The Language Proof: Census and Adoption Evidence That the Most Complex Thing Humans Learn Comes Entirely From Where They Grow Up

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Abstract

No baby is born speaking a language, and every healthy baby ends up speaking the language of the place that raised it. This paper puts numbers on that obvious fact and asks why the law forgets it. Study 1 reruns the original eight-country census design (1.8 billion people): the share speaking the national language ranges from 72.0% to 96.9% (mean Cohen's h = 0.93 against a 50% reference). A sensitivity analysis using each statistics agency's own headline figure (France left out, as its census does not count language) gives the same result (seven countries, 72.0% to 98.1%, mean h = 0.89). Study 2 separates genes from home in 2022 US census microdata for California. Among six ancestries, people born in the US were 30 to 69 percentage points more likely to speak only English at home than people of the same ancestry born abroad. Of 96 children aged 5 to 17 born abroad and adopted into Californian households, 90% (54 of 60) of those adopted into English-only homes spoke only English, against 14% (5 of 36) adopted into homes that speak another language (Fisher exact $p < .001$). Their home language matched the householder's as often as biological children's did (88.5% vs 87.1%, $p = .88$): sharing genes with the household added nothing detectable. Among foreign-born adults, English ability fell with every step in age at arrival. Language is the most complex behaviour people perform, and which language a person speaks is set by environment. Courts that admit genetic "predisposition" evidence should hold it to the standard this case meets.

Keywords: language acquisition | environmental determination | nature and nurture | international adoption | age of arrival | American Community Survey | behavioural genetics | predisposition evidence

Significance. Courts admit "predisposition" evidence, from the "warrior gene" to heritability claims about parents, on far less than this paper shows. The most complex behaviour humans perform, language, follows the home and not the genes: children adopted from abroad speak the language of the household that raised them, as reliably as children born to it. Data and code anyone can rerun are included.

Introduction: a child in Tokyo

A baby born in Tokyo grows up speaking Japanese. A baby born in Perth grows up speaking English. Swap them at birth and each speaks the other's language, with no accent, no hesitation, and no trace of the language their ancestors spoke. Nobody disputes this. It is so obvious it feels trivial, and that is the point of this paper.

No infant is born speaking English, Mandarin, Arabic or any other language. Which language a child speaks is not written in DNA. Yet language is among the most demanding things a human brain does: tens of thousands of words (Brysbaert et al., 2016), grammatical rules applied without conscious thought, sound systems and social conventions, all processed in real time. By around their first birthday, infants have already tuned their hearing to the sounds of the language around them and lost some of their ability to hear distinctions their home language does not use (Kuhl, 2004). By five, they speak fluently without being taught a single rule. Linguists still argue over how much of the *capacity* for language is built in (Chomsky, 1965) and how much is assembled from use (Tomasello, 2003). That argument does not touch this paper's question, because on both accounts the particular language a child ends up with comes from outside.

So here is the argument in three steps.

1. Nobody is born speaking any language.
2. Everyone learns the language of their environment, whatever their genetic ancestry.
3. Language is one of the most complex behaviours humans perform.

Therefore complex behaviour *can* be wholly set by environment, and the claim that simpler patterns (how a person handles anger, fear or trust) are "in the genes" needs evidence of its own. The burden sits with the genetic claim, not the environmental one.

People accept steps 1 and 2 without thinking. When a child in Sydney speaks English, nobody speculates about a genetic predisposition towards English, and nobody suggests the child weighed English against Mandarin and chose. Yet when the same people discuss behaviour, personality or crime, genetics and choice become the default explanation. The rest of this paper puts numbers on the obvious, tests it where genes and environment come apart, and asks what follows for the law.

Two questions, kept apart. Twin and adoption research distinguishes language *ability* from *which* language a person speaks. Ability (vocabulary size, speed, verbal fluency, risk of language disorder) is partly heritable; a meta-analysis of twin, adoption and linkage studies finds substantial genetic influence on language ability and disorder (Stromswold, 2001), in line with the average heritability

of about half found across thousands of human traits (Polderman et al., 2015). Behaviour genetics' "first law" holds that every human behavioural trait is heritable to some degree (Turkheimer, 2000); some people are more fluent than others in any language. But no twin study estimates the heritability of speaking Japanese rather than English, because in every sample the answer is fixed by where the twins grew up. Twins reared apart in the Minnesota study resembled each other on many measures (Bouchard et al., 1990); they spoke the language of the country that raised them.

That distinction carries the whole argument. A capacity can be heritable while its content is entirely environmental. The question this paper asks is about content: which pattern a person ends up with.

