Global and detailed speech representations in early language acquisition

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A few questions about representations

- articulatory or acoustic targets = mental representations

– representations of basic speech units*
(which rules combine into higher order units)

– representations of combined units such as words

- Three questions about representations:

– What could be the "basic units" of representation?

– Same representations in production and perception?

– What degree of detail is coded?

I will focus mainly the last question

Plan

- Data on prelexical children

  The syllable as the basic unit of production?
  Global rather than detailed specifications for early syllables
  Newborns "count" syllables rather than phonemes (or moras)
  Utterances with a syllable structure favor speech-mode processing
  Do infants parse syllables into segments or treat them as whole-units?

- Data on trained and untrained word recognition

  Simplification and regularities in produced first words
  Phonetic detail in trained word recognition at 8 mos (Jusczyk & Aslin, 1995)
  ...not in untrained familiar word recognition ca. 11 months?
  Phonetic detail from ~14 months onward (Swingley, Plunkett, Werker...)
  Consonant-vowel asymmetry? Nazzi vs. Plunkett, Best et al. 2009

- Cs/Vs asymmetries in adults: Cs <-> lexicon; Vs <-> syntax?
  Word reconstruction experiments (van Ooijen, Cutler...)
  Aphasic patient data (Caramazza et al. 2000)
  Theoretical account (Nespor, Peña, & Mehler, 2003)
  Segmentation and generalization experiments with adults (Meher's group)
  Tentative conclusions, Sven Öhman's insight

prelexical children, prelexical representations*

Children need to discover words and how to combine them: Words and Rules

But before children can segment speech into words, what can they do?

– discriminate languages (rhythmic classes), speech sounds like /ba/-/pa/
– start to babble ...

In all these capacities, the SYLLABLE seems to play an important role

- the syllable as a basic unit** of production?

  – implicit in the “canonical” babbling definition (adult-like syllables)

  – explicit in MacNeilage and Davis’ Frame-then-Content model

  – in articulatory phonology: syllable = time frame wherein oscillatory systems are synched to produce consonant and vowel gestures

prelexical (production)

- global rather than detailed specifications for early syllables

– MacNeilage F-then-C: 'content' comes later...
  pure frames, front frames, back frames, nasal frames
  fine-tuning later, via biomechanical maturation and speech input

– articulatory phonology's view of early syllables:
  gross constriction gestures of the lips, tongue tip, tongue body
  imprecise gestural overlap of undifferentiated units
  later, differentiation of whole units into individual components

- CV co-occurrence data support 'global'

– single place of articulation for the entire syllable:
  simplified specification for F-then-C
  gestural overlap for articulatory phonology

=> early representations: syllabic, global, common fate of Cs and Vs?

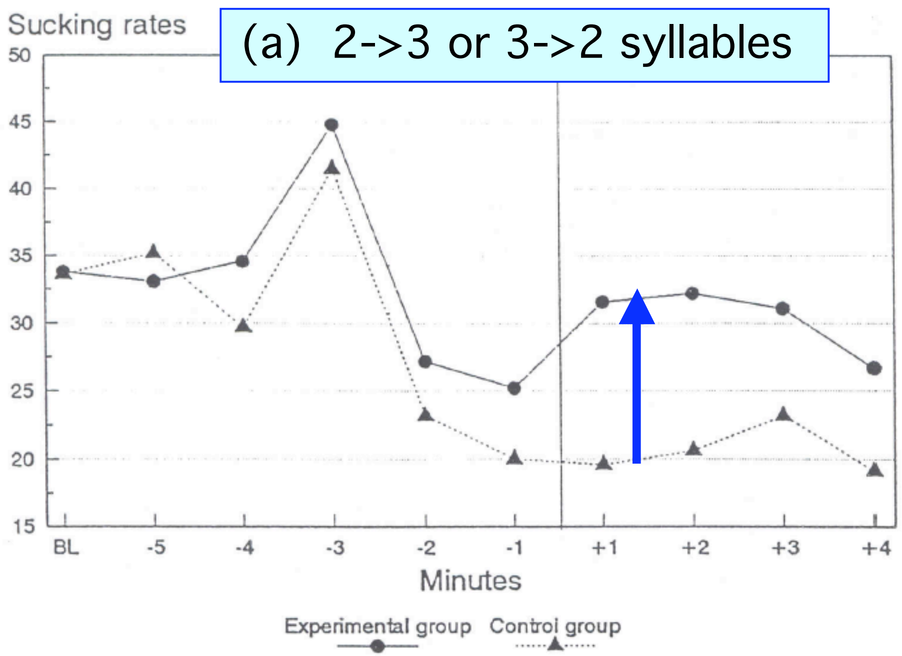
prelexical (perception)

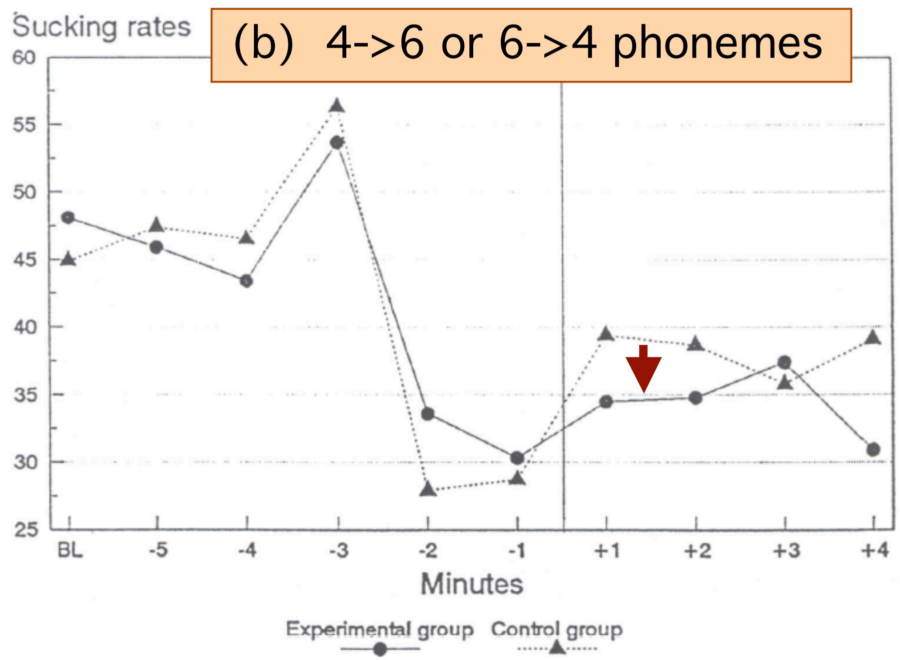
- newborns "count" syllables rather than phonemes (or moras)

Bijeljac-Babic et al. (1993), *Developmental Psychology* : pre-/post-shift sets HAS

(a) newborns discriminate CVCV from CVCVCV

(b) they DO NOT discriminate 4-phoneme from 6-phoneme disyllabic items
4: CV.CV, VC.CV, CCV.V, V.CVC, CV.VC, V.VCC
6: CVC.CCV, CCVC.CV, VC.CCCV, CVC.CVC, CV.CVCC, CCV.CVC, CCV.VCC...





prelexical (perception)

- utterances with a syllable structure favor speech-mode processing

Mehler & Bertoncini (1981), *Infant Behavior & Development* : standard HAS, 2 mos

(a) infants do not discriminate [tʃp]-[pʃt] (*these were not Tashlhiyt infants...*)

(b) they discriminate [utʃpu]-[upʃtu]
as [ut.ʃpu]-[up.ʃtu]?

