Lettura morfolessicale e dislessia evolutiva

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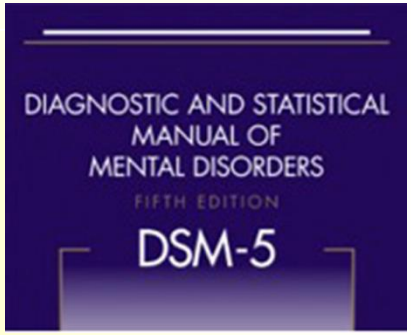
Developmental dyslexia



as a specifier of
Specific Learning Disability (*SLD*)

characterized by academic functioning that is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education

Diagnostic and Statistical Manual of Mental Disorders (DSM-V), *American Psychiatric Association* (2013)

- Greater than expected co-occurrence with other learning difficulties ("comorbidity", Pennington, 2006): The Disorder of written expression (Dysorthographia) and The Mathematics disorder (Dyscalculia) are usually associated with the Reading disorder

- The Reading disorder is manifest in difficulties with decoding words. The reading level (as measured by means of standardized tests for assessing reading speed, accuracy and comprehension) is substantially below that expected given the person's chronological age, measured intelligence, and age-appropriate education

- The reading disorder significantly interferes with learning at school and with daily life activities that require reading

Developmental Dyslexia Assessment

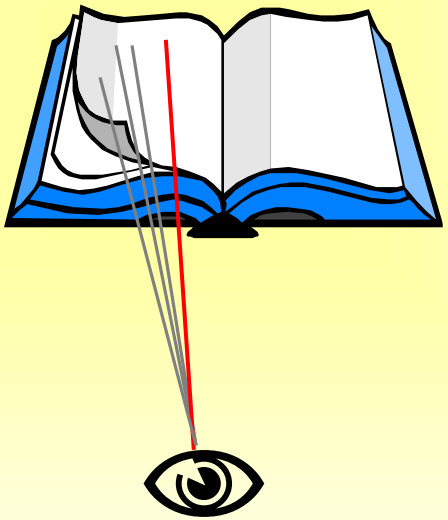
(1) **Reading tests** (Reading Accuracy and Speed, Word and Text comprehension)

(2) **Intellectual level** (Individuals must have an IQ score in the normal range)

(3) ***Other cognitive tests*** (Verbal and Visual Memory, Praxia, Calculus)

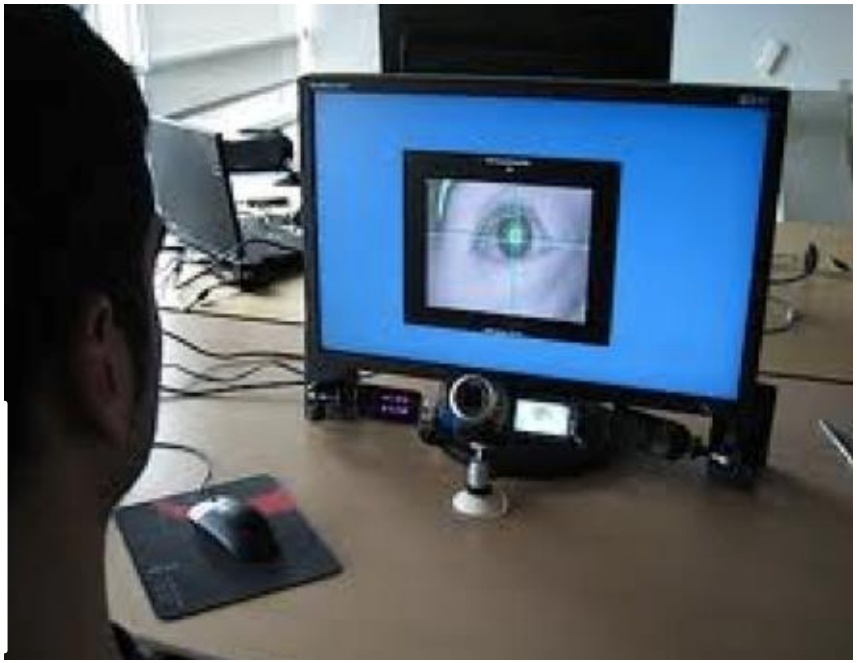
Not usually tested…

Eye movements

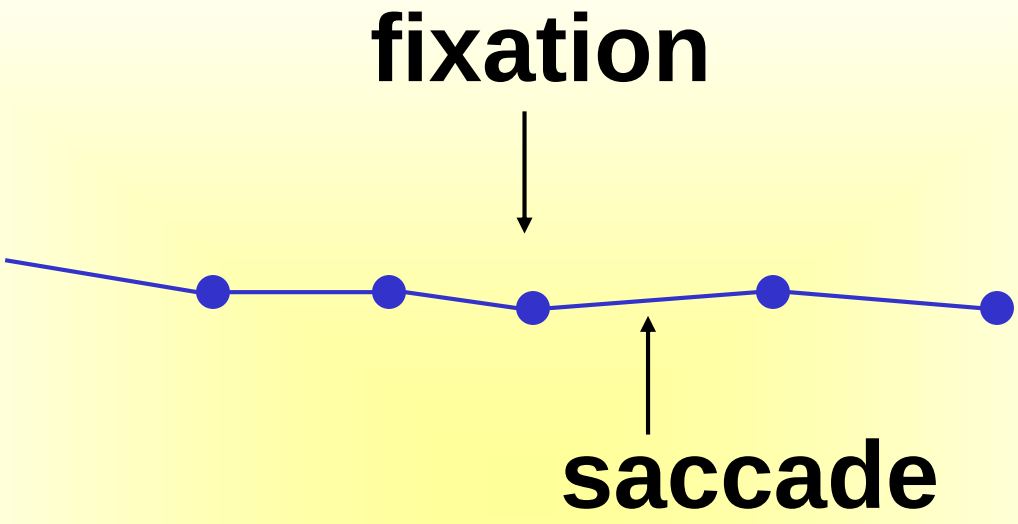


Eyetracker

…to measure eye positions and movements



…video images to extract information on eye movement position, duration, amplitude *etc*



The more skilled the reader, the shorter the fixations and the wider the saccades

Eye movements in Reading

1. The majority of words get one fixation

2. Fixation duration is 150-500 ms (mean: 250 ms)
   → Extraction of visual information

3. Saccade duration: 20-50 ms; amplitude: 7-9 characters
   Progressive and Regressive saccades

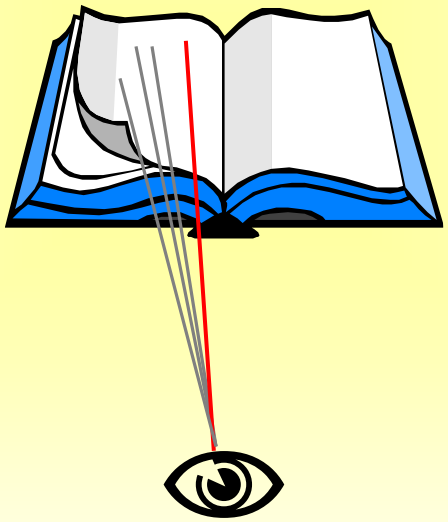
4. Fixations are not on the word centre
   Visuo-perceptual span: 3-5 letters to the left;
   about 15 to the right
   In writing systems as Hebrew it is the opposite

