Syllablic planification and Phonological STM memory in C-SLI children

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First words

• “whole-word hypothesis” the first phonological unit in speech acquisition is a template (Macken 1979, Vihman, 2001).

• Early words produced by typical French children consist solely in templates of syllabic nuclei without consonants except stops. Children first fill the nuclei, and then attempt to fill the consonants slots with different strategies. Consonants and vowels melodies are represented on two independant tiers in stored lexical representations, as it has been proposed by autosegmental phonology. (Wauquier-Gravelines, 2003)
Research questions

- What are the processing limitations and the linguistic markers in C-SLI-children?
- Do C-SLI-children show an uniform or an heterogeneous profile?
  - Planning of consonantal gestures
  - Phonological memory
- What are the developmental outcomes in C-SLI?
  - Non-word repetition
  - Reading
  - Spelling
Medical histories

- Full term birth
- Birth weight: 3510g
- Apgar score: 10
- No auditory problem
- Walked at 13 months
- Familial history of language delay
  - E.,
  - H.,
  - T.,
  - Ma,
  - Mi,

- At the initial stage, severe phonological and naming problems
  - chaussure = /y/ oy/
  - parapluie = /ai/ aai/
  - panier = /e/
  - arbre = /a/
  - lit = /i/
  - ciseau = /o/ io/
  - fourchette = /è/ ouè/
C-SLI Children before any therapy

- **SPEECH PERCEPTION** (BEPL task, Chevrie-Muller et al, 1997)
  - Auditory phonetic perception > mean
- **COMPREHENSION** (BEPL task, Chevrie-Muller et al, 1997)
  - Picture pointing task > mean
- **PRODUCTION** (BEPL task, Chevrie-Muller et al, 1997 & Le Normand, 1986)
  - Picture naming task (25 lexical words) < -2sd
  - 20 minutes spontaneous speech in free play < -2sd
- **AUDITORY MEMORY** (BEPL task, Chevrie-Muller et al, 1997)
  - Sentences repetition task (6 utterances) < -2sd
  - Digit repetition task (11 items) < -2sd
  - Rythmic task (16 items) < -2sd

- Intensive speech training at age of 3 (dissociation between receptive and expressive language)
Question: what is the « locus » of phonetic/phonological deficits?

Data: a phonetic study of free play sessions, 20 minutes (E., T., Mi, H.) at initial stages before any therapy.

Linguistic mode and non-linguistic mode (imitation, play, singing) are considered:

Illustration of the two modes:
(a non-linguistic sequence followed by a linguistic one)
• There are laryngeal fricatives or stops between vowels.
• There are regular laryngeal consonant-vowel alternations.
Laryngeal consonants between vowels
(plus other consonants in few words)

papa acheter voiture   (E.)
papa a H e
papillon -- a / ii (E.)
poussette u / ε u H ε (T.)

Maman /amam/
Manger /aé/
Bébé /é/
Chien /in/
Œufs /e/
Lait /è/

Vowels and rhythm

• **Reduced Vowel System (E.)**
  (based on a corpus of 15 understandable lexical words)
  
  i   (u?)
  e  o  E& &
  a

  ∅ for schwa and the front-rounded vowels

  NB. Probably, no lip rounding (*O can be produced without lip rounding*)

• **Rhythm**
  – Final lengthening at the end of rhythmic groups and utterances
    • according to the French rhythmic pattern

• **Intonation**
  – Fine tuning of the intonation in dialog interaction

*adequate intonation on « oui »*
Prosodic hierarchy of E. built on the timing slots (x)

The syllable is present

laryngeal consonant
Non-linguistic mode

- consonants or consonant clusters
  - fricatives or stop+fricative or vibrant+stop+fricative
    \[ [pS] \text{ (water running)} \] [R\&pS] snoring
- homorganic consonants and vowels
  - C and V shares (roughly) the same point of articulation
    => phonetically, no or short F2 transitional movements

as in a stage prior to canonical babbling
Oller 2000

Realization of the « Syllabic frame » cf. Davis and MacNeilage
The deficit has a linguistic locus

• The locus is not articulatory.
  – C-SLI can produce consonants: they occur in non-linguistic mode

• The locus is not in the perceptual-articulatory loop.
  – C-SLI can adapt articulatory movements to produce adequate sounds in non-linguistic mode

• The locus is linguistic
  – The deficit does not concern the prosodic hierarchy (timing slots, syllables, rhythm)
    – The deficit concerns **oral consonantal features and gestures.**
H., a reverse pattern

In his linguistic production:

- no laryngeal + vowel sequences as in E. or T.
- But closing and opening movements
  (generating more or less vocalic and consonantal alternations)

- as in marginal babbling stage
  - without adult-like timing relationships between C and V
  - transitional movements are also either too short or too long compared to adult’s one (Oller 2000)
• Vowel stretch with mandibular oscillations, gliding effect, without vowel consonant alternations
• Some better-articulated utterances:

Ya quelqu’un? ... a maman    non! Feu!

