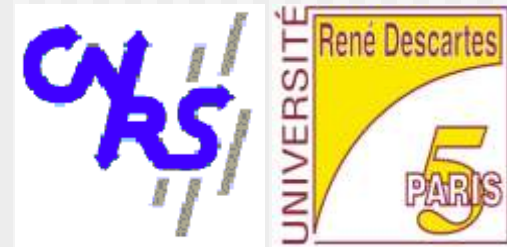


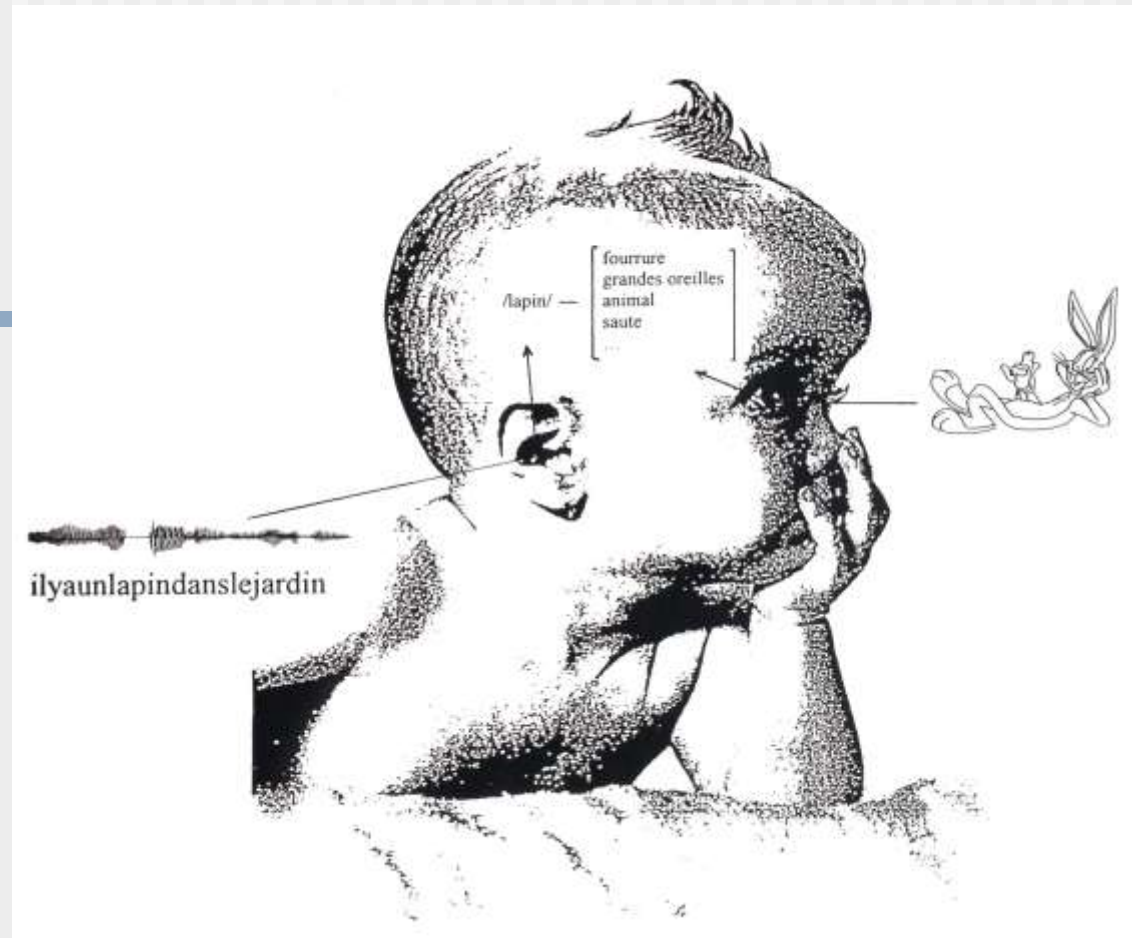
The beginnings of word segmentation in French-learning infants

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FOCUS OF RESEARCH



Mechanisms of lexical acquisition

- (1) segmentation of word forms
- (2) Interaction between
 - phonetic processing
 - lexical acquisition

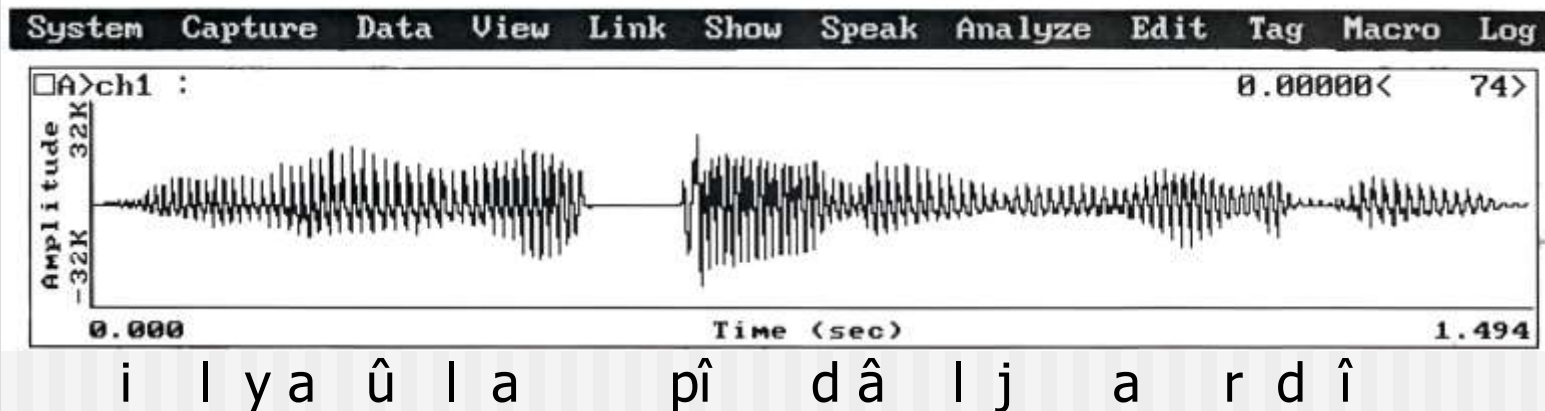
(2) Interaction between - phonetic processing - lexical acquisition

