EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Center for
Advanced Studies

DFG

Modern Human Origins

Interfaces with Archaeology and Genetics

Hugo Reyes-Centeno, Yonatan Sahle, Christian Bentz

24 January 2018, Lecture 10, Bentz

Readings for Lecture 10

Creanza N, Ruhlen M, Pemberton TJ, Rosenberg NA, Feldman MW, and Ramachandran S. 2015. A comparison of worldwide phonemic and genetic variation in human populations. *Proceedings of the National Academy of Sciences* 112(5): 1265-1272.

Moisik SR, and Dediu D. 2017. Anatomical biasing and clicks: Evidence from biomechanical modeling. *Journal of Language Evolution* 2(1): 37-51.

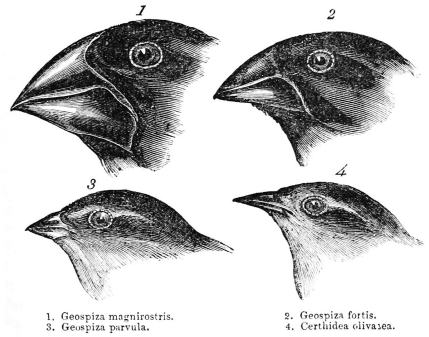
Morgan TJH, Uomini NT, Rendell LE, Chouinard-Thuly L, Street SE, Lewis HM, Cross CP, Evans C, Kearney R, de la Torre I et al. 2015. Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications* 6: 6029.

Recap of Lecture 9

Preadaptations to Language

Terminology

- Adaptation
- Preadaptation
- Exaptation
- Spandrel

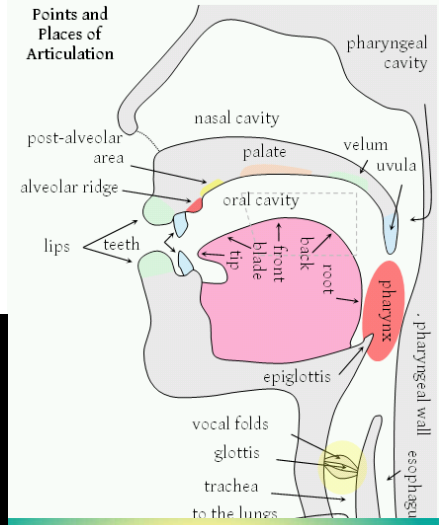


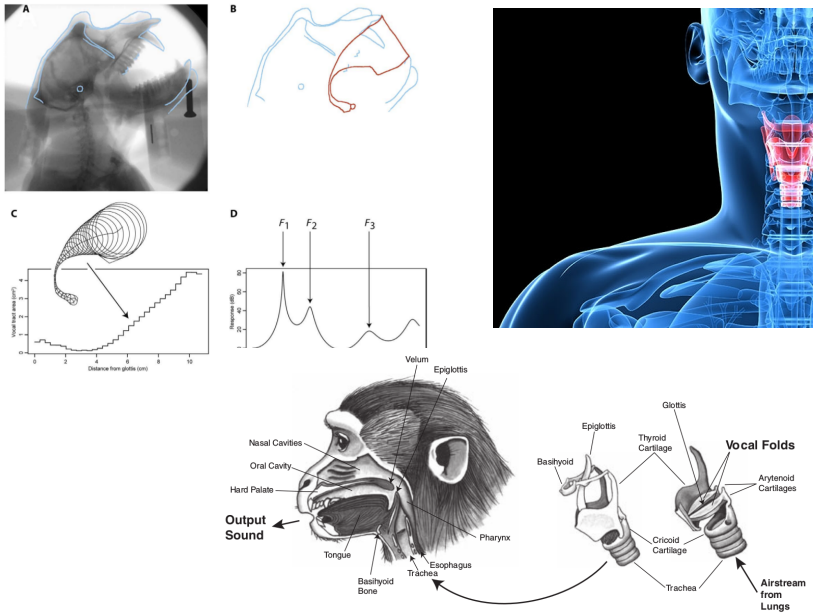
Fitch 2010, p. 63-64

Summary: Speech Production and Perception

There is **no strong** evidence that the vocal tract anatomy and perceptual abilities of animals – **the hardware** – prevents them from using speech.

The difference is more likely in the **software.**





Stone Tool Production and Language

- **Theory**
- Experiments

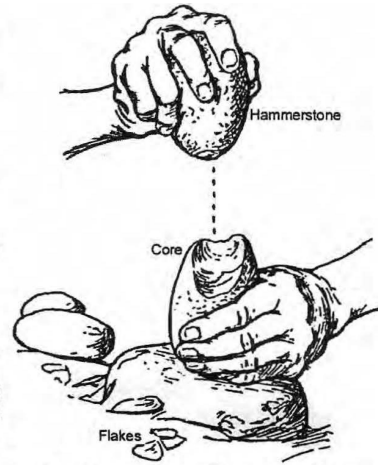
Stone Tools & Language

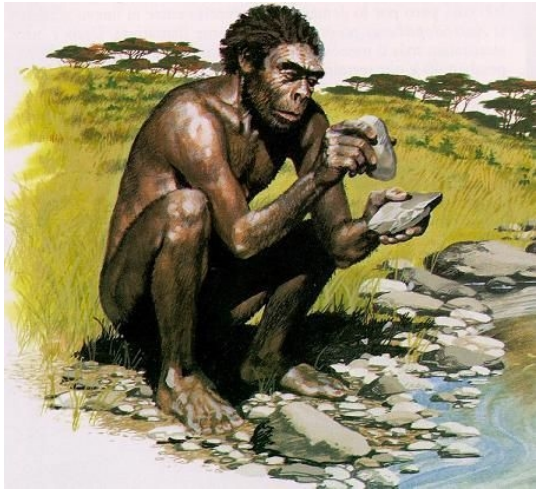
Theory

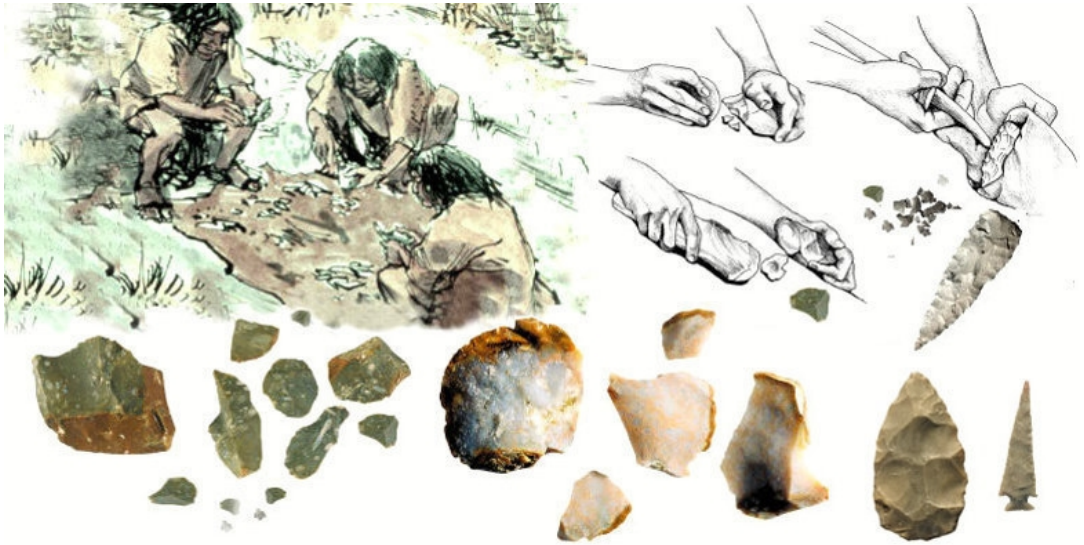
- Hierarchy
- Thinking tools

Experiments

- Oldowan
- Acheulean
- Levallois







Stone Tools & Language

Theory

- Hierarchy
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- Oldowan
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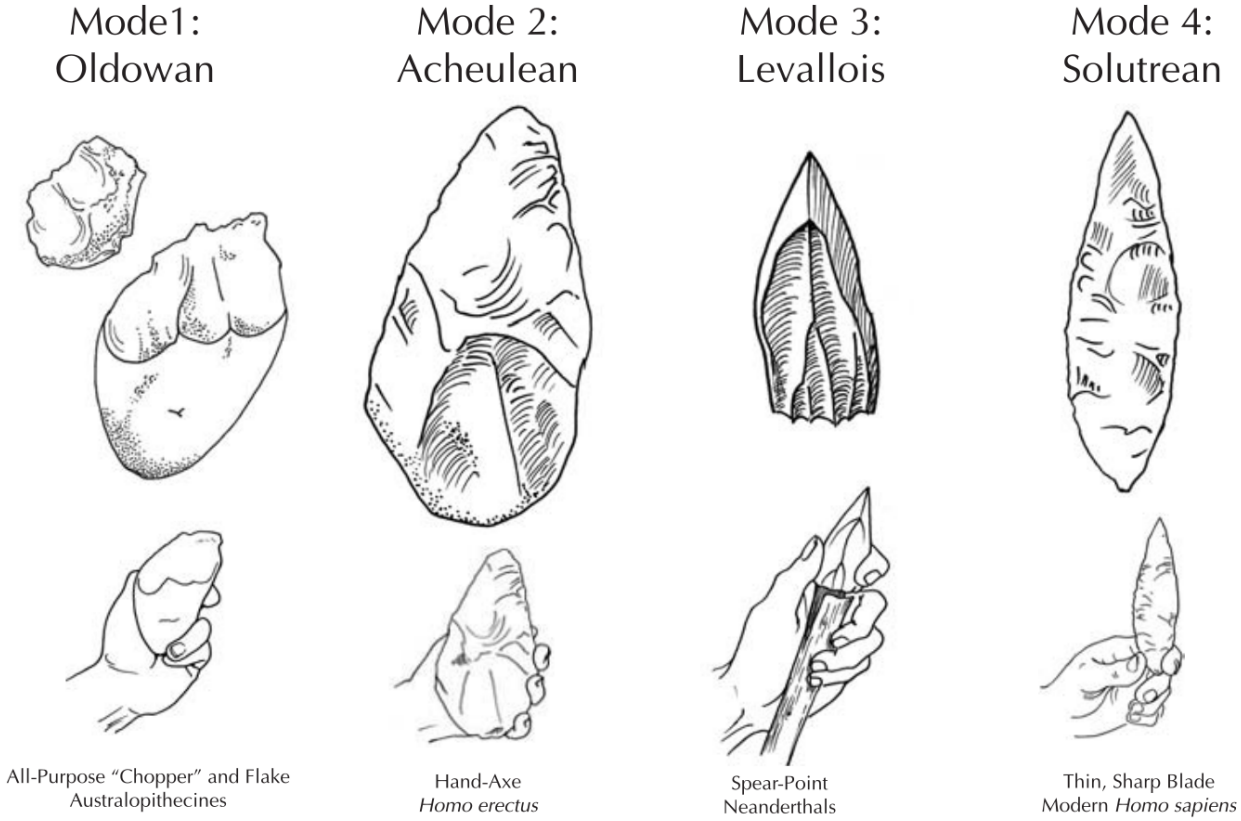
- Levallois



Fitch (2010), p. 256

However… remember slides by Dr. Sahle!

Stone Tools & Language

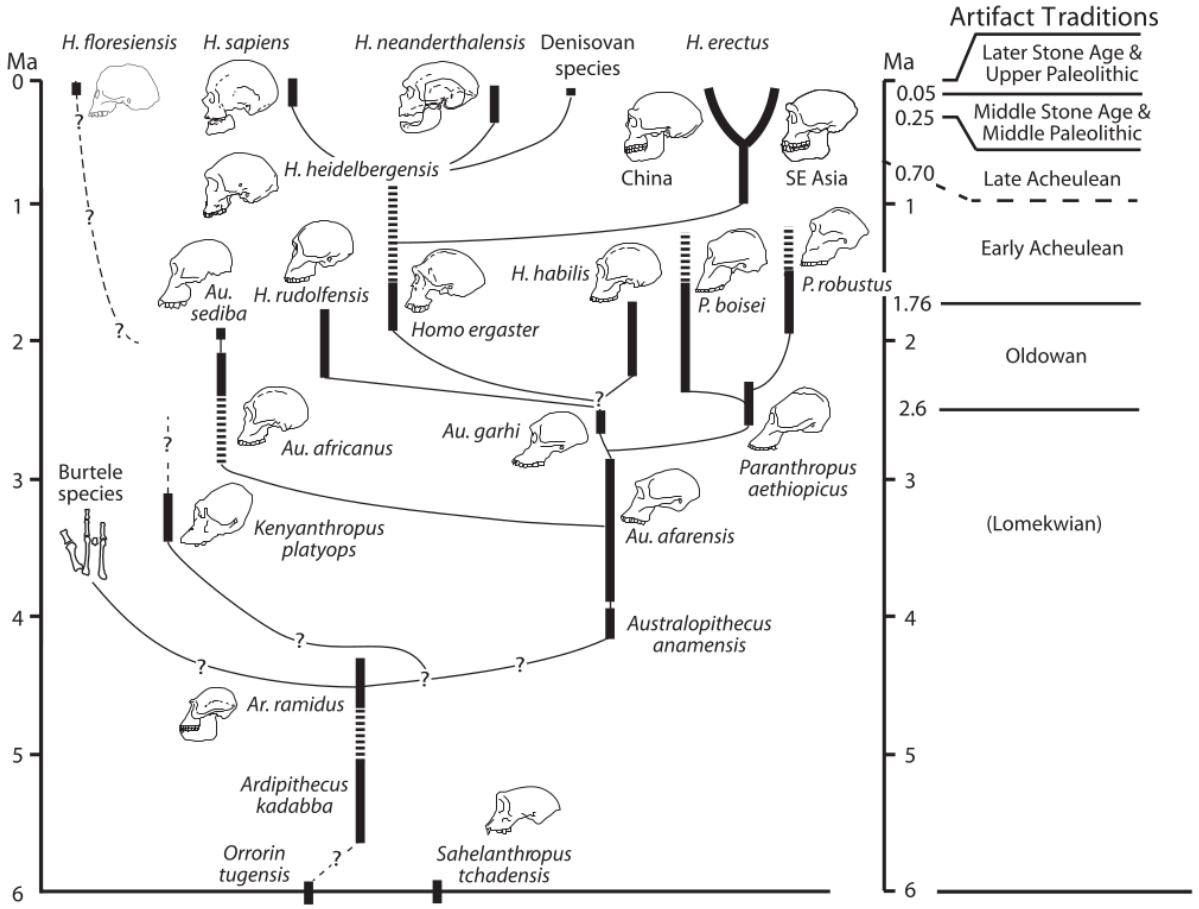
Theory

- Hierarchy
- Thinking tools

Experiments

- Oldowan
- Acheulean
- Levallois

A more fine-grained view



Klein (2017).

