M. Pagel, K. Smith, N. Chater



# Genetic Biasing of Language

## *Computer & Mathematical Models*

- **Bayesian Models of language evolution:**

**ILM** with Maximizer Agents (Kirby et al., 2007): **small biases can be amplified** by cultural transmission & bias size is not very important

More complex settings (Dediu, 2009): the prior (biases) **influence** the emerging language

- Boyd & Richerson's (1985, 2005) **“Content”/“Direct” Biases**

- Other models concerning **compositionality, phonology**, etc.



# Genetic Biasing of Language

## *Two Early Suggestions*

- **Darlington** (1947,1955) & **Brosnahan** (1961):

Europe: correlation between distribution of

- **blood groups** and
- **phonetics** (interdental fricatives, front rounded vowels)

**Dismissed** at the time (e.g., Swadesh, 1961)

- possible racism
- poor genetics & statistics
- probably “accidental” correlation (co-dispersal)

**The mechanism** of individual biases amplified across generations is valid



# Genetic Biasing of Language

## *Two Early Suggestions*

- **Italian and Yoruba vowels**

Ladefoged (1984), Disner (1983)

very similar 7-vowel systems (/i e ε a ɔ o u/)

**F<sub>2</sub> lower** for Italian → differences shape of lips  
(Yoruba larger mouth opening, on average)

“This does not, of course, imply that a Yoruba could not learn perfect Italian. *Any individual speaker could compensate* for the overall, statistical, difference in headshape” (Ladefoged 1984: 86)

Genetic biasing through **vocal tract anatomy**



# Tone, *ASPM* & *Microcephalin*

## *Two Genes Involved in Brain Development*

- ***ASPM*** (1q31), ***Microcephalin*** (8p23)
- Recessive primary microcephaly
- Probably affects the **number of asymmetric divisions**
- **Accelerated evolution** in the lineage leading to humans
- **Derived haplogroups** (*ASPM*-D, *MCPH*-D):