Do infants use detailed phonetic information when learning new words?

→ early asymmetry in consonant/vowel processing at the lexical level

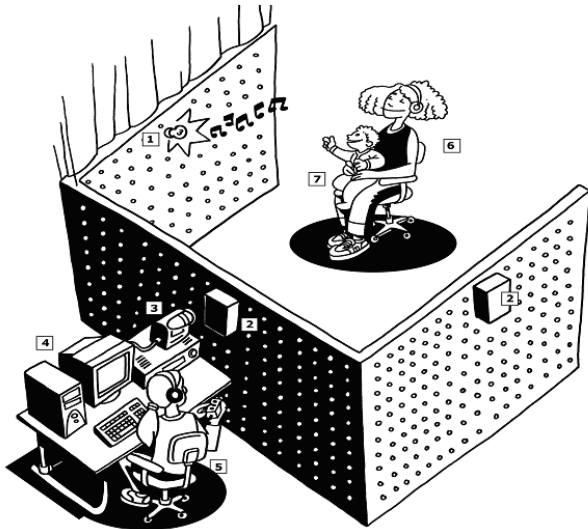
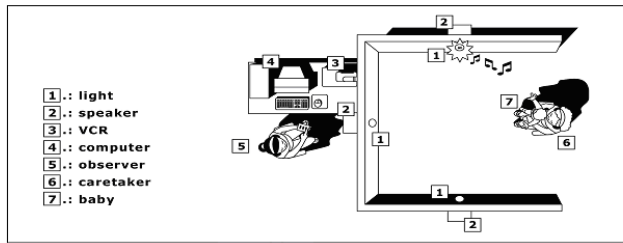
- French 16- and 20-month-olds are able to use consonantal but not vocalic contrasts when learning new words (Havy & Nazzi, ongoing; Nazzi, 2005; Nazzi & New, 2007)
- consonantal information can be used both in onset and coda positions (Nazzi & Bertoncini, submitted)
- by 30 months of age, both French and English infants still pay more attention to consonantal than vocalic information (Nazzi, Floccia, Moquet & Butler, submitted)
- adults: more lexical priming from consonant than vowel structure (New, Araujo, Bour & Nazzi, ongoing)

(1) Word segmentation: speech is continuous



- infants, like adults, hear few words in isolation (< 10%)
 - word boundaries are not clearly and systematically marked at the acoustic level
- ➔ how do infants find word(forms) in the speech stream?

ILLUSTRATION OF THE HEAD-TURN PREFERENCE PROCEDURE (HPP)



EARLY SEGMENTATION in ENGLISH

HPP and the specification
of the cues used by
infants

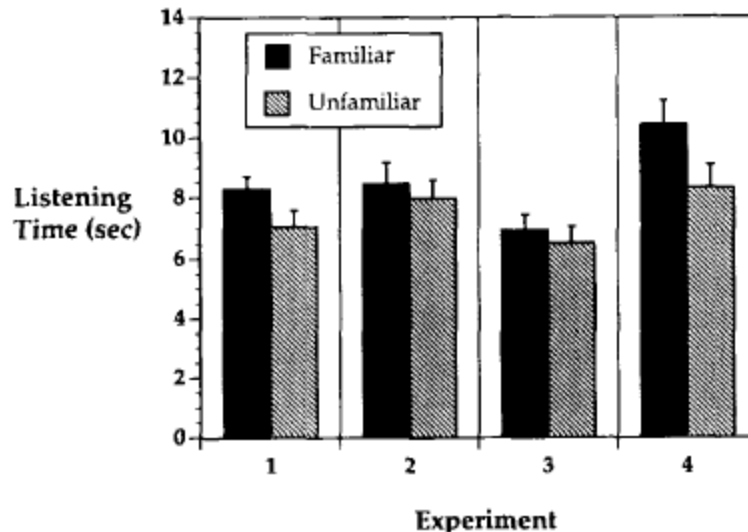
Word segmentation: emergence (Jusczyk & Aslin, '95)

- Familiarization with 2 words:
cup and dog
or
bike and feet

- Test with 4 passages:

The Four Six-Sentence Passages Used in All Four Experiments

Cup:	The cup was bright and shiny. A clown drank from the red cup. The other one picked up the big cup. His cup was filled with milk. Meg put her cup back on the table. Some milk from your cup spilled on the rug.
Dog:	The dog ran around the yard. The mailman called to the big dog. He patted his dog on the head. The happy red dog was very friendly. Her dog barked only at squirrels. The neighborhood kids played with your dog.
Feet:	The feet were all different sizes. This girl has very big feet. Even the toes on her feet are large. The shoes gave the man red feet. His feet get sore from standing all day. The doctor wants your feet to be clean.
Bike:	His bike had big black wheels. The girl rode her big bike. Her bike could go very fast. The bell on the bike was really loud. The boy had a new red bike. Your bike always stays in the garage.



