CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

ETUDES Cognitives

Département d'Etudes Cognitives · Ecole normale supérieure

LETTRES SCIENCES ENS ECOLE NORMALE SUPERIEURE

Quel déficit phonologique dans la dyslexie?

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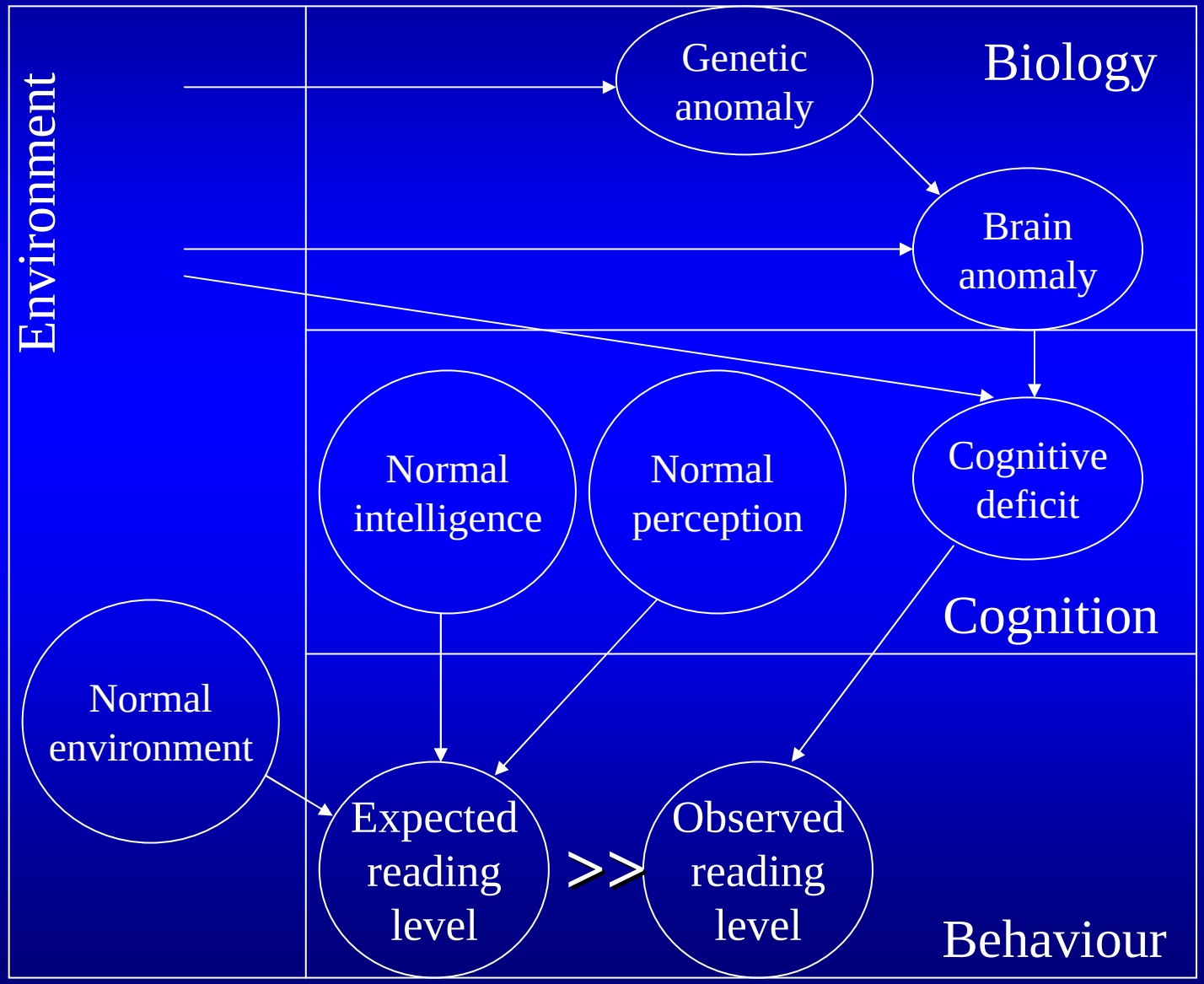
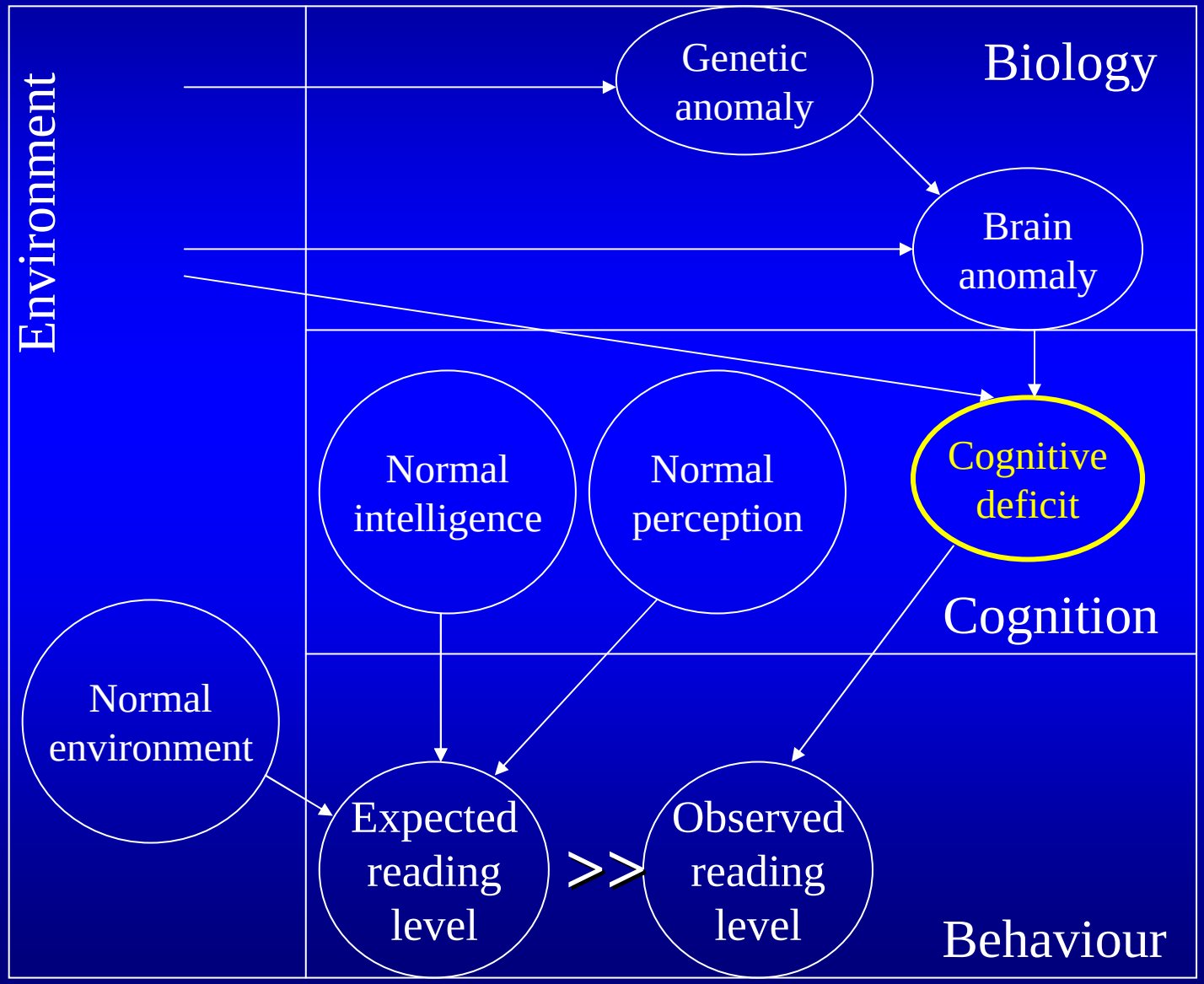
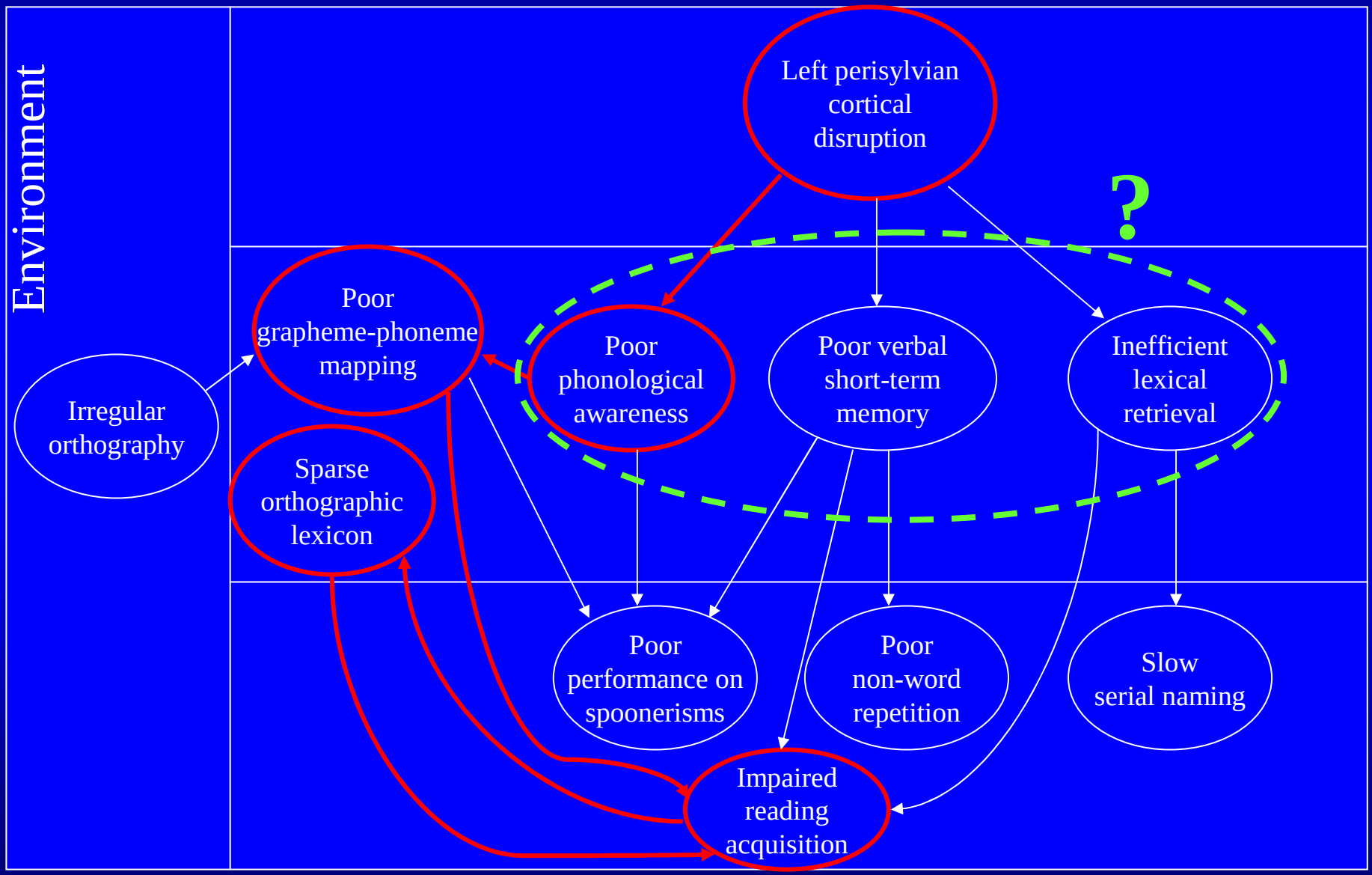
Causal modelling of dyslexia



Causal modelling of dyslexia



The phonological deficit theory



What about alternative theories of dyslexia?