VISUO-PERCEPTUAL SPAN IN TEXT READING

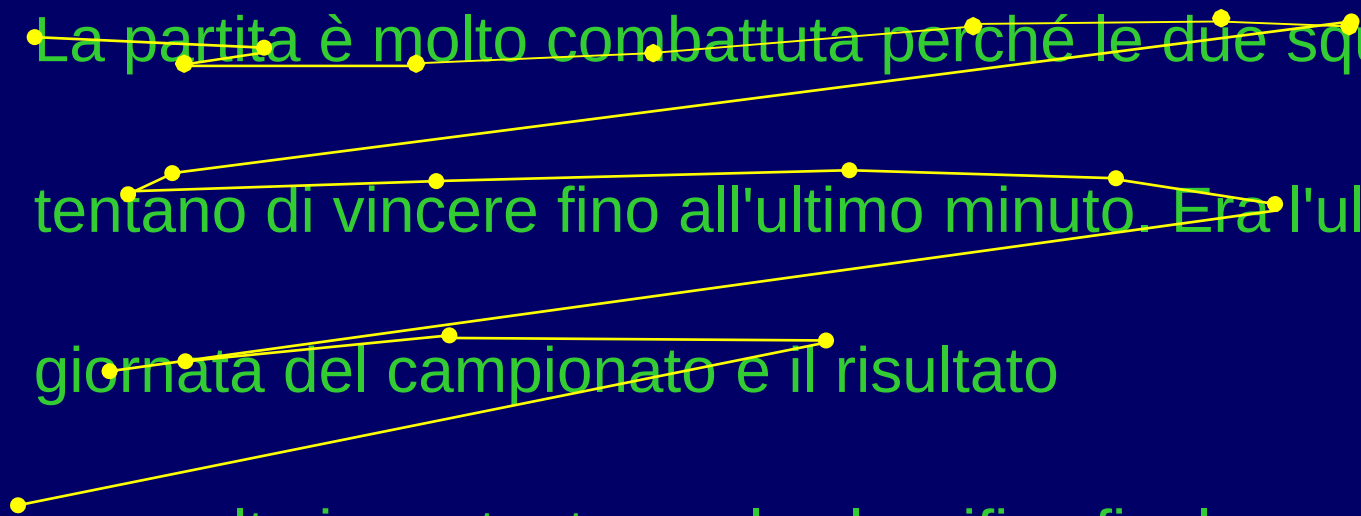
Figura 9.4

Span percettivo nella lettura.

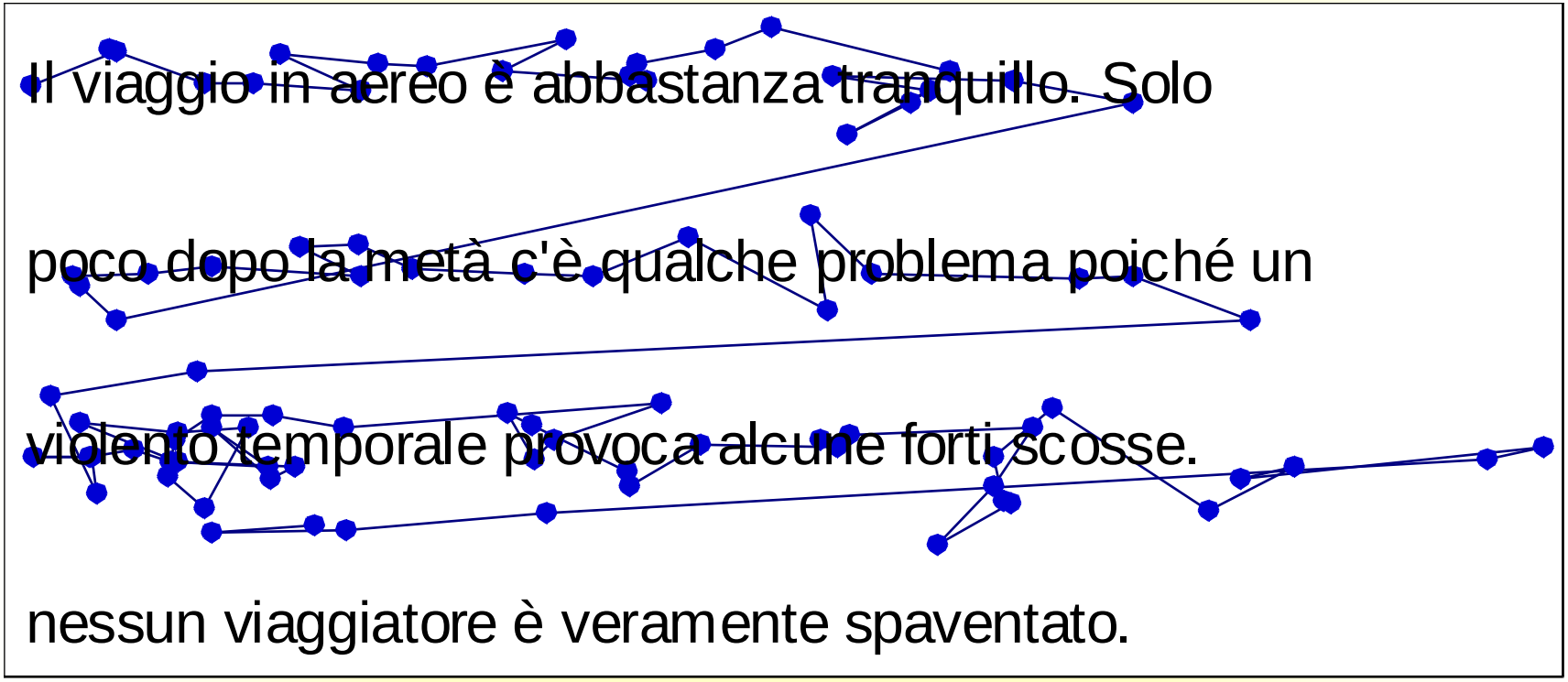
From Eye Movements in Dyslexia to Morpheme-Based Reading



La partita è molto combattuta perché le due squadre tentano di vincere fino all'ultimo minuto. Era l'ultima giornata del campionato e il risultato era molto importante per la classifica finale.