Results: preference for the passages containing the familiar(ized) words between 6 and 7.5 months

Word segmentation: use of various cues

Cues used initially (around 8 months):

- **prosody**: Sw > wS (Jusczyk, Houston & Newsome, '99)
DOctor
gui / TAR
gui / TARis

- **distributional information** regarding syllable order

(Saffran, Aslin & Newport, '96)

tibudogolatu**daropi**pabikugolatu**tibudo**pabikud**aropi**pabikugolatu**tibudo**daropi**golatu**daropitibudopabiku
daropitibudopabikugolatu**tibudo**daropi**pabikugolatu**tibudopabikud**aropi**

Important:

Distributional information **initially** used within prosodically-defined units (c.f. Johnson & Jusczyk, '01; but Thiessen & Saffran, '03)

Word segmentation: use of various cues

Other cues:

- coarticulation (Johnson & Jusczyk, '01)
- phonotactic information : dra vs. dba (Mattys & Jusczyk, '01a)
- allophonic information : nitrate vs. night rate
(Jusczyk, Hohne, & Bauman, '99)
- pitch accent (Nazzi, et al., '05)
- major prosodic boundaries (Gout, Christophe & Morgan, '04)
- nature of initial phoneme (Mattys & Jusczyk, '01b; Nazzi et al., '05)
- known words (Bortfeld, Morgan, Golinkoff & Rathbun, '06;
Shi, Cutler, Werker & Cruickshank, '06)

Word segmentation: crosslinguistic differences?

- From the results on English, it appears that most of the cues used to segment are specific to a language/a language class:
 - phonotactic information
 - allophonic information
 - prosody
- Bootstrapping issue: there should be developmental consequences of contrasting language phonologies
- Need to conduct cross-linguistic studies

Word segmentation: crosslinguistic differences?

Regarding **prosody**

segmentation prior to stressed syllable/trochaic units:

- OK for English, Dutch, German
- not for French

Indeed, in French

- reduced contrast btw stressed/unstressed syllables
- if stress in French, it is word final

Question:

If prosodic information plays a crucial role at the onset of word segmentation, how will infants know what kind of prosodic information is appropriate for segmentation in their native language?

Word segmentation: rhythmic types

Proposal:

Prosodic segmentation will differ across rhythmic-based classes of languages

More specifically: rhythm-based segmentation proposal

Segmentation based on the **rhythmic unit** of the native language

- stress unit for English, Dutch
- **syllable for French**
- mora for Japanese

Word segmentation: crosslinguistic differences?

This hypothesis relies on 3 sets of studies:

- Existence of 3 rhythmic classes:
 - stress-based (English, Dutch, German...)
 - **syllable-based** (French, Spanish, Italian...)
 - mora-based (Japanese, Tamil...)
- Adults from these different classes segment words differently
 - Cutler, Mehler, Norris & Segui, 1986; Mehler, Dommergues, Frauenfelder & Segui, 1981; Otake, Hatano, Cutler & Mehler, 1993; but see Content, Meunier, Kearns & Frauenfelder, 2001)
- Newborns discriminate these rhythmic types

Nazzi, Bertoncini, & Mehler, '98

Word segmentation: rhythmic types

Data supporting the rhythm-based segmentation proposal?

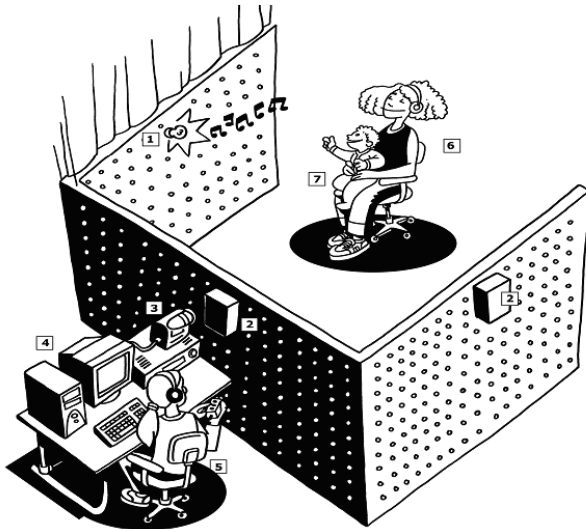
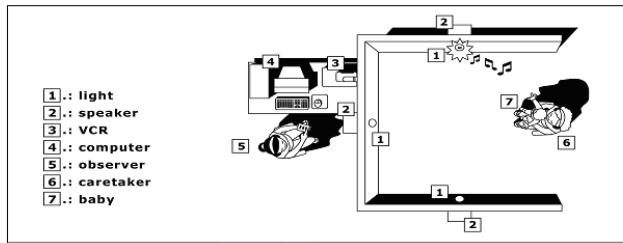
→ Stress units and stress-based languages

- English (Jusczyk, Houston & Newsome, 1999)
- Dutch (Kooijman, PhD dissertation, 2007)
- German (Hohle & Weissenborn, ongoing)

→ **Syllables** and syllable-based languages ???