(c) (control) they discriminate [tɑp]-[pɑt] alright

<u>interpretation</u>: same acoustic [tʃp] and [pʃt] processed differently:
surrounding vowels let emerge a salient syllabic structure
discrimination facilitated by syllabic parsing

prelexical (perception)

- Do infants parse syllables or treat them as whole-units?

". . . My inclination is to suppose that the preliminary auditory segmentation (if any) is syllabic rather than phonemic and that within-syllable segmentation may often be synonymous with classification.” (Studdert-Kennedy 1979, ICPhS, Copenhagen)

Early capacities of discriminating for example /ba/-/pa/ do not tell whether infants abstract /b/ away from /ba/ and /p/ from /pa/.

A clever design was needed.
Bertoncini et al. (1988), *JEP:General* : HAS with preshift and postshift sets

(a) Do infants extract consonants from syllables?

Habituation	*test*	
ba bi be bo ber	bu	new V
	da	**new C**
	du	**new C** & V

2-m-olds react to whatever change

newborns only react to Vowel change
(not to the **da** change)

prelexical (perception)

(b) Do infants extract vowels?

Habituation	*test*		
bi si li mi	di	new C	
	ma	new V	
	da	new C & V	

2-m-olds react to whatever change

newborns only react to Vowel change (not to the **di** change)

interpretation: infants do not parse syllables into phonemes;

they rather treat syllables as whole-units;

vowels seem more salient than consonants *for newborns*

We now turn to words: How do children represent words?

First words in production

Children "select" those words among adult words that correspond to the articulatory patterns, or routines, of their own babbling. (Vihman: "vocal motor schemes", "articulatory filter")

Individual variability is the rule: holistic vs. analytic children

holistic

Emilie (14 mos, 15 words)

ba	*balle*
bo	*bouton*
bebe	*bébé*
poe	*pomme*
po	*chapeau*
popo	*petit* pot
ka	*canard*
ke	*clef*
kki	*cuillère*
kRe	*Mickey*
qa	*sac*

analytic

Marie (14 mos,15-20 words)

aettae	*attend*
hato	*bateau*
bebe	*bébé*
dodo	*dodo*
tebo	*c'est* beau
ebotsa	*c'est* beau ça
ta:tinn	*tartine*
papitza	*papillon*
voajy	*voiture*
hemjetsa	*mimichat*
popi	*poupée*

From whole-word units to segments

Well illustrated by Macken's (1979) case study: Mexican Spanish "Si" from 1;6 to 2;5 (also see Macken 1992; Vihman 1997)

(1) whole-word units

– 1;7–1;9: only one word template (pattern, gabarit): labial–dental

zapato →	pwat:o	*Fernando* →	wan:o
manzana →	mənna	*Ramon* →	mən
supa →	pwæta	*perro* →	bədə
reloj →	buddo	*gato* →	*kako *(harmonic pattern)*

– 1;10–1;11: new templates: **m_s_, f_n_, p_l_, b_ŋ_, k_t_, ŋ_t_...**

(2) adult-like word-forms as strings of segments

– from 2;1; all Cs appear in words, with principled simplifications

Phonological processes at 3-years (Vihman & Greenlee, 1987)

Syllable deletion

animals > ˈæmz

...

Final consonant deletion

because > piˈkʌ

...

Consonant harmony

yellow > ˈlelou

...

Cluster reduction

flower > ˈfawr

...

Segment substitution

– *velar, palatal fronting*

cow > tau, show > sou

...

think > fink /sink

...

– *stopping*

some > tʌm

...

– *gliding*

love > jʌv

red > wed

...

Phonetic detail in trained word recognition at ~8 months

(Jusczyk & Aslin [1995], *Cognitive Psychology*)

6- and 7½-month-olds, HPP paradigm with familiarization

Familiarization: lists of tokens of either {*feet, bike*} or {*cup, dog*}
Test: passages with {*feet, bike*} vs. passages with {*cup, dog*}

7½- but not 6-m-olds recognize (=prefer) familiarized words

7½-m-olds fail to recognize "mispronounced" familiarized words:

dog → **b**awg	*feet* → **z**eet
cup → **t**up	*bike* → **g**ike

conclusion: rather detailed coding of newly learned word-forms

Untrained familiar word recognition

- infant's own firstname: 4 ½ months
  (Jusczyk & Mandel, 1996)

- sound-image matching at 6 months:

  - father's face matched with *dad* or *daddy*,
    mother's face with *mum* (Tincoff & Jusczyk, 1999)