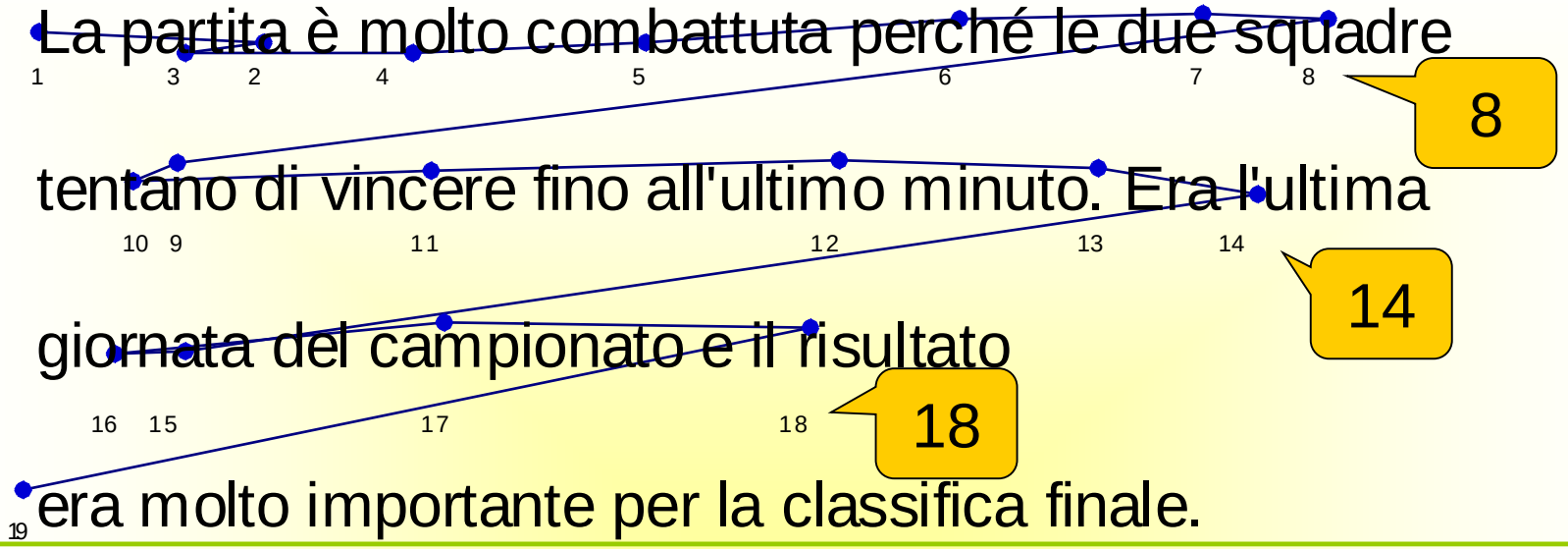


Eye movements of a typically developing 11 years old boy



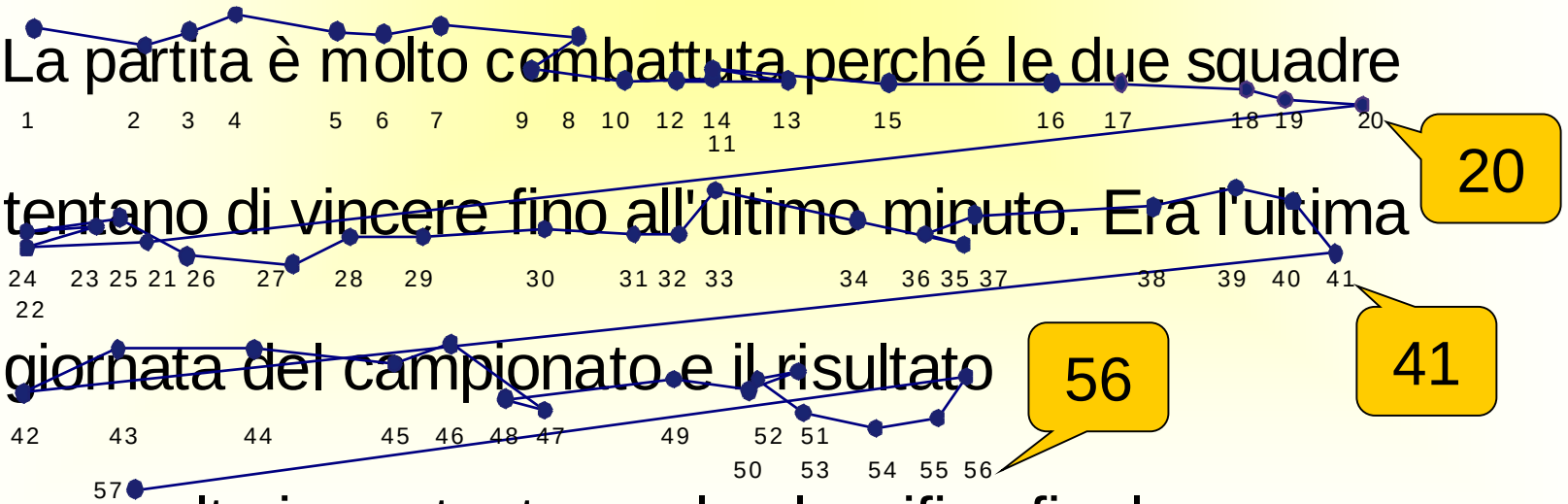
Eye movements of a 11 years old boy with developmental dyslexia

La partita è molto combattuta perché le due squadre tentano di vincere fino all'ultimo minuto. Era l'ultima giornata del campionato e il risultato era molto importante per la classifica finale.



Typical reader

La partita è molto combattuta perché le due squadre tentano di vincere fino all'ultimo minuto. Era l'ultima giornata del campionato e il risultato era molto importante per la classifica finale.



Boy with developmental dyslexia

Eye movements

(De Luca et al., 1999, *Neuropsychologia)*

	Typical readers (mean age: 10:5)	Dyslexics (mean age: 12:6)
N saccades x line	7.4 ± 1.3	16.6 ± 3.8
Saccade amplitude	2.7° ± 0.5	1.2° ± 0.3
Fixation duration	234 ms ± 30	290 ms ± 45
% Regressions	18.9 % ± 9.8	18.9 % ± 7.9