Stone Tools & Language

Theory

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- Thinking tools

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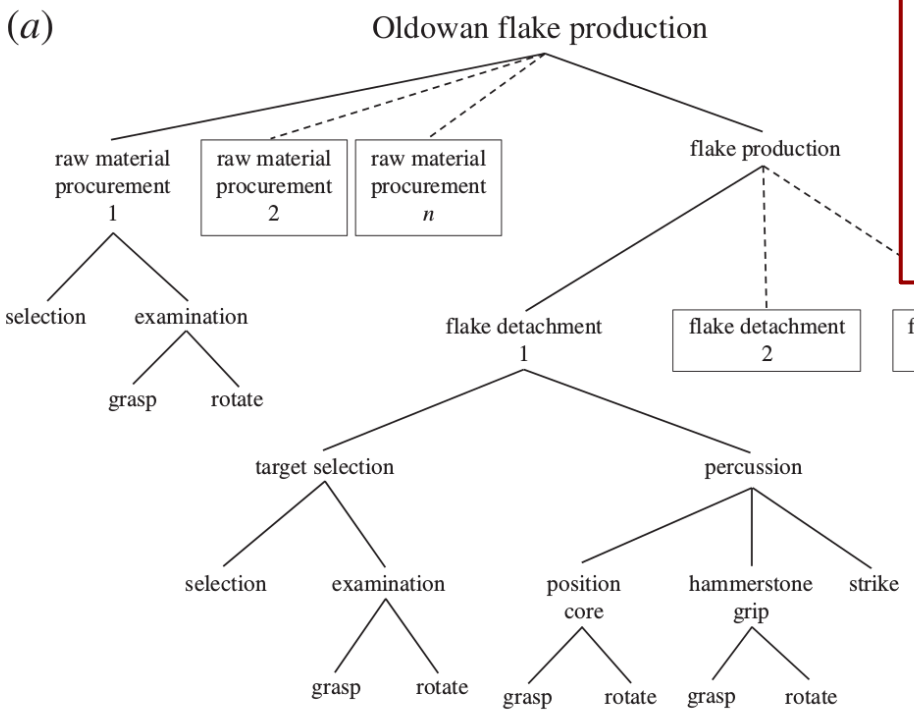

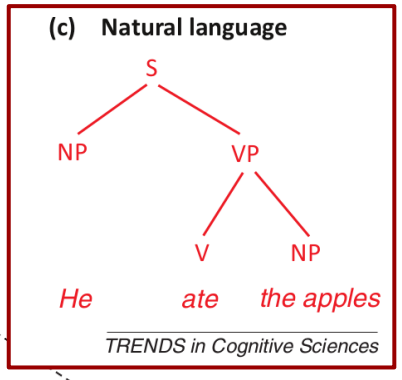

Within this structure, certain discrete **action 'chunks' can be repeated an indefinite number of times**, as indicated by numbers 1, 2, . . . , n. [...]

Such modular structure is an efficient and productive characteristic of hierarchical organization that has received much attention in the study of language under the heading of 'discrete infinity'

Stout (2011). Stone toolmaking and the evolution of human culture and cognition.

Stone Tools & Language

Tool use in our closest living relatives:

Theory

- Hierarchy
- **Thinking tools**

Experiments

- Oldowan
- Acheulean
- Levallois

Video

https://www.youtube.com/watch?v=o2TBicMRLtA

Stone Tools & Language

Theory

- Hierarchy
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Example: Fishing for termites

Cognigrams
Reflecting action steps and attention foci

0. Perception of basic need: feeding
0a. Perception of sub-problem 1: open termite nest / extract termites
0b. Perception sub-problem 2: tool necessary to open nest
0c. Perception of sub-problem 3: tool necessary for probing

PHASE I: manufacture of probe I
1. Search for appropriate twig

PHASE II: manufacture of probe II
2. Detaching the twig
3. Shortening / removal of leaves / fraying of brushtip

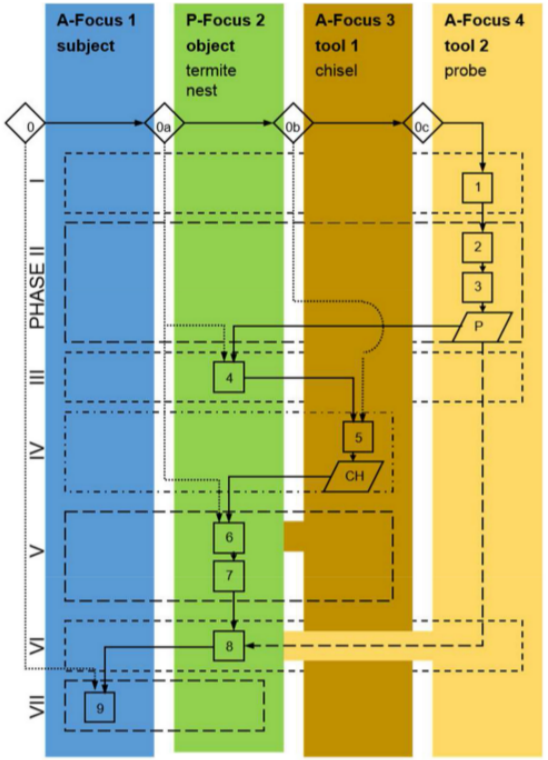
PHASE III: transport of probe
4. Transport of probe to termite nest

PHASE IV: search for chisel
5. Selection of chisel on site

PHASE V: opening the termite nest
6. Pushing with chisel (several times)
7. Inspection of chisel

PHASE VI: probing for termites
8. Extraction of termites with probe

PHASE VII: satisfaction of need
9. Consumption



Haidle (2014). Building a bridge – an archaeologist's perspective on the evolution of causal cognition.

Stone Tools & Language

Theory

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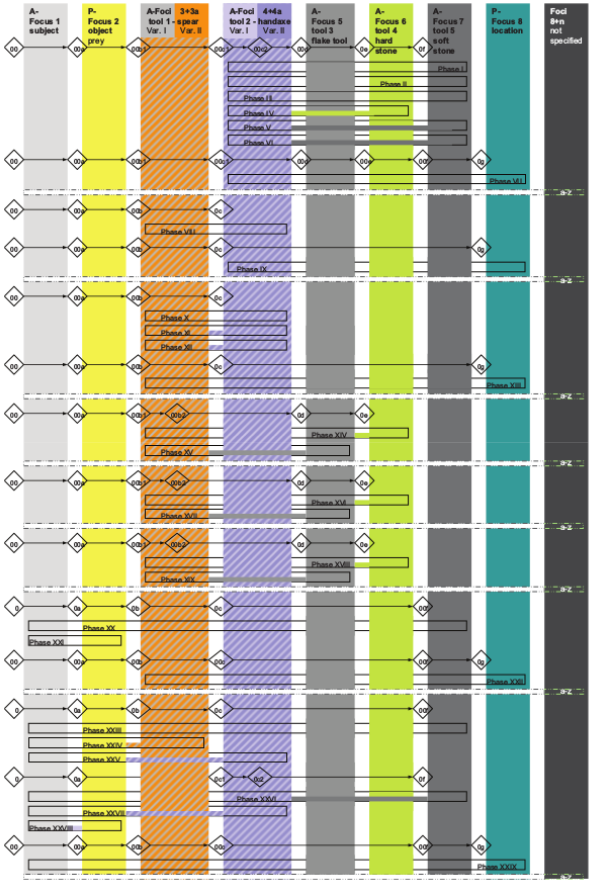
Example: Building a spear/javelin

Schöningen javelin (300 kya)



Haidle (2014). Buidling a bridge – an arachaeologist's perspective on the evolution of causal cognition.

Stone Tool Production and Language

- Theory
- **Experiments**

Stone Tools & Language

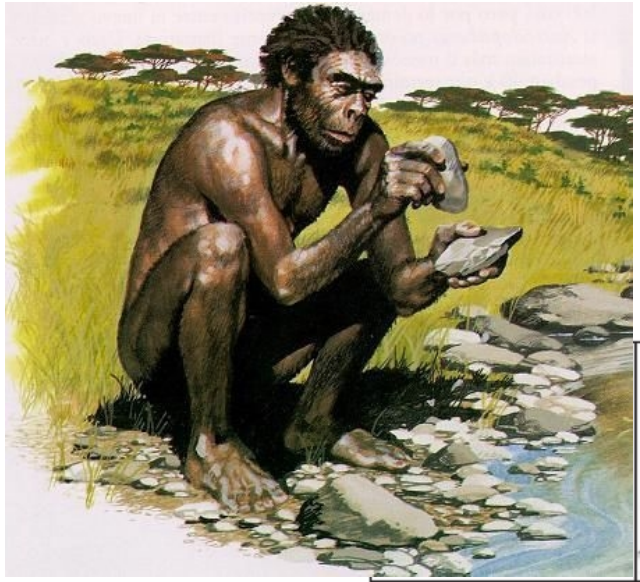
How much gesture and speech do we need to build tools?

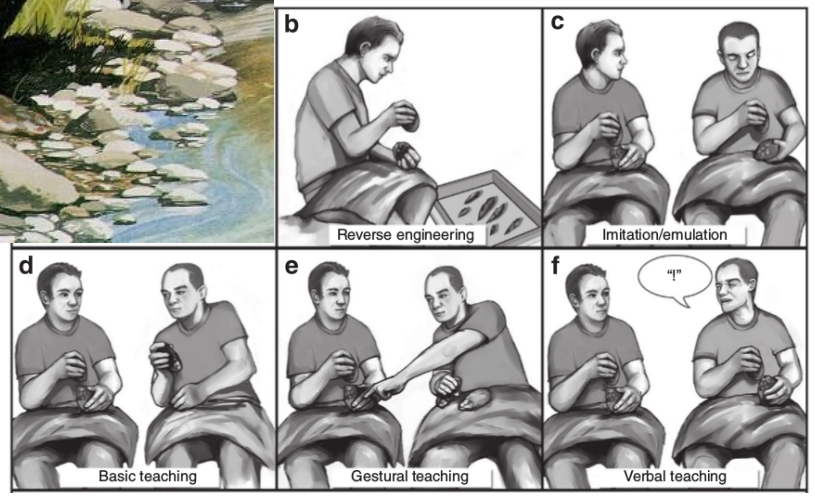
Theory

- Hierarchy
- Thinking tools

Experiments

- Oldowan
- Acheulean
- Levallois





Stone Tools & Language

Theory

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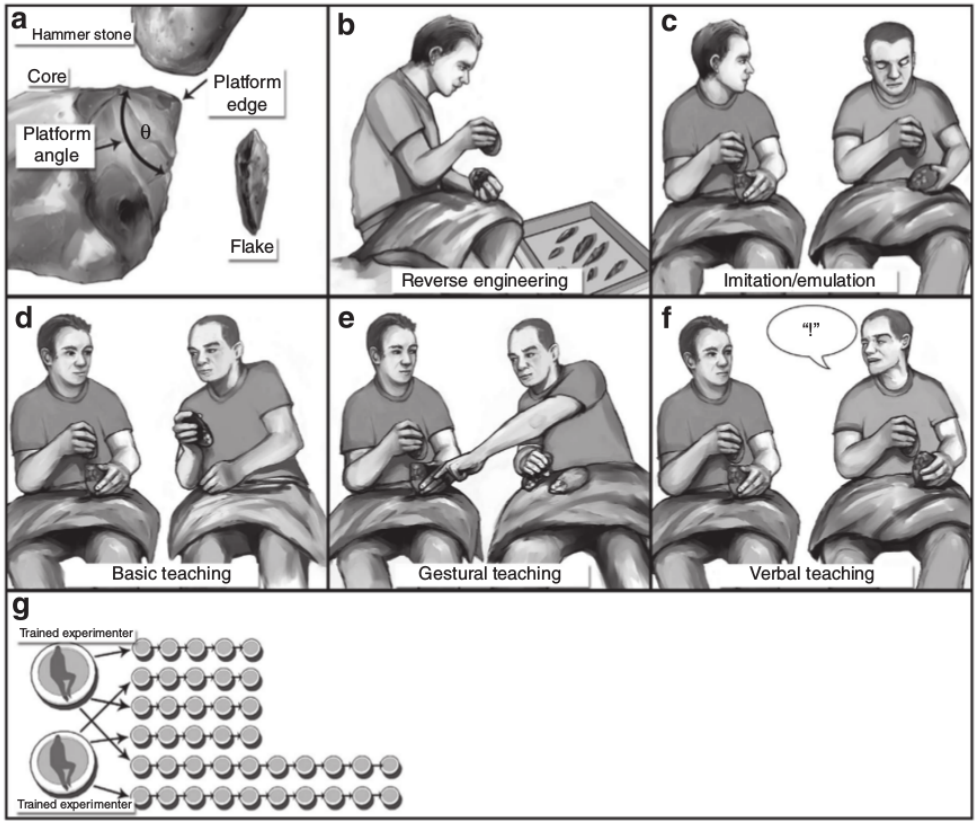
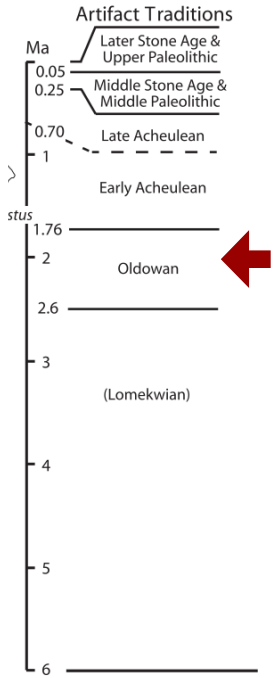
Learning and transmission of Oldowan technology





Morgan et al. (2015).

Stone Tools & Language

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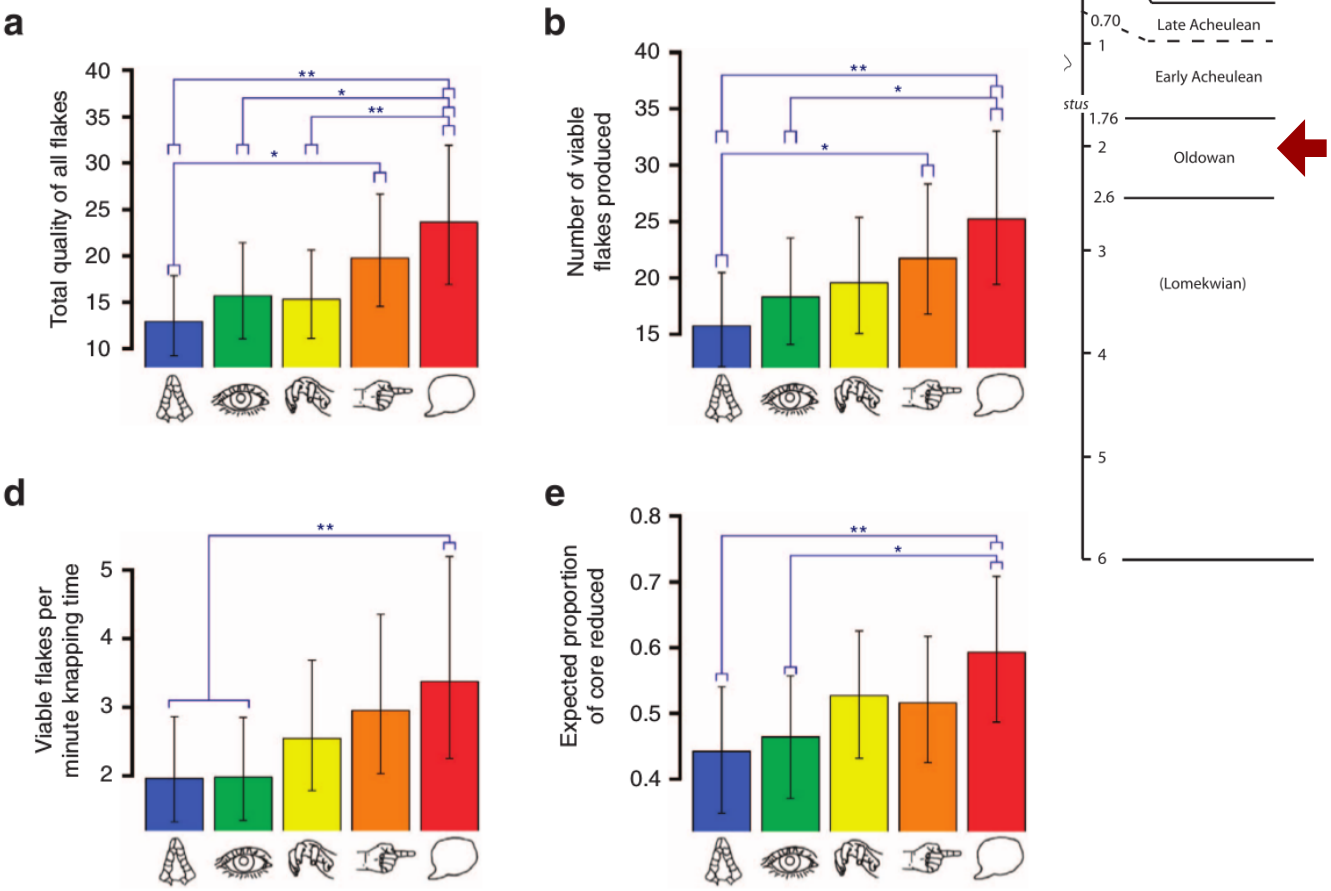