→ **Morae** and mora-based languages ???

ILLUSTRATION OF THE HEAD-TURN PREFERENCE PROCEDURE (HPP)



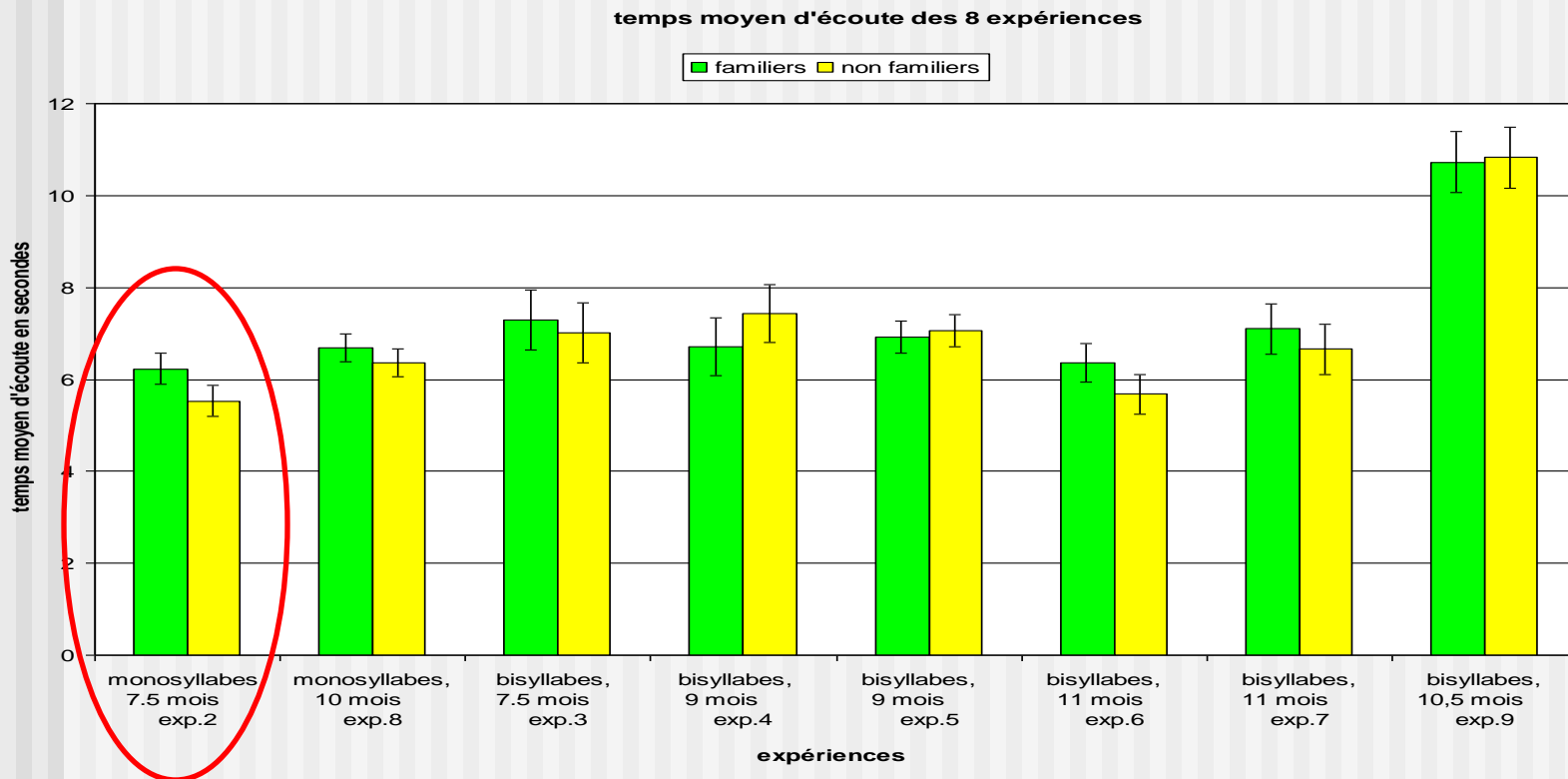
EARLY SEGMENTATION in syllable-based FRENCH

HPP results

Segmentation in French: previous research

Segmentation by Parisian French infants

- monosyllables: around 7.5 months (but not at 10 mos; Gout, '01)
- bisyllables: no evidence between 8 and 11 months (Gout, '01)



Segmentation in French

Gout ('01) results:

compatible with the idea that there are developmental consequences of contrasting language phonologies

Role of the **syllable**?

Nazzi, Iakimova, Bertoncini, Frédonie & Alcantara (2006)

Test the segmentation of bisyllabic words in French

Are they segmented

- as whole units?
- as independent syllables?

	whole words	individual syllables
Initially	no	yes
Later	yes	no

Step 1 - When do bisyllabic words start being segmented as wholes?

