

Cognitive, bio-, and psycholinguistics: Methods vs. hypotheses

James Myers
National Chung Cheng University
Lngmyers@ccu.edu.tw

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Collaborators

- Jane Tsay
- Li Yingshing
- Ko Yu-Guang
- Wang Wenling & Huang Yuying
- NSC 94-2411-H-194-018, NSC 95-2411-H-194-005, NSC 95-2411-H-194-002, NSC 97-2410-H-194-067-MY3, NSC 97-2410-H-194-067-MY3, CCKF RG001-D-02

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Overview

- Three linguistic “frameworks”
 - Cognitive linguistics (hypothesis)
 - Bilingualistics (another hypothesis)
 - Psycholinguistics (methodology)
- Three case studies
 - Syntax (cognitive linguistics)
 - Morphology (bilingualistics)
 - Phonology (cognitive vs. bilingualistics)

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Methods vs. hypotheses

- Different frameworks and hypotheses may require different methods...
- ... yet disagreements among competing linguistic “schools” can only be resolved via objective evidence...
- ... that is, *shared* empirical observations...
- ... collected via methods that all parties respect as valid

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Kuhn (1970, pp. 12-13): “Each of the corresponding schools ... emphasized, as paradigmatic observations, the particular cluster of ... phenomena that its own theory could do most to explain. Other observations were dealt with by ad hoc elaborations, or they remained as outstanding problems for further research.... Being able to take no common body of belief for granted, each writer ... felt forced to build his field anew from its foundations. In doing so, his choice of supporting observation and experiment was relatively free, for there was no standard set of methods or of phenomena that every ... writer felt forced to employ and explain.”

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Standard set of methods...?

- Cognitive & bilingualists agree on one thing:
Language is psychological
- Thus the *best way* to resolve the rivalry is through *psycholinguistic* evidence...
- ... collected by and for *linguists* (not psychologists, with their own agendas)
- For precision’s sake, the psycholinguistic data should be *quantitative*

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Cognitive linguistics

- What it sounds like:
 - The objective study of language as mental
- What it actually is:
 - Hypotheses about language/mind interactions
- Key hypotheses (Croft & Cruse, 2004, p. 1)
 - Language is not autonomous
 - Grammar is conceptualization
 - Linguistic knowledge arises from language use
 - All from a view of perception...? (Noonan, 1999)

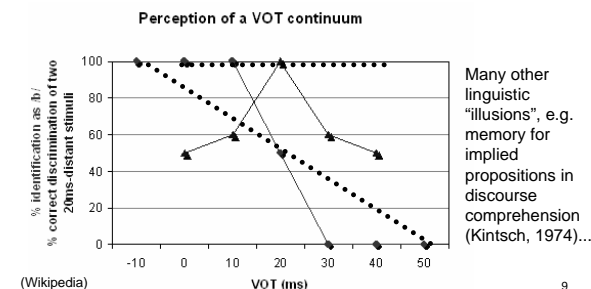
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Noonan (1999): “Structuralism [e.g. generative linguistics] is best viewed as a mode of perception.... [In this view, w]hat the brain knows is a highly modified, processed version of what the senses perceive. [p. 13] [By contrast, t]he model of perception that is most compatible with recent work done by [functionalist linguists like Noonan] is ... a sort of WYSIWYG model of perception: ‘what you see is what you get’. That is, the constructs created by the mind mirror the perceived reality.” [p. 23]

- Iconicity...?

WYSIWYG perception?

- Most psycholinguists would disagree



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Cognitive linguistics and evidence

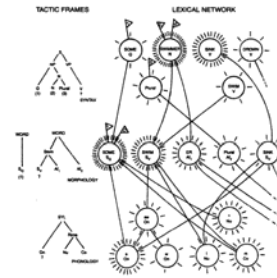
Noonan (1999, p. 26):

“A basic element of the new model [of functionalism] is that one should posit only those constructs — abstract elements and units — that are needed to account for the data and that are compatible, if possible, with those that have been shown to be required by psychological research.”

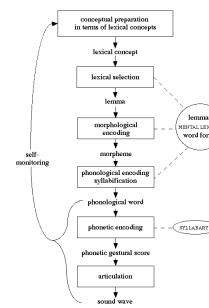
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Which psychological research?