Study 1: eight national censuses

Method. The original design takes the latest census or official survey figure for the share of each country's population speaking its dominant national language, in eight countries on six continents with a combined population of 1,811,487,320. For each country it tests the observed share against a 50% reference with a chi-square goodness-of-fit test and reports Cohen's *h*, the standard effect size for a difference between proportions (Cohen, 1988). Cohen's conventions are 0.20 small, 0.50 medium and 0.80 large.

The original figures are the headline. On 9 July 2026 we also checked each against the agency that publishes it, as a sensitivity analysis. Four match exactly. Four rest on a different concept or label from the agency's own headline figure:

- **France** does not collect language in its census; its constitution bars ethnic and linguistic counting (Wikipedia, 2026). The 91.2% can only be a survey estimate, so the sensitivity set leaves France out.
- **China**: the official figure for people who speak Putonghua (Mandarin) is 80.72% (Ministry of Education of the People's Republic of China, 2021). The original 92% counts all Chinese languages, the concept the paper intends (the national language family).
- **Canada**: the census share who can converse in English or French is 98.1% (Statistics Canada, 2022), not 96.9%.
- **"United Kingdom"**: the 91.1% is England and Wales only (Office for National Statistics, 2022).

Germany's 81.34% comes from the Mikrozensus, a 1% sample survey, not the full census (Federal Statistical Office of Germany (Destatis), 2024); Mexico's 93.9% is 100% minus the 6.1% who speak an Indigenous language (Instituto Nacional de Estadística y Geografía, 2020); Australia's 72.0% is people who use only English at home (Australian Bureau of Statistics, 2021); New Zealand's 95.4% is people who can converse in English (Stats NZ, 2020). We report both versions. The original stays as one variant so a reader can see exactly what changed.

Results.

Table 1. Share of each country speaking its national language. Headline figures as the 2026 manuscript used them; sensitivity analysis with each agency's own headline figure. Source: `studies/01-eight-countries`.

Country	Headline %	Agency headline %	Cohen's *h* (agency figures)
Australia	72.0	72.0	0.46
Canada	96.9	98.1	1.29
China	92.0	80.72	0.66
France	91.2	not counted	n/a
Germany	81.0	81.34	0.68
Mexico	93.8	93.9	1.07
New Zealand	95.4	95.4	1.14
England and Wales	91.1	91.1	0.96
Mean *h*	**0.93**		**0.89**

On the original figures, every country exceeds the 50% reference (all $p < .001$), with *h* from 0.46 to 1.22 and a mean of 0.93 (SD 0.24). On the agency figures (sensitivity analysis) the result barely moves: seven countries, 72.0% to 98.1%, mean $h = 0.89$ (SD 0.28). Weighted by population, 82.3% of the 1.74 billion people in the verified set speak their country's national language.

The lowest figure is the most instructive. Australia sits at 72.0% because more than a quarter of its people were born overseas (Australian Bureau of Statistics, 2021). The residue is not random: it is mostly people who grew up somewhere else. The exception confirms the rule.

The comparison against 50% is deliberately conservative. The meaningful comparison is not "better than chance" but near-perfect prediction: knowing where someone lives predicts their language with more than 90% accuracy in most of these nations, and the mean effect ($h = 0.93$) is larger than the average effect of educational interventions ($d = 0.40$) (Hattie, 2009) or of psychotherapy (0.68) (Smith & Glass, 1977). Study 1 shows the size and consistency of the pattern. It cannot separate environment from ancestry, because in most countries most people share both. Study 2 does.

Study 2: same genes, different home

Method. The US Census Bureau's American Community Survey (ACS) asks every member of a sampled household whether they speak a language other than English at home, how well they speak English, where they were born, when they arrived, their

ancestry, and how they are related to the householder (U.S. Census Bureau, 2023). We used the public microdata file for California in 2022: 391,171 person records, of whom 373,942 were aged five or over with a language answer. California has some of the largest immigrant and adopted-child populations in the country. Percentages are weighted by the person weight; tests use the unweighted counts.

Four comparisons pull genes and environment apart:

A. Children aged 5 to 17 of the householder, biological or adopted, born in the US or abroad.

B. Children born abroad: does their home language follow their birthplace, or the household they live in? We linked each child to the householder's own answer and compared adopted children, who share no genes with the household, with biological children, who do.

C. Same ancestry, different birthplace: people of Mexican, Chinese, Filipino, Korean, Vietnamese and Asian Indian first ancestry, born in the US or abroad.