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Stone Tools & Language

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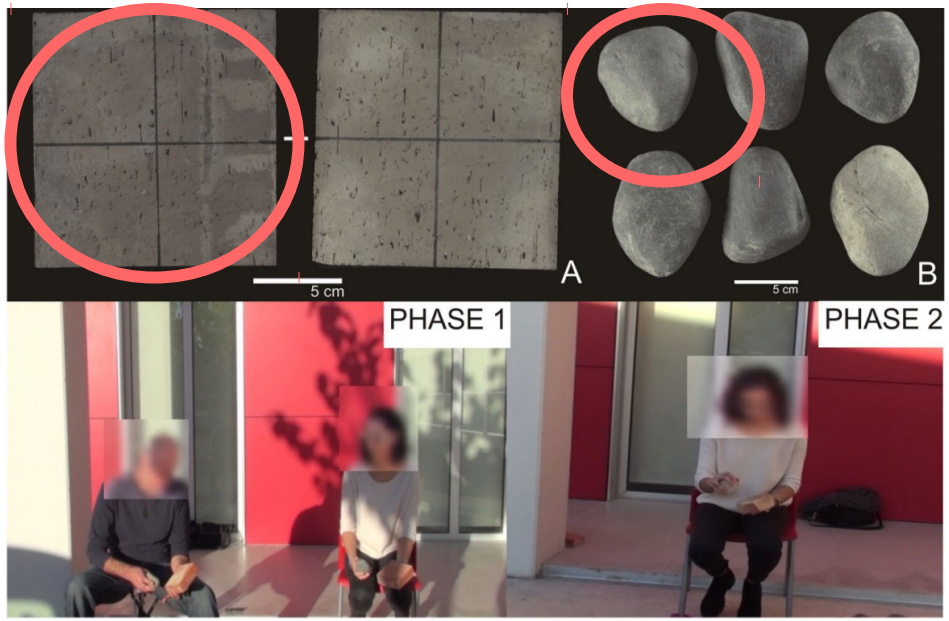
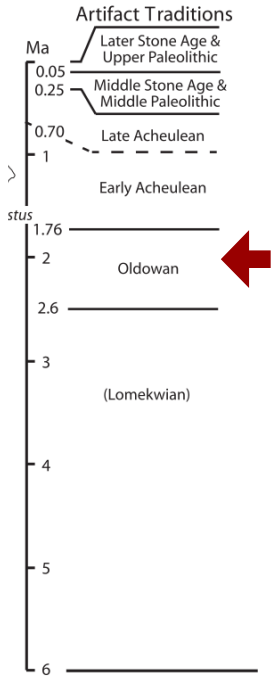


Figure 6. (**A**) Brick used as a blank, (**B**) set of hammerstones used in the experiment. Phase 1: expert knapper and an apprentice knapping; Phase 2: apprentice knapping alone.

Same blanks and hammerstones for all participants.



Lombao et al. (2017). Teaching to make stone tools: new experimental evidence supporting a technological hypothesis for the origins of language.

Stone Tools & Language

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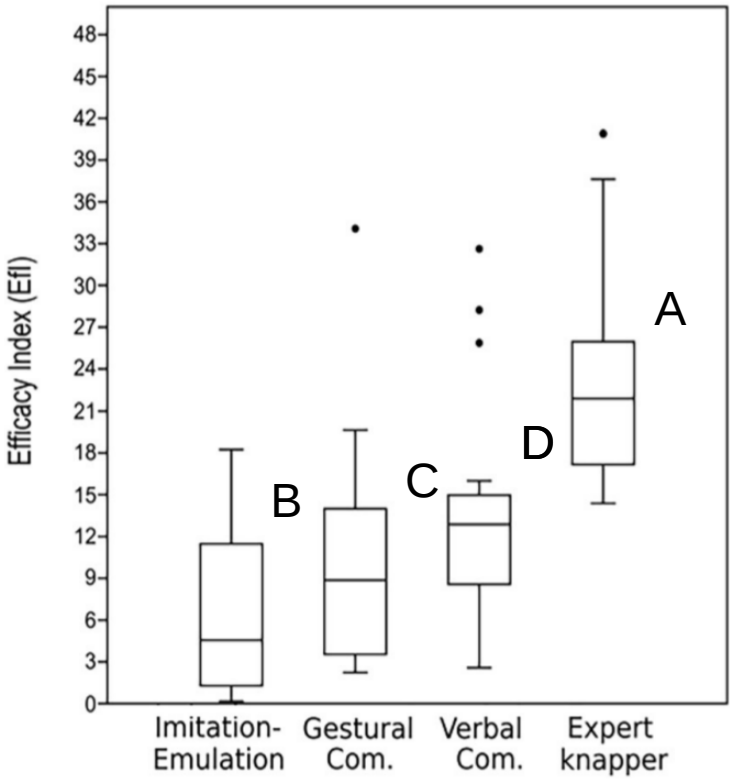
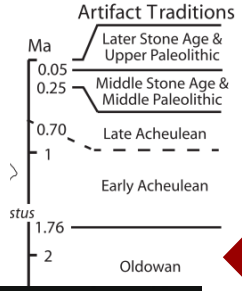
Learning and transmission of Oldowan technology





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Stone Tools & Language

Theory

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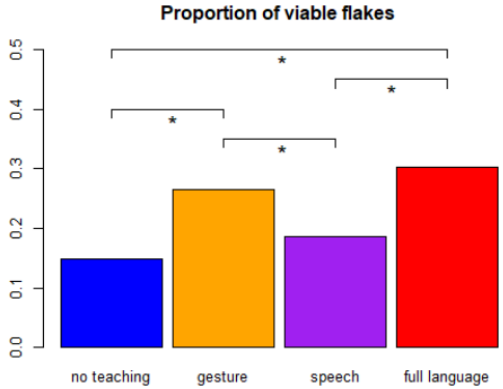
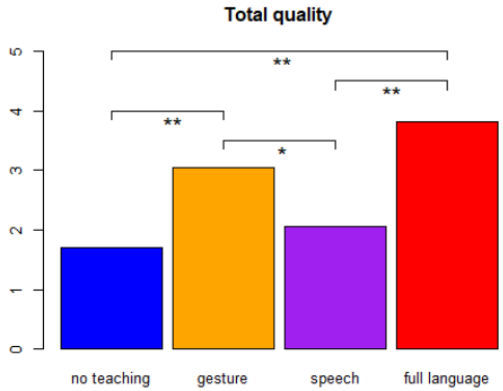
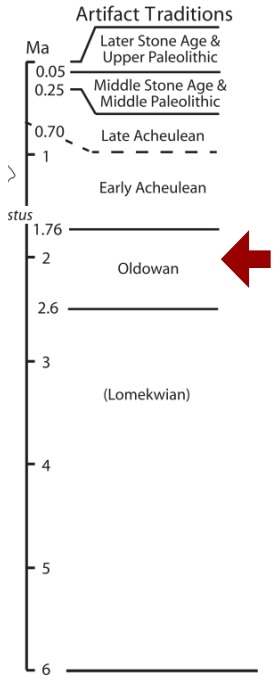
Most recent paper:
Learning and transmission of Oldowan technology





Speech (on its own) is an ineffective method of transmission of Oldowan-style tool-making skills, i.e. not significantly better than no teaching at all (!)

Full language (gesture+speech) is most efficient, but not significantly better than gesture alone (!)



Cataldo et al. (2018). Speech, stone tool-making and the evolution of language.

Stone Tools & Language

Theory

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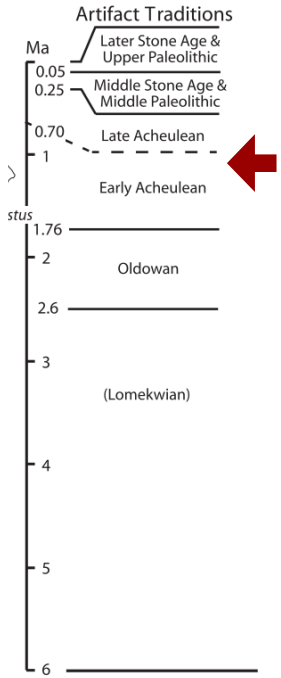
Learning and transmission of bifacial (Acheulean) technology

Instructor

Students



Putt et al. (2014). The role of verbal interaction during experimental bifacial stone tool manufacture.

Stone Tools & Language

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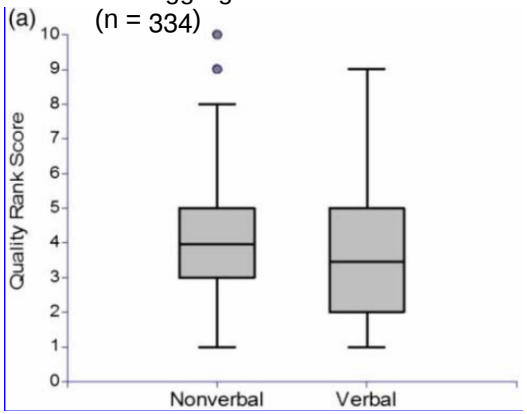
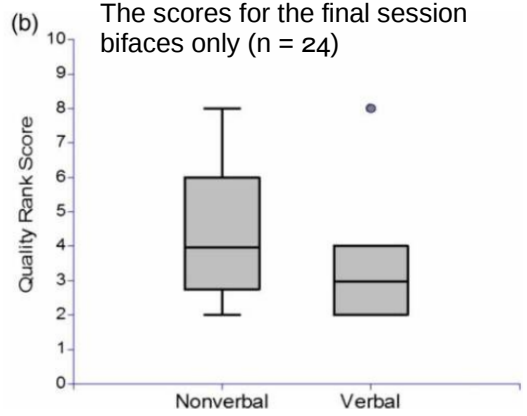
Learning and transmission of bifacial (Acheulean) technology

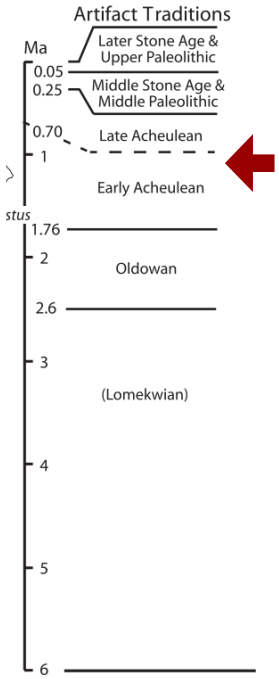
Total aggregate number of bifaces (n = 334)



The scores for the final session bifaces only (n = 24)



These results indicate that **verbal interaction is not a necessary component** of the transmission of the overall shape, form, and symmetry of a biface in modern human novice subjects, and it **can hinder the progress of verbal learners** because of their tendency to over-imitate actions of the instructor that exceed their current skill set.



Putt et al. (2014). The role of verbal interaction during experimental bifacial stone tool manufacture.

Stone Tools & Language

- Theory
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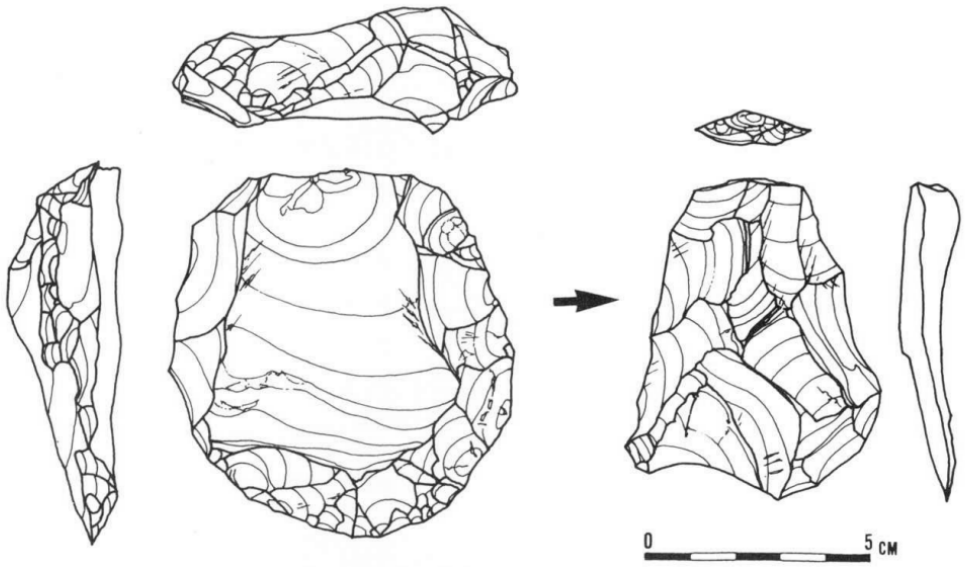
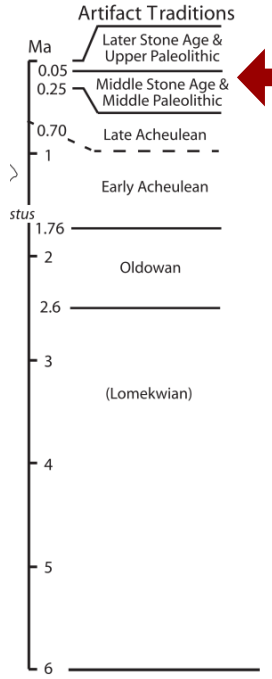
  - Thinking tools
- **Experiments**
  - Oldowan
  - Acheulean
  - **Levallois**

Learning and transmission of Levallois technology

Demonstrator





Ohnuma al. (1997). Transmission of tool-making through verbal and non-verbal communication: preliminary experiments in Levallois flake production.

Stone Tools & Language

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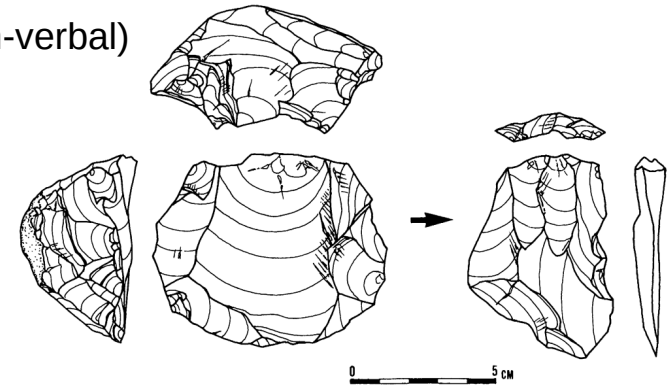
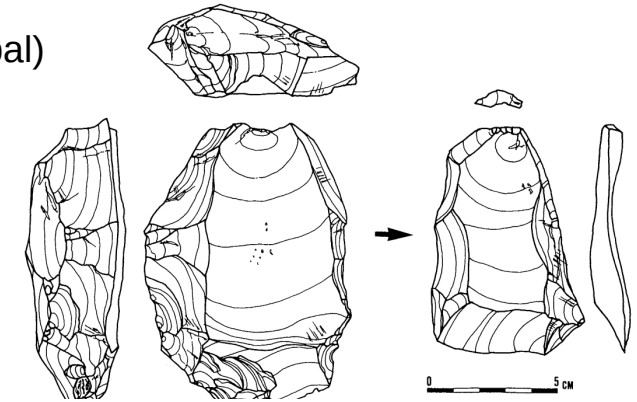
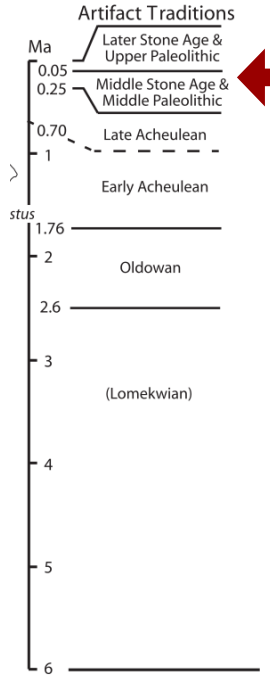
Learning and transmission of Levallois technology

Student (non-verbal)



Student (verbal)





Ohnuma al. (1997). Transmission of tool-making through verbal and non-verbal communication: preliminary experiments in Levallois flake production.