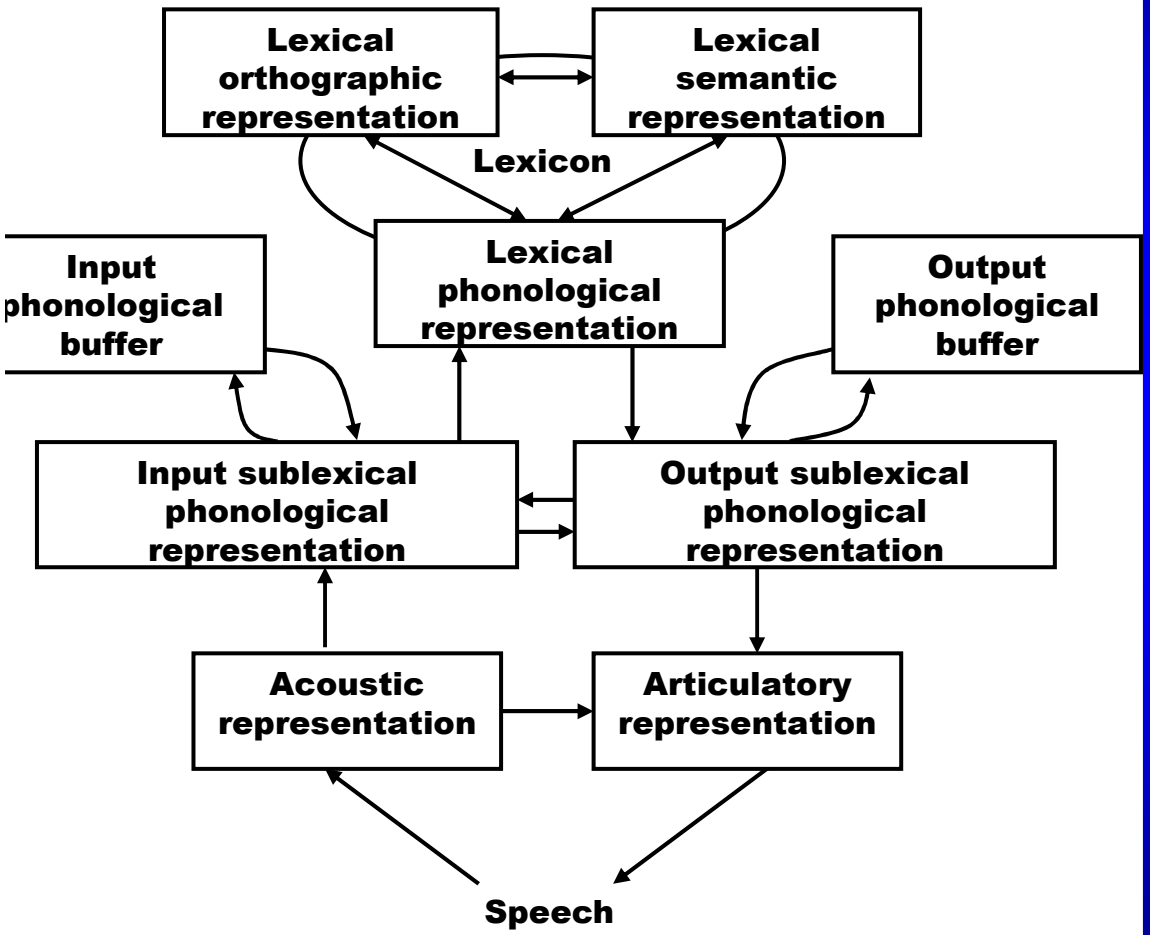
- Auditory theories
- The cerebellar theory
- The general magnocellular theory

All assume a phonological deficit (but disagree about distal causes).

Only purely visual theories of dyslexia are totally phonology-free (and may explain a few cases).

Regardless of theoretical options, it is useful to explore the nature of the phonological deficit.

Hypotheses about the phonological deficit

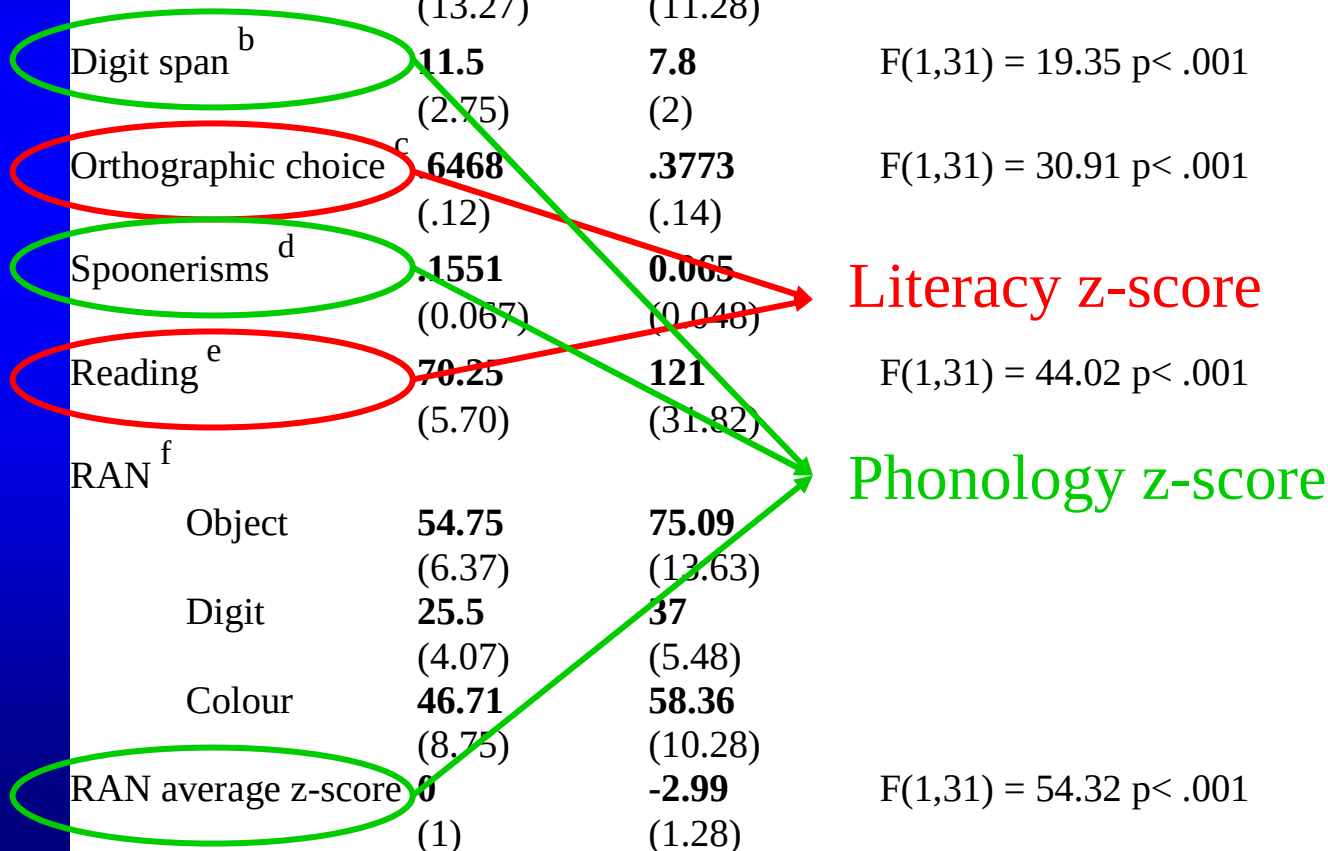


- Input or output phonological representations?
- Lexical or sub-lexical representations?
- Disrupted representations or short-term memory processes?
- What about "phonological grammar"?
- What about lexical access?

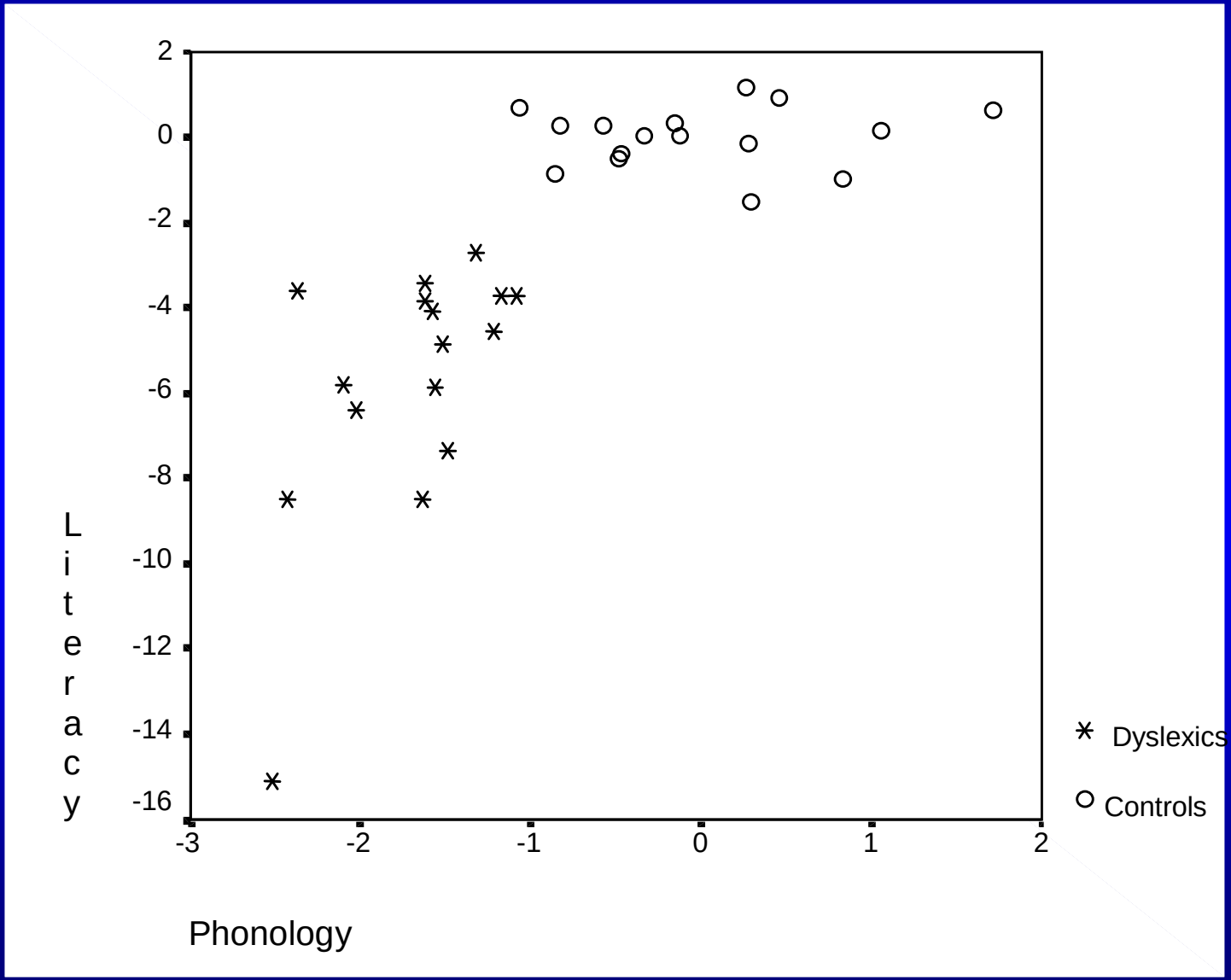
See Ramus (2001) *Dyslexia*, Szenkovits & Ramus (2005) *Dyslexia*