- Familiarization with whole words

2 conditions: putois/bandeau vs. toucan/guidon

- Test with the 4 associated passages

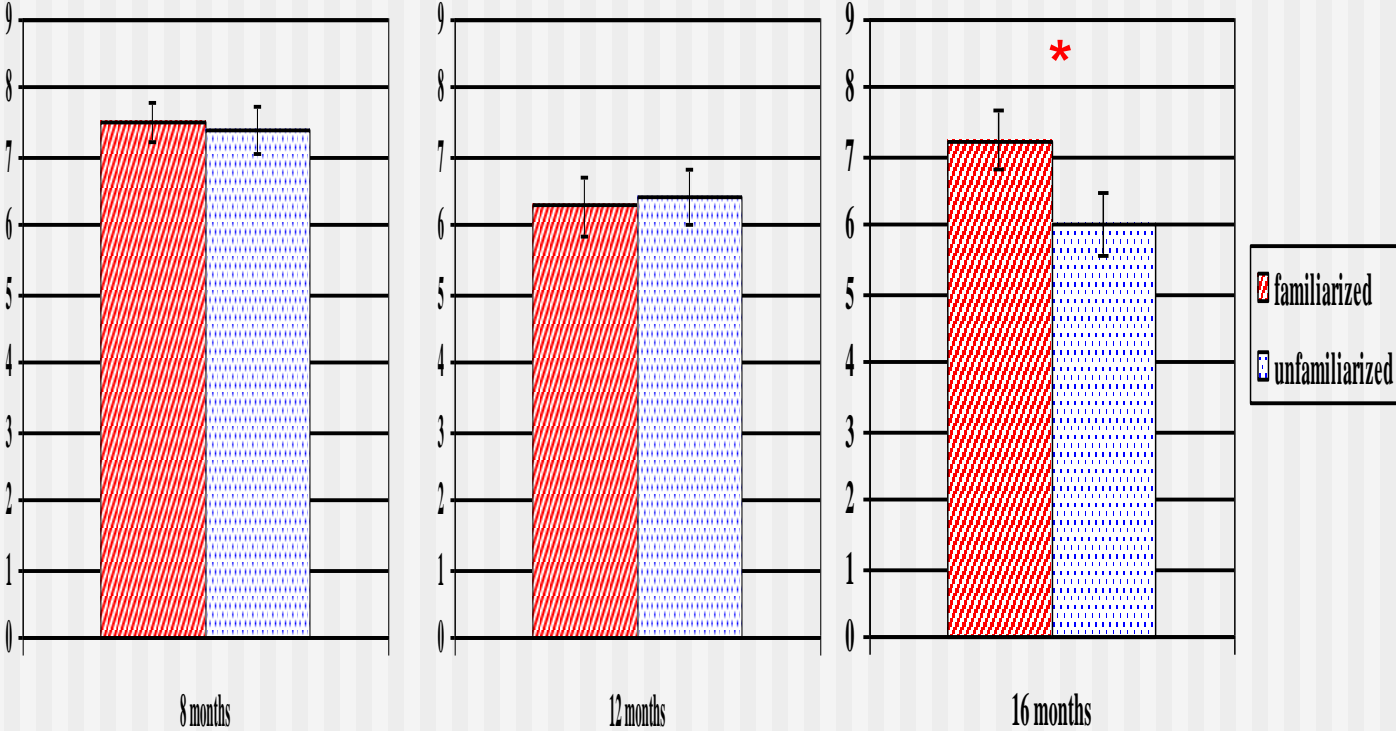
Un **toucan** mangeait des grains de blé. Elle aimait beaucoup le vieux **toucan**. Il trouvait mon **toucan** des plus beaux. Le très joli **toucan** était célèbre. Ce **toucan** savait bien chanter. Il est devenu un si grand **toucan**.

Un **putois** a encore essayé de fuir. Il voulait voir mon **putois** du zoo. Mais il n'a trouvé que le vieux **putois**. Ce **putois** n'était pas très content. Elle pensait au joli **putois**. Alors le grand **putois** s'est énervé.

Mon **bandeau** se plie très facilement. Elle veut un joli **bandeau** de cette sorte. Il faudrait jeter le vieux **bandeau**. Tu sais que ce **bandeau** me manque beau-coup. Il ne trouve pas de grand **bandeau**. Un **bandeau** est toujours à la mode.

Mon **guidon** est original. Il est plus résistant qu'un vieux **guidon**. La selle et ce **guidon** me plaisent beaucoup. Ce joli **guidon** doit être repeint. Il faut qu'un **guidon** soit bien fixé. Elle aurait voulu un grand **guidon**.

Segmentation in French: whole words



predicted

in line with
Gout (2001)

segmentation effect

Step 2 - Evidence for the segmentation of individual syllables before 16 months?

- Familiarization with final syllables (**more accented in French**)
2 conditions: toi/can vs. deau/don

- Test with the 4 associated passages

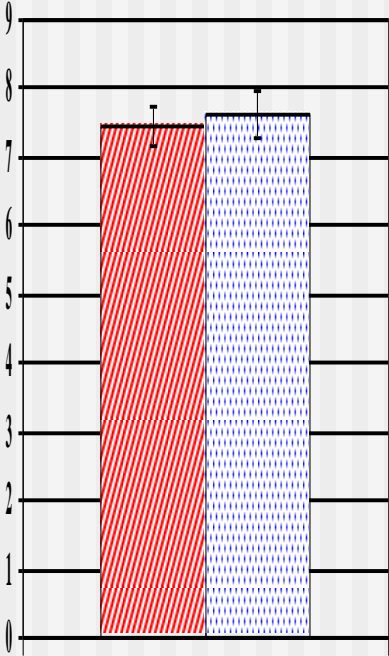
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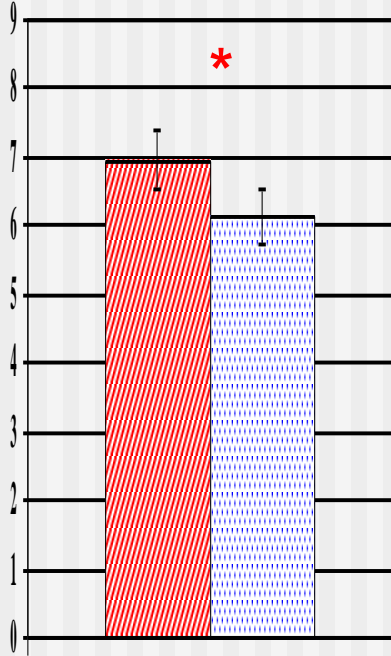
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Segmentation in French: final syllables