**Recent** origin

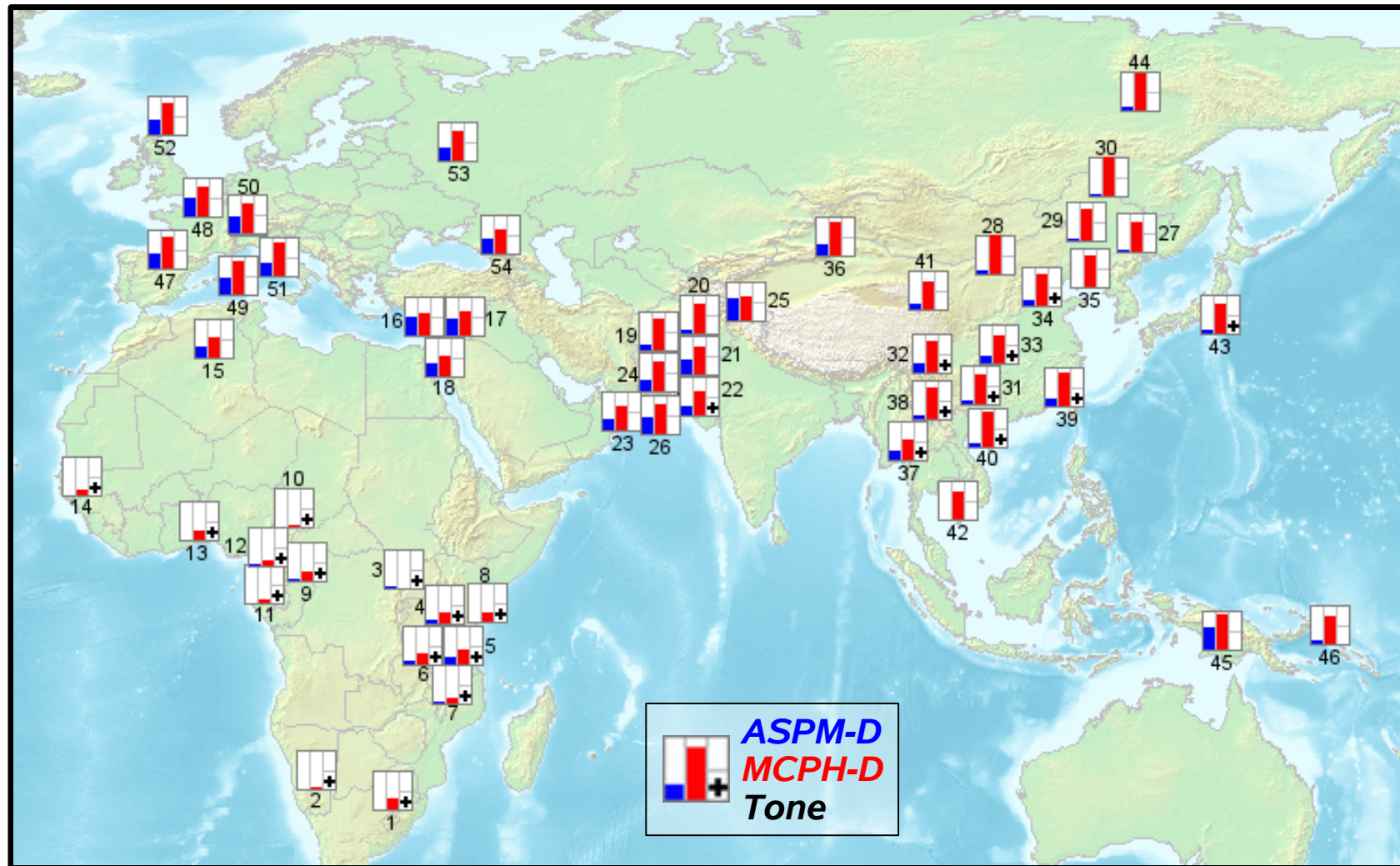
Marked **geographic structure**

Recent/ongoing **natural selection** (???)

Unknown phenotypic effects



# Tone, ASPM & Microcephalin



1. SE-SW Bantu, 2. San, 3. Mbuti, 4. Masai, 5. Sandawe, 6. Burunge, 7. Turu, 8. NE Bantu, 9. Biaka, 10. Zime], 11. Bakola, 12. Bamoun, 13. Yoruba, 14. Mandenka, 15. Mozabite, 16. Druze, 17. Palestinian, 18. Bedouin, 19. Hazara, 20. Balochi, 21. Pathan, 22. Burusho, 23. Makrani, 24. Brahui, 25. Kalash, 26. Sindhi, 27. Hezhen, 28. Mongola, 29. Daur, 30. Orogen, 31. Miaozi, 32. Yizu, 33. Tujia, 34. Han, 35. Xibo, 36. Uygur, 37. Dai, 38. Lahu, 39. She, 40. Naxi, 41. Tu, 42. Cambodian, 43. Japanese, 44. Yakut, 45. Papuan, 46. NAN Melanesian, 47. French Basque, 48. French, 49. Sardinian, 50. N Italian, 51. Tuscan, 52. Orcadian, 53. Russian, 54. Adygei.