  NB. not very robust: 8/14 infants succeeded; not replicated

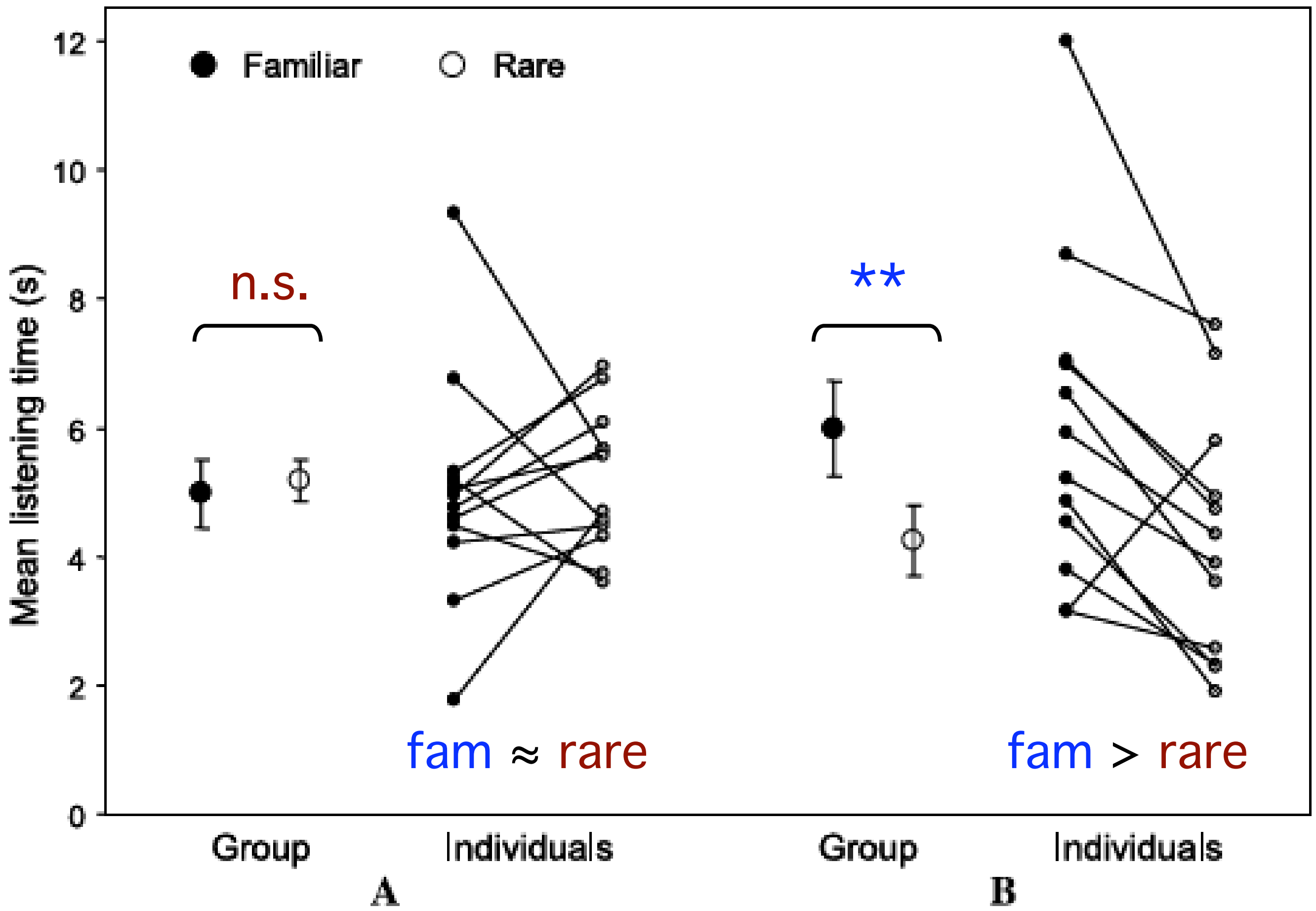
- words assumed to be familiar: 10-11 months (no-training HPP)

  found for: French, Japanese, British English, Welsh, Dutch

(e.g., Hallé & de Boysson-Bardies, 1994, *Infant Behavior & Development*)

Looking times at familiar vs. rare words: British 9- & 11-m-olds

examples: familiar: *button, balloon;* rare: *maiden, taboo*



9-month-olds

11-month-olds

Vihman, dePaolis, Nakai, & Hallé (2004), *J. Memory and Language*

Phonetic detail of word representation in early receptive lexicon

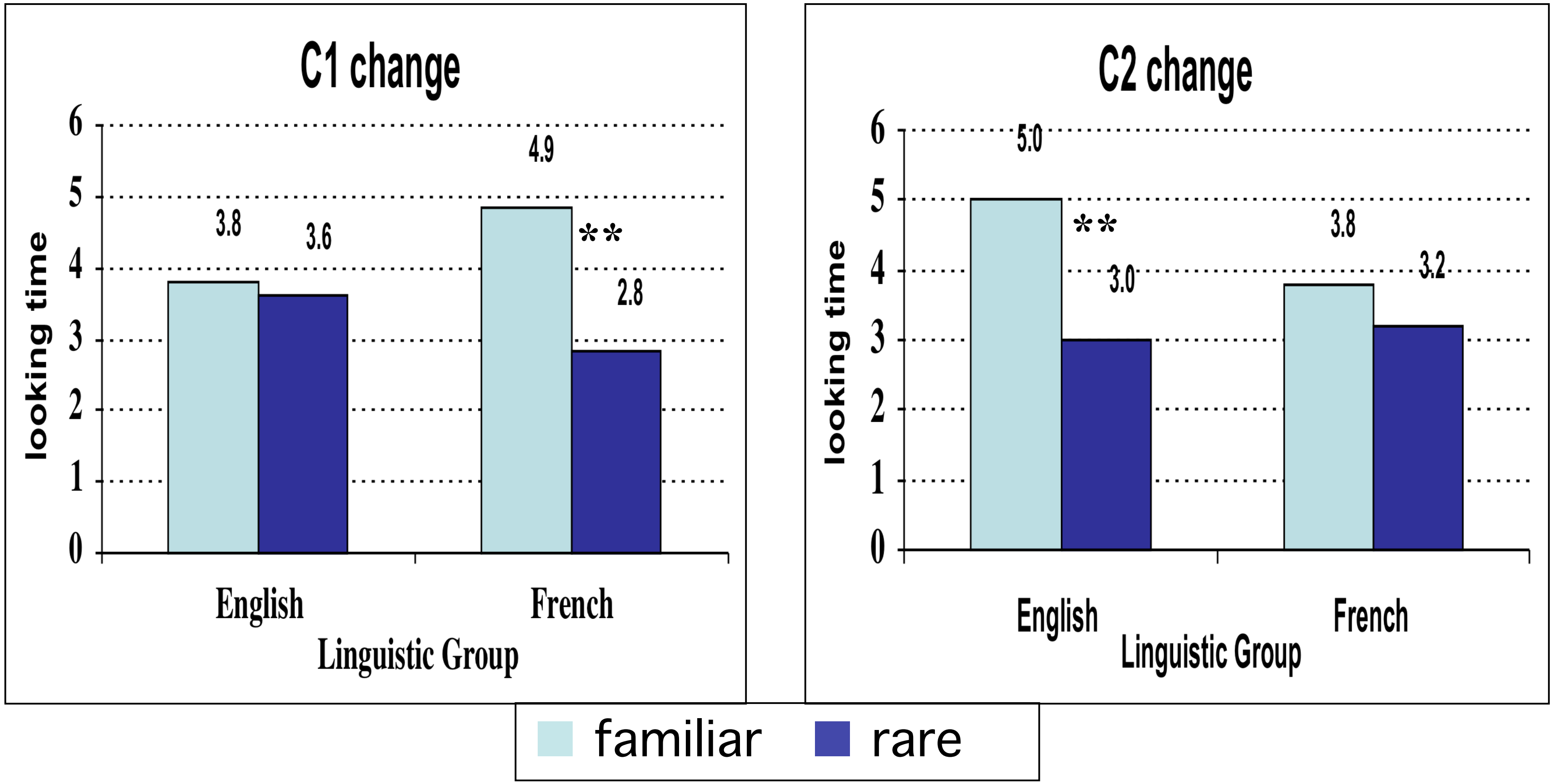
- at the 11-month onset point, representation seem rather flexible

method: no-training HPP with ***mispronounced*** words (MPs)