D. Foreign-born adults aged 25 and over: English spoken only or "very well", by age at arrival.

Results. **Same ancestry, different birthplace.** In every ancestry, people born in the US were far more likely to speak only English at home than people of the same ancestry born abroad (all $p < .001$). The gaps run from 29.8 percentage points (Mexican, 35.0% vs 5.2%) to 69.3 (Filipino, 82.6% vs 13.3%); Chinese 56.1% vs 9.3%, Korean 51.6% vs 12.5%, Vietnamese 40.8% vs 6.7%, Asian Indian 51.8% vs 12.3%. Ancestry is held constant; birthplace changes; the language changes with it.

Adopted from abroad. Ninety-six children aged 5 to 17 in the sample were born abroad and adopted by the householder, most often from China, Guatemala, Mexico, Ethiopia, Russia and Vietnam. Of the 60 adopted into homes where the householder speaks only English, 54 (90.0%; 95% CI 79.9 to 95.3) spoke only English. Of the 36 adopted into homes where the householder speaks another language, 5 (13.9%) did. The odds ratio is 55.8 (Fisher exact $p < .001$). These children carry the genes of one country and speak the language of the home that raised them.

Table 2. The child's home language follows the household, not the birthplace. ACS PUMS 2022, California. Source: `studies/02-adoptees-and-arrival`.

Children born abroad, aged 5 to 17	*n*	Speak only English at home (weighted %)
Adopted, householder speaks only English	60	92.4
Adopted, householder speaks another language	36	9.4
Biological, householder speaks only English	178	53.7
Biological, householder speaks another language	2,101	9.5

Genes add nothing detectable. The decisive comparison is between the two kinds of child. An adopted child's home language matched the householder's in 88.5% of cases; a biological child's in 87.1% (Fisher exact $p = .88$). If shared genes pulled a child towards the parents' language, biological children would match more often. They do not. One difference runs the other way: in English-only homes, adopted children spoke only English far more often (92.4%) than biological children born abroad (53.7%), most likely because a biological child born abroad usually lives with other relatives who still speak the family's first language. That too is environment.

Age at arrival. Among 96,114 foreign-born adults, the share who speak only English or speak it "very well" falls with age at arrival: 78.6% of those who arrived aged 0 to 4, 75.9% aged 5 to 9, 59.6% aged 10 to 14, 40.5% aged 15 to 19, 45.1% aged 20 to 29 and 35.0% aged 30 or older (Spearman $\rho = -0.23$, $p < .001$). The same pattern appears in the 1990 census for 2.3 million Chinese- and Spanish-speaking immigrants (Hakuta et al., 2003) and in laboratory tests of grammar (Johnson & Newport, 1989). The earlier the environment changes, the more completely the language changes with it.

Discussion

What the two studies show together. Study 1 shows the size of the pattern across nations: wherever people grow up, most of them speak that place's language, and the people who do not are mostly people who grew up elsewhere. Study 2 shows the mechanism. Hold ancestry constant and vary birthplace: the language moves. Hold the household constant and vary the genes: nothing moves. Vary the age at which the environment changes: the language follows the environment in proportion to how early it took hold.

The published adoption research says the same in finer grain. Korean children adopted into French families, scanned as adults, show brain responses to Korean no different from those of French people who never heard it (Pallier et al., 2003). Swedish research on international adoptees finds the first language replaced by the new one (HYLTENSTAM et al., 2009). In the families of immigrants, the parents' language fades within two or three generations (Alba et al., 2002; Portes & Rumbaut, 2001); in