• Does processing work like this...? (Dell, 1986)



• Or like this...? (Levelt, Roelofs, & Meyer, 1999)



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Biolinguistics

- What it sounds like:
 - The objective study of language as biological
- What it actually is:
 - A hypothesis about linguistic innateness
- Key hypothesis (Chomsky, 2007)
 - Only a tiny bit of language is innate
 - The rest emerges through “natural laws” of efficient growth

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Chomsky (2007, pp. 19-20): We should seriously consider the claim that “acquisition of language involves not just a few years of experience and millions of years of evolution, yielding the genetic endowment, but also ‘principles of neural organization that may be even more deeply grounded in physical law’ [Chomsky, 1965, p. 59]... [By the ‘strong minimalist thesis’], language would be something like a snowflake, taking the form it does by virtue of natural law....”

- Beauty is truth...?

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Pinker & Jackendoff (2005, p. 221): “Just as Minimalist syntax is far from minimalist, the ‘principles of economy’ ... are not particularly economical.... (That is, they are not derivable mathematically from deeper principles in the way that principles of naive physics like ‘water finds its own level’ are derivable from principles of energy minimization).”

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Biolinguistics and evidence

Jenkins (2000, pp. 28-29): Pinker dismisses Chomsky’s arguments “since they don’t meet his criterion of ‘converging evidence’” [e.g. psycholinguistic experiments]

“But generative grammarians had already performed years of experiments ... by introspection ...” [p. 30]

“... the argument from the poverty of the stimulus [is] strong enough [by itself] to support the conclusion that the ‘basic design of language is innate’” [p. 31]

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Testing biolinguistics seriously

- Acceptability judgments
 - Schütze (1996): Historical overview
 - Cowart (1997): How-to manual
 - Myers (2009a,b): Overview & manual
- Poverty of the stimulus
 - Pullum & Scholz (2002): empirical problems
 - Legate & Yang (2002): empirical support

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Three case studies in Chinese

- Syntax in cognitive linguistics
 - Temporal sequence principle
- Morphology in (quasi-)biolinguistics
 - Functors in word structure
- Phonology: “cognitive” or “biological”?
 - Knowledge of phonotactics

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Case 1: Temporal sequence principle

- Tai (1985, p. 50): “the relative word order between two syntactic units is determined by the temporal order of the states which they represent in the conceptual world”
 - 張三上樓睡覺 (upstairs, then sleep)
 - 他跑累了 (running, then tired)
- For further discussion, see Tai (2002)
- Focus here is psycholinguistic predictions (with Ko Yu-Guang)

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Psycholinguistic predictions

- Conceptual judgments:
“跑” should be judged as happening before “累”
- Syntactic judgments:
張三上樓睡覺 *張三睡覺上樓 (* = unacceptable, 他跑累了 *他累跑了 according to Tai, 1985)
- Temporal order “determines” word order:
 - Stronger temporality = more fixed word order...?
 - Temporality as origin of fixed word order rules
 - Stronger temporality = freer word order...?
 - Temporality as online cause of word order choices ¹⁹

Preparing sentences

- 240 sentences (60 from Tai, 1985), both normal (他跑累了) and reversed (他累跑了)
- Five syntactic constructions:
 - Coverb: 他在廚房裡做飯
 - Postverbal adverb: 他病了三天了
 - Resultative: 他跑累了
 - Serial verb: 張三上樓睡覺
 - Temporal connective: 你給了我錢才能走

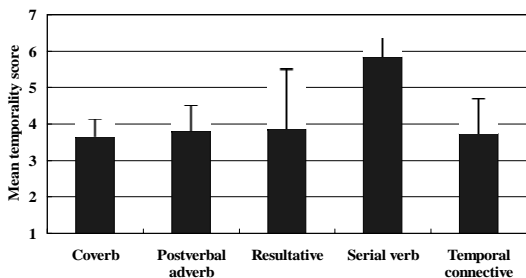
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Quantifying “temporality”

- 20 linguistically naive students
- Unreversed sentences with colored phrases
張三上樓睡覺。
- Judge if their order relates to real world
請決定：句子中A、B的順序，是否跟現實世界中兩個部分發生的順序相關
- Seven-point scale
(1 = least [最不相關], 7 = most relevant [最相關])

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Constructions differ in perceived temporality



(Error bars = standard deviation)

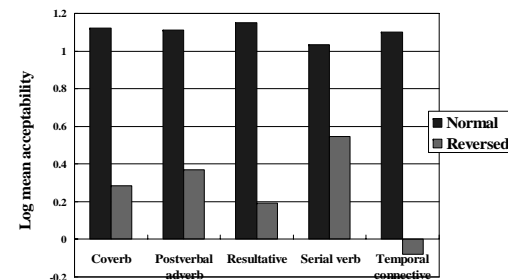
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Quantifying acceptability

- Another 30 linguistically naive students
- Counterbalanced lists (no explicit pairing)
- Magnitude estimation (Bard et al., 1996):
 - First score a baseline sentence on an open-ended numerical scale of one’s own choosing:
郭先生打球洗澡。
 - Then score remaining sentences proportional to this baseline (e.g. twice as good...)
 - Respects gradient nature of acceptability*
*(but more on this issue later...)