# Tone, ASPM & Microcephalin

## Database, Methods & Results

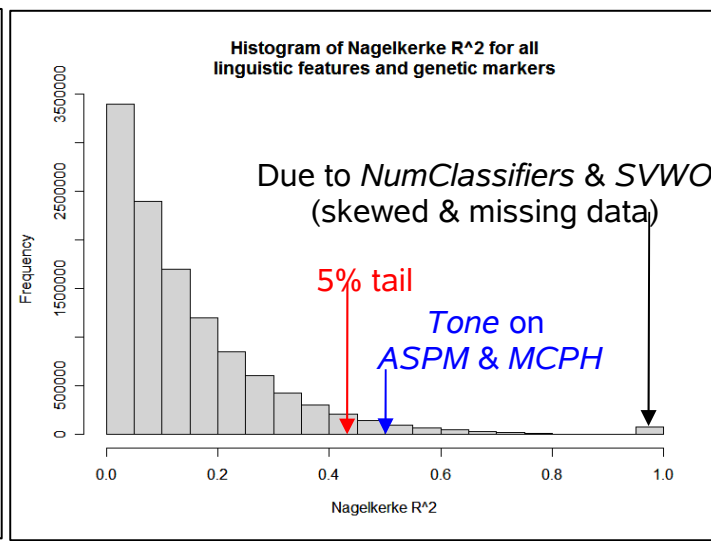
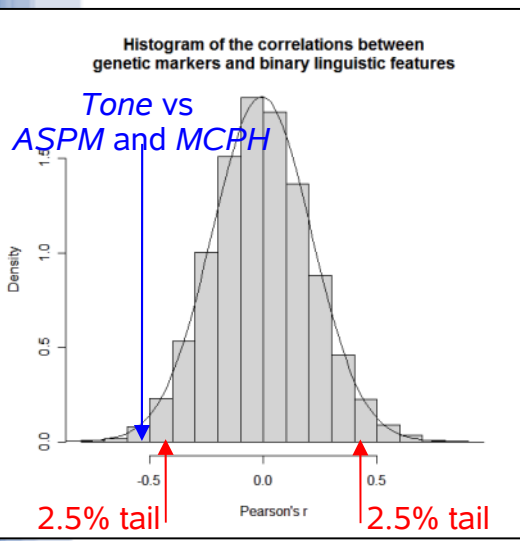
**49 populations, 981 genetic markers, 26 binary features**

- $r_{ASPM-Tone} = -0.53$ ,  $r_{MCPH-Tone} = -0.54$ ,  $p < 0.05$ , top 1.4%