Demographic and psychometric data

	Controls (n = 16)	Dyslexics (n = 16)	One Way ANOVAs
Age	**23.8** (4.23)	**23.6** (2.96)	F(1,31) < 1 ns
Nonverbal IQ [a]	**116.8** (13.27)	**111.0** (11.28)	F(1,31) = 1.41 ns
Digit span [b]	**11.5** (2.75)	**7.8** (2)	F(1,31) = 19.35 p< .001
Orthographic choice [c]	**.6468** (.12)	**.3773** (.14)	F(1,31) = 30.91 p< .001
Spoonerisms [d]	**.1551** (0.067)	**0.065** (0.048)	
Reading [e]	**70.25** (5.70)	**121** (31.82)	F(1,31) = 44.02 p< .001
RAN [f]			
Object	**54.75** (6.37)	**75.09** (13.63)	
Digit	**25.5** (4.07)	**37** (5.48)	
Colour	**46.71** (8.75)	**58.36** (10.28)	
RAN average z-score	**0** (1)	**-2.99** (1.28)	F(1,31) = 54.32 p< .001



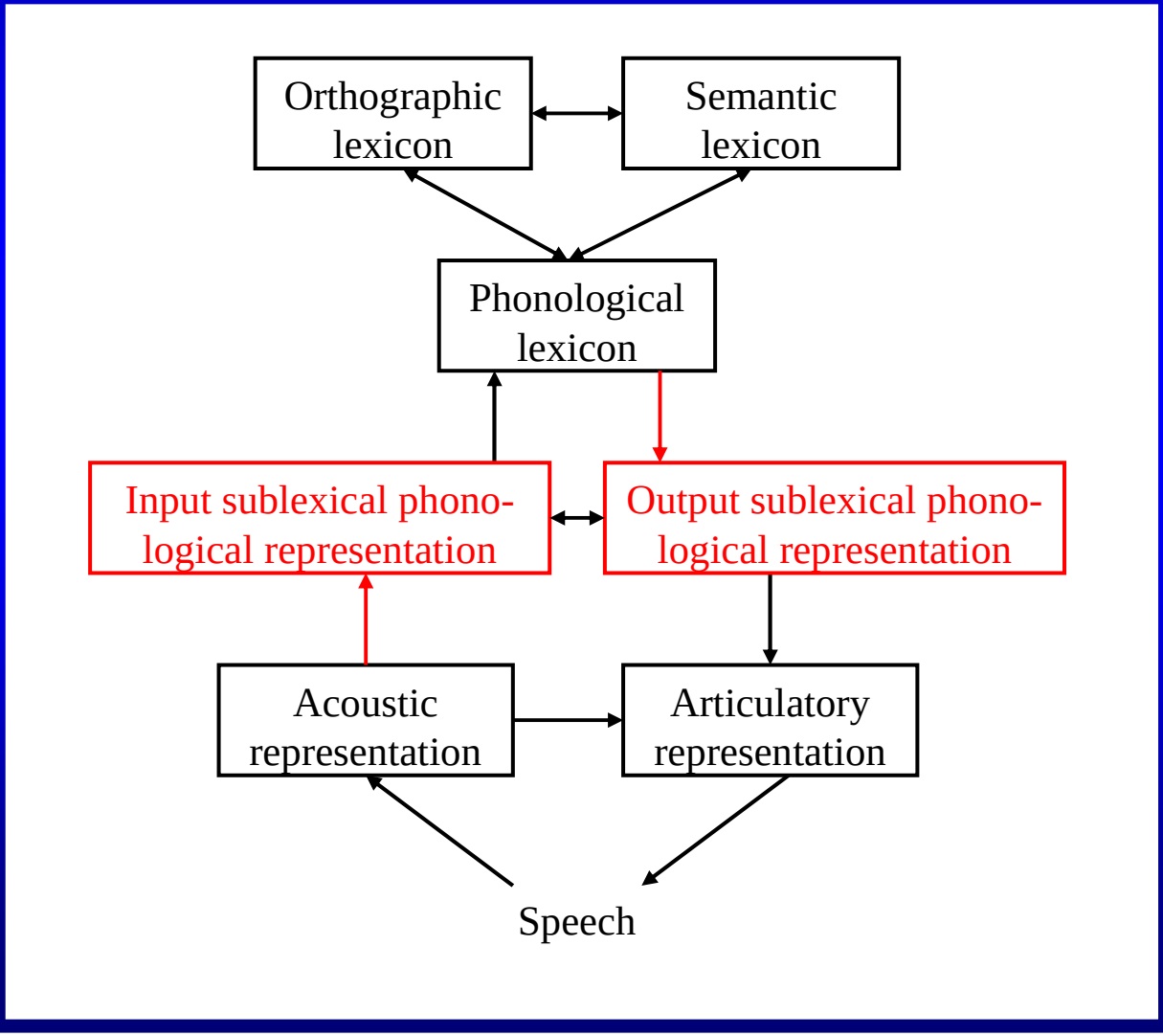
Literacy and phonology measures



Phonological grammar

Gayaneh Szenkovits, Liaan Darma,
Isabelle Darcy, & F. Ramus

Phonological grammar



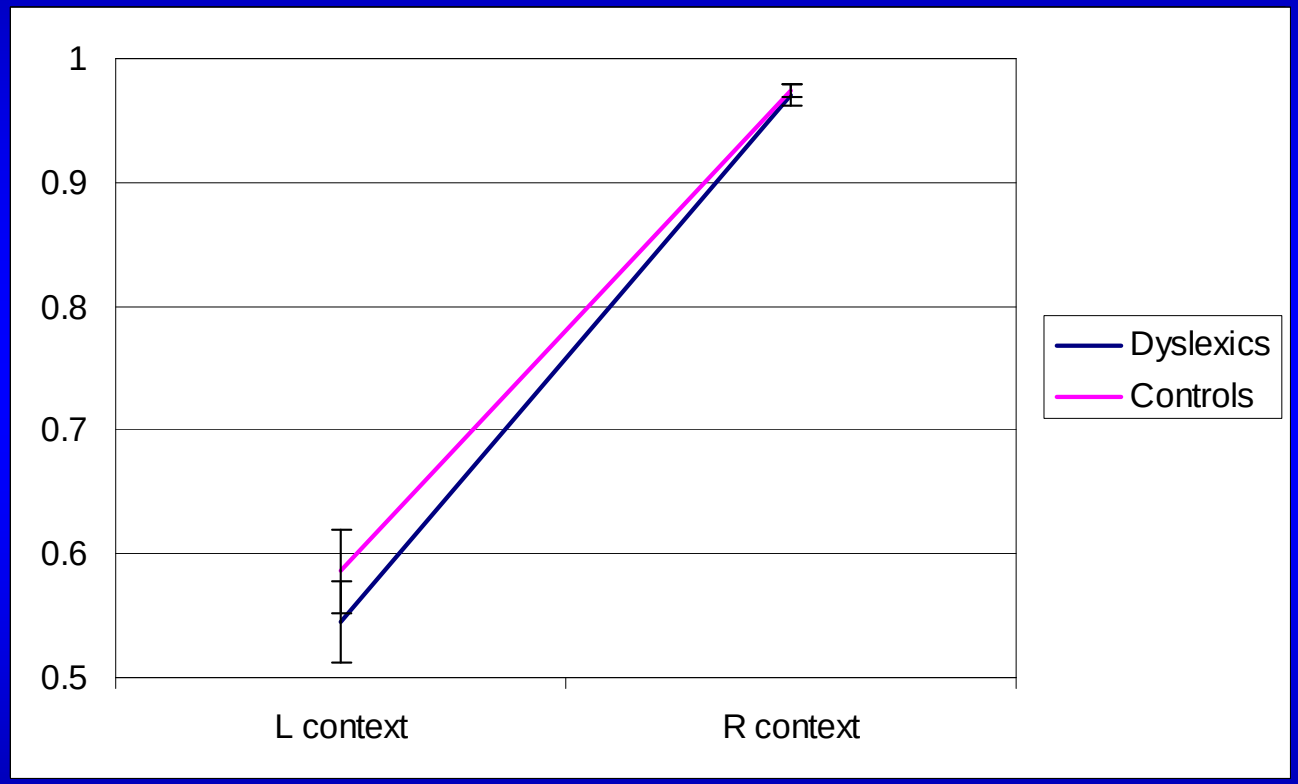
Phonological grammar I: Perceptual illusions due to French phonotactics

- In French:
  - [dra] [tra] [gra] [kra] [gla] [kla] are legal
  - [dla] [tla] are illegal
- Consequence on perception (Hallé et al. 1998 *JEP:HPP*):
  When French listeners hear [dla], they think they hear [gla].
  When French listeners hear [tla], they think they hear [kla].
- Perceptual assimilation to the closest cluster that is legal according to native phonotactic rules.
- Are dyslexic people sensitive to these phonotactic regularities? Have they accordingly acquired this perceptual assimilation?

Phonotactic perceptual illusions in French dyslexics

- Task: nonsense syllable discrimination across speaker change
- Conditions:
  - R context:
    [kraz]-[traz] or [kraz]-[kraz]
    [druk]-[gruk] or [druk]-[druk]
  - L context:
    [klaz]-[tlaz] or [klaz]-[klaz]
    [dluk]-[gluk] or [dluk]-[dluk]

Phonotactic perceptual illusions in French dyslexics



Just the same as in controls

Context effect: $p<.001$ Group effect: $F<1$ n.s.

Context x Group interaction: $F<1$ n.s.