Stone Tools & Language

Learning and transmission of Levallois technology

Theory

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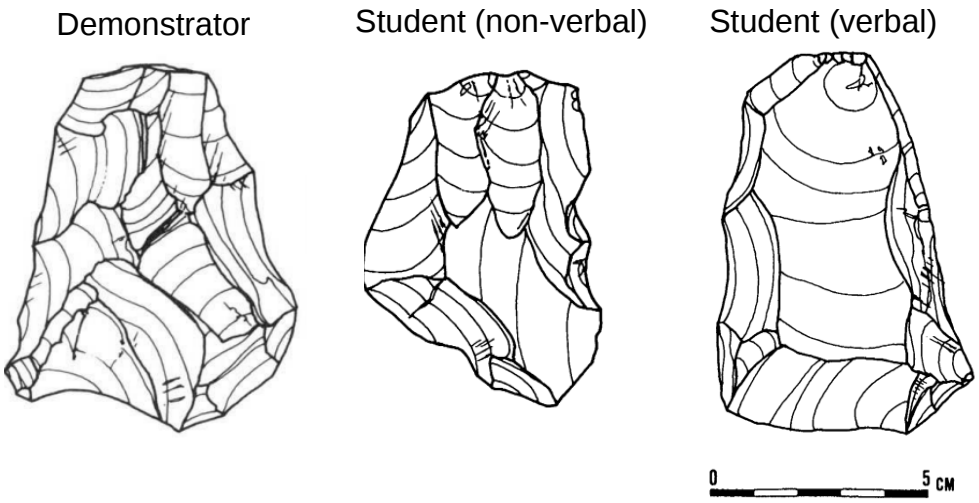
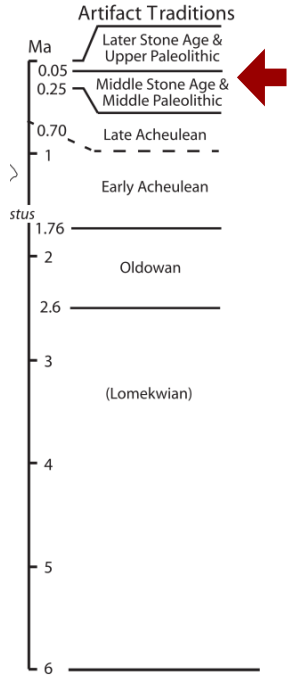
The rates and mean times of acquisition of the Levallois technique and of successful flake production were compared. They did not differ significantly between the two groups. From these results, we infer that **spoken language was not Indispensable** for Levallois flake production in the Middle Palaeolithic.





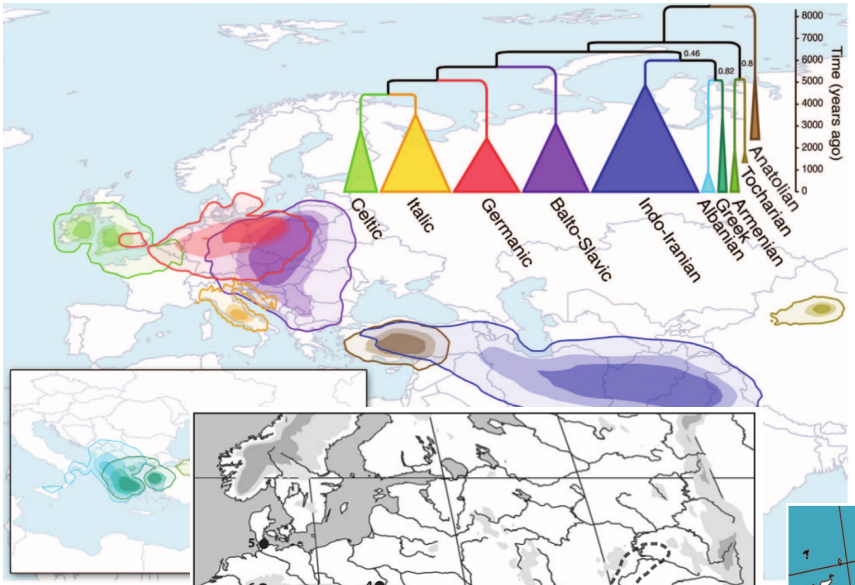
Ohnuma al. (1997). Transmission of tool-making through verbal and non-verbal communication: preliminary experiments in Levallois flake production.

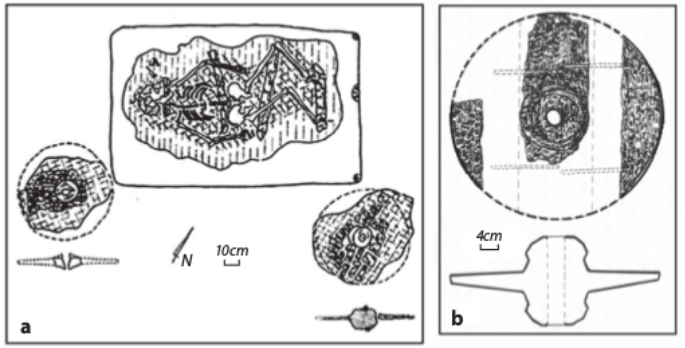
Reconstructing the Human Past:

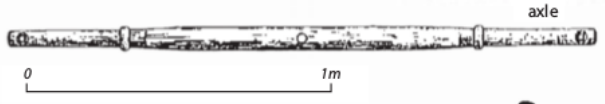
Linguistic and Archaeological Evidence

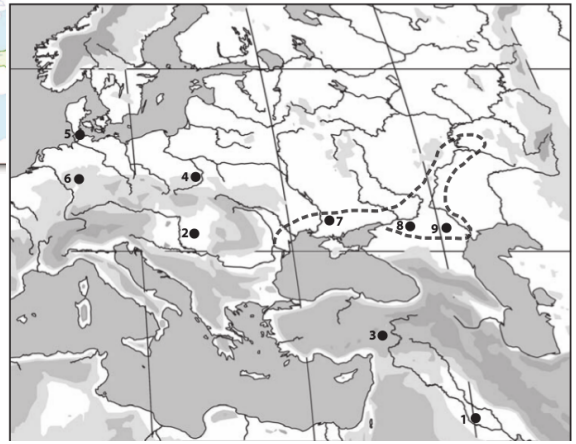
- The Indo-European Controversy

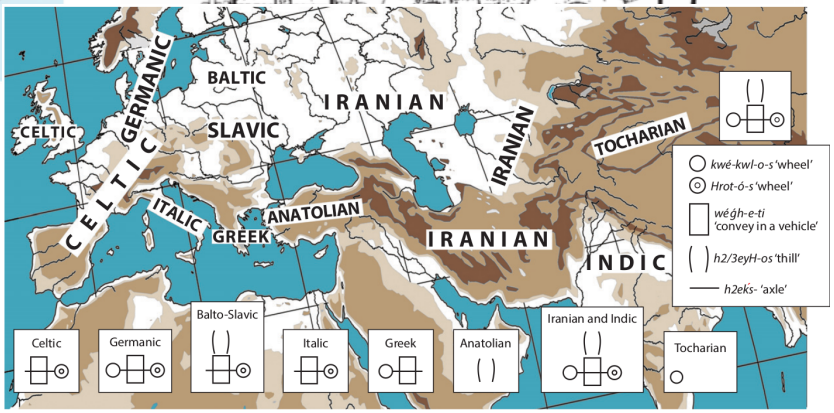
Linguistics & Archaeology







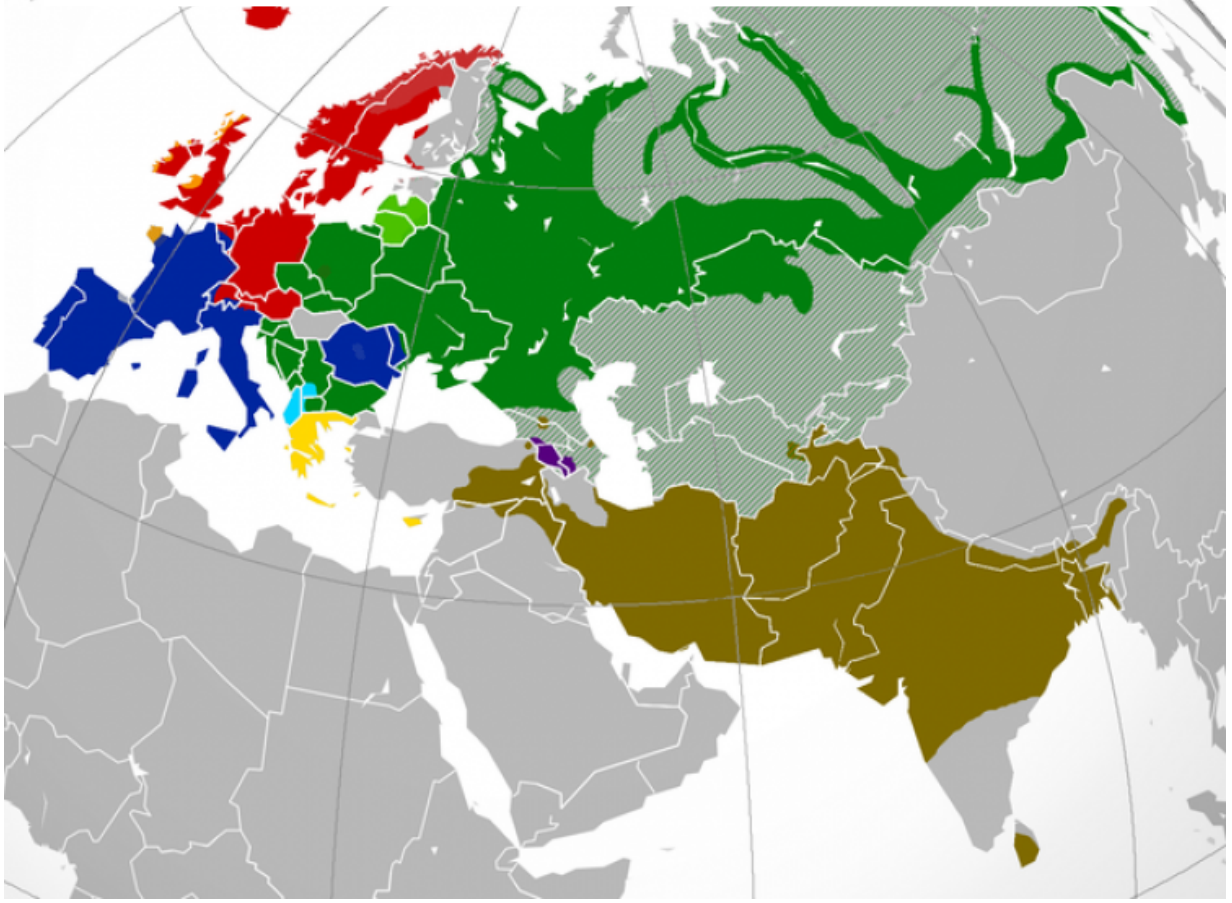




Linguistics & Archaeology

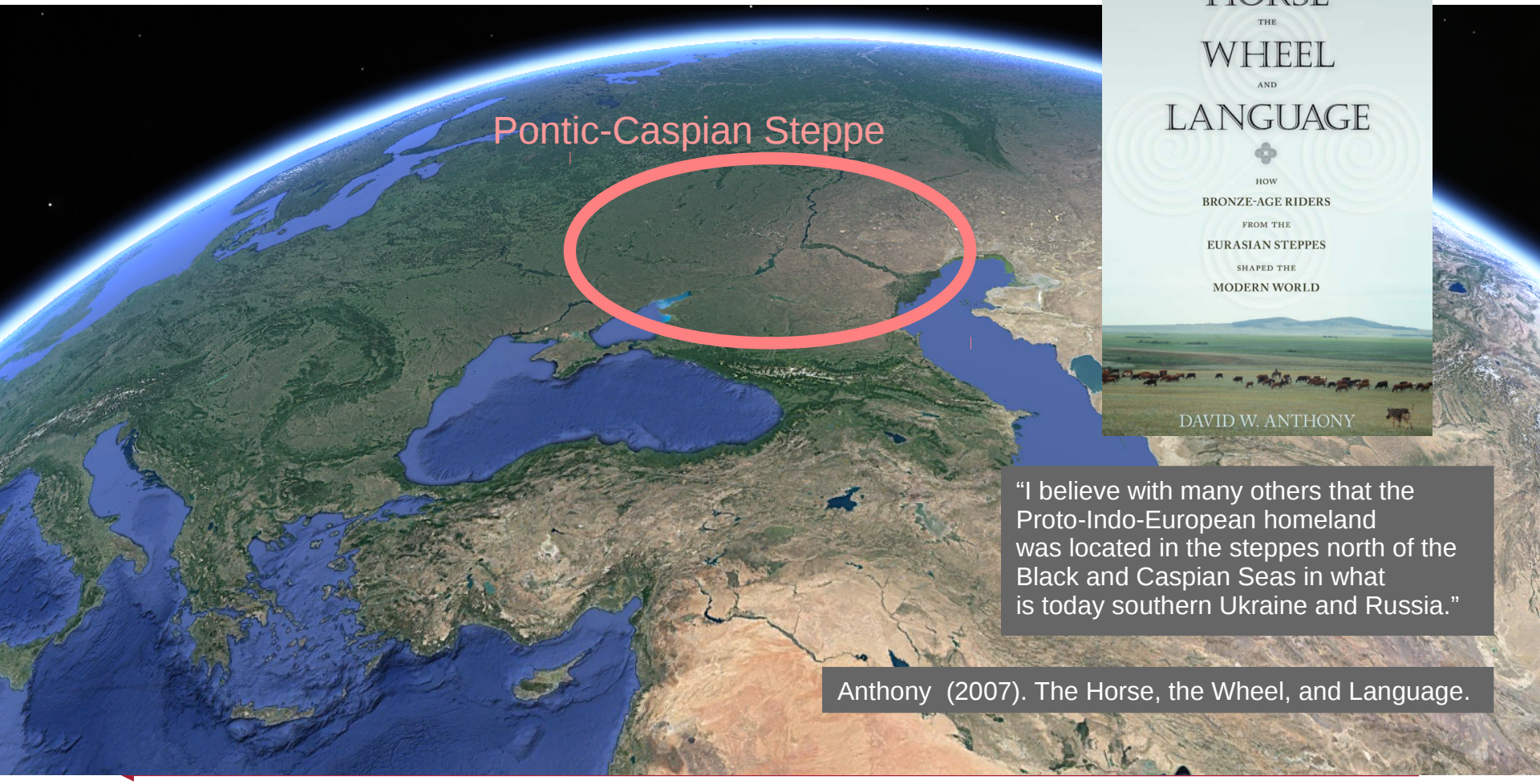
The Indo-European Controversy

Where is the Indo-European homeland?
When did the first IE people spread from there?



Linguistics & Archaeology

The Indo-European Controversy
The Steppe Hypothesis



"I believe with many others that the Proto-Indo-European homeland was located in the steppes north of the Black and Caspian Seas in what is today southern Ukraine and Russia."

Anthony (2007). The Horse, the Wheel, and Language.

Linguistics & Archaeology

The Indo-European Controversy
The Anatolian Hypothesis

"I have argued that before about 6000 BC there were, in the eastern part of Anatolia, and perhaps in some adjacent lands to the east and south-east, and probably nowhere else, people speaking languages ancestral to all the Indo-European languages of today."

Renfrew C. 1987. Archaeology and Language: The Puzzle of Indo-European Origins.

Linguistics & Archaeology

The Indo-European Controversy Evidence for the Steppe Hypothesis

Linguists have been able to reconstruct a Proto-Indo-European sequence of phonemes, **k'mtom*, that could have developed into all the attested phonemes in all the attested daughter forms.

Anthony (2007), p.30

Indo-European Cognates for the Root "Hundred"

Branch	*Language*	*Term*	*Meaning*
Celtic	Welsh	cant	hundred
	Old Irish	cēt	hundred
Italic	Latin	centum	hundred
Tocharian	TochA	känt	hundred
	TochB	kante	hundred
Greek	Greek	ἑκατόν	hundred
Germanic	Old English	hund	hundred
	OldHighGerm.	hunt	hundred
	Gothic	hunda	100, 120
	OldSaxon	hunderod	(long) hundred
Baltic	Lithuanian	šimtas	hundred
	Latvian	simts	hundred
Slavic	OldChurchSlav.	sŭto	hundred
	Bulgarian	sto	hundred
Anatolian	Lycian	sñta	unit of 10 or 100
Indo-Iranian	Avestan	satəm	hundred
	OldIndic	śatám	hundred

Linguistics & Archaeology

Linguistic Archaeology

The Indo-European Controversy
Evidence for the Steppe Hypothesis

All Indo-European subfamilies retained cognates derived from the PIE word meaning ‘axle’ which can be shown to have evolved phonologically from the proto-form *h_2eḱs.