French 11-m-olds recognize:	*canard, chaussure...*
tolerate C1 mispronunciations:	*ganard, kaussure ...*
but not C1 deletion:	***anard, aussure***
but not C2 mispronunciations:	*calard, chauture ...*
British 11-m-olds recognize:	*button, dirty...*
tolerate C2 mispronunciations:	*busson, dirny...*
tolerate mis-stressed forms:	*buTTON, BAlloon...*
but not C1 mispronunciations:	*vutton, nirty...*

Phonetic detail according to position in English vs. French

(Hallé & de Boysson-Bardies 1996, Vihman et al. 2004)



<u>interpretation</u>: less flexible (more detailed) coding of stressed syllables

Dutch infants on monosyllabic familiar words

Swingley (2005), *Developmental Science*

11-month-old Dutch infants, HPP, familiar monosyllabic words

Example:

mont ('mouth') (CP) (higly familiar)
- --> ***nont*** (onset MP)
- --> ***monk*** (offset MP)

CPs and MPs compared with (Dutch) nonwords

- preference for CP over nonwords
- for CP over onset MP (but not over offset MP)

=> fine consonant detail coded for familiar words?

CP: correct pronunciation; MP: mispronunciation

Global representations at 11 months?

- limited degree of flexibility:

(1) initial consonants of stressed syllables strictly specified

(Vihman et al. 2004; Swingley 2005)

(2) consonant skeleton must be there (Hallé & de Boysson-Bardies 2006)

- underspecification:

(1) initial consonants of non-stressed syllables loosely specified

(2) stress pattern: baLLOON ≈ BAlloon (Vihman et al. 2004)

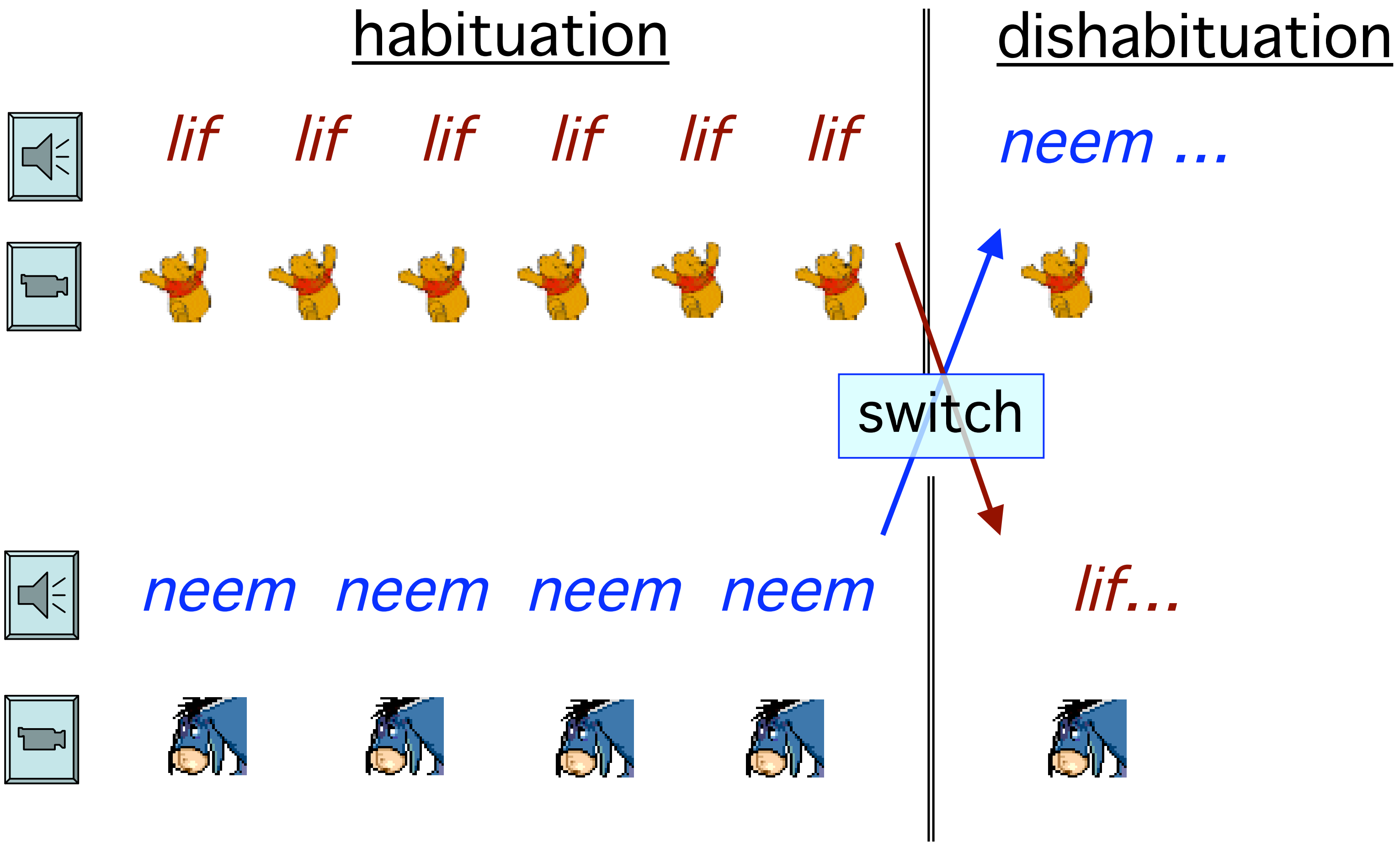
- different coding for newly learned words?

C1 contrast ignored in some word-learning studies:

Example: word pair dih-bih not learned at 14 months
(Stager & Werker 1997, *Nature*)

=> review of this line of research

"switch" procedure with visual fixation (VF)
(learning word–object associations)



expected if association learned: VF recovery after switch

Phonetic detail in lexical representation: from 14 month onward
(Werker, Swingley, Plunkett, Nazzi, etc.)