Word naming studies

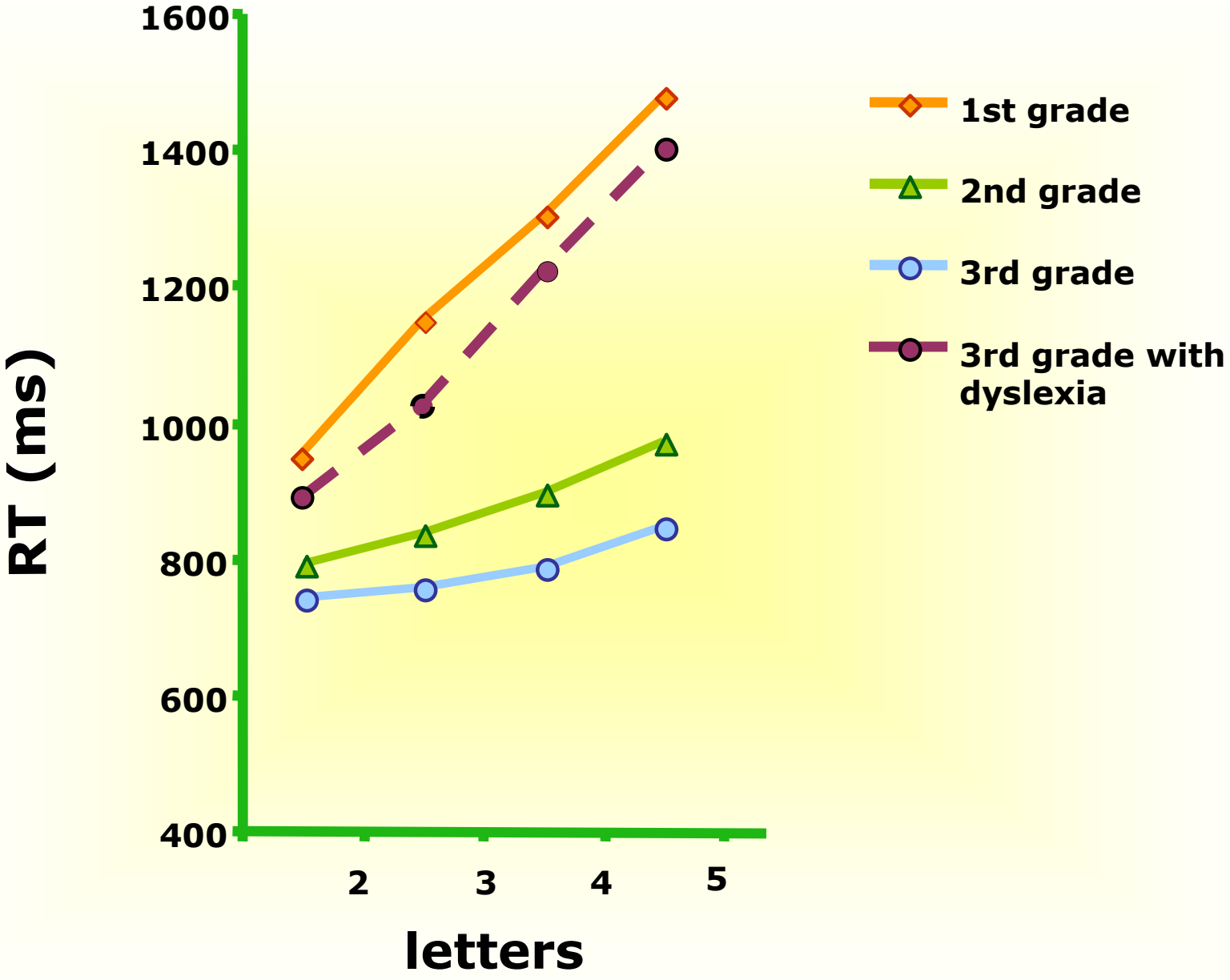
Reading aloud task:

Words (or Nonwords) are singularly presented on the screen

" Read it aloud as fast and as accurately as possible "

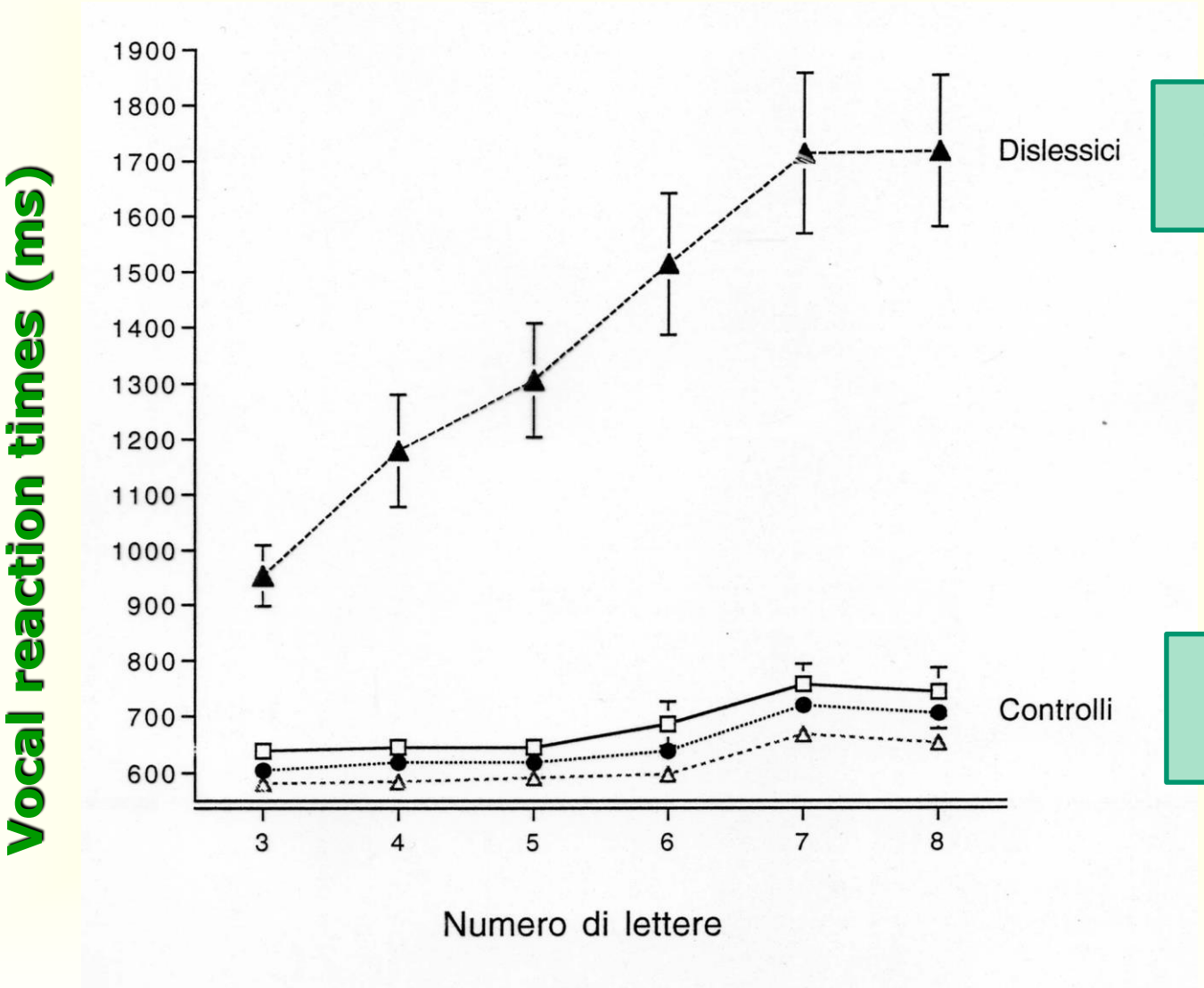
Registration of:

- RTs (voice onset time/transcoding time)
- Accuracy (% correct pronunciations)