- **logistic regression:  $p < 0.05$ , Nagelkerke's  $R^2 = 0.53$ , 73% corr. classif., in top 2.7%.**

**Mantel corr: geography, genetics, typology & history:**

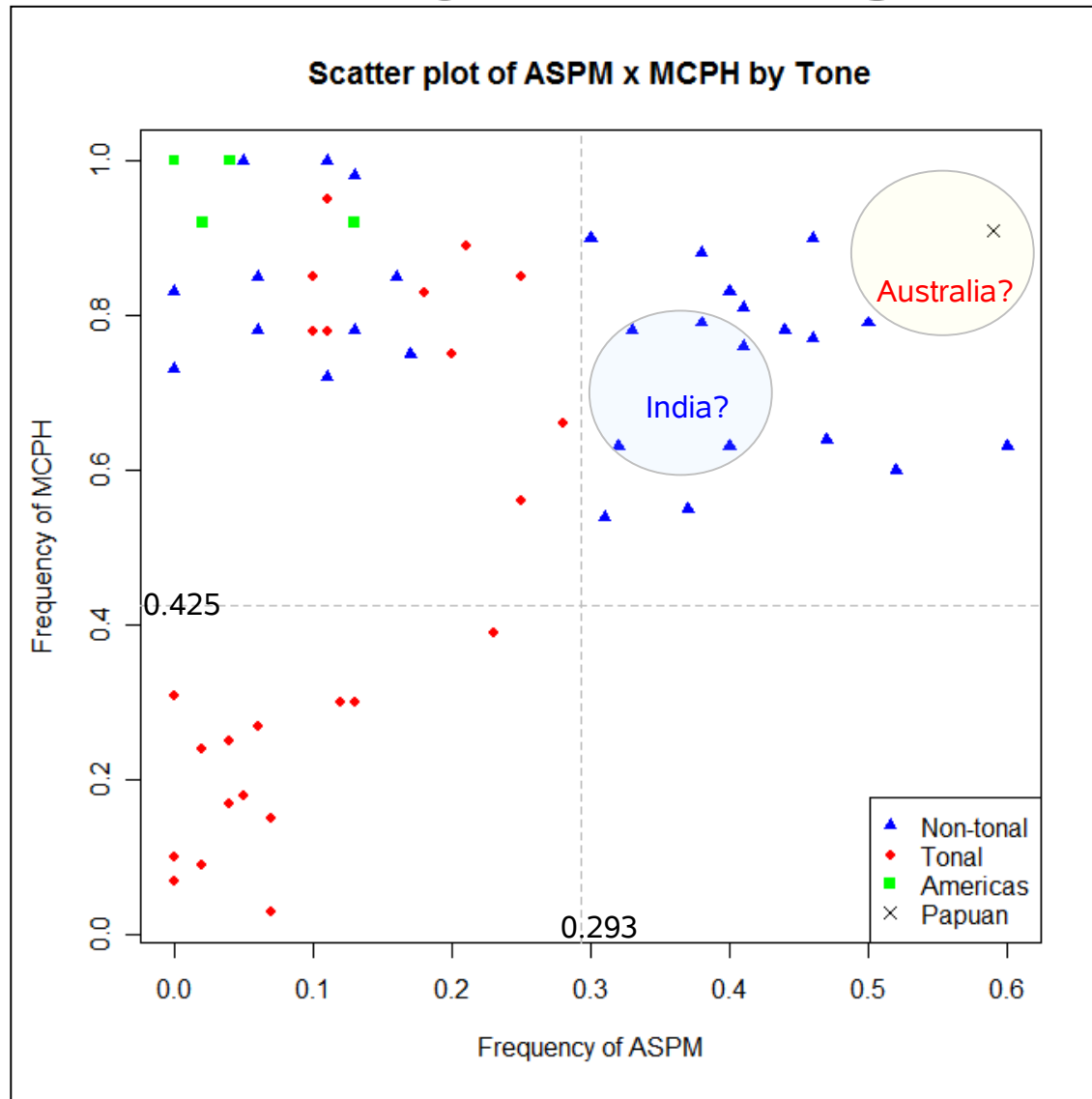
- controlling geography:  
 $r = 0.291$ ,  $p = 0.003$