(a) *Werker's group: switch procedure, word-learning*

- "easy" switch: *lif* → *neem* detected at 14 months
  (not before 14 mos: Werker et al. 1998, *Dev. Psy.*)

- one-feature change *dih* → *bih* detected at 17 mos, not at 14 mos
  (Stager & Werker 1997, *Nature;* Werker et al. 2002, *Infancy*)

- two-feature change *pin* → *din* not detected at 14 months
  Pater, Stager, & Werker 2004, *Language*)

- /d/ → /b/ switch detected *for familiar words* (*doll* → *ball*) at
  14 months (Fennel & Werker 2003, *Language & Speech*)

=> suggests coding in word-learning harder than in known words

Phonetic detail in lexical representation: from 14 month onward

(b) *Swingley: preferential looking procedure, word-recognition*
correct pronunciation (CP) and mispronunciation (MP) of a word,
visual choice between *matched picture* and *distractor picture*

- *dog* and *tog* : longer looking time (LT) to target than distractor
  but longer LT for dog than tog ; idem with ***baby*** and ***gaby/vaby***
  at 18-23 months (Swingley & Aslin 2000, *Cognition*)
  already at 14 mos (Swingley & Aslin 2002, *Pych. Science*)

(c) *Plunkett (same procedure)*
MP rejected: children wouldn't look at the dog's picture for ***tog***

=> phonetically detailed representations

Increasing phonetic detail in lexicon: pressure of vocabulary size?

- *the pressure of the growing vocabulary argument*

– irrelevant variation can be ignored in early lexicon (sparse population)

– but rapidly many distinctions become relevant

> "…representations of lexical items may become increasingly segmented (phonemic) with development from the pressure of an increasing vocabulary size. Young children may represent *only those distinctions that are necessary* for word recognition. ... Words that have *many similarly sounding neighbors* may be forced to become *phonemically represented* chronologically earlier than words that do not have to be discriminated by many similarly sounding word neighbors." (Metsala 1997, *Memory and Cognition*, p. 161)*

- *How do representations get refined?* (parenthetical issue!)

item-specific coding or **rule-like generalization**?

Example: (1) only *pin* => *pin*=*kin*=*bin*

(2) *kin* learned => *pin*≠*kin* but what about ***bin***?

Qualification of the neighbors' pressure account

- (Dutch) *bal* ('ball') mispronounced *dal* or *gal* (Swingley 2003, *L&S*)

/d/ frequent, /g/ very rare => children likely have heard *dal* not *gal*

(a) *specific-item coding* view: *bal* ≠ *dal,* but still *bal* = *gal*
=> CP ≈ MP-g > MP-d

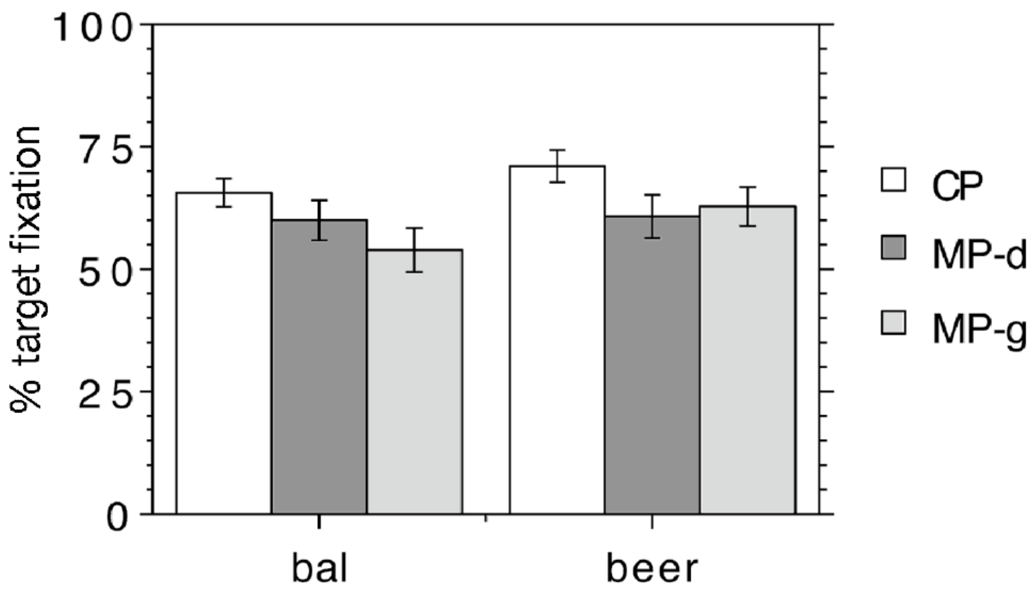
(b) *generalization* view: [b], [d], and [g] = different segments
(feature or gesture generalization, however infrequent is /g/)
=> CP > MP-g ≈ MP-d

found:

CP > MP-d ≈ MP-g

=> (b) rather than (a)

(18-m-olds)



Back to phonetic detail from 14 months onward

- Werker and Swingley: only looked at consonant MPs *
- Nazzi, then Plunkett, looked at phonetic detail in vowels

– "name-based categorization" data (Nazzi 2005, Cognition):

performance <-> success at learning contrasted word-object pairings

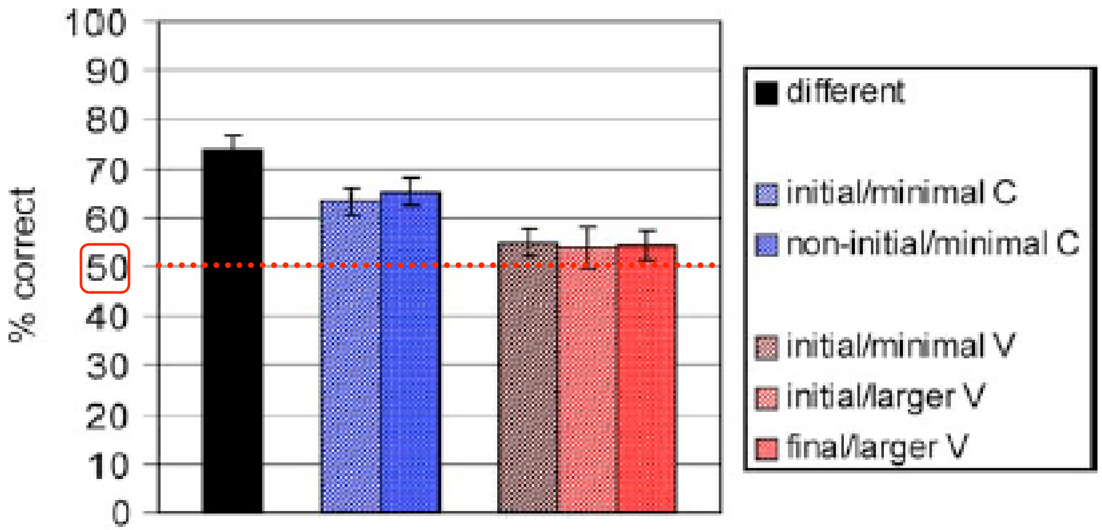
C-contrast > V-contrast

(65% > 54% ≈ chance)

Example:

pize-tize, pize-pyze

(French 20-month-olds)



=> Vs coded more loosely than Cs in children's lexicon?