Zoccolotti, De Luca, Di Pace, Gasperini, Judica, & Spinelli (2005)

Vocal reaction times as a function of word length



6 th-8 th grade

6 th grade
7 th grade
8 th grade

Spinelli, De Luca, Di Filippo, Mancini, Martelli, & Zoccolotti (2005), *Devel Neurops*

- Italian children with dyslexia fail to develop reading units of a large size (i.e., words), because of limitations in their visuo-perceptual span

- They make several long-lasting fixations with several small amplitude saccades (De Luca et al., 1999; 2002)

- They typically read rather accurately, but very slowly and serially (Spinelli et al., 2005)

- They have increasing difficulties with increasing word length (Zoccolotti et al., 1999; 2005)

(similarly to developing readers of other transparent orthographies)

For developing Italian readers

reading **speed** is a particularly sensitive measure

to capture reading ability

"Speed dyslexia"
(Wimmer, 1993)

"Sub-lexical reading", similar to children in their first reading stages ? *

Over-reliance on

smaller than the word reading units

MARTELLO

* … children learning to read in a transparent orthography would rely to a great extent on **small grain-size units of processing** such as single letters and phonemes… (Ziegler & Goswami, 2005)

However, in a transparent orthography, reading based on **units of a small grain size**
→ Correct but slow reading

Units of a larger grain-size

are necessary to achieve fast and fluent reading

Morpheme-based reading

may foster fluency in readers with dyslexia

The use of morpho-lexical reading units at a large grain size is inevitable in a consistent orthography to face the speed/fluency problem

Experimental comparisons

DERIVED

SIMPLE

CANTANTE

CASTELLO

CANT

ANTE

(root)

(suffix)

C A N T A N T E

C A S T E L L O

• • • • • • • •

• • • • • • • •

Long words composed of morphemes (roots and derivational suffixes) are expected to be read aloud by dyslexics faster than matched words not composed of morphemes (Burani, 2010)

because

Morphemes are shorter reading units than the word (too long for dyslexics to be processed in a single fixation), but are larger reading units than graphemes (that entail slow analytical sub-lexical processing)

Readers with dyslexia
Have difficulties in processing
the whole-word as one reading unit

They rely on reading units
of a smaller size than the word

Morphemes provide
lexical reading units (roots and affixes)
of an intermediate size
between single graphemes (laborious strategy)
and the whole-word (difficult for dyslexics to process)

Morphemes affect reading aloud speed at different extents according to

- Reading ability
- Properties of linguistic materials

Properties that may affect naming latencies to derived words in interaction with reading skill

1) Lexicality (words *vs.* pseudowords)
2) Word Frequency
3) Word and Root length

Word naming studies

Reading aloud task:

Words (or nonwords) singularly presented on the screen

"Read it aloud as fast and as accurately as possible"

- RTs (onset of pronunciation) - (transcoding time)
- Accuracy (% correct pronunciations)

(1) Lexicality: Pseudowords and Words

(Burani, Marcolini, De Luca, & Zoccolotti, *Cognition*, 2008)

	Simple	*vs*	**Morphological**
Pseudowords	VOTREZZO	**vs**	VETREZZA
	(----------)		(glass-ness)
Words	VULCANO	**vs**	VETRAIO
	(volcano)		(glazier)

(1) Lexicality: Pseudowords and Words

(Burani, Marcolini, De Luca, & Zoccolotti, *Cognition*, 2008)

Predictions:

Simple *vs* **Morphological**

Pseudowords	VOTREZZO	>	VETREZZA
	(----------)		(glass-ness)
Words	VULCANO	≥	VETRAIO
	(volcano)		(glazier)

Participants

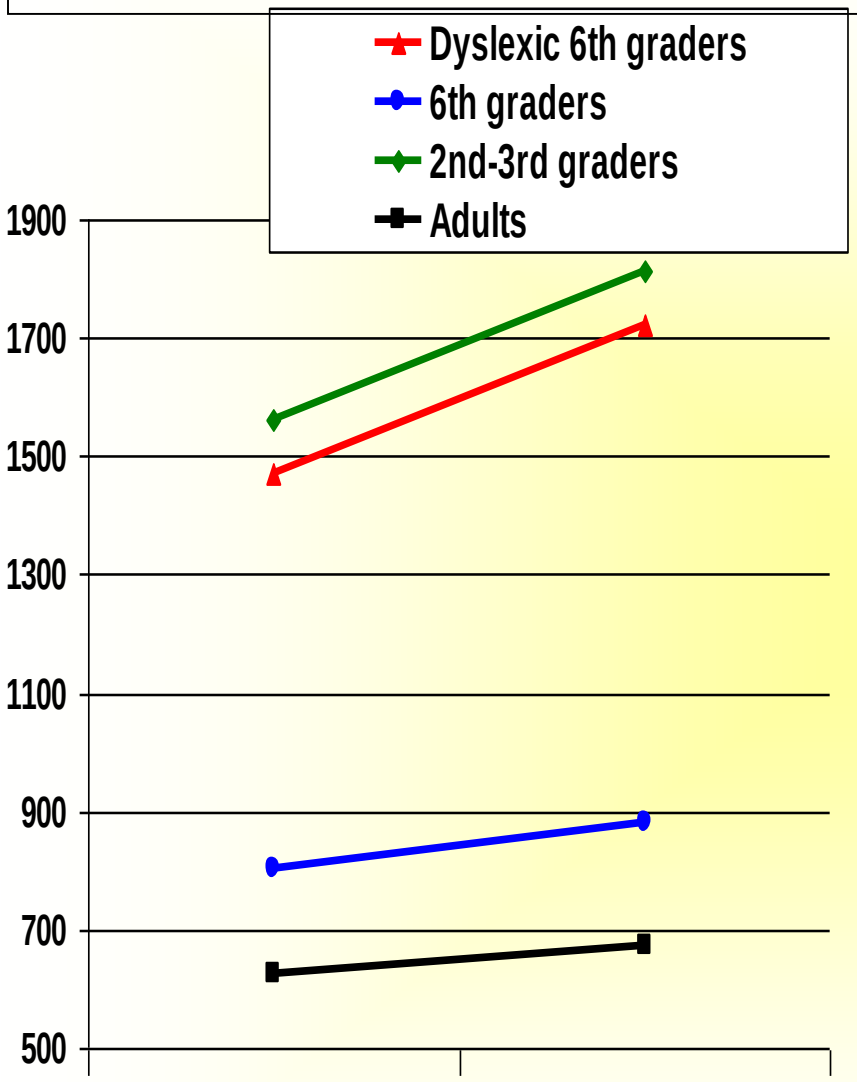
- **6th grade readers with dyslexia**
  Marked reading delay on a standard reading battery for either speed or accuracy or both, without comprehension deficit. IQ level within normal limits

- **6th grade typically developing readers,** matched to readers with dyslexia for chronological age, gender and non-verbal intelligence (Raven test)