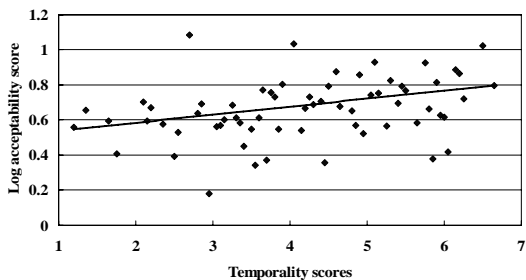
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Constructions differ in sensitivity to order reversal



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))` ²⁴

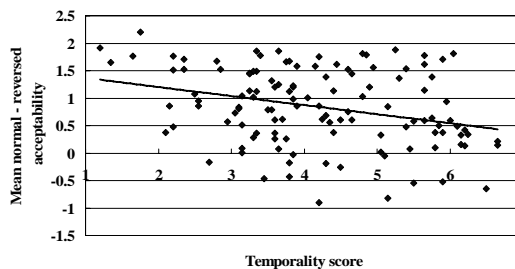
Perceived temporality improves overall acceptability



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))` ²⁵

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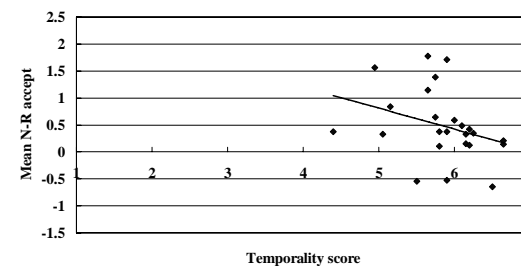
Higher temporality score = weaker syntactic order effect



Temporality *increases* word order freedom ²⁶

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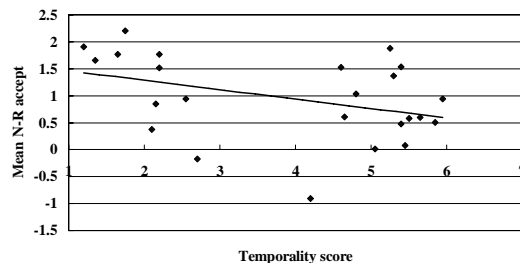
Temporal sequence effect in serial verb construction



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))` ²⁷

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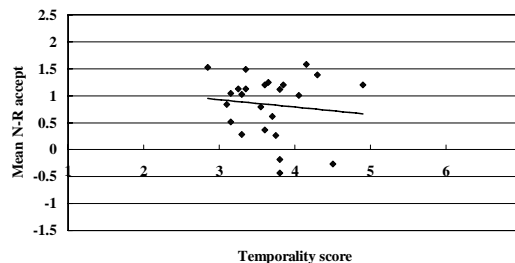
Temporal sequence effect in resultatives



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))`

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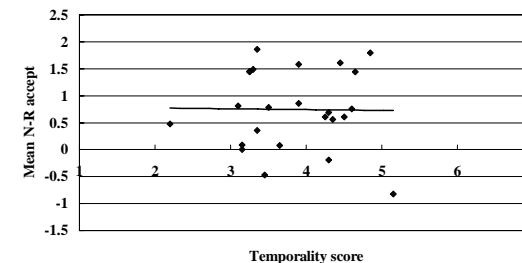
Temporal sequence effect in coverb construction



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))`

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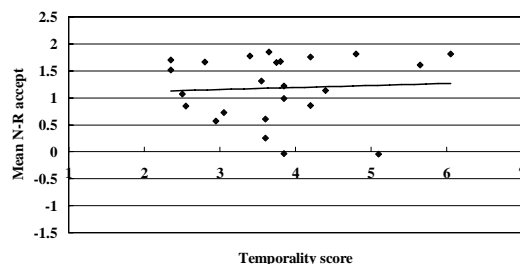
Temporal sequence effect in postverbal adverb



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))`

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Temporal sequence effect in temporal connectives



R code: `anova(lmer(logJudge ~ SynCon*SynOrder*TempScore+(1|Subject)))`

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Tentative conclusions

- Stronger temporality = more order freedom
- Most constructions have fixed word order, regardless of perceived temporality
- Possible psycholinguistic model:
 - Word order is specified in “autonomous” syntax
 - Only where order is unspecified in syntax does the temporal sequence principle come into play
- Diachronic speculation
 - “Fixed” orders were also derived via temporality