Phonological grammar II: Regressive voicing assimilation

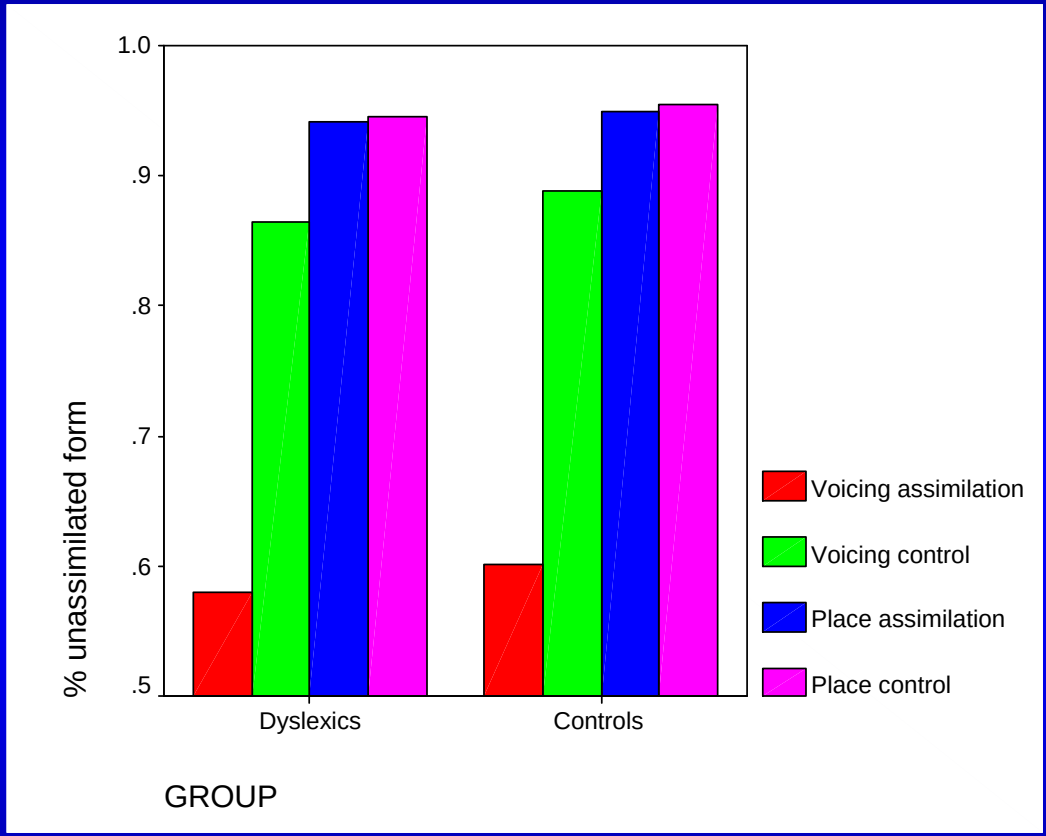
- In French, voicing spreads regressively from obstruent or fricative, but not from nasal consonants:
  - cape grise ⇒ [kabgriz]
  - cape noire ⇒ [kapnwar]
- Such phonological rules are specific to a particular language.
- In English, place spreads regressively from velar to coronal stops, but not from sonorants:
  - brown bag ⇒ [brawmbag]
  - brown fig ⇒ [brawnfig]
- Phonological rules must therefore be learnt during language acquisition.
- Are they learnt equally well by dyslexic persons?

Regressive voicing assimilation in French dyslexics

- Task: read a sentence, practice pronouncing it rapidly several times, then record it.
- Conditions:
  - Voicing context: La petite fille jette sa cape grise
  - Voicing control: La petite fille jette sa cape noire
  - Place context: Il habite dans une zone portuaire
  - Place control: Il habite dans une zone fluviale
- Post-test:
  - target words edited out: cape, zone…
  - presented auditorily to 8 French native listeners, who judged between normal and assimilated form:

cabe cape

Regressive voicing assimilation in French dyslexics

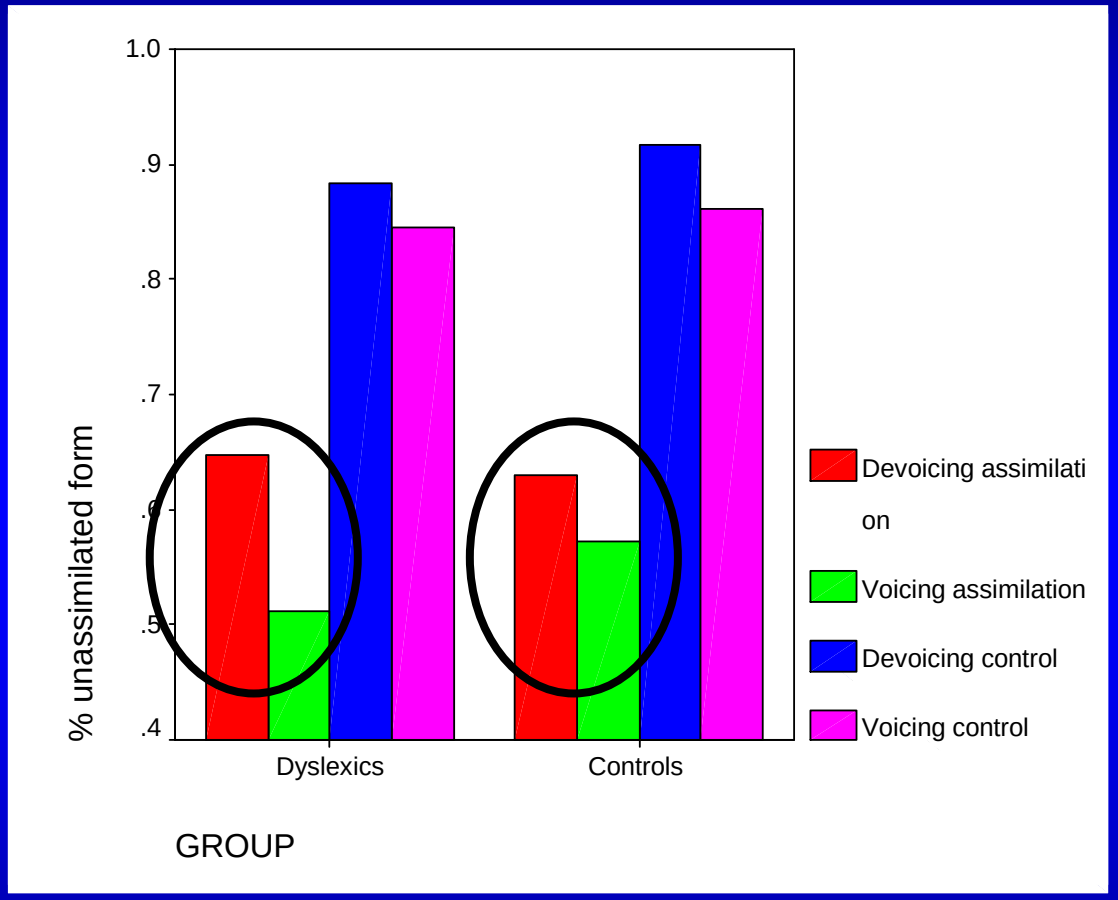


Context effect: p<.001 Group effect: F<1, n.s.

Context x Group interaction: F<1, n.s.

Identical patterns of assimilation in both groups

Voicing/devoicing asymmetry



+/- voicing effect: p<.05 Group effect: F<1, n.s.

+/- voicing x Group interaction: F<1, n.s.

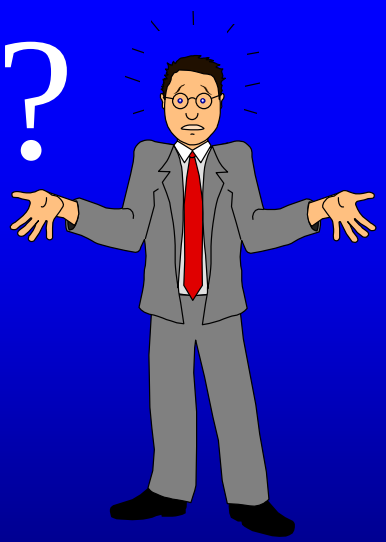
Identical asymmetry of assimilation in both groups

Perceptual compensation for regressive voicing assimilation

Because French speakers do voicing assimilation, French listeners must undo it for lexical access:

La petite fille jette sa [ropsal]

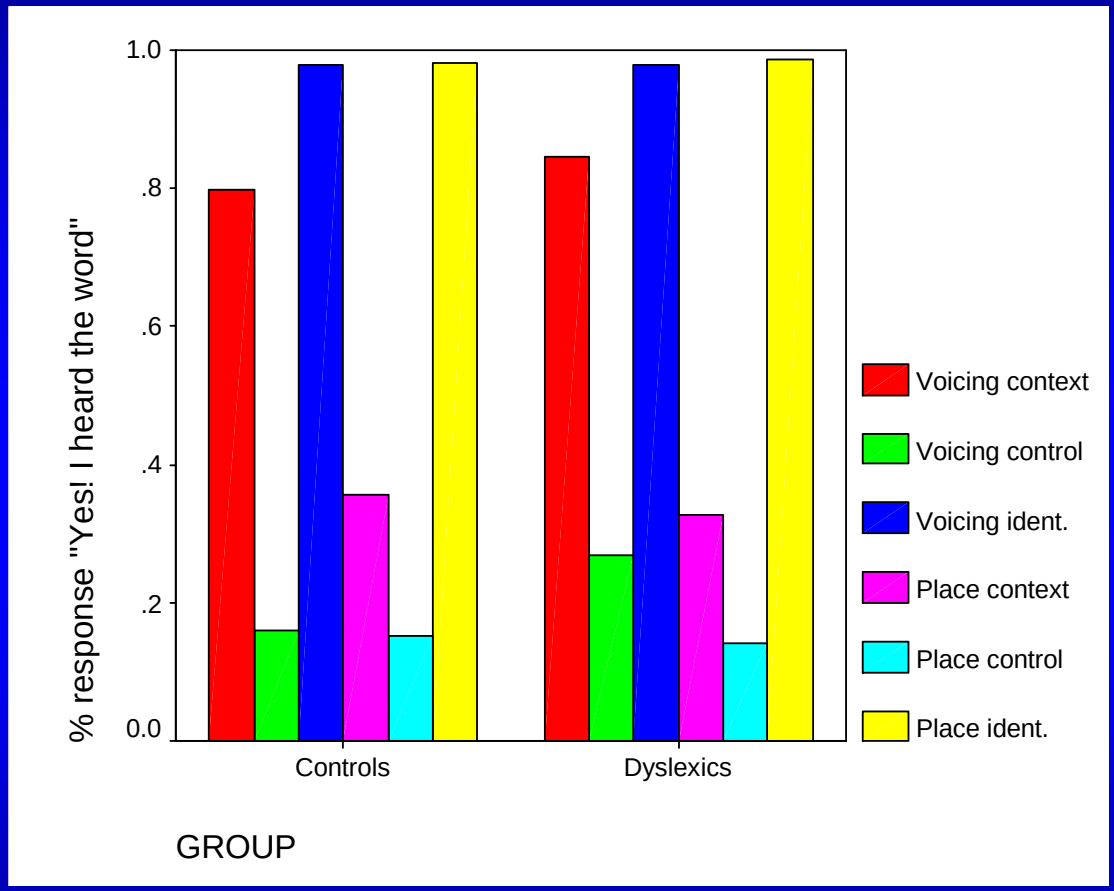
[rop] ?



“robe” !

Do dyslexic persons perceptually compensate for phonological assimilations equally well?