- **Adult readers**

- **2nd-3rd graders**, reading speed-matched to readers with dyslexia

Pseudowords



Morphological

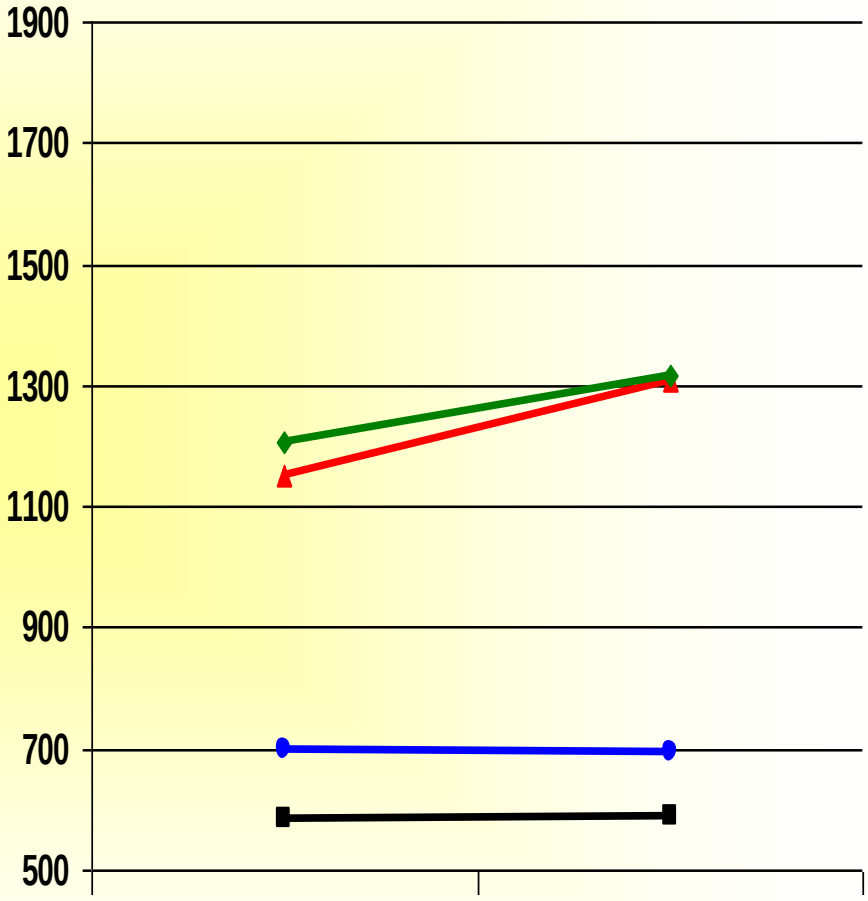
VETREZZA

Simple

VOTREZZO

Words

Burani et al., *Cognition*, 2008



Derived

VETRAIO

Simple

VULCANO

(2) Word frequency: High- and Low-frequency words

(Marcolini,Traficante, Zoccolotti, & Burani, 2011, *Applied Psycholinguistics*)

Access to morphemes is more likely for

Low-frequency words

BASSEZZA BASS - EZZA

FASHIONIST FASHION - IST

Than for

High-frequency words

BELLEZZA

TERRORIST

(see Lexical decision and Eye-movement studies)

Marcolini *et al.* (2011)

	Derived	Simple
High-Frequency	PALLONE (balloon)	POLMONE (lung)
Low-Frequency	PIEDONE (big foot)	PANTERA (panther)

Derived words: phonologically and semantically transparent with respect to their base, with highly familiar roots and suffixes.

Mean word length : 8.5 letters (range: 7-11)

Root length : 4 letters or more

Participants

- Twenty-one 6th grade readers with dyslexia

  Marked reading delay on a standard reading battery for either speed or accuracy or both. IQ level within normal limits

- Forty-two typically developing 6th graders *

  Within normal limits for reading speed and accuracy

- Thirty adult readers

* Matched to readers with dyslexia for gender, age and non-verbal intelligence (Raven test)

Predictions:
Faster naming of Root + Suffix words
than Simple words

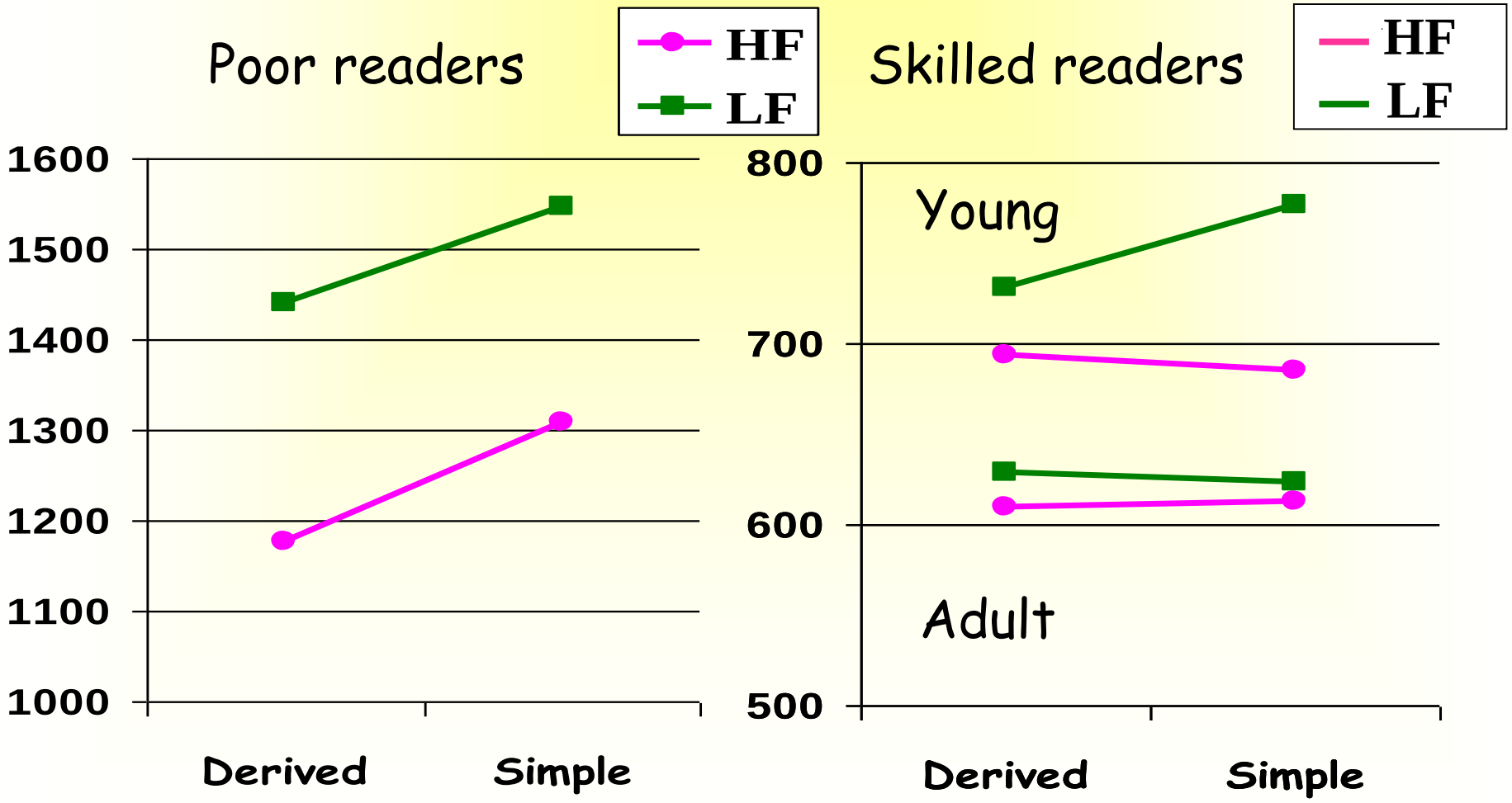
Skilled readers :