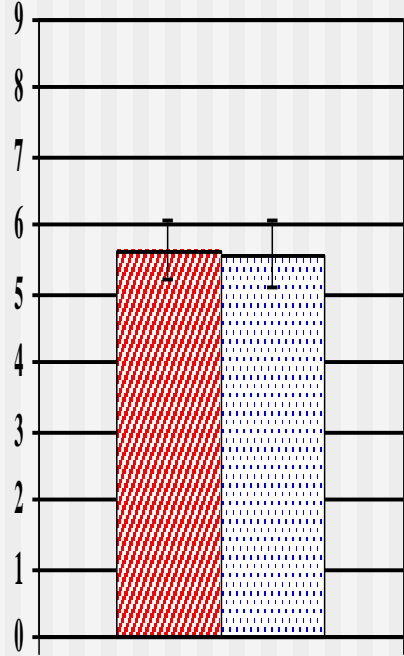
8 months

delay?



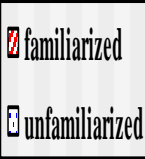
12 months

predicted



16 months

compatible
with Jusczyk et al. ('99)



Step 3 - Evidence for the segmentation of initial syllables at 12 months?

- Familiarization with initial syllables (less accented in French)
2 conditions: pu/tou vs. ban/gui

- Test with the 4 associated passages

Un **toucan** mangeait des grains de blé. Elle aimait beaucoup le vieux **toucan**. Il trouvait mon **toucan** des plus beaux. Le très joli **toucan** était célèbre. Ce **toucan** savait bien chanter. Il est devenu un si grand **toucan**.

Un **putois** a encore essayé de fuir. Il voulait voir mon **putois** du zoo. Mais il n'a trouvé que le vieux **putois**. Ce **putois** n'était pas très content. Elle pensait au joli **putois**. Alors le grand **putois** s'est énervé.

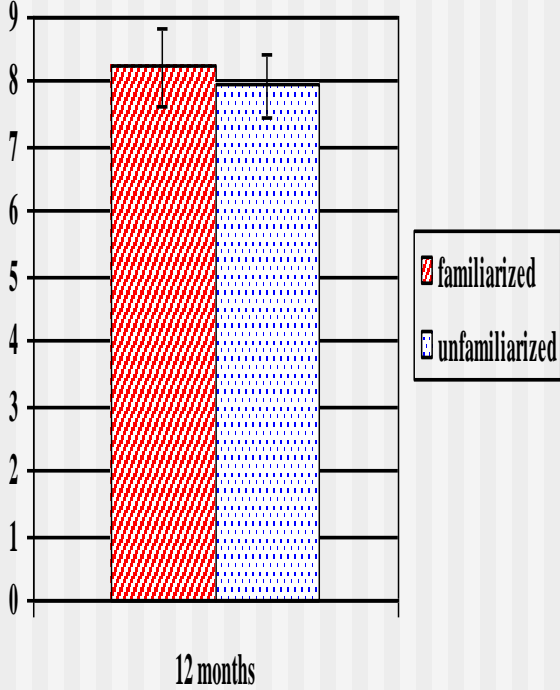
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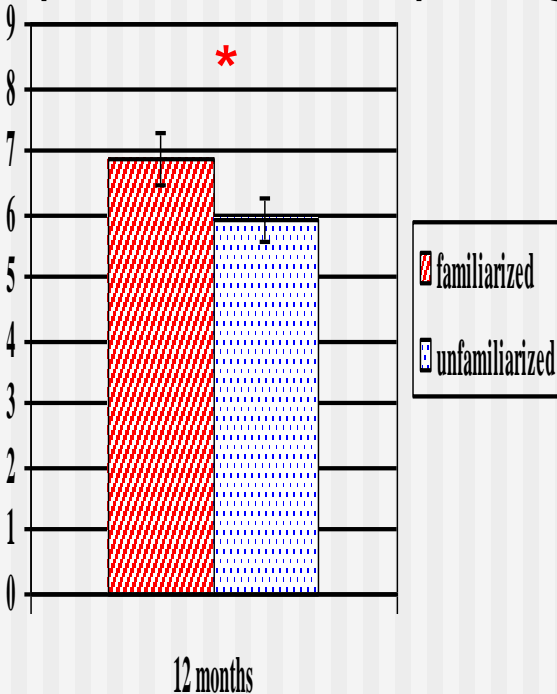
Word segmentation in French. 12-month-olds

initial syllable

recorded in isolation



spliced-out from passages



predicted (more difficult than final)

Word segmentation in French

Data (at 12 and 16 months) **compatible** with:

- the hypothesis that there are **crosslinguistic differences** in the way segmentation procedures emerge in different languages
- more specifically, the pattern of emergence seems predicted by the rhythmic type of the native language, with reliance on the rhythmic unit:
 - English-learning 8-month-olds: **trochaic unit**
 - French-learning 12-month-olds: **syllable**
- by 16 months age, infants can probably use cues to word segmentation other than the early prosodic cue

Word segmentation in French

Data at 8 months **compatible** with:

- (slight?) delay (between 8 and 12 months) in the emergence of segmentation abilities in French-learning infants (see also Dutch infants)
- note that delay is more marked for the segmentation of bisyllabic words, which relies on cues other than prosodic cues
 - Is the delay “genuine”?
 - or
 - is it a methodological effect, due to the use of HPP?