Anthony & Ringe (2015). The Indo-European homeland from Linguistic and Archaeological perspectives.

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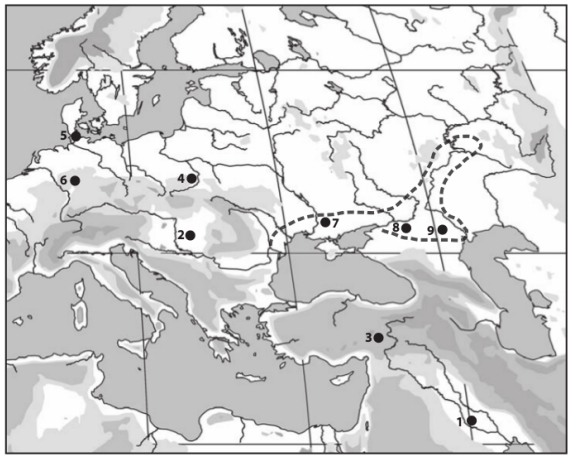
Linguistic Archaeology

The Indo-European Controversy
Evidence for the Steppe Hypothesis

The invention of the wheel-and-axle principle, which first made wagons and carts possible, is solidly dated by radiocarbon after 4000–3500 BCE [...] This external fact ties late **PIE to a real-world date** after wheeled vehicles were invented, that is, after **4000–3500 BCE** .

Anthony & Ringe (2015), p. 201-202



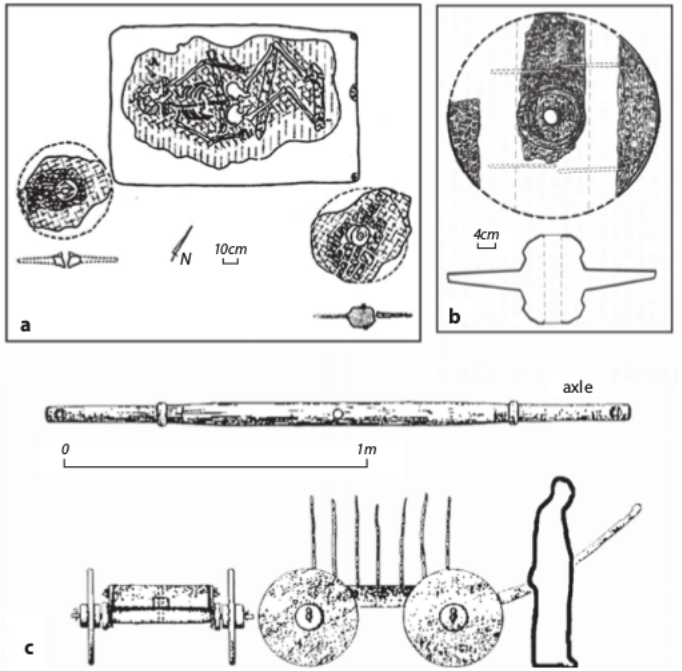


Figure 4.4 Preserved wagon parts and wheels: (a) two solid wooden wheels at the corners of grave 57, Bal'ki kurgan, Ukraine, radiocarbon dated 3330–2900 BCE; (b) Catacomb-culture tripartite wheel with dowels, probably 2600–2200 BCE; (c) preserved axle and reconstructed wagon from various preserved wheel and wagon fragments in bog deposits in northwestern Germany and Denmark dated about 3000–2800 BCE. After (a) Lyashko and Otroshchenko 1988; (b) Korpusova and Lyashko 1990; (c) Hayen 1989.

Anthony (2007), p. 70.

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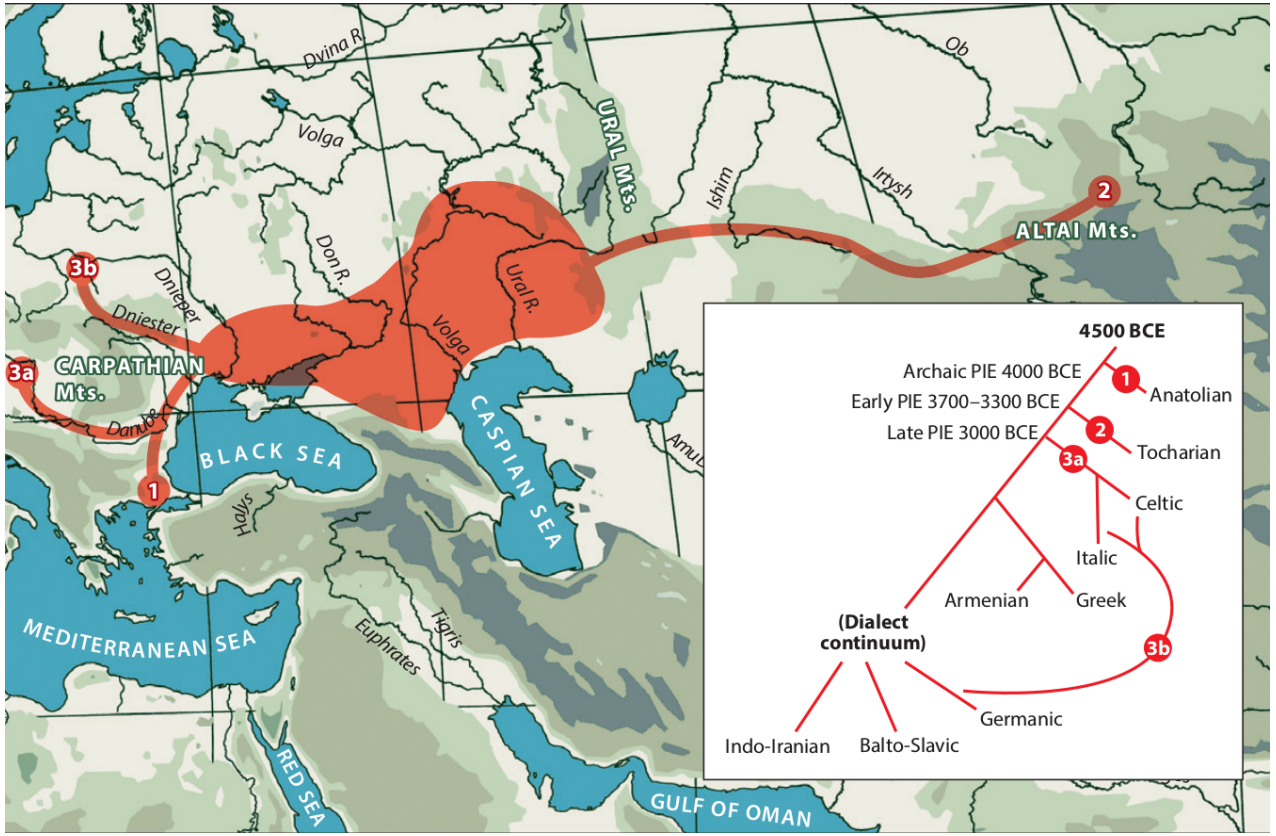
The Indo-European Controversy Chronology of the Steppe Hypothesis



Anthony & Ringe (2015), p. 209

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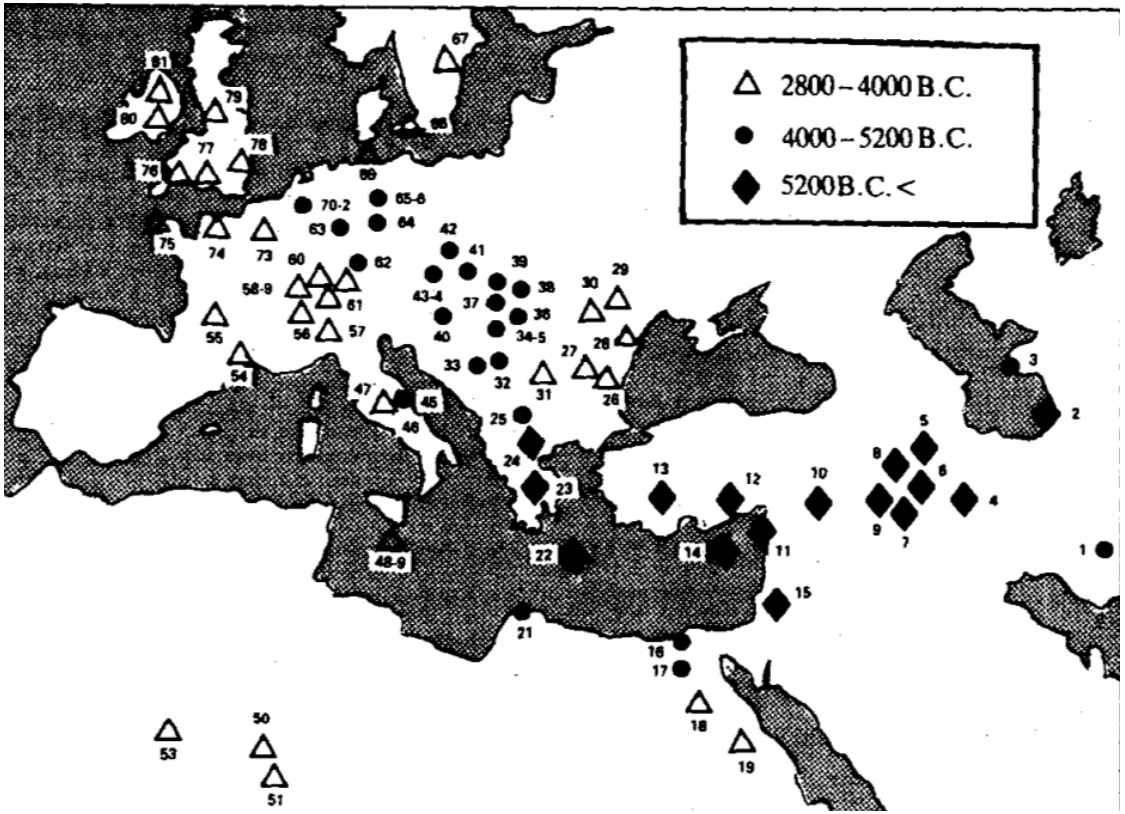
The Indo-European Controversy
Evidence for the Anatolian Hypothesis



Renfrew (1987), p. 149

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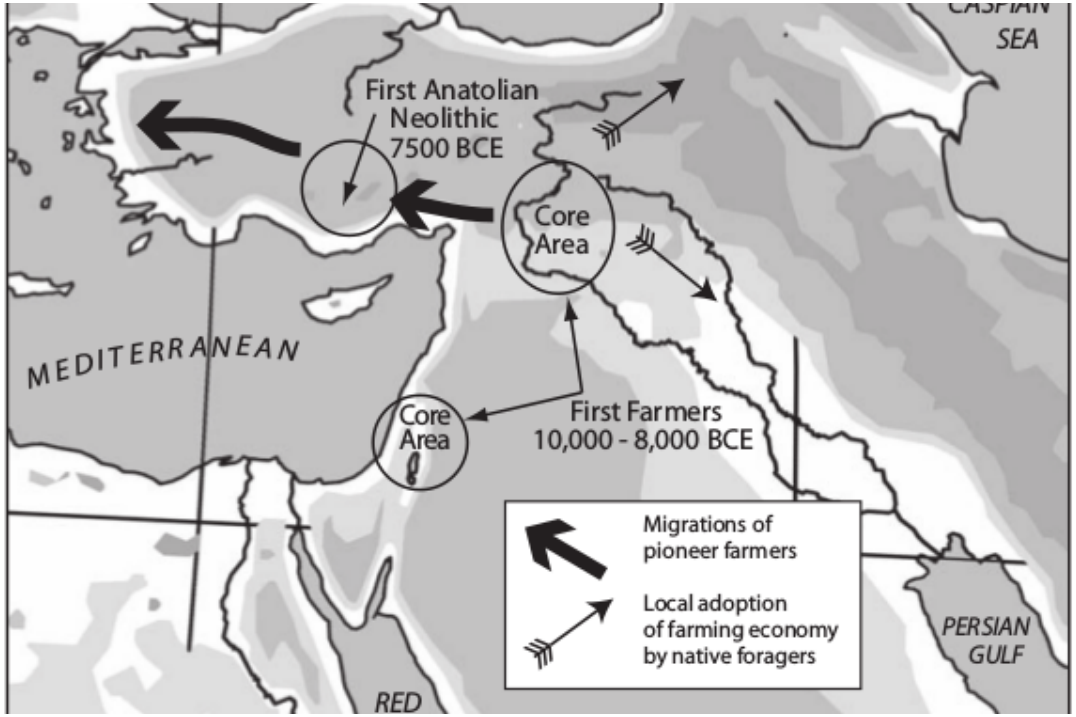
The Indo-European Controversy
Evidence for the Anatolian Hypothesis



Summary of the farming hypothesis by Anthony (2007).

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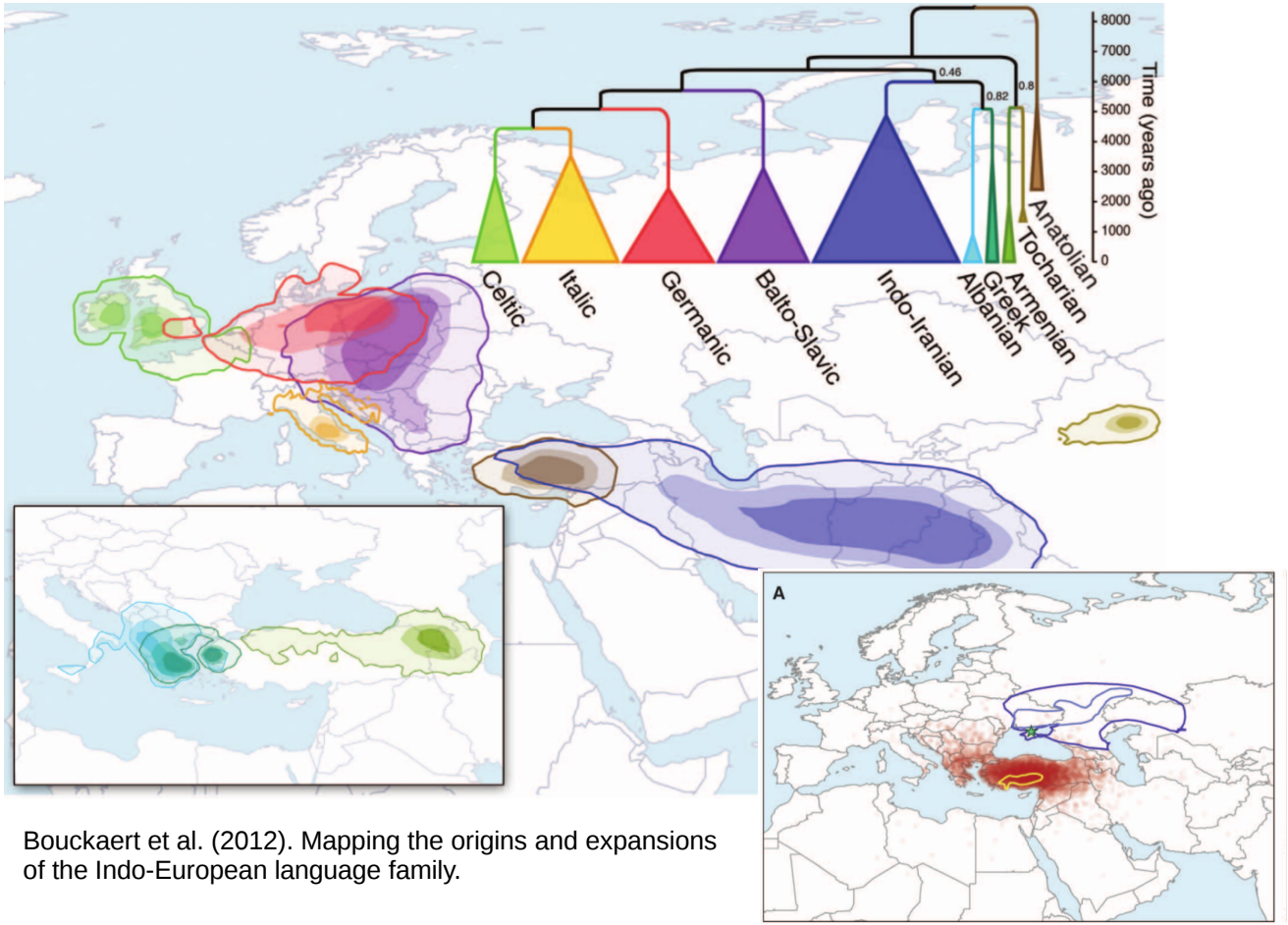
The Indo-European Controversy
Evidence for the Anatolian Hypothesis



Bouckaert et al. (2012). Mapping the origins and expansions of the Indo-European language family.