Low-frequency words (PIEDONE) only?

Readers with dyslexia:

both High-(PALLONE) and Low-frequency (PIEDONE) words ?

High- and Low- Frequency words



Marcolini, Traficante, Zoccolotti, & Burani, 2011, *Applied Psycholinguistics*

Morpheme-based reading speed in developing readers is a main function of the **Root** (Traficante, Marcolini, Luci, Zoccolotti, & Burani, 2011, *Lang. and Cogn. Processes*)

Consistently with data on eye-movements in adult readers:

For long words, whole-word information cannot be extracted in a single fixation

Long words elicit more than one eye fixation

Head start of morphemic parsing based on the first constituent (Bertram & Hyönä, 2003)

Beauvillain (1996)

Effects of **Root Frequency** on

. First fixation duration in reading isolated 9- to 12- letter long **suffixed** French words

(e.g., **historique** vs. **dynamique**)

. Second fixation duration in reading isolated 9- to 11- letter long **prefixed** French words

(e.g., **surpasser** vs. **surclasser**)

Niswander, Pollatsek, & Rayner (2000)

(sentence reading)

Effects of **Root Frequency** on

First fixation duration for English
derived words 7-12 letters long (mean : **9.8 letters**)
(e.g., **attachment, blindness**)

No effects of root frequency on

first fixation durations for English
inflected verbs 5-9 letters long (mean : **6.8** letters)
(e.g., **boats**, **turned, killing**)

Bertram & Hyönä (2003)

(sentence reading)

Effects of **first-constituent frequency**
for **long** Finnish compounds (mean word length: **12.8**)
e.g., keskushermosto (central nervous system)

No effect
for short compounds (mean word length: **7.7**)
e.g., sivuovi (side door)

Andrews, Miller, & Rayner (2004)

(sentence reading)

Effects of both **first-** and **second-** constituent
on English compounds (mean word length: **8.8**)
e.g., battlefront, playoff, peanut

Weaker or later effects of 2nd constituent?

Hyönä & Pollatsek (1998)

Eye movements in reading English compound words

- The visual width of the first constituent may control the size of the saccade (fixations farther in the word the longer the initial morpheme)
- Long first constituent → shorter first-fixation
- Initial fixation near the word beginning (not «optimal viewing position», O' Reagan et al., 1984) → marginal control of eye movements by morphemes
- Initial fixation near the middle of the word→ the length of the initial morpheme affects initial fixation and modulates the location of 2nd fixation

Hyönä & Pollatsek (1998)

A compromise between visual and morphemic guidance, likely to be acquired during reading development

(3) Root properties, specifically Root Length

(Burani, Marcolini, Traficante, & Zoccolotti, 2018, *Frontiers*)

Morpheme-based reading speed is mainly a function of the **Root**

Do root properties modulate children's morphemic processing?

Does root length differentially affect reading processing in children with and without dyslexia?

NASINO	**CAVALLINO**
(small nose)	(young horse)

- Longer roots are more informative access units with less lexical competitors than shorter ones, but they require an efficient eye-scanning system to be processed as a unit in a single fixation (Rayner, 1979; O' Regan et al., 1984; Hyönä et al., 2017)

NASINO	**CAVALLINO**
(small nose)	(young horse)

- Long roots can be processed efficiently by good readers, but might exceed the visual scanning capacities of a dyslexic reader (no flexible/mature visuo-perceptual integration; initial fixations near the word beginning, missing the middle of longer roots; Havelka et al., 2010)

NASINO	CAVALLINO
(small nose)	(young horse)

Prediction:

Long roots may promote faster lexical access and increase reading speed particularly in typical readers

Participants:

- Forty typically developing 6th graders

  Within normal limits for reading speed and accuracy

- Twenty 6th grade readers with dyslexia

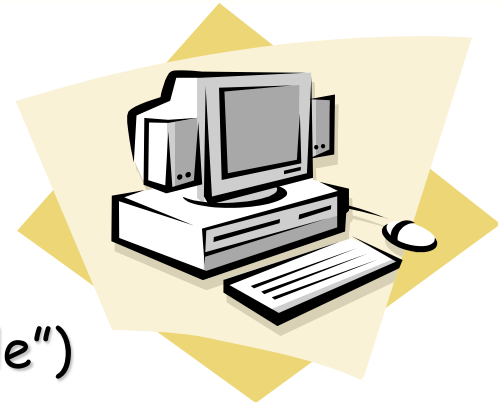
  Marked reading delay on a standard reading battery for either speed or accuracy or both. IQ level within normal limits

Matched for gender, age and
non-verbal intelligence (Raven test)

Burani et al., 2018

Word naming

(Reading aloud task: "Read it aloud as fast and as accurately as possible")



Dependent measures:

- RTs (onset of pronunciation)
- Accuracy

Materials

Sixty **low-frequency** (0-56 per million) words, with a root and a derivational suffix (*e.g.*, **PIED-INO**, 'little foot').

Othographically, phonologically and semantically transparent; all with familiar roots and suffixes.