Perceptual compensation for regressive voicing assimilation in dyslexics

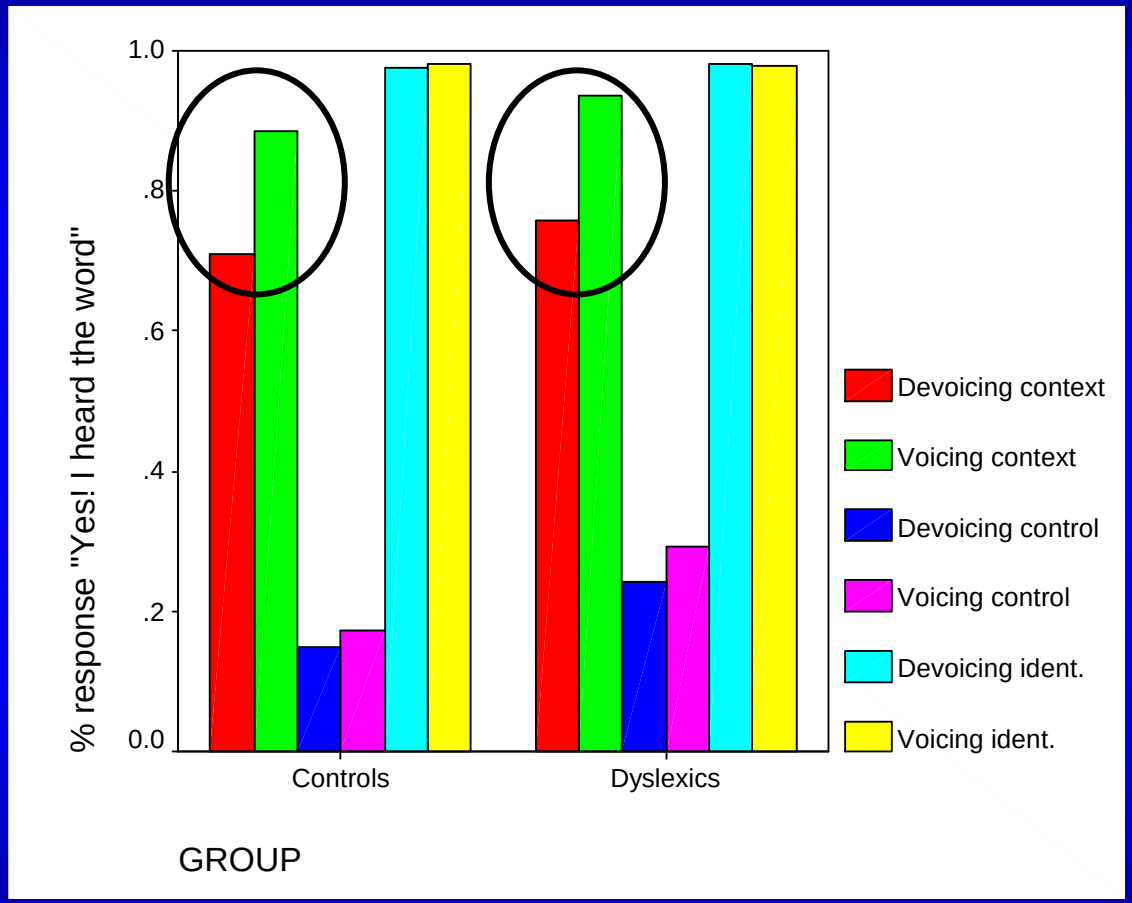


Voicing condition effect: p<.001 Group effect: p=.09, n.s.

Voicing condition x Group interaction: p=.2, n.s.

Identical pattern of compensation for voicing assimilation in both groups

Voicing/devoicing asymmetry in perceptual compensation



+/- voicing effect: p<.001 Group effect: p=.3, n.s.

+/- voicing x Group interaction: F<1, n.s.

Identical asymmetry of compensation in both groups

Summary

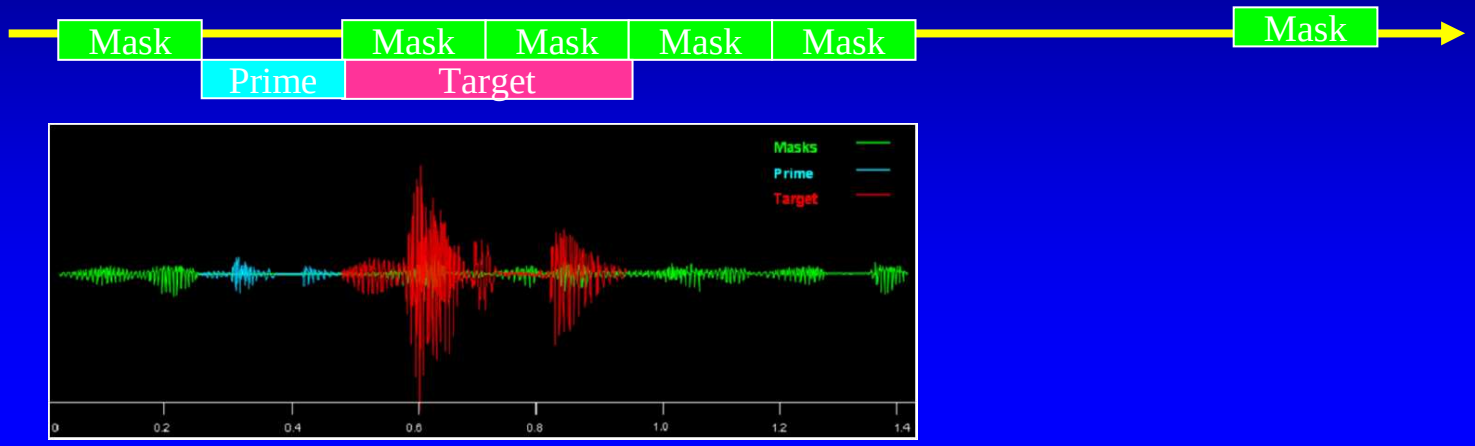
- Dyslexics produce voicing assimilation just like controls.
- Dyslexics perceptually compensate for voicing assimilation just like controls.
- Dyslexics show a voicing/devoicing assimilation asymmetry just like controls.
- NB: they must have a fairly good perception and representation of voicing…
- NB2: a degraded phonological representation would predict noisier responses and less context-specificity.

Lexical access in dyslexia: a study using auditory subliminal priming

Emilie Gaillard, Gayaneh Szenkovits, Vincent de Gardelle, Sid Kouider, Franck Ramus

Auditory subliminal priming

(Kouider & Dupoux, Psychological Science 2005)

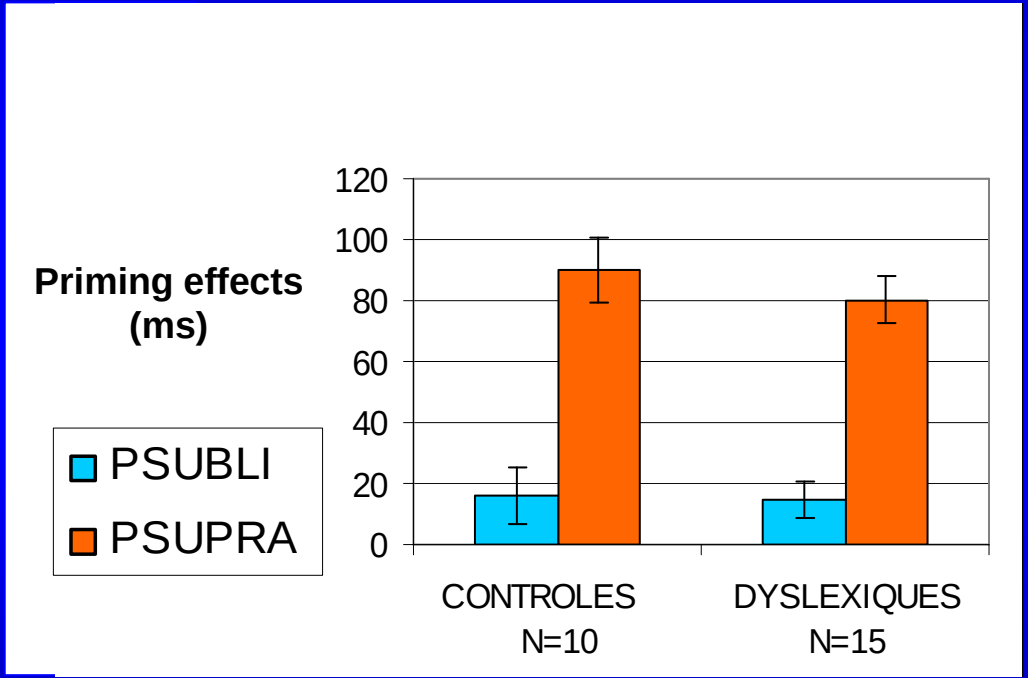


- Elaboration of an auditory masking technique
- Lexical decision on a target preceded by a masked (subliminal) prime, that is either the same or a different word.
- Main effect: repetition priming (RT decrease when prime = target).
- Repetition priming is strictly lexical:
  - restricted to words (nonword does not prime identical nonword)
  - maintained across two different speakers.

Auditory subliminal priming in dyslexics

- Are unconscious speech perception and lexical access preserved? (lexical decision and subliminal priming)
- Are dyslexics' lexical phonological representations abstract and intact? (subliminal priming across 2 voices)

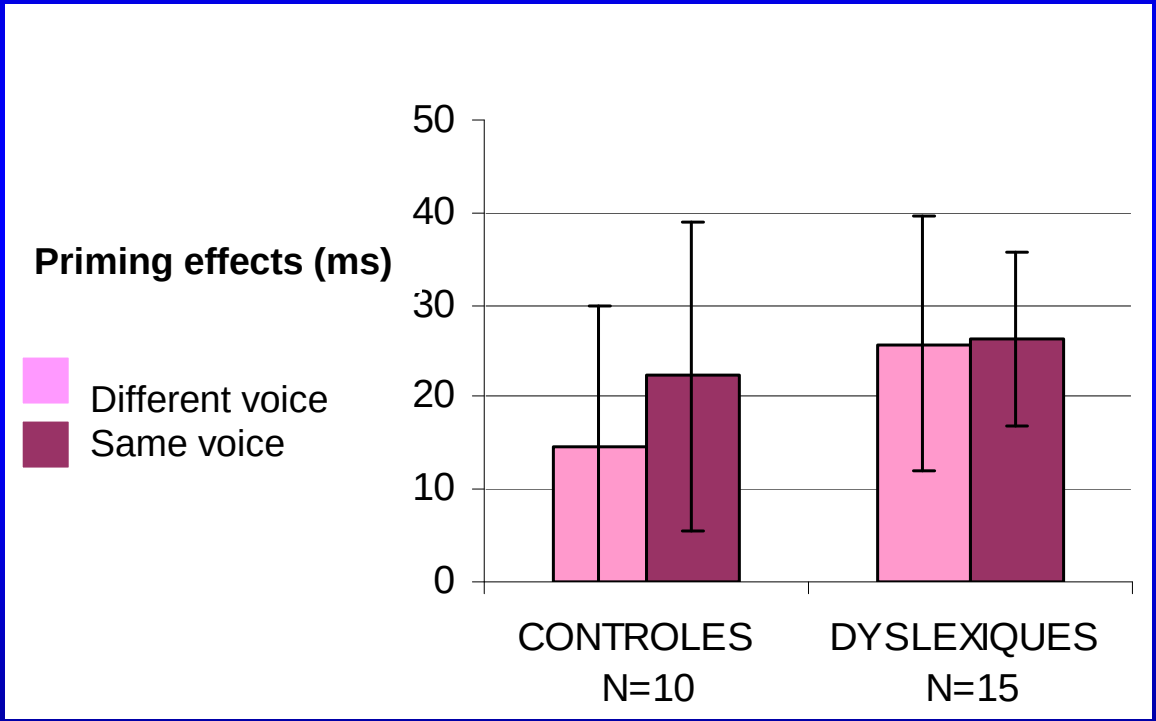
Results
Subliminal and supraliminal priming



No group X condition interaction

Results
Subliminal priming

Same vs. different voices



No Voice X group interaction

Conclusions on auditory subliminal priming in dyslexia

1. Do dyslexics have a problem with unconscious speech perception and lexical access?

→ **NO**

2. Do dyslexics have an abstract lexical phonological representation?

→ **YES**

And if phonological representations were degraded, there would be decreased priming

Universal or “hyper-native” phonology?