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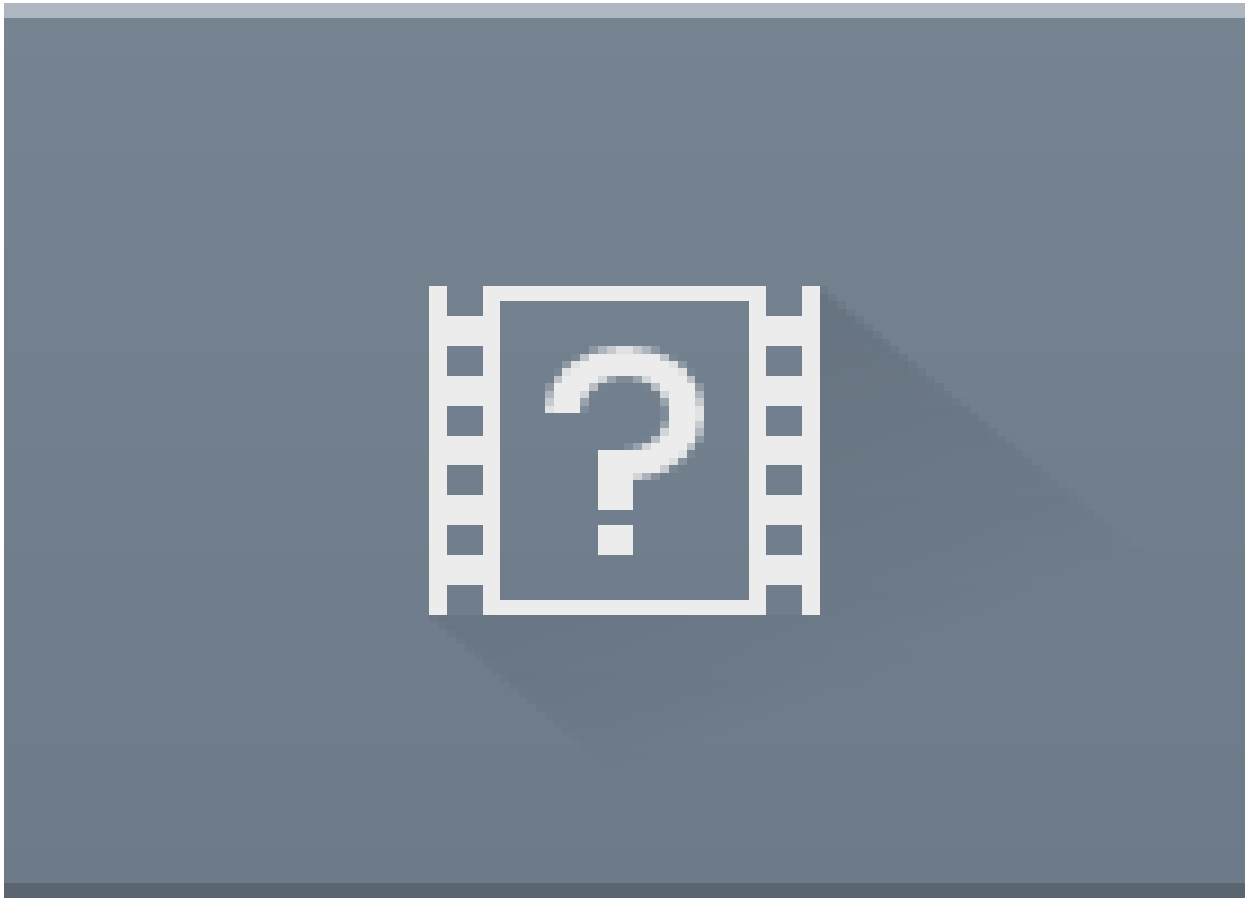

Bouckaert et al. (2012). Mapping the origins and expansions of the Indo-European language family.

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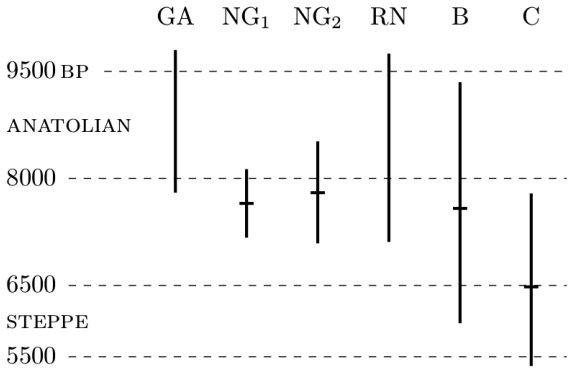
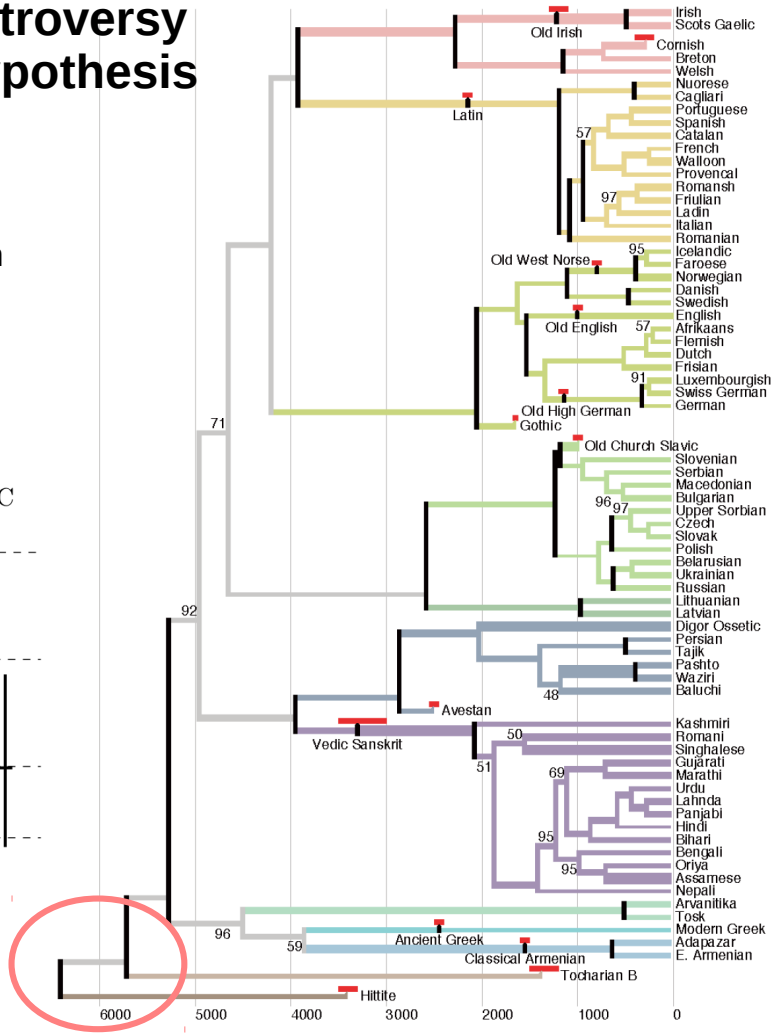
Linguistic Archaeology

The Indo-European Controversy Return of the Steppe Hypothesis

"Here we present a phylogenetic analysis in which **ancestry constraints** permit more accurate inference of rates of change, based on observed changes between ancient or medieval languages and their modern descendants, and we show that the result strongly supports the steppe hypothesis."



GA: cognate data by Gray & Atkinson (2003)
C: cognate data by Chang et al. (2015)



Chang et al. (2015). Ancestry-constrained phylogenetic analysis supports the Indo-European steppe hypothesis.

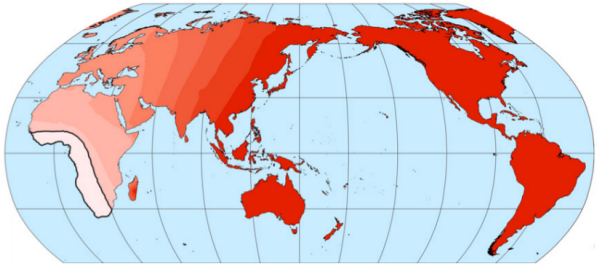
Genetic and Linguistic Diversity

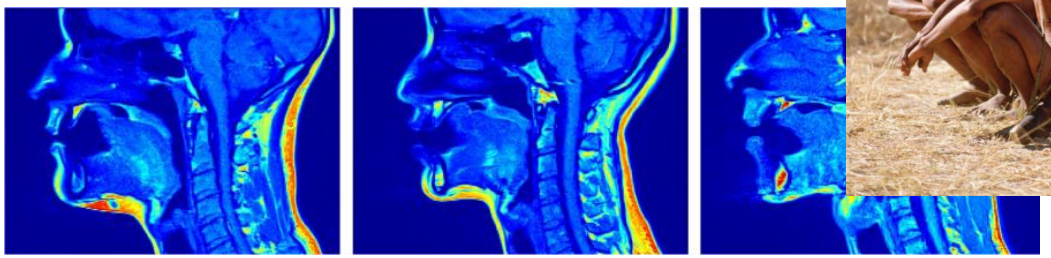
- **Linguistic Out-of-Africa Effect?**
- Diversity within Africa: The Khoisan

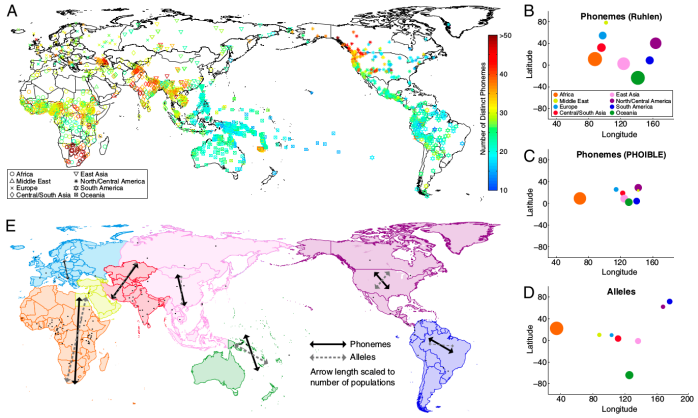
Genetic & Linguistic Diversity

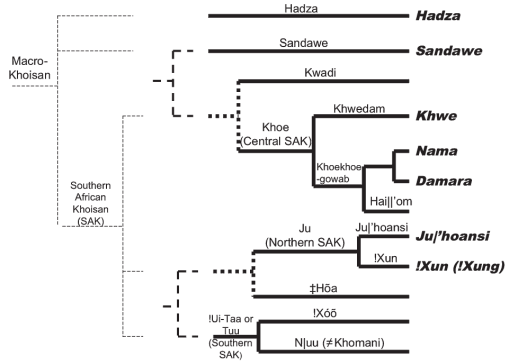
- Out-of-Africa:
A Linguistic Effect?

- Diversity within Africa: The Khoisan





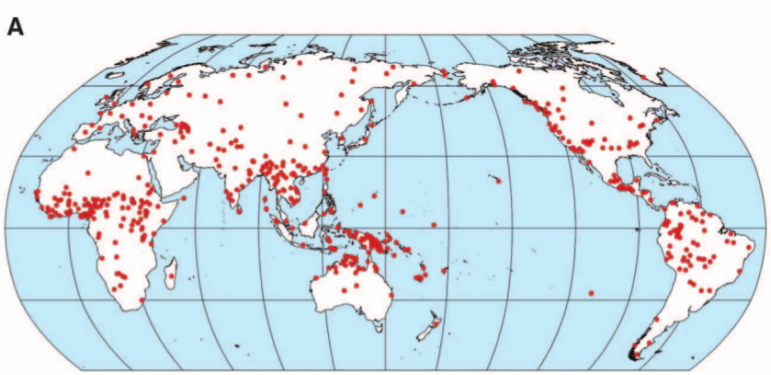


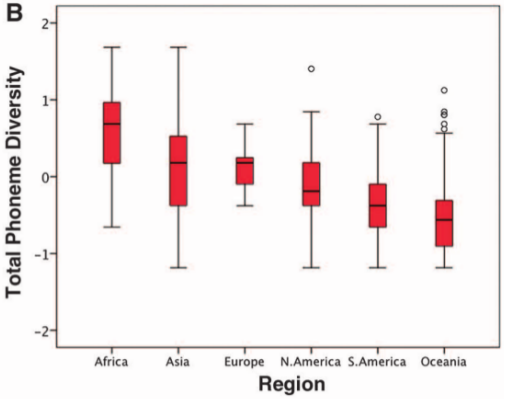


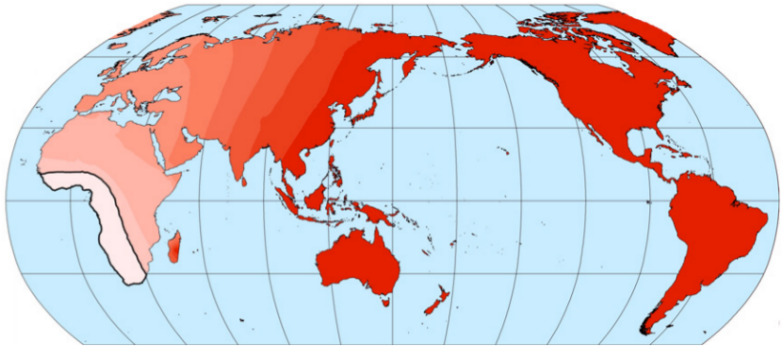
Genetic & Linguistic Diversity

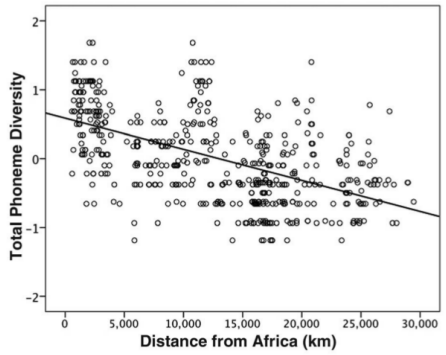
- **Out-of-Africa: A Linguistic Effect?**
- Diversity within Africa: The Khoisan

A linguistic serial founder effect?









Atkinson (2011). Phonemic Diversity Supports a Serial Founder Effect Model of Language Expansion from Africa.

Genetic & Linguistic Diversity

- **Out-of-Africa: A Linguistic Effect?**
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A linguistic serial founder effect?

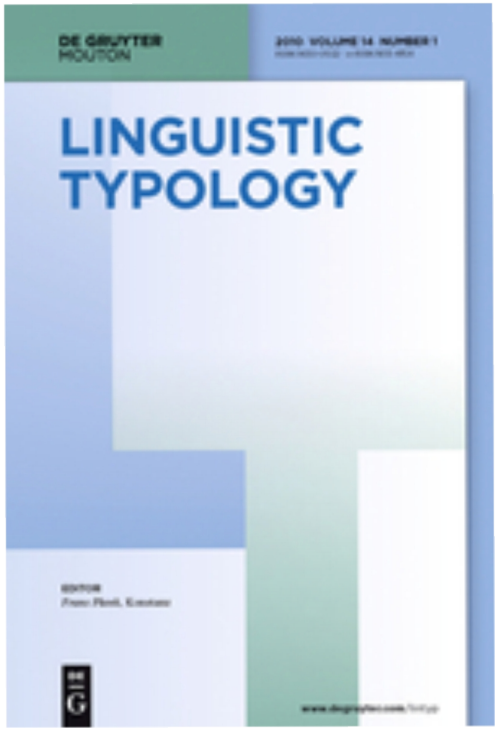
In the volume:

Wichmann et al.