Impact of vowel versus consonant mispronunciation

– Plunkett's group: PL, familiar words' CP vs. MP (Mani & Plunkett 2007)

<u>Example</u>: ***bib*** (CP), ***bab*** (MP-V), ***dib*** (MP-C)

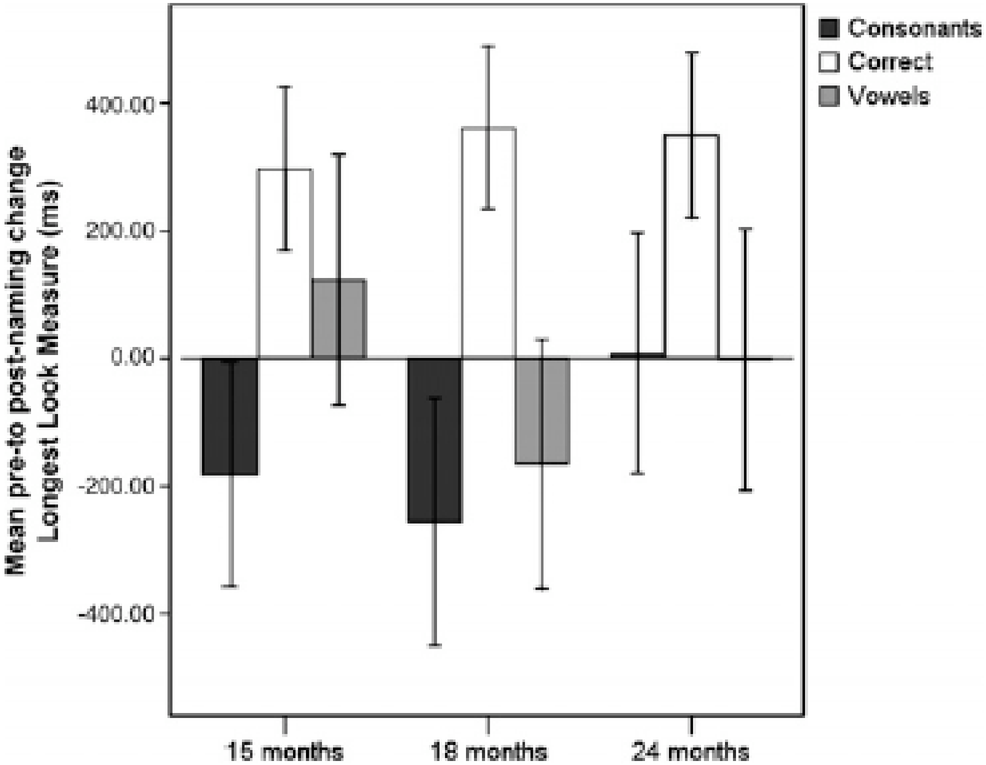
15-, 18-, and 24-month-old English children fail to look at target when hearing MPs; 15-m-olds tend (ns) to look at target for MP-Vs

=> Contradicts Nazzi 2005?

<u>dev. trend</u>: Vs first ignored, later as important as Cs

<u>measures</u> = increase of %looking at target (**PTL**); of longest looking time (**LLK**) at target, after target is named.

<u>shown</u>: **LLK** data



Discrepancies between Nazzi and Plunkett's data: Why?

- very different experimental procedures (PL vs. NBC)
- word-recognition vs. word-learning
- one vs. two syllable words, English vs. French

○ vowel MP effects found in word-learning, English 14-m-olds
padge --> *poudge*, *mot* --> *mit* (Mani & Plunkett 2008)

○ vowel *switch* in ***deet–dit*** (but not ***deet-doot***) detected by English 14-m-olds (Curtin et al. 2009; also see Dietrich et al. 2007)

○ V contrast ignored and C contrast learned in French 16-m-olds (simplified NBC: Havy & Nazzi 2009); in 30-m-old French *and English* children (Nazzi et al. 2009)

=> unclear picture, methodological issues...

More support for a lesser weight of Vs in the lexicon

- AE and JE (Jamaican English) differ mainly on vowels:

  hid, head, hood: /ɪ, ɛ, ʊ/ (AE) vs. /i, e, u/ (JE)

  had, hawed, hod: /æ, ɔ, ɑ/ (AE) vs. /ɑ, ɑ, ɑ/ (JE)

- Preference for familiar words across AE and JE:

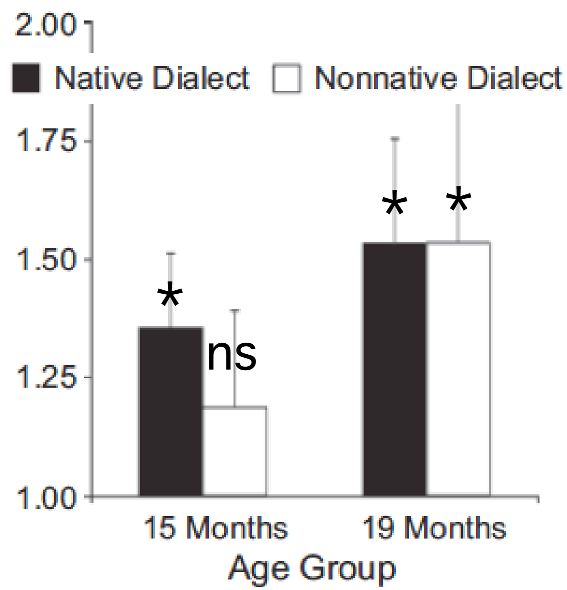
  found with 19- but not 15-month-old AE children

=> *At 19 months, children ignore dialectal variation in vowels*

<u>developmental trend</u>:

young children *sensitive to V variations*, older ones *tolerate V variation* in recognizing words

(Best et al. 2009 *Psych. Science* : *phonological constancy*)



Consonant/Vowel asymmetry in adults

- *word reconstruction (WR) data:*

Cs more important to maintain than Vs (or Vs' greater mutability)