- **& controlling history:  
 $r = 0.283$ ,  $p = 0.000$**



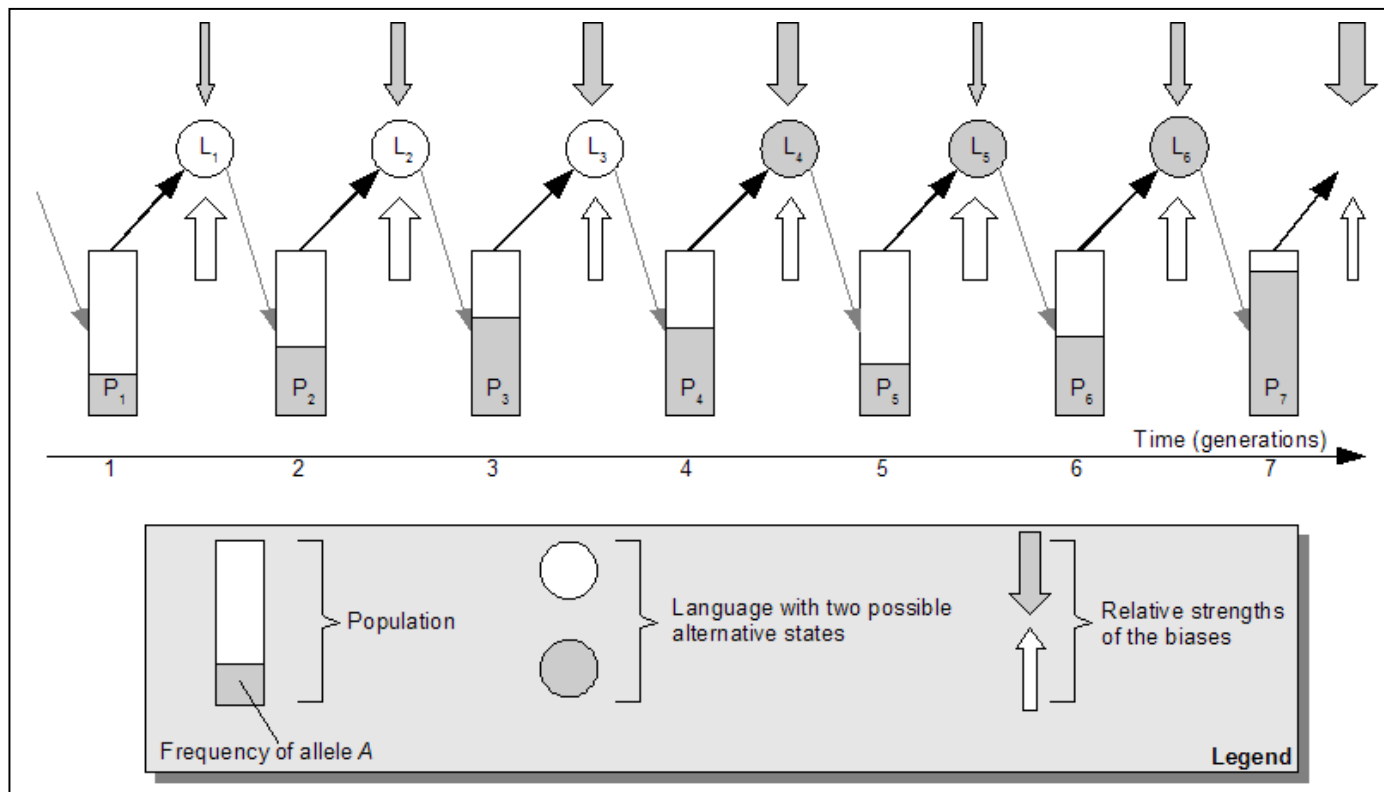
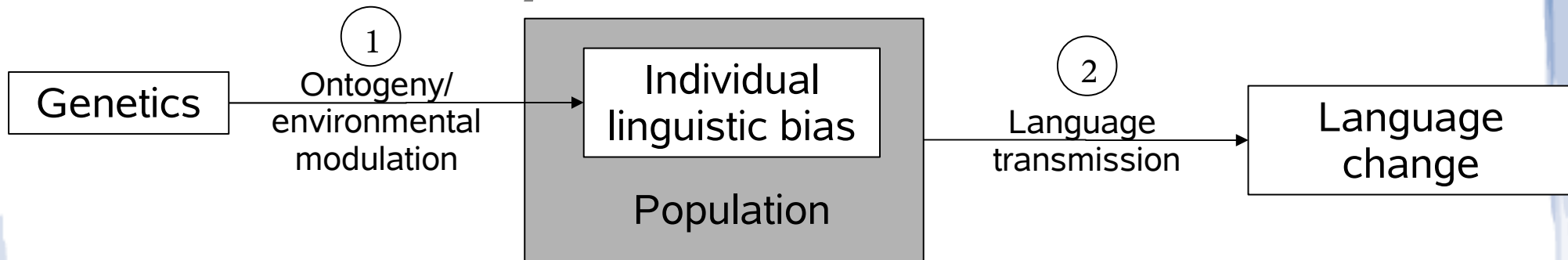
# Tone, ASPM & Microcephalin

## Summary of Findings



# Tone, ASPM & Microcephalin

## Proposed Mechanism



# Tone, *ASPM* & *Microcephalin*

## *Other Supporting Evidence & Future Work*

- Christiansen, Kelsey & Tomblin (pc. 2008): preliminary **association** between an *ASPM* SNP and several measures (probably) related to **phonology**
- Dediu (*in preparation*): tone seems to be **more stable** than expected
- **Work in progress:**
  - Operationalization** of the bias & association with “ethnicity”, *ASPM* & *Microcephalin*
  - Historical characteristics** of tone
  - Effects of *ASPM/Microcephalin* on **brain anatomy**



# The Genetic Biasing of Language

*... and Language Evolution, Change & Diversity*

- In a trivial sense, genes influence language
- Seems to favor a gradual evolution of language
- Suggests the possibility of a "genetic archeology" of language (see Fitch)
- One of the causes of past & current linguistic diversity
- Can constrain the language "design space"
- Practically, exploratory method for suggesting aspects under genetic influence.



# End

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