Variable	**cor.**	**significant**
population size	+	yes
word length	-	yes
distance from Africa	-	yes

Jäger et al.

Variable	**cor.**	**significant**
population size	+	no
distance from Africa	-	yes



Plank et al. (eds.) (2011). The vanishing phonemes debate, apropos Atkinson 2011.

Genetic & Linguistic Diversity

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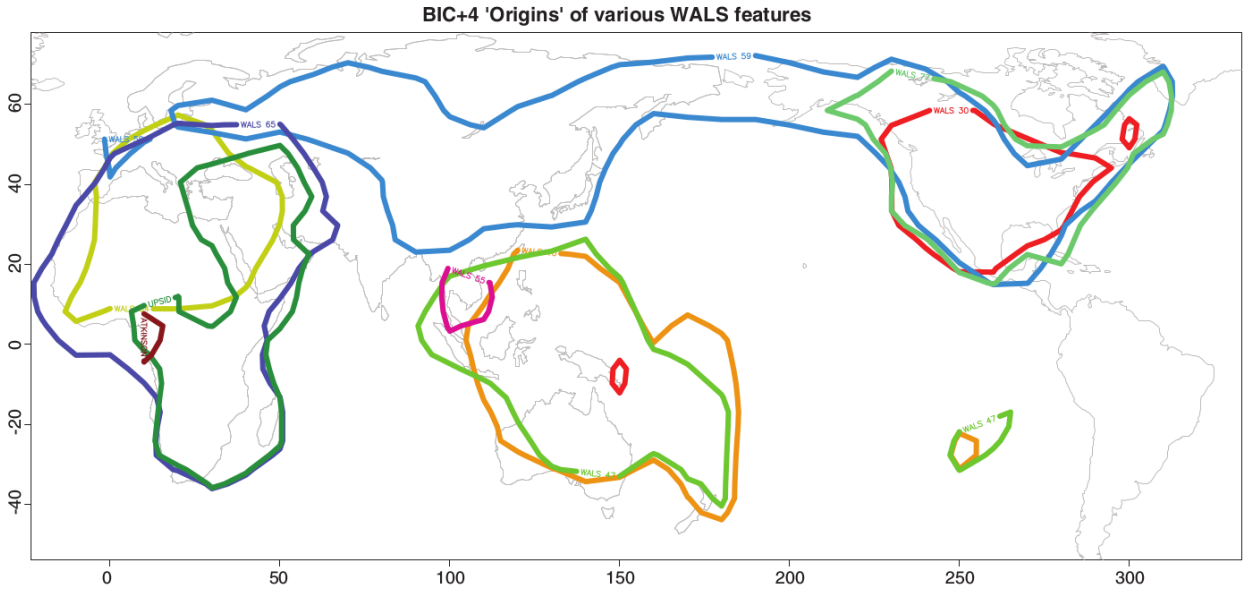

Fig. 1. Areas of "origin" of various other inventory-like linguistic characteristics as identified using Atkinson's methodology. Notably, the origins are dispersed over the whole globe and not concentrated in Africa. The **dark red area** in Africa is the origin of phoneme inventories as proposed by Atkinson. The **dark green area** in Africa and the Near East is the corresponding area based on the UPSID phoneme inventory data. The **small red area** on the eastern tip of New Guinea is the origin for the UPSID phoneme inventory data using a quadratic geographical distance model.

Cysouw, Dediu & Moran (2012). Comment on "Phonemic Diversity Supports a Serial Founder Effect Model of Language Expansion from Africa".

Genetic & Linguistic Diversity

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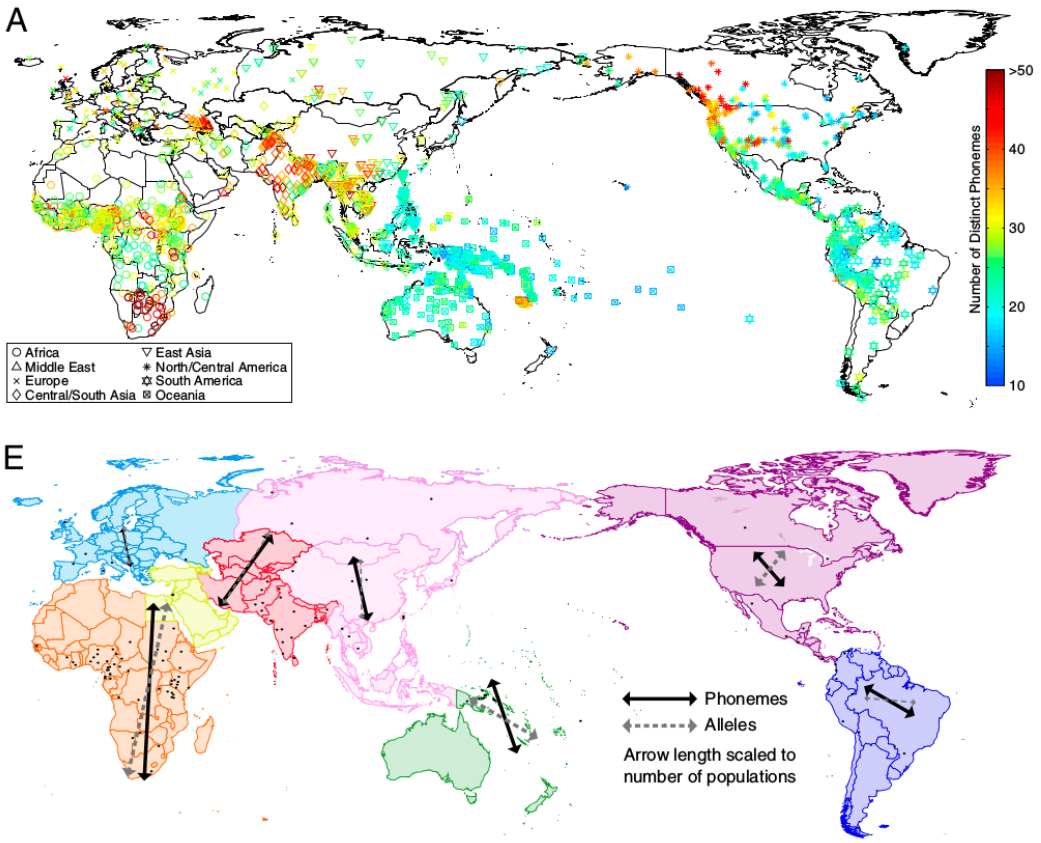


The rotated axis of *geographic distance* that was most strongly associated (greatest Mantel r) with **phonemic distance (black arrows)** and **genetic distance (gray dashed arrows)** is shown.

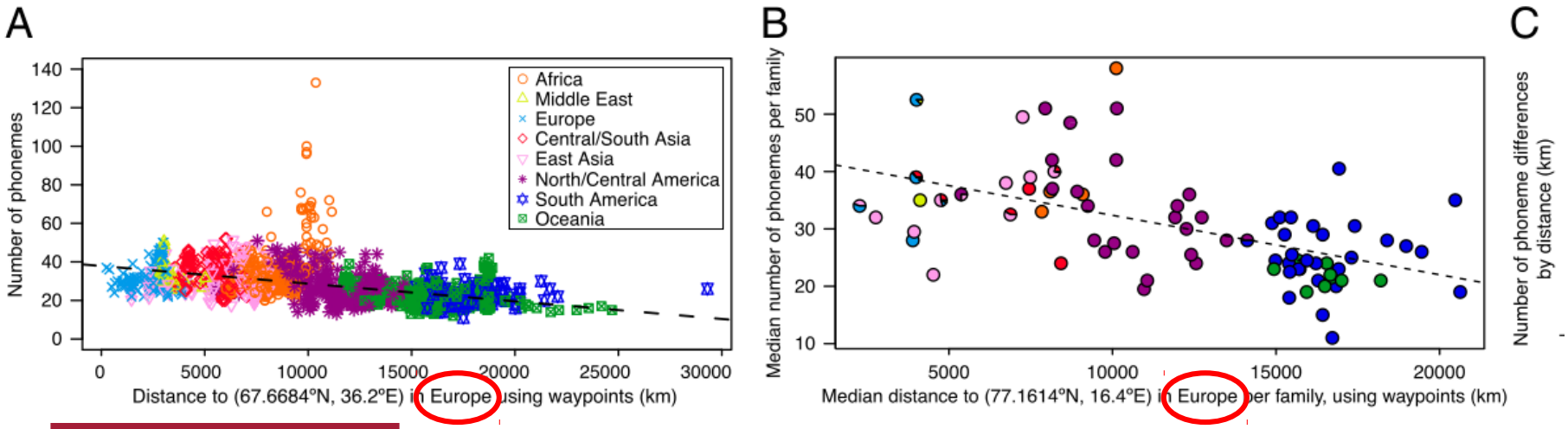
Creanza et al. (2015).

Genetic & Linguistic Diversity

- **Out-of-Africa: A Linguistic Effect?**

A linguistic serial founder effect?

The regional geographic axes of greatest phonemic differentiation correspond to axes of genetic differentiation, suggesting that there is a relationship between human dispersal and linguistic variation. However, the geographic distribution of phoneme inventory sizes **does not follow the predictions of a serial founder effect** during human expansion out of Africa.



Creanza et al. (2015).

Genetic and Linguistic Diversity

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- **Diversity within Africa: The Khoisan**

Genetic & Linguistic Diversity

- Out-of-Africa: A Linguistic Effect?

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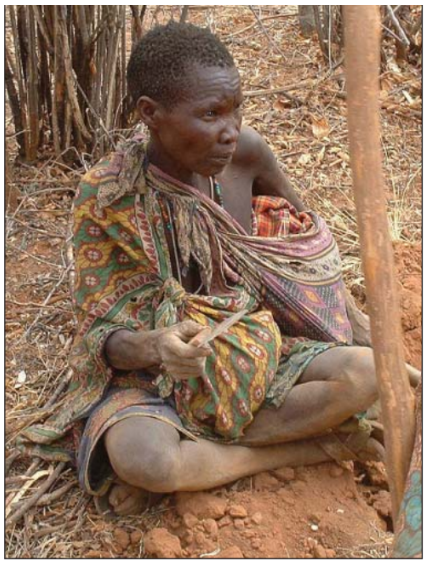
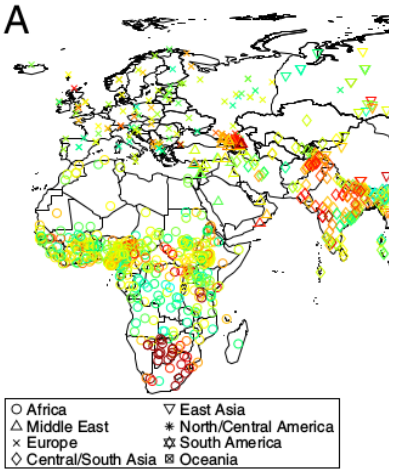
Silent stalkers. !Kung hunters may use clicks while sneaking up on prey in the savanna.



All alone. Researchers ponder why the Hadzabe live so far from other click speakers.



Pennisi (2004). The first language?

IV. KHOISAN

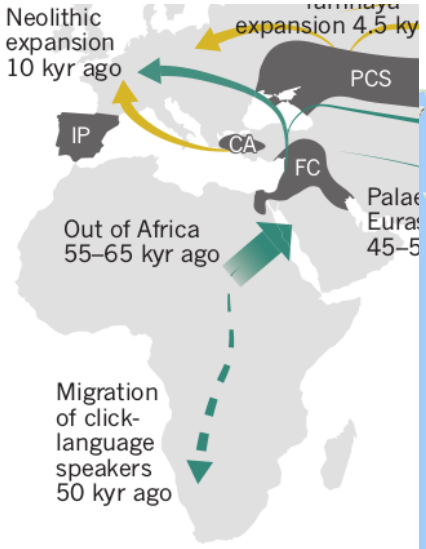
Schapera is the author of the convenient term Khoisan, compounded of the Hottentot's name for themselves (Khoi) and their name for the Bushmen (San). Culturally, two groups are usually distinguished, the cattle-raising Hottentots with a somewhat complex political organization and sense of ethnic distinctness and the hunting, food-gathering Bushmen. Both of these peoples speak languages whose most conspicuous feature is the presence of click-sounds.[1]

Greenberg (1963). Languages of Africa.

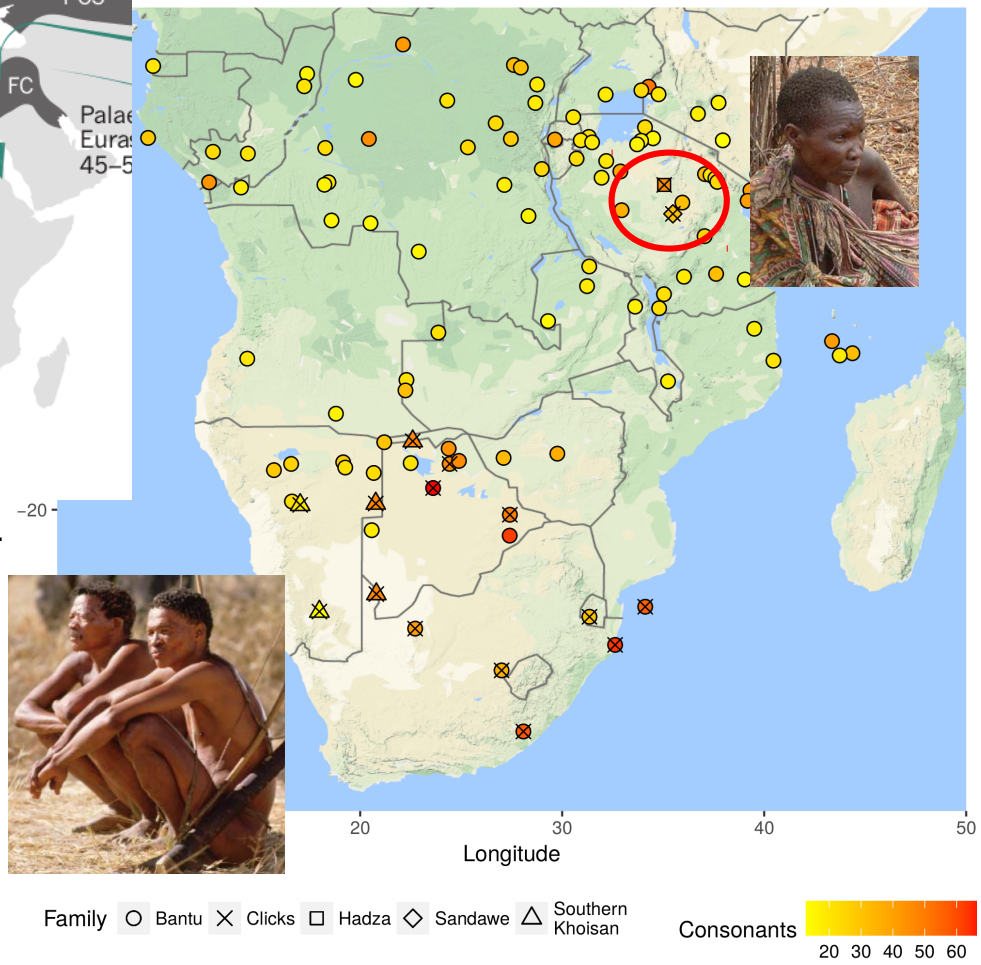
Genetic & Linguistic Diversity

- Out-of-Africa: A Linguistic Effect?

- Diversity within Africa: The Khoisan



Nielsen et al. (2017).