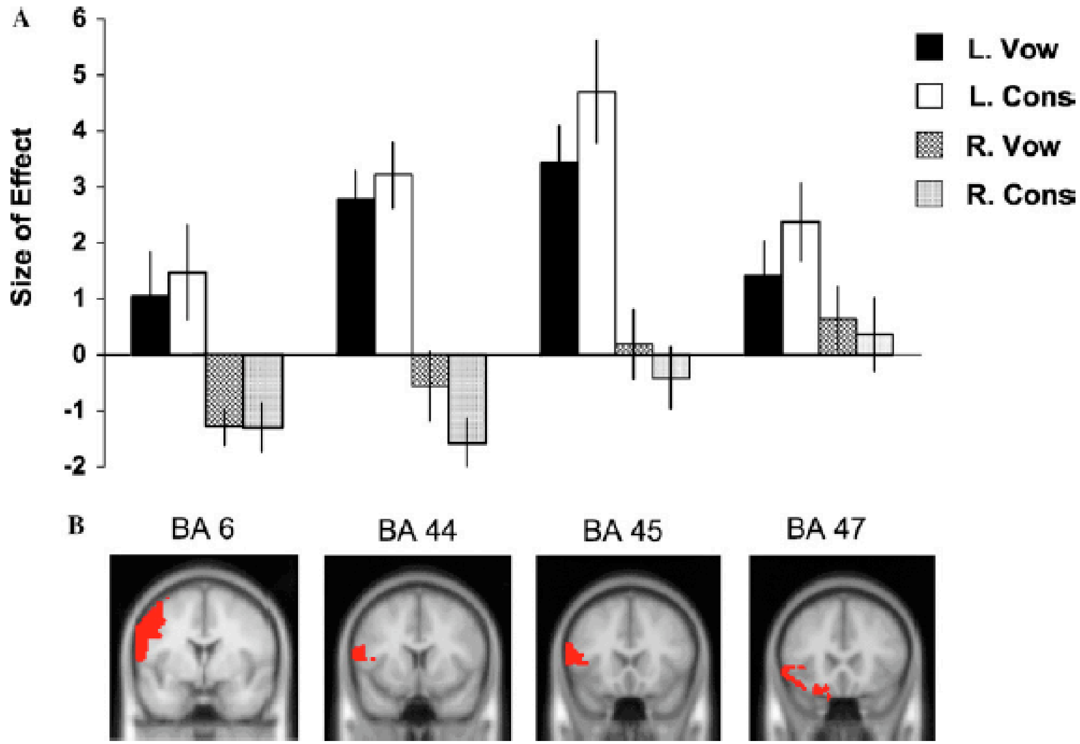
**kebra* --> *cobra* more often than *zebra* (Cs not Vs maintained)
(Cutler at al. 2000; van Ooijen 1996: *Memory and Cognition*)
found for English, Spanish, Japanese, Dutch: ~70% > 30%

– PET study of WR

**unsane* --> *insane*/*unsafe*

more activation for C than V reconstruction in anterior left IFG (BA 45 & 47) and in PMC (BA 6)

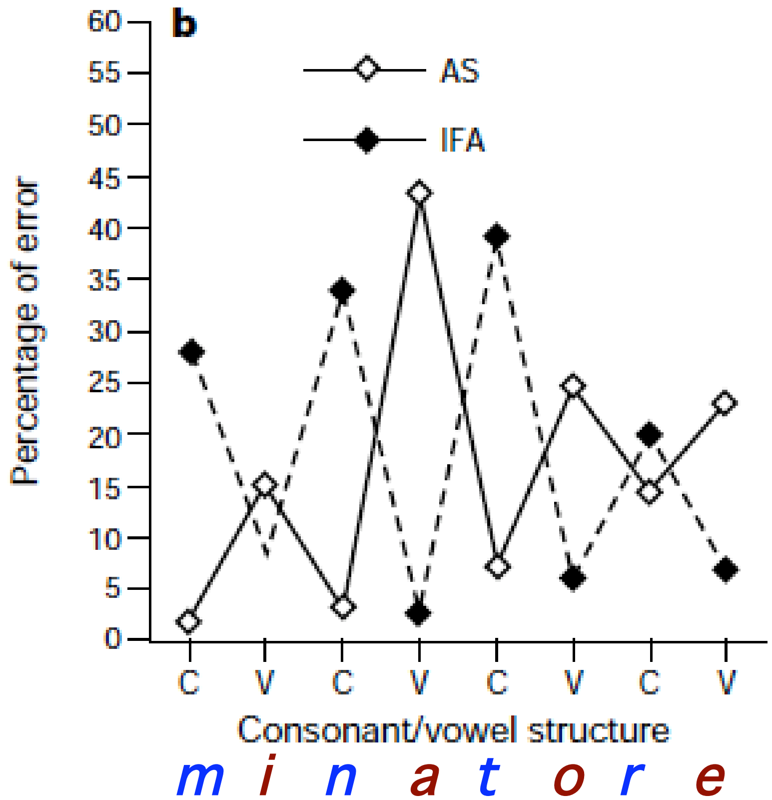
(Sharp et al. 2005, *B&L*)



Consonant/Vowel asymmetry in adults

- *aphasic patient data* (double dissociation)

AS: more errors on Vs than Cs; IFA: more errors on Cs than Vs
(Caramazza et al. 2000, *Nature*)



Consonant/Vowel asymmetry in adults

- *quantitative facts*

– acoustically, Vs much more variable than Cs
– categorical perception of C quality, continuous of V quality

- *theoretical considerations*

(Nespor, Peña, & Mehler 2003, *Lingue e Linguaggio*)

– more Cs than Vs across languages => Cs bear more info
– Cs tend to disharmonize, Vs to harmonize within words
– Cs tend to alternate in quality, not often in quantity as Vs
– Vs not required to alternate in quality (e.g., *banana*)
– Cs, not Vs may constitute morphological roots (Semitic languages)
– C tier has a lexical motivation, V tier motivation is prosodic in nature

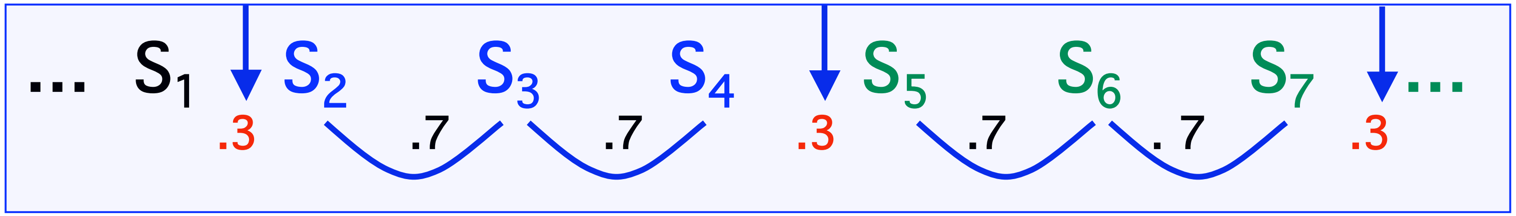
(McCarthy 1985; Goldsmith 1976)

Consonant/Vowel asymmetry in adults

- *word segmentation data with artificial "language"*

– based on Saffran et al. 1996: learning "words" from a stream of syllables with manipulation of syllable transition probabilities (TPs)

S-words: $S_2S_3S_4$ $S_5S_6S_7$ … *defined by TP "dips"*



Both 8-month-olds (HPP) and adults (forced-choice) succeed in "segmenting" S-words:

they have learned $S_2S_3S_4$ rather than e.g. $S_4S_5S_6$

Word segmentation experiments

– Elaboration: TPs between Cs or between Vs (Bonatti et al. 2005)