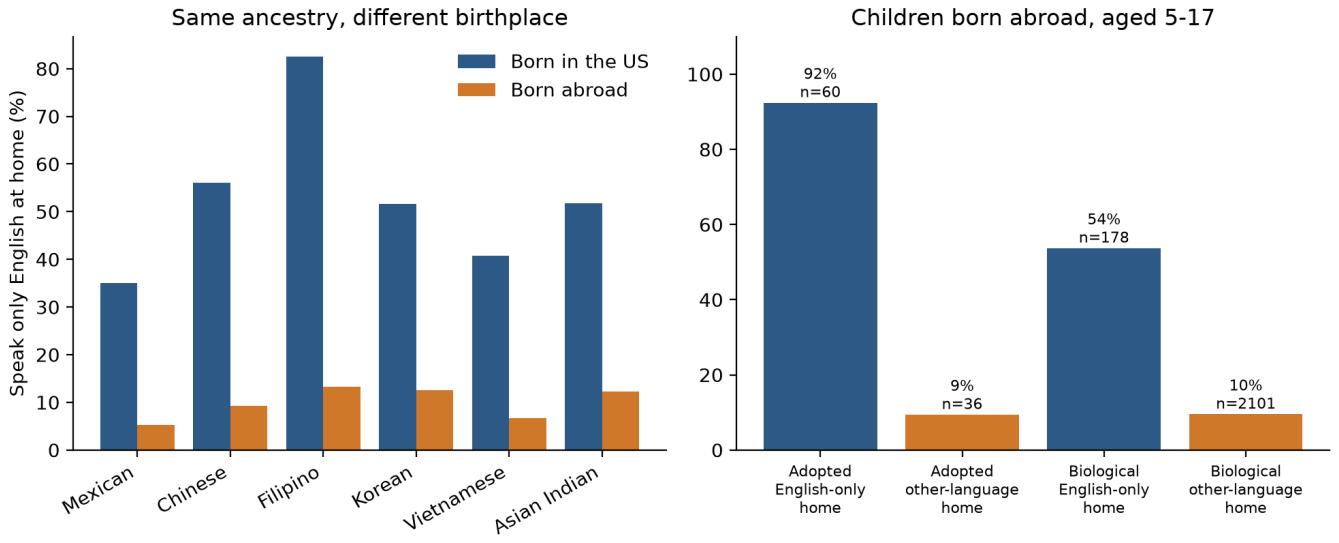


Fig. 1. Same ancestry, different birthplace (left); children born abroad, by type of child and householder language (right). Navy: born in the US or English-only home. Orange: born abroad or other-language home.

Southern California its "life expectancy" is short (Rumbaut et al., 2006). None of this research found a child who spontaneously spoke the language of their ancestors without hearing it.

Alternative explanations. Three alternatives could in principle produce the census pattern: people predisposed to a language migrating to where it is spoken, genetic clustering of populations, and language deciding where people live. Each fails on timing. Infants do not choose where they are born, show no language at birth that could guide their parents' moves, and acquire the language around them after birth. Study 2 tests the first two directly, by holding ancestry constant and by comparing adopted with biological children.

The double standard.

Table 3. The asymmetry this paper questions.

Domain	What people assume
Language	Obviously learned from the environment
Temper, trust, violence, "character"	Probably in the genes, or freely chosen

Why the difference? If an environment can install something as intricate as a language, with no conscious instruction and no awareness that anything was learned, there is no principled reason to assume it cannot install patterns of emotion and behaviour. A child does not analyse grammar; it absorbs patterns from exposure, and by five it speaks without knowing the rules. A child does not analyse how adults handle fear, anger or trust either. It absorbs those patterns the same way, and by adulthood responds in learned ways without knowing they were learned. Machine learning has a name for a learner that copies a teacher's outputs without access to the teacher's reasoning: distillation. Children are the original case.

What the law does with "predisposition". Courts in several countries admit genetic predisposition evidence. Defence experts have testified about *MAOA* and *SLC6A4* genotypes at murder trials in the United States (Bernet et al., 2007), and an Italian appeal court cut a murder sentence partly on *MAOA* evidence (Forzano et al., 2010). A study of more than 1,500 US judicial opinions found neuroscience and behavioural genetics routinely raised in criminal cases, mostly by the defence to argue for mitigation (Farahany, 2016). Forensic risk-assessment instruments, used in courts and parole decisions in dozens of countries, include items framed as fixed traits of the person (Singh et al., 2014).

Predisposition talk cuts both ways. Offered as mitigation, it says the person could not help it; heard by a sentencing judge or a parole board, it can just as easily say the person will not change. Either way it locates the cause inside the body. The language case shows how weak that inference is. The strongest candidate for "complex behaviour in the genes" collapses once environment is controlled: genes shape how fluent a person is, not which language they speak. We do not argue that genetic evidence should be barred. We argue that it should meet the standard the language case meets: a measured contribution of genes over environment, shown at population scale, with an effect size proportionate to the weight it is given. Very little predisposition evidence offered in court meets it.

What this does not claim. It does not claim genes are irrelevant: they shape capacity, sensitivity and speed of learning (Polderman et al., 2015; Stromswold, 2001). It does not claim every behaviour is like language; some may have stronger biological roots. It does not claim people lack agency; people learn new patterns when the environment gives them new input, which is exactly what Study 2's adoptees did. And it is observational, not an experiment. What it does establish is the default. Until shown otherwise, assume a complex pattern was learned. If it was learned, it can be relearned, and the place to intervene is the environment that taught it. Blaming a person for having learned one pattern rather than another addresses the wrong level. We do not punish people for speaking English instead of Japanese.