Genetic & Linguistic Diversity

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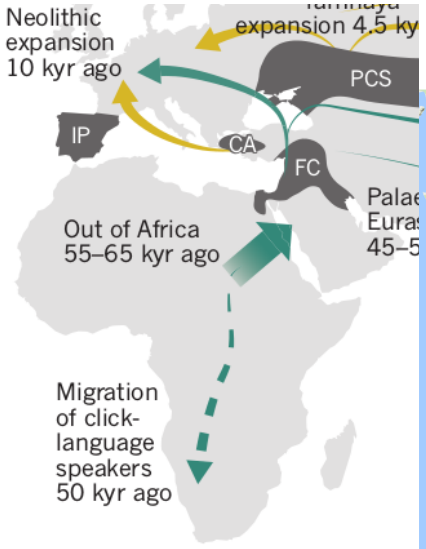
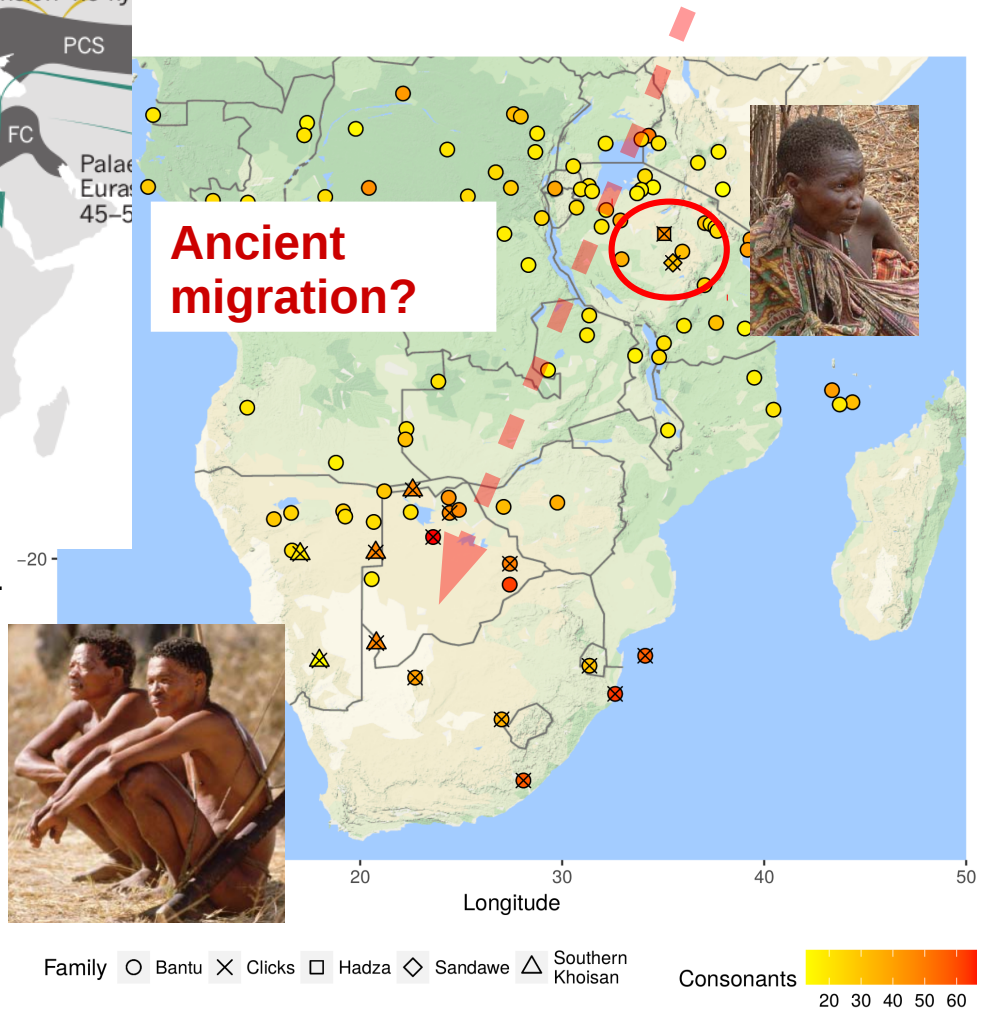
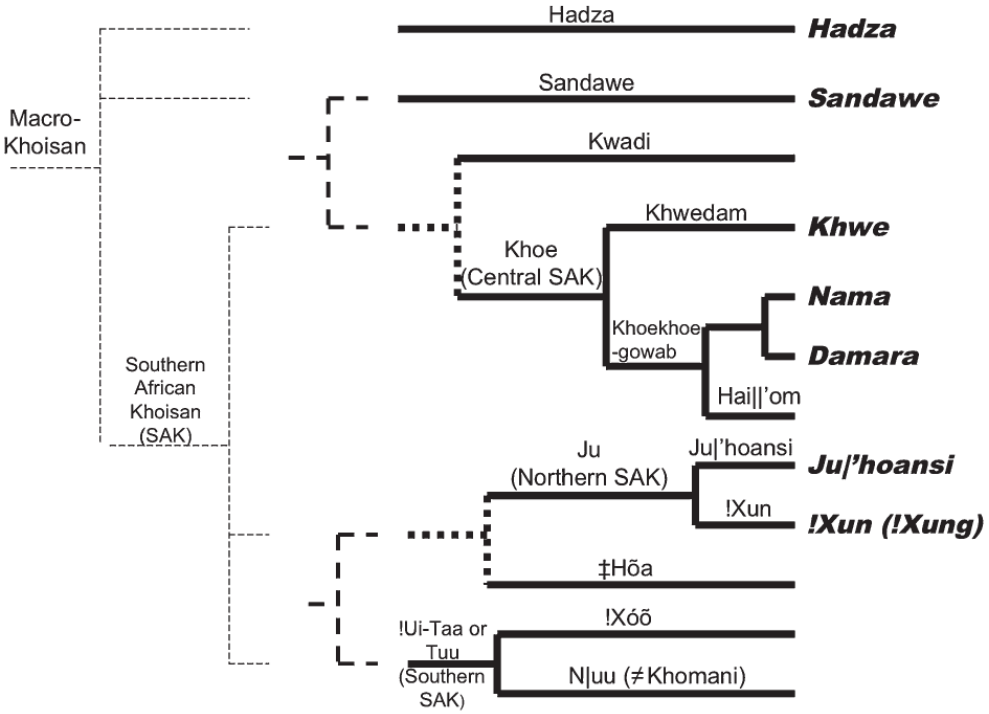


Nielsen et al. (2017).

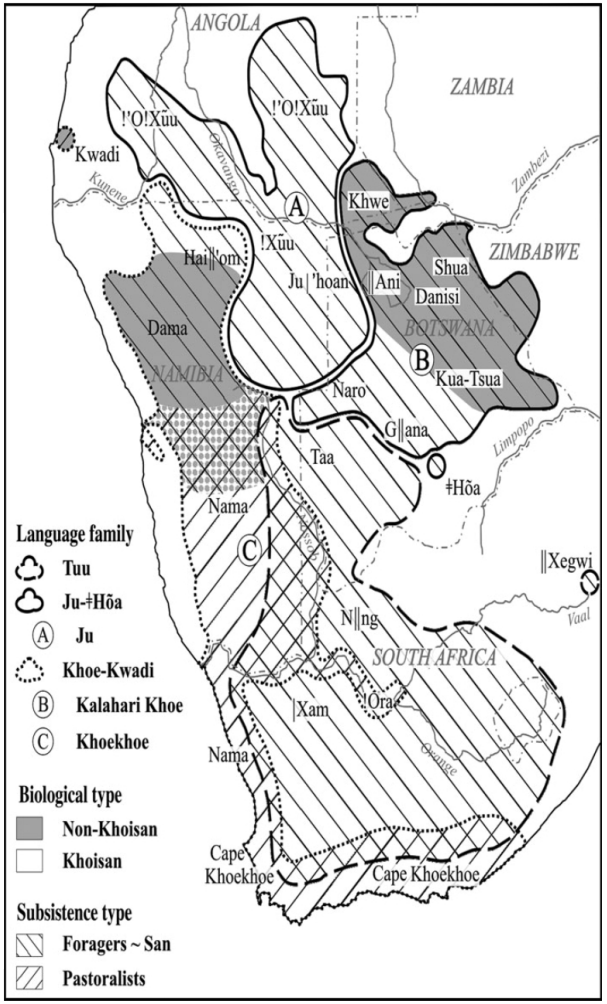


Genetic & Linguistic Diversity

Note: the highest level classification of “Khoisan” is generally **not accepted** by experts



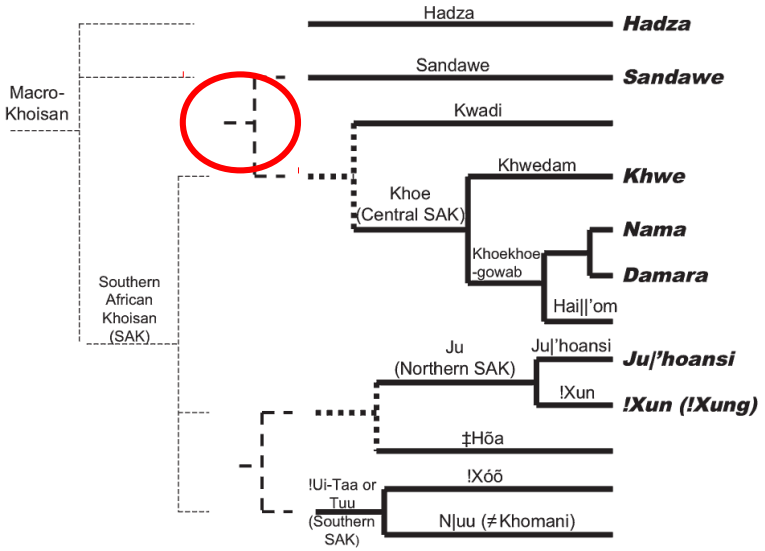
Tishkoff (2007). History of Click-Speaking Populations of Africa Inferred from mtDNA and Y Chromosome Genetic Variation.



Güldemann & Stoneking (2008). A historical appraisal of clicks: a linguistic and genetic population perspective.

Genetic & Linguistic Diversity

Is there a **deep connection** between the Sandawe and Khoe-Kwadi?



Genetic evidence

New genetic data show that the Sandawe and southern African click speakers share rare mtDNA and Y chromosome haplogroups; however, common ancestry of the 2 populations dates back > 35,000 years.

Tishkoff (2007).

Linguistic evidence

Pronoun element	Proto-Khoe-Kwadi	Sandawe
1st person singular pronoun	*ti (Kwadi *tfi*)	*tsi*
2nd person singular pronoun	*sa	*ha-*
3rd person pronoun base	*xa- (Kwadi *ha-*)	*he-*
3rd person masculine singular suffix	*-V[front] (Khoe *-bV[front], *-mV[front])	*-w(e), -m*
3rd person feminine singular suffix	*-V[front] (Khoe *-sV[front])	*-su*

Güldemann (in prep.)

Genetic & Linguistic Diversity

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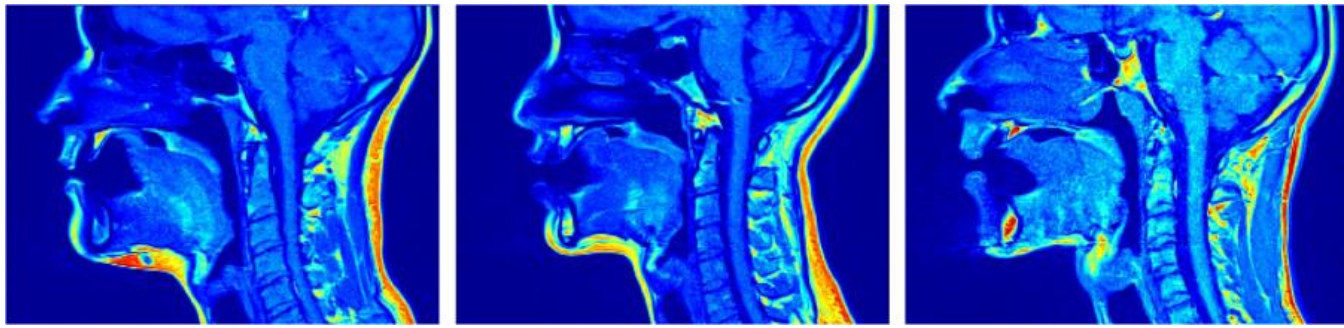
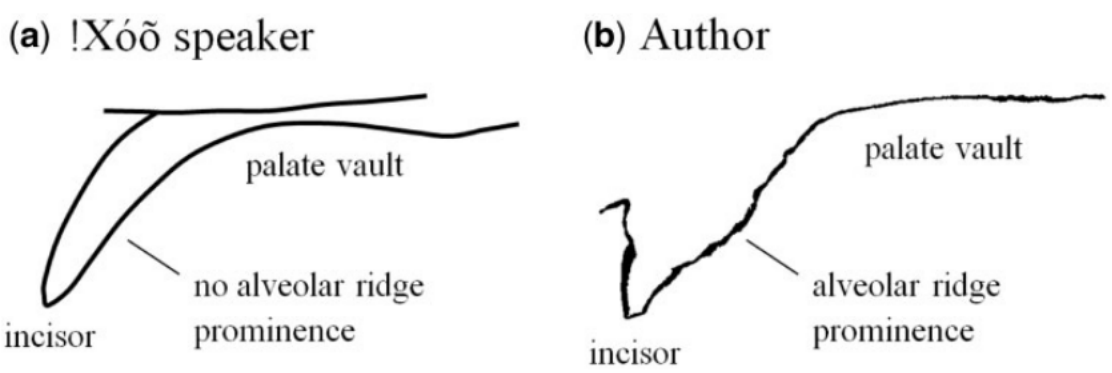
New research: Is the usage of clicks reflected in morphological differences?





Moisik & Dediu (2017).

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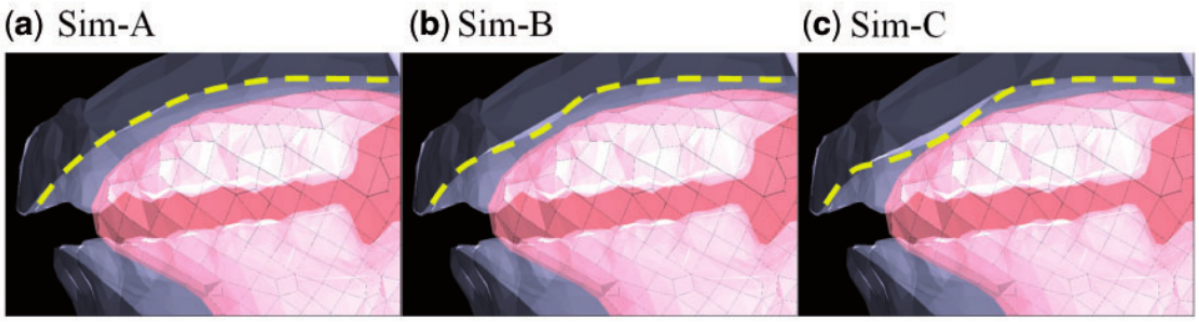

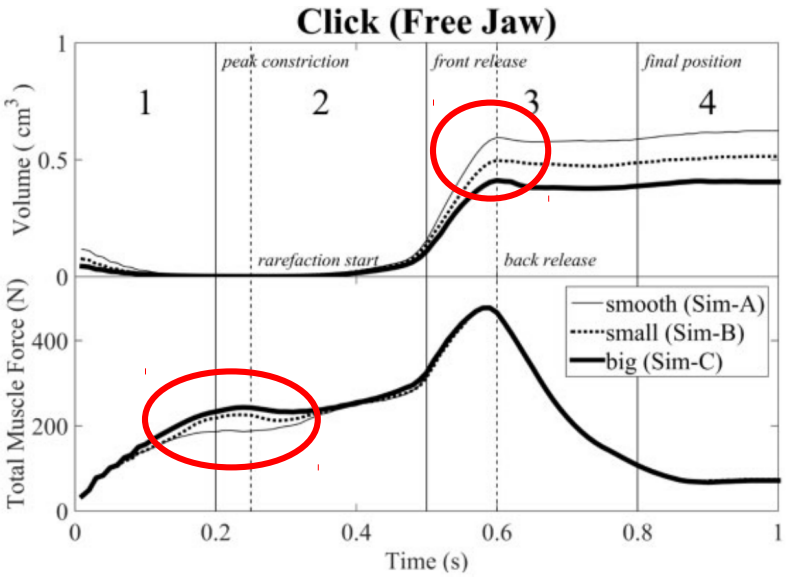

Moisik & Dediu (2017).

Overall, the effect of having a larger alveolar ridge [...] is to **reduce the rate and amount of volume gain** during release of the front closure (phase 3, Fig. 7) and to **increase the articulatory effort**, as gauged by total muscle force, in producing and maintaining closure while enlarging the air space.

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