Foreign speech perception and repetition

Eva Soroli, Gayaneh Szenkovits,
Franck Ramus,

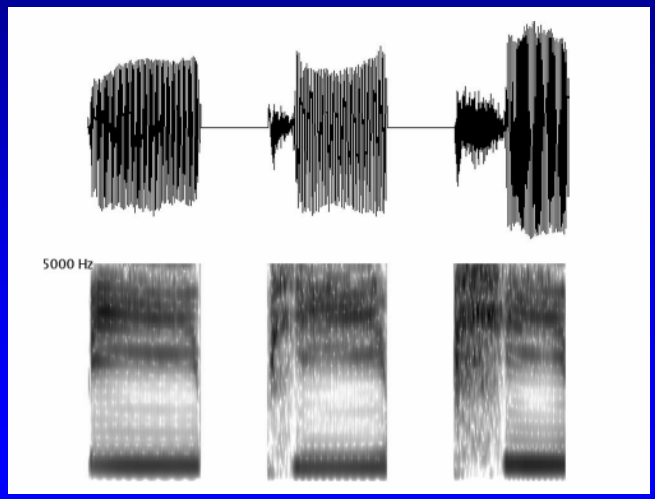
with help from Christophe Pallier and
Sharon Peperkamp

Universal or “hyper-native” phonology?

- Foreign speech perception/production because language acquisition shifts the phonological system from a universal, initial state, to a native-language specific state, which becomes rigidified.
- Do dyslexics fully attain native-language phonology? (or do they stay in a more “universal” state?)
- Is their native-language phonology more, or less, or equally rigidified?

Foreign speech perception and repetition

3 contrasts

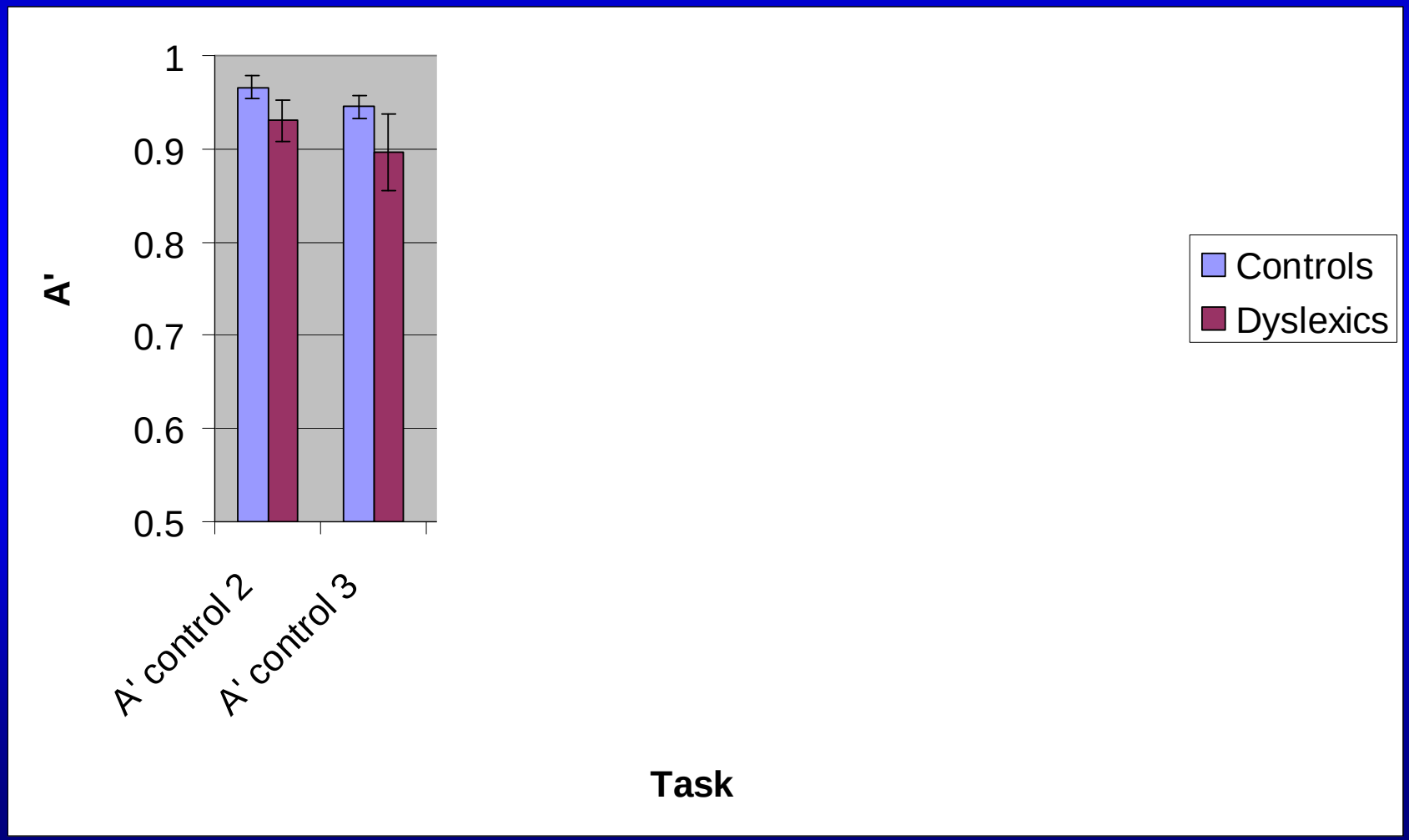


- Korean aspiration contrast: plain/tense/aspirated [p]
  (Ventureyra, Pallier, & Yoo 2004)
  [p°ada]-[pada]-[p^hada]
- Lexical stress contrast (in French nonwords):
  (Dupoux, Peperkamp & Sebastian-Galles 2001)
  [**MI**pa]-[mi**PA**]
- Control phonemic contrast:
  [mipa]-[mita]

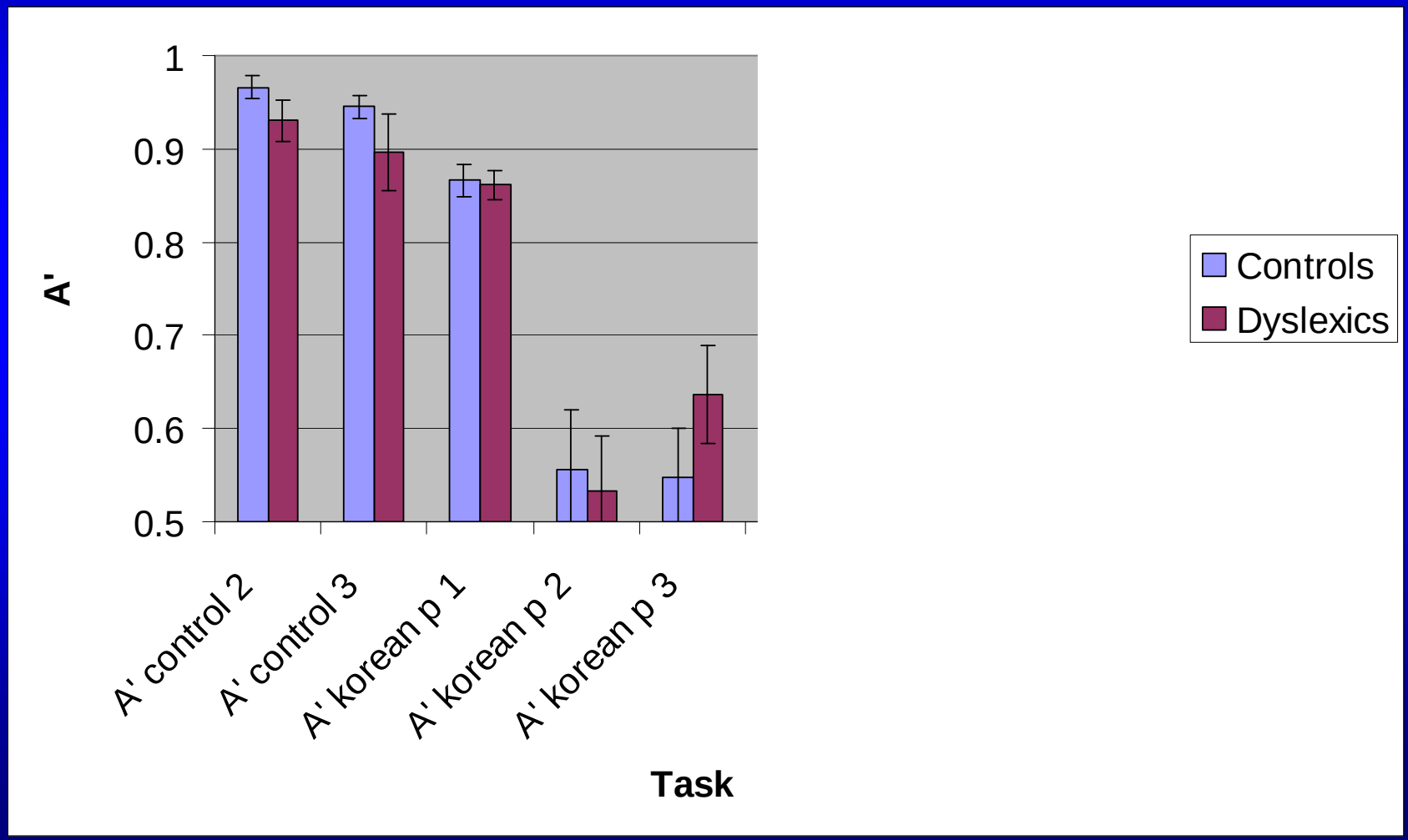
2 tasks:

- NW sequence discrimination across speakers (1-3 NW)
- Repetition

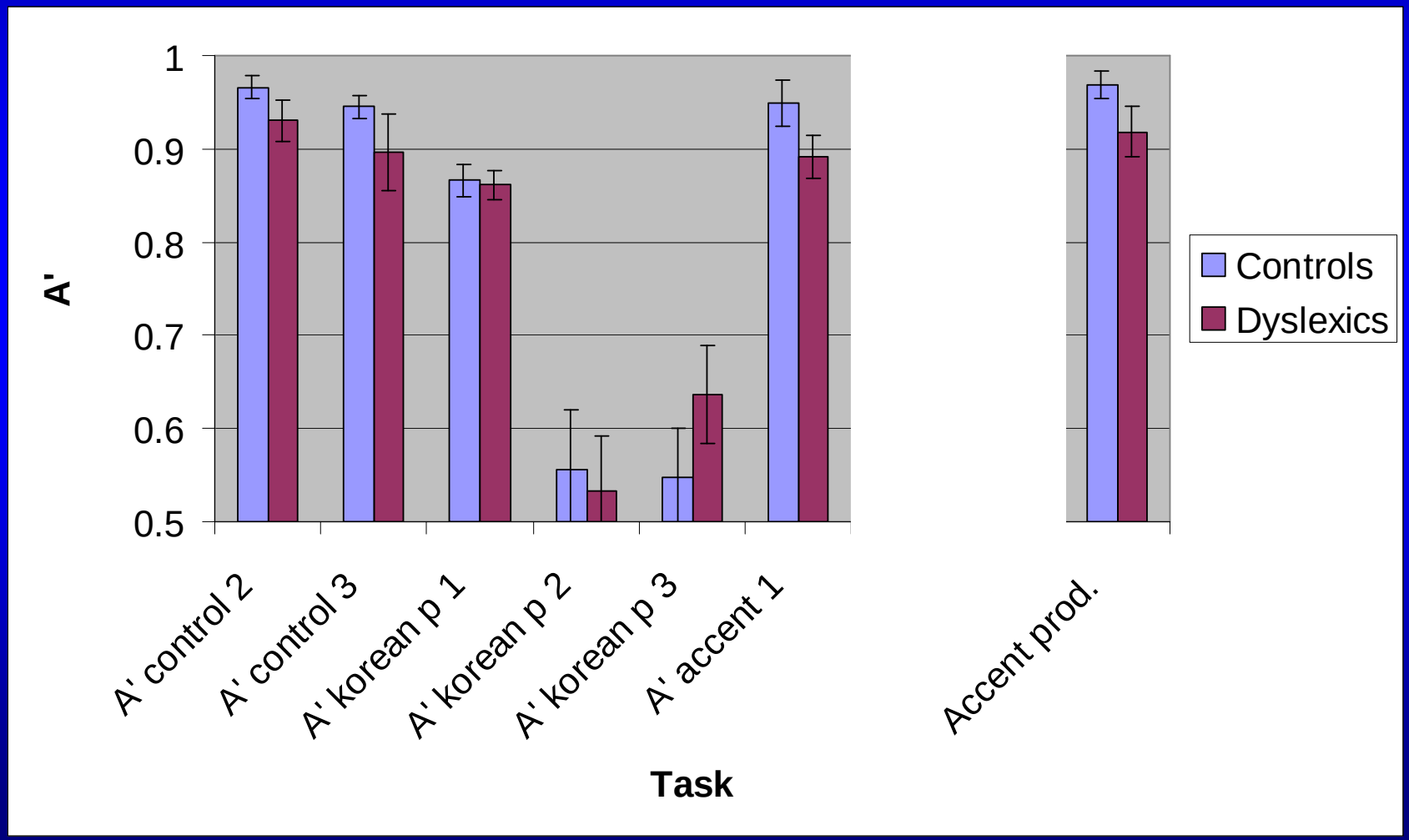
Foreign speech perception and repetition in dyslexics



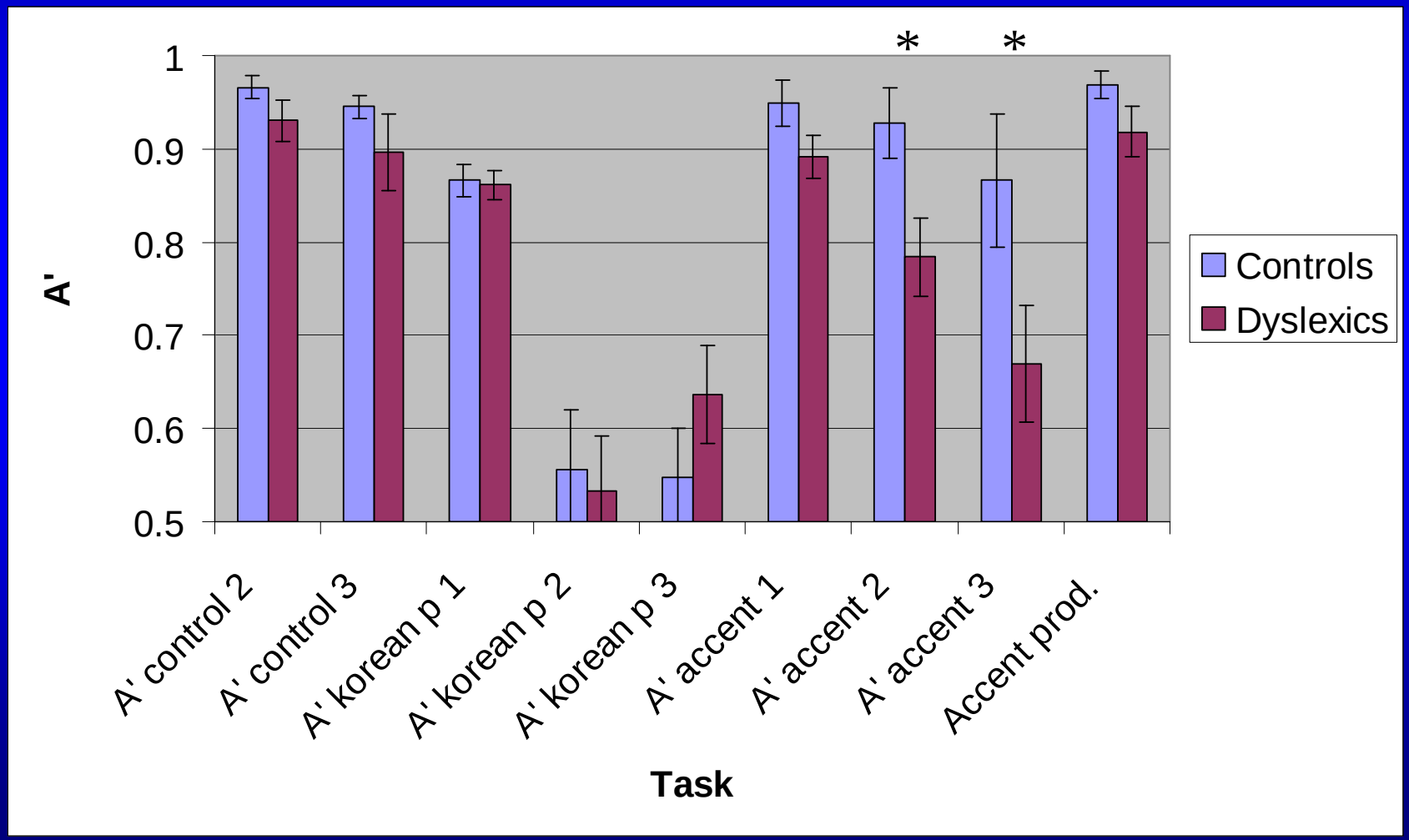
Foreign speech perception and repetition in dyslexics



Foreign speech perception and repetition in dyslexics



Foreign speech perception and repetition in dyslexics



Summary

- Dyslexics have difficulties with foreign speech contrasts, just as much like controls.
- Their phonological system seems to be in the same native-language specific state as controls.
- Group differences appear when short-term memory load is high.

Conclusions

- Very difficult to pin down one specific phonological deficit.
- No evidence of a deficit in phonological representations and processes *per se*.
- Deficit appears mainly in complex tasks, with high memory load, time constraints and/or metalinguistic/awareness components, involving phonological representations.

Degraded phonological representations vs. short-term memory processes

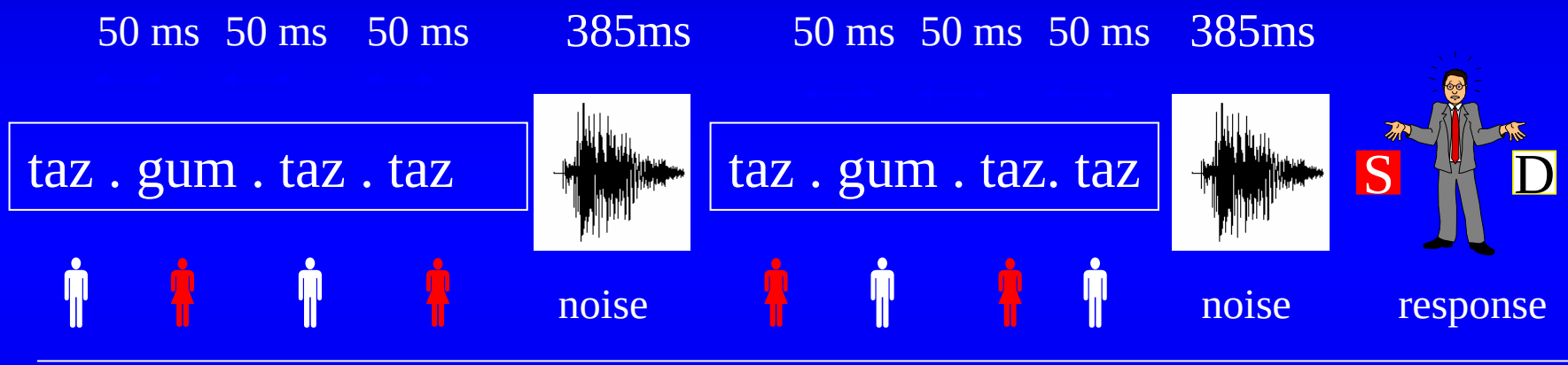
Gayaneh SZENKOVITS

Franck RAMUS

Emmanuel DUPOUX

Experimental paradigm

Sequence discrimination (matching span)



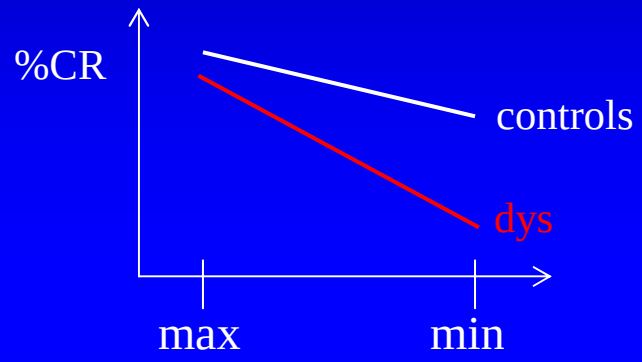
2 conditions:

- Maximal change (taz - gum)
- Minimal change (taz - ta$\mathbf{C}^{\star}$)

Predictions

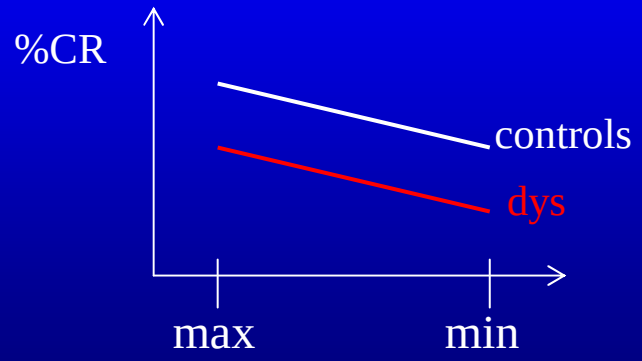
1) Degraded phonological representation hypothesis