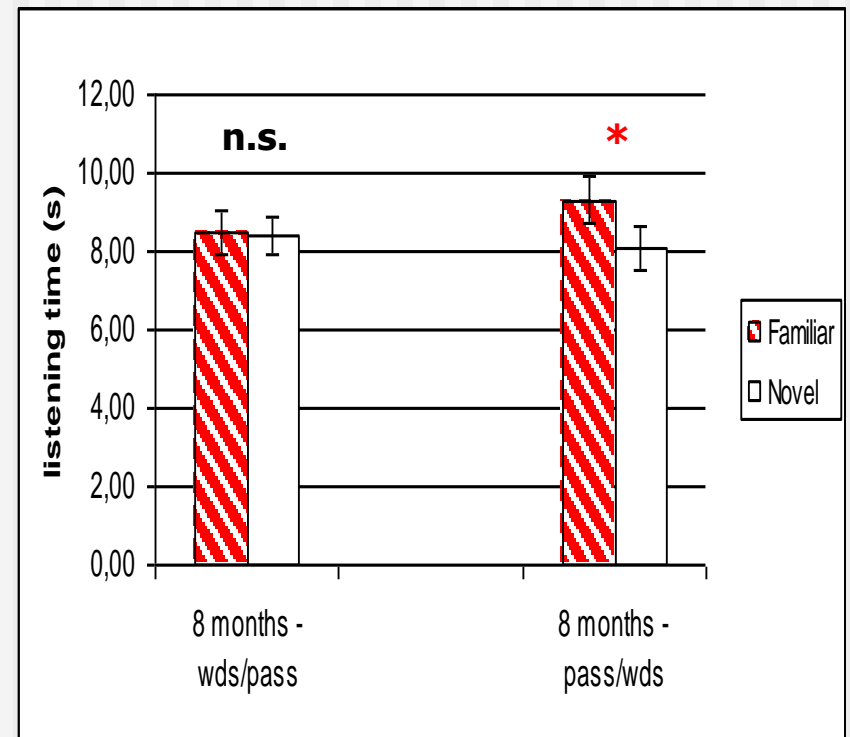
Segmentation of P&S'03 Parisian French stimuli by Parisian infants

(Nazzi, Iakimova, Bertoncini, Polka, Sundara & Girard, 2006)

2 words béret/surprise vs. devis/guitare
4 passages

2 familiarization/test conditions

→ earlier segmentation effect
with passage/word condition



Why do we find order effects (contrary to English)?

- differences in the (number of) processes measured during the test phase (segmentation + recognition vs. recognition)?
 - possibility to use distributional information at 8 months in passage-first condition given more processing time, which is necessary for Parisian-French infants to “go beyond” syllabic segmentation and “retrieve” bisyllabic word forms through distributional analysis?
- problem as HPP only gives access to the final product of segmentation processes; use ERPs to have online information



EARLY SEGMENTATION

Using ERPs

Early word segmentation and ERPs in Dutch

A recent series of experiments by Kooijman (PhD dissertation, 2007)

At 7 months

- **no** segmentation evidence using HPP for trochaic words
- segmentation evidence using ERPs for trochaic words

At 10 months

- segmentation evidence using HPP for trochaic words
- segmentation evidence using ERPs,
with advantage for trochaic over iambic words

➔ moreover, the ERP pattern changes between the 2 ages
(changes in processes/underlying networks involved)