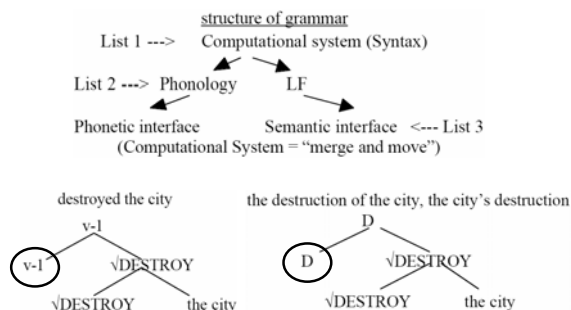
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Case 2: Functors in word structure

- Bilingualistics has yet to address word structure (as far as I know)
- But another “minimalist nativist” model has: **Distributed Morphology** (Marantz, 1997)
- Key claim:
 - Morphological structure is minimalist syntax
- Key distinction
 - Vocabulary items (abstract “roots”)
 - Syntactic functors (abstract “affixes”)

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Examples (Marantz, 1997)



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Is affixation universal?

- Affixation per se is “merely” phonology
uglier vs. more beautiful [same functor]
 - Yet shouldn't functors be distinct from roots?
 - If so, Chinese is a problem, since the root vs. affix distinction is fuzzy (Myers, 2007)
 - 語言學 vs. 大學 (cf. 化 & other loan translations)
 - 研究者 vs. 未量體溫者 (as during SARS scare)
 - 子 merely selects (not coerces) N (e.g. 刷子)
- (not just Chinese – e.g. *bio*: affix or root...?)

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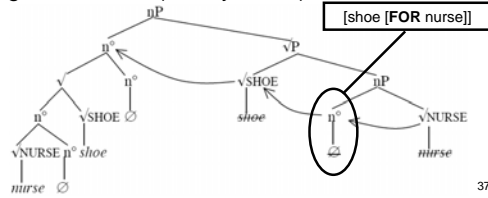
Psycholinguistic predictions?

- Frequency effects (Andrews, 1986)
 - Suffixed word recognition speed does not depend on root frequency (vs. compounds)
- Priming effects (Marslen-Wilson et al., 1994)
 - Suffixed words sharing root do not prime each other (vs. compounds)
- At best only weak replications in Chinese... (with Wang Wenling and Huang Yuying)
 - ... but results are not presentable yet

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Testing abstractness

- Above diagnostics too “surfacey”...?
 - Merely phonology? (e.g. Pastizzo & Feldman, 2002)
- Do root compounds have abstract “affixes”?
 - e.g. nurse shoe (Harley, 2009)



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Competition as a clue...?

- Suffixation (Marslen-Wilson et al., 1994)
 - Suffixes compete in confession / confessor
- Compounds (Gagné, 2001)
 - student vote (BY relation) primes student accusation (BY relation) relative to student car (FOR relation)
 - Thus relations compete in student FOR car / student BY accusation
- Abstract compound “affixes”? (Myers, 2007)
 - Caveat 1: Isn't suffix effect partly phonological...?
 - Caveat 2: In Chinese, effect equally strong for modifier and head (Ji & Gagné, 2007), so “syntactic” structure is irrelevant – not even “abstract” affixes in Chinese?

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Case 3: Knowledge of phonotactics

- Why do some fake words sound better than others?
 - blick* > *bnick* [Halle, 1962]
- Cognitive-linguistics-style answer:
 - Learning from experience with many /bl/ words and no /bn/ words
- Biolinguistics-style answer:
 - Innate knowledge that /bl/ obeys some “natural” principle while /bn/ violates it

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Comparing the two hypotheses

- Support for learning from experience:
 - Children are sensitive to the probability of phoneme sequences (Zamuner et al., 2004)
- Support for innateness of natural patterns:
 - Patterns are easier to learn if they are typologically common (Moreton, 2008)
- Our study (with Jane Tsay & Li Yingshing)
 - Collect acceptability judgments for phonotactic patterns in Mandarin
 - Test their correlations with experience vs. naturalness

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Mandarin phonotactic patterns