- condition × group interaction

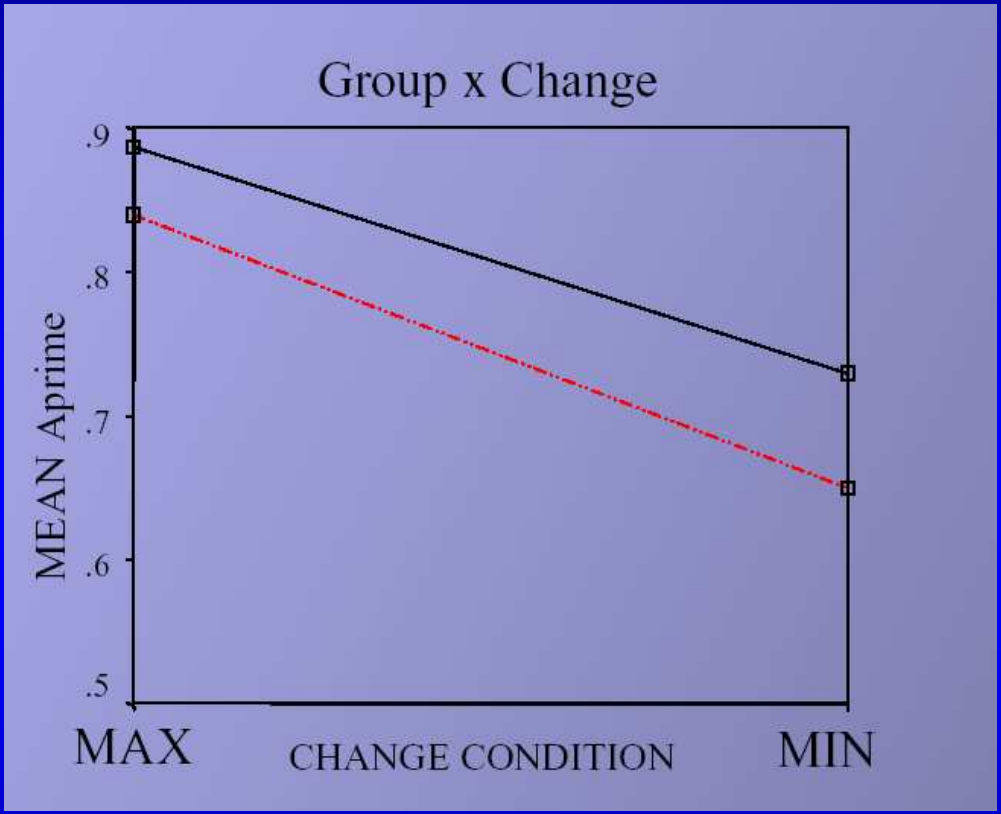


2) Intact phonological representations but impaired short-term memory processes

- no condition × group interaction



Results



*Condition F(1,24) =76.42 ****

*Group : F(1,24) =5.21 p=0.031 **

Interaction : F< 1 ns

Idem with articulatory suppression.

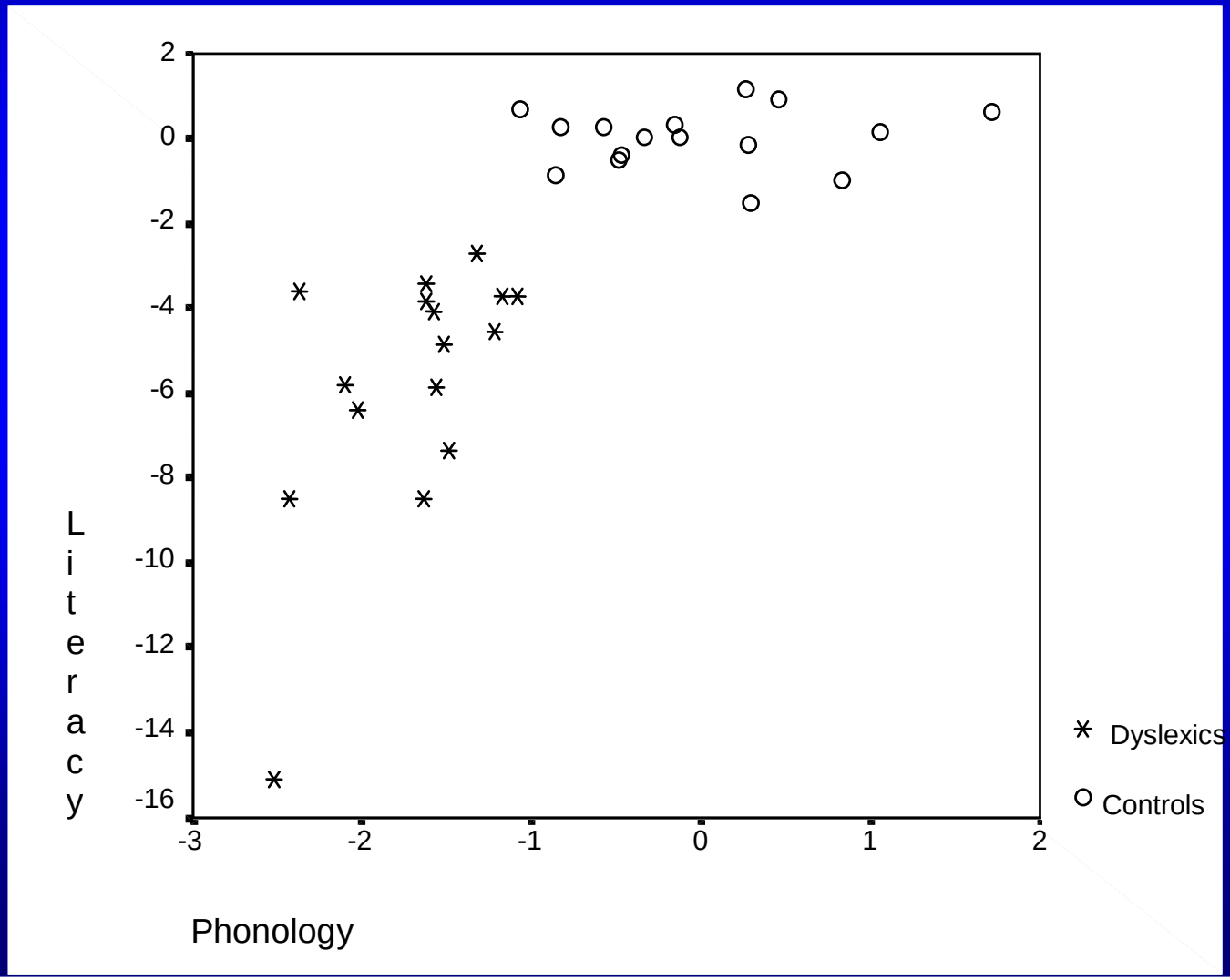
Idem with sequence repetition.

No task X change X group interaction

Conclusions

- Dyslexics have a verbal short-term memory deficit (in the input as well as the output pathway).
- But they show no phonological similarity effect.
- The short-term memory deficit cannot be attributed to degraded phonological representations.

Are these people really dyslexic?

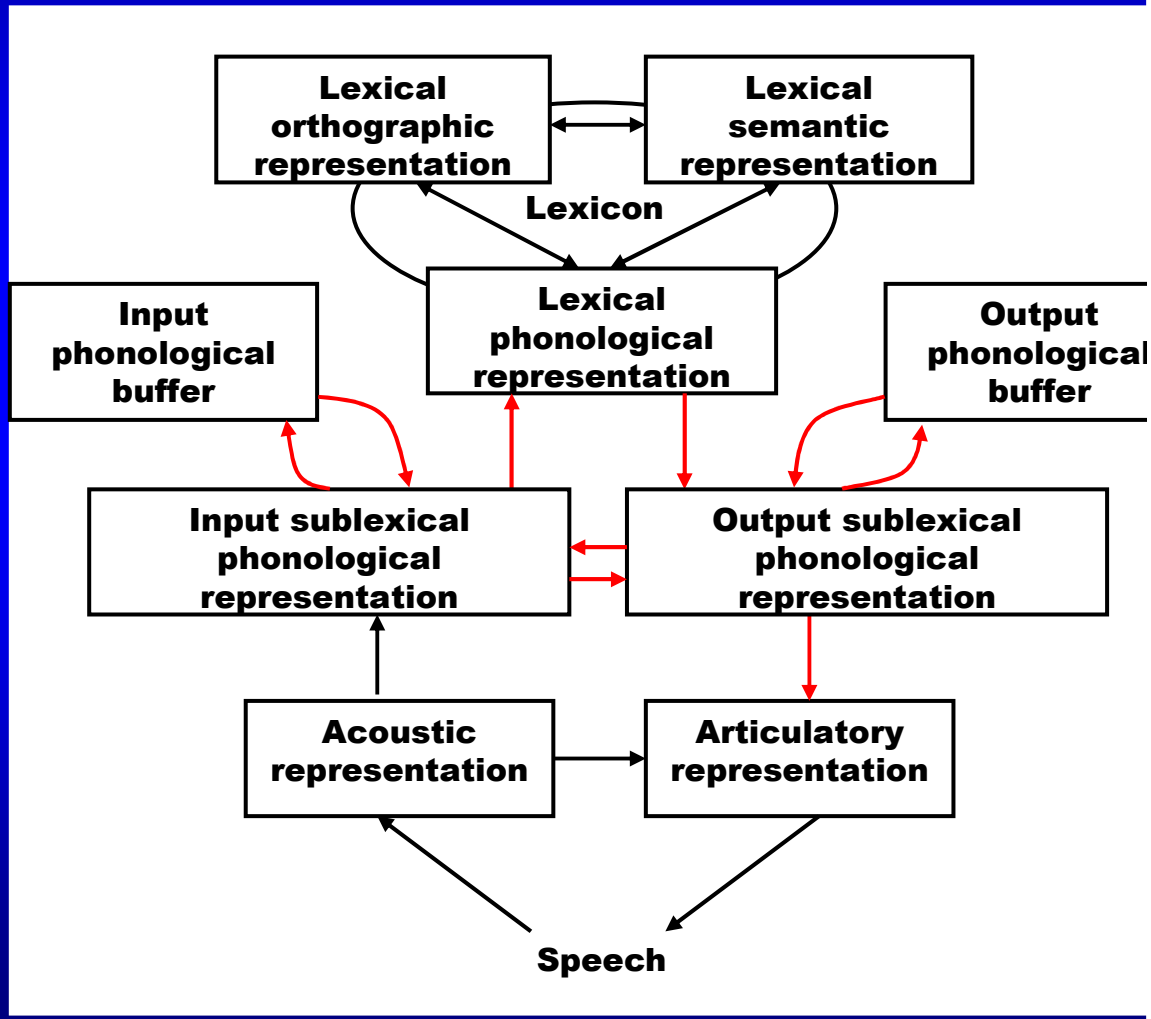


Conclusions - 2

- Dyslexics seem to have normal phonological representations, and normal perceptual and productive processes operating on those representations.
- Their phonological deficit must be of a different nature.

A deficit in access to phonological representations?

- Would appear when task constraints make access difficult:
  - Short-term storage, recycling and retrieval.
  - Conscious access.
  - Speeded and repeated accesses.
  - Any other task difficulty factor: stimuli degradation (sinewave speech, noise…)



Taking stock

- "Phonological access" hypothesis initially made by Shankweiler & Crain (1986)…
- Similar conclusions reached by research on auditory and visual deficits in dyslexia:
  - no deficit specific to magnocellular or rapid temporal processing
  - deficit only when auditory or visual stimuli must be stored in short-term memory (Ahissar et al.)
  - deficit only when visual stimuli are presented in noise (Sperling et al.)

  ⇒ The deficit is not stimulus-, but task-specific.

⇒ A special kind of executive dysfunction, more or less restricted to a processing module (speech) or modality (audition, vision).