The hierarchy of phonetic features in printed syllables matching, in adult skilled readers, normally developing young readers and dyslexic children

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Syllable matching task:
choice between two phonetic features categories

Experiments designed to investigate the hierarchical organization of cognitive (but implicit) knowledge of 3 categories of phonetic features:

- Voicing
- Place of articulation
- Manner of articulation

- 3 printed CV, the vowel was always /a/

- The target syllable was to be matched with one of two printed CV, according to intuitively estimated acoustic similarity

- **Experiment 1**: Manner / Voicing
- **Experiment 2**: Manner / Place
- **Experiment 3**: Voicing / Place
Example (Voicing-Manner)

ja

ka

ba

+
Participants

- 24 adults, normal reading level, without academic knowledge in linguistics
- 10 children with normal reading level, 2nd graders (CE1)
- 20 dyslexic children (Debrousse Hospital, Lyon)

12 dyslexic children:
- 6 had phonological deficit
  - Chronological age = 11 years 10 months
  - Lexical level = 7 years 10 mois
  - Reading retardation = 4 years

- 6 had no obvious phonological deficit
  - Chronological age = 12 years
  - Lexical level = 8 years 1 month
  - Reading retardation = 3 years 11 months

Each child is paired with another one for age and lexical level
MANNER or PLACE?

Growing preference for Manner (versus place), from dyslexic group, to 2d graders, to adults

% of Manner matching

Adults

2d graders

Dyslexic children with phonological deficit

Growing preference for Manner (versus place), from dyslexic group, to 2d graders, to adults
• Young normal readers prefer Voicing to Manner, contrary to adults

• Dyslexic children are not similar to 2d graders (not only a reading retardation, but a qualitative difference)

• Opposite modulating effect of the Voicing of the target upon the choice between Manner and Voicing
VOICING or PLACE?

Adult skilled readers prefered Place for front consonants.

2d graders have no preference for place.

Dyslexic children prefer Place... but only for back consonants.
• **Adult skilled readers** : a hierarchical organization for phonetic features categories in this implicit task

  - Prominent status for **Manner**
    (compared with Place and with Voicing)

  - A slight role of Voicing similarity, as a modulator effect on Manner categorization

  - Preference for Place, rather than Voicing similarity, only for front consonants:
    - visual influence (lip reading) (?)
    - influence of articulatory properties (front-back) (?)
    - influence of acoustical properties (?)
• Dyslexic children without obvious phonological deficit:
  - No preference for any category of phonetic features

• Dyslexic children with phonological deficit:
  - Do not respond at random
    - They may use phonetical rules as a basis for phonemic knowledge organization
    - But these rules seem different from those of adult skilled readers and normal reading children paired in reading level
Voicing similarity decreases performances on the 2d stimulus in lexical decision

Bedoin (1998)
CONSTANT EFFECT:

- **whatever the SOA**: 
  - SOA 33 ms \( F_1(1,46)=13.15; p=.0007, \quad F_2(1,10)=5.99; p=.028 \)
  - SOA 66 ms \( F_1(1,22)=7.505; p=.012, \quad F_2(1,10)=5.98; p=.0283 \)
  - SOA 100 ms \( F_1(1,22)=13.715; p=.0012, \quad F_2(1,10)=2.501; p=.136 \)

- **whatever the prime lexicality**: pseudoword as the prime effect with pseudo-words, \( F_1(1,26)=5.094; p=.03, \quad F_2(1,13)=3.917; p=.06 \)

- **whatever frequency** difference between prime and target

- **whatever the other phonetic difference** between prime and target

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**Place**

**Manner**

**Place and Manner**
• The effect may be due to the organization of phonemic knowledge.
• Inhibitory relations are supposed between phonemic detectors, according to the number of shared phonetic features

Proposed interpretation:

**Phonemic level**

/d/  /b/

**Letter level**

/D/  /t/  /B/

To test this hypothesis: priming and backward masking experiments

SOA = 33 ms

Backward masking: recall of the 1st stimulus

Prime | target  | mask
---- | --------| -------
(Res) | ZÉVUT (Diff) | SÉFUT

Priming: lexical decision on the 2nd stimulus

Target  | mask
---- | -------
(Res) | ZÉVUT (Diff) | SÉFUT

Masquage: performance 1er stimulus

$F_{1}(1,34)=8.865; p=.013$
$F_{2}(1,22)=5.823; p=.0246$

Amorçage: performance sur 2ème stimulus

$F_{1}(1,34)=8.025; p=.007$
$F_{2}(1,22)=8.269; p=.009$

**VOICING SIMILARITY:**

- decreased performances for the 2nd stimulus,
- increased performances for the 1st stimulus
Both effects are replicated with voicing similarity manipulated within one single CVCV stimulus

Letter detection task

Voicing similarity

- decreased performances for C2
- increased performances for C1
Results in adults

Presentation = 33 ms

Presentation = 50 ms

Presentation = 66 ms

*Presentation = 100 ms

⇒ no effect
Results in normal reading children (presentation = 85 ms)

Results in dyslexic children

After an intensive audio-visual training about voicing:

(Krifi, Bedoin & Mérigot, 2003)
Voicing similarity effects (benefit for C1, cost for C2) in a syllable recalling test

Procedure:
1000 ms × 500 ms × 60 ms × 60 ms × 33 ms

Recall of syllable 1 or syllable 2

Results:
Syllable rank X Voicing similarity,
\( F(1, 23) = 41.78, p < .0001 \)

- Voicing similarity improves C1 processing
  \( F(1, 23) = 49.56, p < .0001 \)

- Voicing similarity impaired C2 processing
  \( F(1, 23) = 4.42, p < .047 \)

% of errors according to Voicing similarity
The role of other phonetic categories in priming

- 6 experiments tested the role of Manner and Place similarity between two stimuli (lexical decision was made on the second stimulus)

Prime and target differed in voicing
- Experiment 7 (SOA = 100 ms)
- Experiment 8 (SOA = 66 ms)
- Experiment 9 (SOA = 33 ms)

Prime and target did not differ in voicing
- Experiment 10 (SOA = 100 ms)
- Experiment 11 (SOA = 66 ms)
- Experiment 12 (SOA = 33 ms)
**Additional difference in Voicing**

- Manner similarity increases performances

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<th>Expé. 7</th>
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**No difference in voicing**

- Manner similarity
- And
- Place similarity increases performances

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- Place similarity decreases performances
- Manner similarity decreases performances
- Place similarity and Manner similarity decreased response accuracy

- Place similarity decreases performances

- Place similarity decreases performances

- Place similarity decreases performances

- Place similarity decreases performances
phonemes /d/ /b/
letters D B
Expérience avec un essai de condition « neutre »

Chaque mot cible (e.g., PEINE) est précédé de :
- amorce qui diffère sur un trait (Lieu ou Mode) (teine)
- amorce qui diffère sur un trait (Lieu ou Mode) + sur le Voisement (deine)
- amorce sans phonème en commun et commençant par une voyelle ou une consonne liquide (aurul)

Résultats :
- effet du facteur condition,
  \[ F(2, 66) = 3.72, \, p < .03 \]
- différence entre les 2 conditions avec ressemblance ou différence de voisement, \[ F(1, 66) = 7.40, \, p < .01 \]
Effet négatif de ressemblance infra-phonémique sur le traitement du 2ème stimulus, dans d’autres travaux :

- Production de parole, (Rogers & Storkel, 1998)
- Perception de parole, (Goldinger, Luce, Pisoni and Marcario, 1992)

Deux propositions d’interprétation :

- **Effet de compétition** : la ressemblance faciliterait le traitement du 2ème stimulus qui, par effet de backward masking, restaurerait les traitements auparavant effectués sur le 1er stimulus (parce qu’il lui ressemble) --> renforcement de l’identification du 1er stimulus --> compétition entre les 2 stimuli

Prédiction : le 1er et le 2ème stimulus devraient être moins bien identifiés
Entraînement audio-visuel intensif, portant sur les six oppositions de Voisement

3 sessions de 15 minutes par jour, 4 jours par semaine, pendant 3 semaines

- 18 enfants répartis en deux groupes:
  - groupe A: bénéficiant de l'entraînement
  - groupe B: sans entraînement

Danon-Boileau & Barbier, 2000
Enfants dyslexiques avant entraînement

Enfants dyslexiques après entraînement sur voissement

Enfants dyslexiques après entraînement sur vocabulaire