- Twenty-two “patterns”, e.g.
 - *V₁V₂V₃ (V₁=V₃): /iau/ vs. */uau/ [Lin, 2007]
 - */fi/: /fu/ vs. */fi/ [Wang, 1998]
 - *LabV/u/: /pei/ vs. */pou/ [Wang, 1998: accidental?]
 - */s/[-high]³⁵: /san⁵⁵/ vs. */san³⁵/ [Tung, 1965]
- Caveat: What counts as a “pattern”...?
 - Which are systematic enough to consider?
 - Our choices biased by linguistic theory?
 - In future we'll look at *all* feature combinations

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Quantifying experience

- Within a language, patterns differ in how many forms (e.g. words) obey them
- Patterns appearing in more words have a stronger effect on experience
- Quantifying language-internal robustness:

$$\log(\text{words}_{\text{obey pattern}} / [\text{words}_{\text{violate pattern}} + 0.5])$$
 - [cf. Poisson regression: Myers, 2008]

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Quantifying naturalness

- Cross-linguistically, patterns differ in how many languages show them
- Patterns appearing in more languages are more “natural” (easier to learn?)
 - Caveat 1: May be diachronic (Blevins, 2004)
 - Caveat 2: Not very biolinguistic (cf. Reiss, 2003)
- Quantifying typological robustness:

$$\log(\text{patterns}_{\text{cross-linguistically}} + 0.5)$$
 - [based on 1527 patterns in much larger database compiled by Mielke (2008); aix1.uottawa.ca/~jmielke/pbase/index.html]

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Quantifying acceptability

- 288 nonlexical syllables
 - 2-10 items per pattern violating *only* that pattern
 - 82 items violating no pattern (“accidental gaps”)
- 30 linguistically naive students
- Quick good/bad judgments
 - Binary scale easier for judges, yet about as informative as gradient scales (Weskott & Fanselow, to appear)
- Quantifying acceptability robustness:
 - Logistic regression weights (negative = stronger)
 - R code: `lmer(Accept ~ Constraints + (1|Subject), family="binomial")`

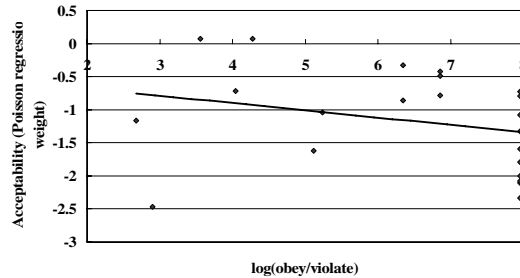
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Sample Mandarin patterns

Pattern	“Experience”	“Naturalness”	Acceptability
*V ₁ V ₂ V ₃ (V ₁ =V ₃)	7.955 (no exceptions)	1.705 (5 cases)	-1.788
*/fi/	7.955 (no exceptions)	0.405 (1 case)	-2.108
*LabV/u/	4.046 (24 exceptions)	1.872 (6 cases)	-0.717
*/s/[-high] ³⁵	6.856 (1 exception)	-0.693 (no cases)	-0.489

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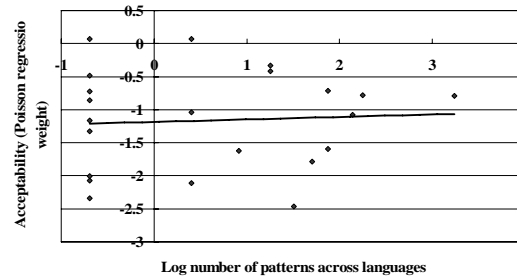
Experience predicts acceptability



R code: `Imer(Accept~lnLng+CrsLng+(1|Subj),family="binomial")`

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Naturalness (as defined this way)* doesn't predict acceptability



*But defined as "What James Myers thinks is natural" – it does predict! 47

Which "experience"? Which "naturalness"?

- Nativists & empiricists can agree:
 - Grammar learning is corpus analysis
- Only question is:
 - Which corpus analysis algorithm(s) do actual kids actually use?
- Answer is surely "somewhere in between"
- Crucial evidence will be psycholinguistic
 - Developmental data from children
 - Tests of productive adult knowledge

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Summary of findings

- Temporal sequence principle
 - It does affect word order preferences
 - But its strength varies across constructions
- Functors in word formation
 - Even abstract "affixes" in root compounds?
 - But Chinese...? And truly "abstract"...?
- Knowledge of phonotactics
 - Mainly based on experience...
 - ... but the "how" depends on learning algorithm 49

Conclusions

- Ideological purity tends to lead to methodological sloppiness
- All linguistic "frameworks" should battle it out in a shared empirical arena
- If you say your theory is cognitive (or biological), back it up with actual cognitive (or biological) data
- For maximum precision, the data should be quantitative (THE END) 50

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