• Central locus of the deficit: the rhythmic organization

confirms the statement: « Their [dyspraxic children] output string may lack « placeholders » for juxtaposing consonants and vowels » Marquart et al. 2002

(In familiar sentences, we can hypothesize that the rhythm is acquired)
C-SLI children: refining the « loci »

Two different phonetic /phonological « loci »:

- Oral consonantal features and gestures (E., T., Ma.)
- Timing tier (H.)

Simplicity of the phonological structures and of the gestural score associated with them:
   Consonant phonological specification:
       only a laryngeal place node with the features [spread] and [constricted]
   Consonantal gestures are only laryngeal gestures (constrictions)

Is this simplicity related to a limitation of C-SLI children on the programming of complex coarticulation and gestural scores?
Planning of sequencing and coarticulation in apraxia

• Planning of (phonological and phonetic) sequencing and coarticulation is a central deficit in apraxia of speech (Dogil & Mayer 1998)

• **Sequencing and coarticulation involve high-level processing:**
  « sequencing of phonemes is « located » outside the sensorimotor cortex (Broca’s area and dorsolateral prefrontal cortex) » (Riecker & al. 2000)
  based on functional imaging data (Wildgruber & al. 1999), clinical data (Kimura 1993), electrical simulation experiments (Ojemann 1983, 1994)

• **Different control mode for larger coarticulated units (Riecker & al. 2000) than for smaller ones**
  Data: brain fMRI during productions of CV, CCV and CVCVCV
  Riecker & al. found a processing mode shift in CVCVCV

  Hypothesis: C-SLI might have difficulties shifting from one processing mode to another, when the task gets more complex.
Emergence of the syllable and the «frame/content» approach

• According to the frame/content theory (Davis and MacNeilage), the syllable originates from mandibular oscillations, providing the «frame». Vowels and consonants are implemented on this frame.

• However, C-SLI children (E., T.) have acquired the syllable, as a rhythmic structure, without mandibular oscillations and CV coarticulations.
### Follow-up studies: MLU stages

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<th>CHI:</th>
<th>3 yrs</th>
<th>3;6</th>
<th>4 yrs</th>
<th>4;6</th>
<th>5 yrs</th>
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**Narrative tasks:** 28 spontaneous speech samples
Emergence of Functional categories

Mean MLU <2.5 (stage II)
E., age 5 (MLU, stage III)
1. xx le garçon
2. xx tomber
3. xx plein de terre
4. xx au bain
5. xx regarder dans la glace

Emerging grammar
Stuttering
determiners
no pronouns

E., age 6 (MLU, stage IV)
1. le petit garçon tient son chien avec la laisse
2. le petit garçon est tombé
3. le petit garçon est tout sale
4. le petit garçon en train xx un bain
5. le petit garçon en train se sécher
Developing grammar
Ma., 7yrs, MLU stage V

Abnormal speech timing, narrative tasks
On the nature of the deficit, Ma.,

Le Normand et al, 2000
Reading outcomes, H., 9 yrs

• unfamiliar words
  - catapulter = capsuler

• pseudowords
  - molitendu = moulin vendu
  - iffarmitave = iffarmative
  - obypitienne = oublié
  - lonveugner = lanveugner
  - valcronceux = valnonceux

• regular words
  - friser = fiser

• irregular words
  - revolver = revolter
Cognitive tasks, H., 9 yrs

- **Good** in syntax comprehension and picture naming
- **Poor** in phonological memory (ccv)

Metaphonology, H., 9 yrs

- Syllabes Inversion
- Phonemic Inversion
- Syllabe substraction
- Phonemic substraction
- **Deficit** in auditory Acronyms

Mousty et al task, 1994
Spelling, H., 9 yrs

- **Free graphemes**
  - quatre (four) = quetre
  - siamois (siamese) = ciamois
  - taudis (slum) = todi
  - bambou (bamboo) = bau bau

- **Bound graphemes**
  - guignol (puppet) = guignole

- **Inconsistent graphemes**
  - cachalot (sperm whale) = cagealot
  - cagoulle (cowl) = cagolle

- **Derivation graphemes**
  - exquis (delicious) = esquit
  - délicat (delicate) = déligat

Mousty et al, 1994
Summary and Discussion

- C-SLI children do not present a specific articulatory deficits but a severe and persistent working memory impairment.
- C-SLI children show reduced capacities to process and store phonological information in phonological working memory, at the encoding stage.
- C-SLI children exhibit a specific deficit in integrating consonant tiers with other speech information and putting together vocalic and consonant melodies within a prosodic shape.
- Their motoric capacity to perform consonant is preserved. Such impairment is neither a failure of the ability to plan articulatory gestures of consonants nor an articulatory deficit, but rather a failure to plan phonological information.
General discussion: C-SLI

• Linguistic and cognitive deficits
  – No deficit in auditory-phonetic perception
  – No deficit in receptive language tasks
  – Deficits in all phonological memory tasks
  – Deficits in all metric tasks

• Durational unit size may be an important factor in determining neural processing system
  – Internal metronome hypothesis support the notion that one central time keeper underlies rhythm production across modalities (Alcock et al, 2000, Wong 2002)