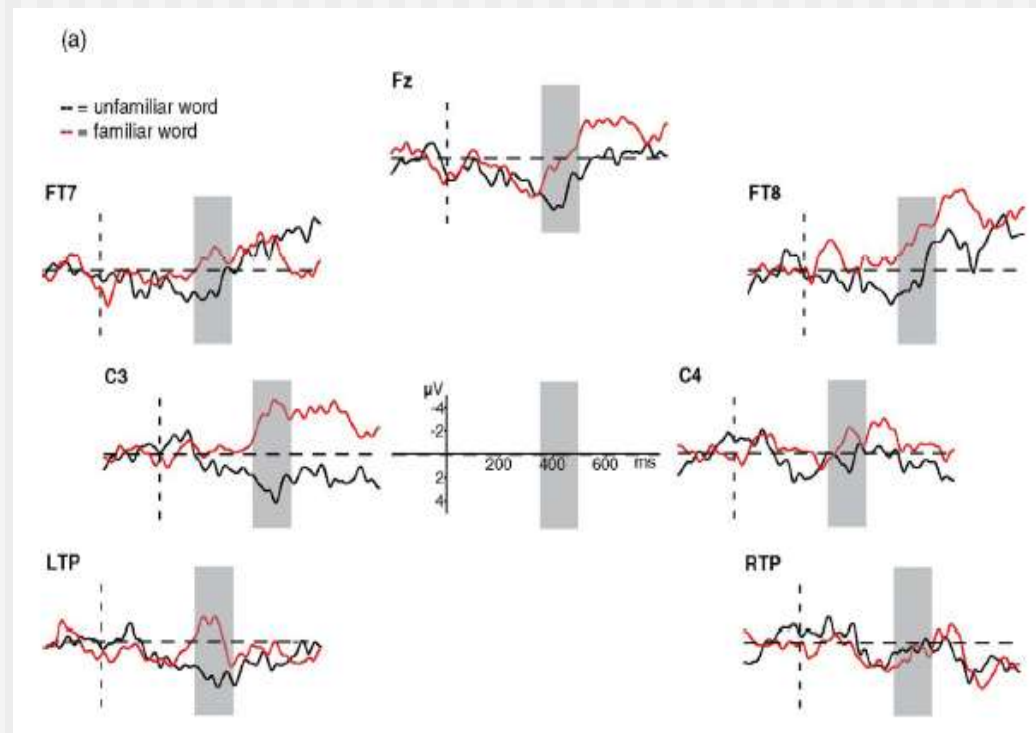
Early word segmentation and ERPs in Dutch

Kooijman, Cutler & Hagoort (2005)

10-month-old Dutch infants

Segmentation effect

- marked by larger negativity for familiar items
- starting around 350 ms after word onset
- effect more marked on left electrodes



Early word segmentation and ERPs in French

As in Kooijman, use an adaptation of Jusczyk paradigm with ERPs

12 to 20 blocs of stimuli

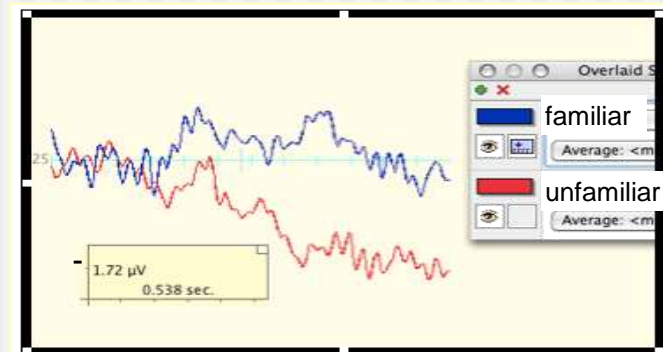
- 10 repetitions of a bisyllabic word
- 12 sentences
 - 6 with familiarized bisyllabic word
 - 6 with other bisyllabic word

- measure ERP response (geodesic net) time-locked to
- onset of initial syllable
 - onset of final syllable

prediction: segmentation effects for both syllables at 12 months

Early word segmentation and ERPs in French

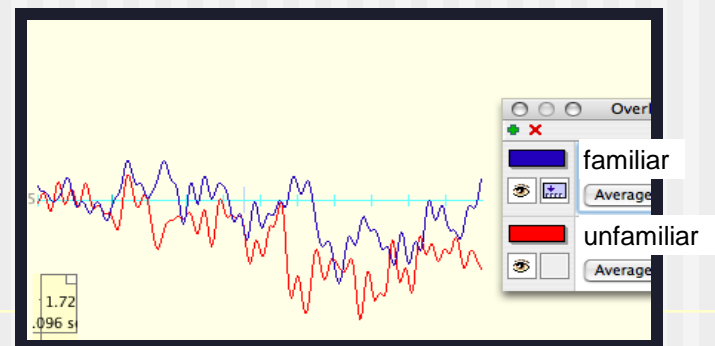
- ERPs time-locked to **initial syllable**
- marked by larger negativity for familiar items
- starting around 300 ms after word onset
- overall effect



electrode 25 (left temporo-parietal)

ERPs time-locked to **final syllable**

- no effect



Early word segmentation and ERPs in French

- ERPs can be used to reveal early segmentation effects in word-onset positions (effects similar to those by Kooijman et al., '05)
 - syllabic effect “not replicated” –against syllabic hypothesis?
 - whole segmentation effects found earlier with ERPs than with HPP?
 - effect on final syllable masked by response on initial syllable? (with HPP, syllabic effects were found after segmentation on individual syllables)
- follow-up1: familiarization with final syllable only (as in HPP study)
- follow-up2: remove recognition component to test syllabic segmentation; test different age groups

Main findings

(1) There are **crosslinguistic differences** in the pattern of emergence of segmentation abilities → bootstrapping issue

(2) One possible solution: rhythmic-based (bootstrapping) segmentation proposal (based on early prosodic sensitivity)
The pattern of emergence observed is predicted by the rhythmic type of the native language, with reliance on the **rhythmic unit**:

- English-learning infants: trochaic unit (at 8 months)
- French-learning infants: syllable (btw 8 and 12 months)

(3) **Need to compare data** across different experimental tasks (different windows into cognition)

Thanks to

segmentation:

Carmela Alcantara
Scania de Schonen
Séverine Frédonie
Louise Goyet
Galina Iakimova
Karima Mersad
Linda Polka
Megha Sundara

phonetic specificity:

Veronica Araujo
Nathalie Bour
Caroline Floccia
Alison Gopnik
Mélanie Havy
Boris New

Supported by: Fyssen Foundation, European Science Foundation,
Ministère de la Recherche