Limitations

Study 1 compares countries, and its census concepts differ (home language, main language, ability to converse). With populations in the millions every chi-square test is significant; the effect sizes, and their stability across both sets of figures, carry the result. Study 2 is one US state in one year. The ACS asks about language spoken *at home*, which measures the home environment as much as the child; a child who speaks only English at home may still understand a heritage language. The householder's language stands in for the parents', and in some homes the adoptive parent who speaks to the child is not the householder. Only 96 foreign-born adoptees appear in the sample, enough for the large effects reported but not for finer splits by birthplace. Percentages are weighted but tests use unweighted counts rather than the ACS replicate weights, so the p values are approximate; the effects are large enough that this does not change any conclusion. Age at arrival is confounded with education and the reasons for migrating, which is why the gradient, not any single step, is the finding.

Conclusion: back to Tokyo

The baby born in Tokyo speaks Japanese. The baby born in Perth speaks English. A child born in China and adopted into an English-speaking Californian home speaks English, as reliably as a child born to that home. Language is among the most complex things humans do, and which language a person speaks is set by where they grow up. If that is true of language, the default for every other learned pattern is the environment that taught it, and any claim that a pattern is innate or chosen has to bring its own evidence.

Data and code availability

Every number in this paper is reproduced by `reproduce.sh` from the data in `studies/`: Study 1 from the eight published figures and the agency figures used as a sensitivity analysis (`studies/01-eight-countries/data/countries.csv`), Study 2 from a column extract of the 2022 ACS PUMS California person file with instructions to rebuild it from the Census Bureau (`studies/02-adoptees-and-arrival`). Expected outputs are in `expected/`. The statistics appendix below explains each test; the full statistical appendix, with confidence intervals and the sceptic's questions, is `appendix/statistical-appendix.pdf`. Repository: https://github.com/vexanonus/language-proof.

Appendix: statistics

Chi-square goodness of fit against 50% (Study 1). *Why:* it was the original design and tests whether a share differs from an even split. *Assumptions:* independent observations, expected counts over five; met trivially. *Power:* with populations in the millions power is effectively 1 for any difference. *Sceptic:* "50% is a straw man." *Answer:* it is a conservative floor, not a rival theory; the effect sizes (Cohen's h) and the lowest country (Australia, 72%) show how far above it every country sits. *Script:* `studies/01-eight-countries/src/run.py`.

Cohen's *h* (Study 1). *Why:* the standard effect size for proportions, comparable across countries of different size. *Assumption:* none beyond valid proportions. *Sceptic:* "The agency figures change the answer." *Answer:* mean h moves from 0.93 to 0.89; both versions are printed side by side.

Weighted percentages and chi-square tests of independence (Study 2C). *Why:* the question is whether birthplace changes the share speaking only English within one ancestry; a 2 × 2 table is the simplest test. *Assumptions:* independent observations; household clustering is ignored, which understates standard errors. *Power:* each ancestry has between 1,536 and 35,063 US-born people; gaps of 30 to 69 points are detectable many times over. *Sceptic:* "US-born and foreign-born people of the same ancestry differ in age, education and income." *Answer:* yes, and those are environmental differences too; the paper's claim is that the language follows the environment, not that birthplace is the only part of it.

Fisher's exact test (Study 2B). *Why:* small cells (5, 6) among 96 adoptees; Fisher's test is exact for 2 × 2 tables. *Assumptions:* fixed margins; independent children. *Power:* with 60 and 36 children, a difference of 90% vs 14% gives power above .99; the matched-language comparison (88.5% vs 87.1%) can rule out large genetic advantages but not very small ones. *Sceptic:* "Adoptive parents of foreign-born children may themselves share the child's ancestry." *Answer:* they sometimes do, and then the child speaks the household's language, which is the point: the comparison is between household language and child language, whatever the ancestry. The 95% Wilson interval for English-only homes is 79.9% to 95.3%.

Spearman correlation (Study 2D). *Why:* the outcome is binary and age at arrival is ordinal in effect; a rank correlation tests a monotonic trend without assuming linearity. *Assumptions:* independent observations. *Sceptic:* "Later arrivals are less educated." *Answer:* the published 1990-census analysis controlling for education finds the same decline (Hakuta et al., 2003).

Script for Study 2: `studies/02-adoptees-and-arrival/src/run.py` (figure: `src/figure.py`).

Related papers: *Environmental Determination of Educational Outcomes* (Study 2 of this series, same census file) and *Learning Distillation*.

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