C-words: p_r_g_ b_d_k_ m_l_t_

success

(87.7 > chance)

V-words: _ɔ̃_i_a _o_ɛ̃_y _u_e_ɑ̃_

failure

(54.2 ≈ chance)

segmentation versus generalization

- *segmentation into "words" seems much easier for C- than V-words*

Fits well with the idea that Cs are essential for coding lexical items

- pattern generalization (e.g., ABA: 1st element = last element)

example

Familiarization: b_d_k_ words with ABA V pattern (e.g., ***badeka, bedoke***)

Segmentation test: C-word vs. part-word (e.g., ***badeka*** vs. ***naboda***)

Generalization test: rule-word vs. nonrule-word (e.g., ***budiku*** vs. ***biduku***)

generalization found for ABA V patterns

NOT found for ABA C patterns or even AAA C patterns

(Peña et al. 2002, *Science;* Toro et al. 2009, *Psychological Science*)

Cs and Vs and learning mechanisms

Two mechanisms seem to help discovering *words and rules*

• *statistical learning* helps to find words

– seems to rely on the distribution of C rather than V co-occurrences in the input; *large input required* (e.g., each "word" repeated 50 times)*

• a *generalization mechanism* helps to find rules

– seems to rely on the regularities across Vs rather than Cs
– precise implementation unknown, needs further research
– *fast extraction* of regularities (Peña et al. 2002)**

Cs and Vs and representations

- the C-V asymmetry line of research is consistent with the autosegmental account of two independent C and V tiers

Vowel tier: domain/locus of prosodic processes such as tone spreading

Consonant tier: main specification of lexical items*

- also consonant with the idea that the speech stream is a stream of vowels on which consonants are coproduced

> The essential features of the coarticulation properties of Swedish dental stops in vowel-consonant-vowel contexts can be described by the formula $s(x; t) = v(x; l)+k(t)[c(x) - v(x; t)]wc(x)$ ... Vocal tract shapes measured from x-ray motion pictures of a set of Swedish vowel-consonant-vowel utterances compare well with shapes generated by the formula. This result is consistent with our earlier conclusions about coarticulation, viz., that the vowel and consonant gestures are largely independent at the level of neural instructions. (Sven Öhman (1967), *JASA*)

Merci pour votre attention

Sketch

-- Whether articulatory or acoustic "goals," the goals of speech production are what psycholinguists would call "representations." A debated issue is of whether the representations for perception are similar, an issue, I believe, that will be much addressed during this summer school. In this talk, I will address the issue of speech representations in infants but will mainly focus on perception and lexical access.

-- Most researchers agree that the syllable is a basic unit of production in prelexical children; this is implicit in many descriptions of the babbling stage, and quite explicit in MacNeilage and Davis' Frame-then-Content model. The articulatory phonology approach would also hold that the syllable is the time frame wherein oscillatory systems are synched to produce consonant and vowel gestures.

-- Likewise in perception, the syllable seems to play a primary role. The capacity of newborns to discriminate most *phonemic contrasts*, even nonnative ones, does not necessarily entail the *phoneme* is a unit of representation for them. Indeed, in the discrimination experiments using HAS, CHT, or other paradigms, infants are usually tested on syllables, for example on /ba/-/pa/: we don't know about exactly /b/-/p/!

-- Yet, a few clever experiments have tried to examine whether infants decompose syllables into consonants and vowels, or whether they "count" syllables rather than phonemes or moras. The available data point on syllables rather than anything else.

-- Now what about the lexical stage? Do young children who start a productive or a receptive lexicon represent words (as production targets or as recognized spoken items) as composed of syllables or of something else?

-- Child phonology studies have proposed that children first go through a whole-word stage during which the word is the basic unit (the “prosodic word”: Macken,1979; also see Vihman, 1997). Children would then develop more adult-like phonological representations,* that is, rule-like representations gradually leading to principled segmental units. For example, some children, usually during the second year, develop a few (possibly just one) consonant-vowel templates, or word patterns, followed by all their attempted words. This whole-word stage is followed by a segmental stage.

-- For word recognition, there is an analogous though less radical claim that infants begin with rather holistic or flexible representations and later move to phonetically more detailed representations, presumably under the pressure of a growing lexicon (Hallé & de Boysson-Bardies, 1996; Vihman et al., 2004).** Studies with older children (≥14 mos) tend to show they are sensitive to phonetic detail. A few studies suggest that Cs are more important than Vs in lexical representations. If confirmed, this trend would be fully consonant with adult studies on C/V asymmetries.

-- Classic word reconstruction studies, as well as recent adult studies suggest that the consonant tier mainly codes lexical units whereas the vowel tier is involved in prosody-related rule extraction (Mehler and Nespor’s group; similar findings seem to hold for 12-m-old children, Hochman et al., submitted).
-- At stake in this line of research is the notion that two mechanisms coexist in language acquisition: discovery of *words* via distributional statistics on Cs, and of *rules* via regularities in V patterns.

Extra materials

words (production)

pre-phonological strategies

(2) *"harmonic patterns" = simplification via C (or V) harmony**

Examples:

chapeau → **papo**

gâteau → **tato**

canard → **nanar**

* More often, regressive harmony
(e.g., *chapeau* → papo rather than *chapeau* → chacho)

words (production)
proto-phonological regularization

Example from de Boysson-Bardies (1996):

"Henri" (16 mos) systematically replaces /m/ with either /b/ or /p/ in /m/–voyelle–consonne–voyelle words, according to the rule:

/m/ → { /b/ if C voiced
       /p/ if C voiceless }

voiceless /s/:	*monsieur* →	peussieu
voiceless /ʃ/:	*méchant* →	pécha
voiced /z/:	*musique* →	bizik

Hochman, Benavides, Nespor, & Mehler (submitted)

Experiment A: word learning

(1) familiarization: kuku <-> A and dede <-> B

(2) test with novel "words": keke and dudu

- C_C_ learned => keke with A and dudu with B (C-looks)
- _V_V learned => keke with B and dudu with A (V-looks)

Score: (C-looks – V-looks)/(C-looks + V-looks)

RESULTS: Score = .23 >> 0 => C_C_ learned more than _V_V

Experiment B: extraction of a regularity

(1) familiarization: {lula, lalo, fufa, fofu, dado, dodu} <-> A

{dala, dolo, fudu, fodo, lafa, lufu} <-> B

(2) test with novel "words": {meke, kimi} and {kike, memi}
(*new Cs and Vs*)

- C1=C2 learned => {kike, memi} with A (A)
- V1=V2 learned => {meke, kimi} with B (B)

Scores: (A–B)/(A+B) for {kike, ...}; B–A)/(A+B) for {meke, ...}

RESULTS: –0.16 < 0 for {kike, memi}; +0.6 for {meke, kimi}

=> V1=V2 learned, not C1=C2