- Word length **(6-11 letters)**
- Root length **(3-6 letters)**
- Suffix length **(3-5 letters)**

Sixty simple filler words, to prevent a forced parsing strategy

DITONE (big toe)

POTENZA (power)

SALVEZZA (safety)

OCCHIATA (glance)

PAROLACCIA (bad word)

SCHERZETTO (joke)

LONTANANZA (distance)

Variables that may affect naming latencies to derived words :

- Word frequency (*e.g.*, Balota et al., 2004)
- Word length (*e.g.*, Zoccolotti et al., 2005)
- Root frequency (*e.g.*, Baayen et al., 2007; Colombo & Burani, 2002; Deacon et al., 2011; Mann & Singson, 2003)
- **Root length** ? (Hyönä & Pollatsek,1998, effects of length of the first constituent on eye-movements)
- Suffix frequency ? (Lazaro et al., 2017 in lexical decision)

DITONE POTENZA SALVEZZA OCCHIATA

PAROLACCIA SCHERZETTO LONTANANZA

Longer roots are included in longer words

(Word length - Root length correlation: $r = .79$)

The respective contributions of root length and word length should be disentangled

Root length residualized as predicted from Word length

(Kuperman et al., 2010)

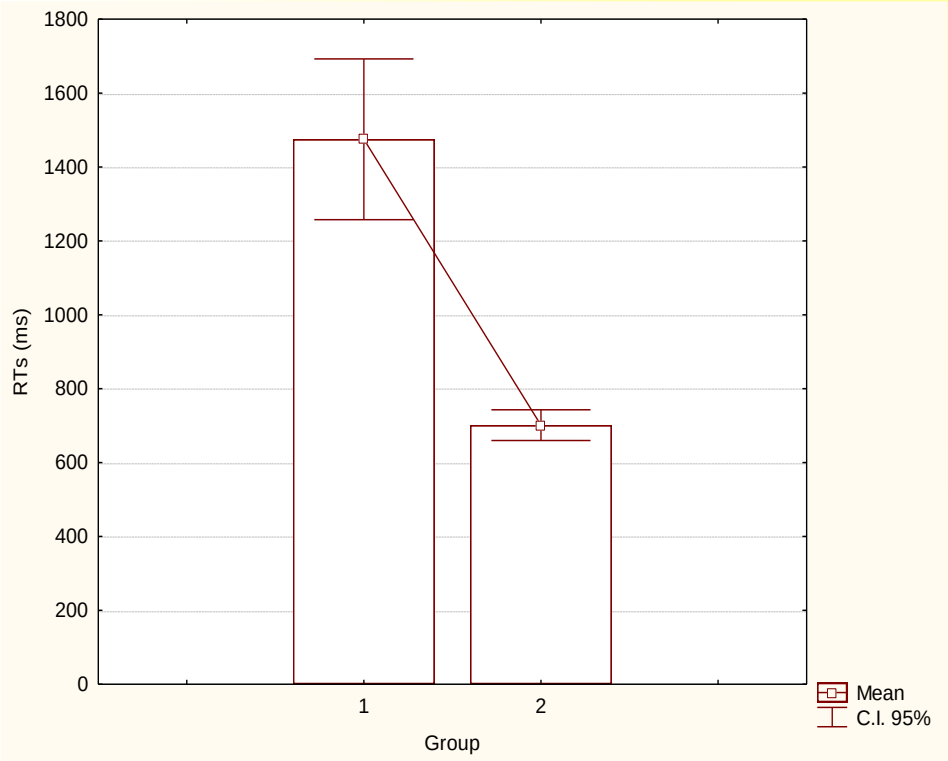
The longer the word,

. the lower the probability of accessing it as a whole

. the higher the probability of morphological decomposition

(see Bertram & Hyona, 2003; Niswander et al., 2000; Niswander & Pollatsek, 2003)

RTs raw data



Children with dyslexia

M = 1475 ms

Typically developing children

M = 701 ms

Due to the large difference between groups both in mean values and in dispersion measures, analyses of data were carried out within each group separately

Data Analysis

- Linear mixed-effects regression (Baayen *et al*., 2008) on RTs
- Generalized mixed-effects regression on Errors

Fixed effect Predictors :

- Word frequency
- Word length
- Root frequency
- **Root length**
- Root family size
- Suffix frequency

All frequency measures were calculated on a **written child frequency count (Marconi et al., 1993)**

Typically developing children

Coefficients of the best mixed-effects model on RTs

Fixed effects	*Estimate*	*t* value	Pr (>|*t*|)
(Intercept)	6.7478	88.227	<0.001
Word Length	0.0277	3.977	<0.001
Root Frequency	-0.0226	-2.708	0.008
Root Length	-0.0140	-2.022	0.047
Suffix Frequency	-0.0174	-2.220	0.03

Children with dyslexia

Coefficients of the best mixed-effects model on RTs

Fixed effects	*Estimate*	*t* value	Pr (>|*t*|)
(Intercept)	7.5393	61.960	<0.001
Word Length	0.0465	3.620	0.0006
Root Frequency	-0.0485	-3.675	0.0005
Root Family Size	0.0320	2.217	0.03

Interpretation: RTs

For all readers, both typical and with dyslexia :

- The large word length effect confirms laborious processing of low-frequency derived words
- The facilitatory effect of root frequency along with the absence of a word frequency effect indicates pervasive morphemic processing

For typical readers

- The reversed (facilitatory) effect of root length, over and above the inhibitory effect of word length, points to a stronger activation for longer roots as particularly informative units for word decoding: At similar word lengths, the longer the root, the faster the response.

For readers with dyslexia

- The facilitation of root frequency indicates a benefit from root activation to bypass difficulties in processing whole-words within a single fixation and to increase reading speed
- The lack of root length facilitation suggests that longer roots cannot result in specific reading benefits because most of them are for dyslexics too large units to be processed within a single fixation

- The effect of suffix frequency for typical readers only suggests parafoveal processing of morphological information in readers with intact visuo-perceptual span (greater modulation of the location of 2nd fixation by long roots). Readers with dyslexia focus more on foveal information.

- The (negative) effect of family size for readers with dyslexia only (and lack of suffix processing) indicates uncertainty in planning pronunciation when the root is compatible with several possible suffixes/words (e.g., autista vs. durezza)

Accuracy

Typically developing readers: 2.2 % Errors

Children with dyslexia: 9.6 % Errors

Typically developing children

Coefficients of the best generalized mixed-effects regression model on Accuracy

Fixed effects	*Estimate*	*z* value	Pr (>|*z*|)
(Intercept)	1.0514	1.037	0.300
Word Frequency	0.2199	2.027	0.043
Suffix Frequency	0.4132	2.694	0.007

Children with dyslexia

Coefficients of the best generalized mixed-effects regression model on Accuracy

Fixed effects	*Estimate*	*z* value	Pr (>|*z*|)
(Intercept)	-0.4897	-0.631	0.528
Word Frequency	0.1433	1.930	0.054
Suffix Frequency	0.4252	3.636	<0.001

Root → Head-start to morphemic decomposition → Faster reading

But this may result in word-form substitutions, mainly on low-frequency derived words

e.g.:	OCCHIATA	→	OCCHIALI
	VECCHIAIA	→	VECCHIACCIA
	BIGLIETTAIO	→	BIGLIETTO
	OSSARIO	→	OSSO
	TENTAZIONE	→	TENTARE

Marcolini, Traficante, Zoccolotti, & Burani (2011)

Why **Suffix** effect on reading **accuracy**?

(see also Traficante et al., 2011)

The **Suffix**

- is a strong cue for lexical status

  (Quémart, Casalis, & Duncan, 2012) (see **– ismo**)

- is a **stress attractor** (Jarmulowicz et al, 2007; 2008)

giving a **cue to stress position** (Grimani & Protopapas., 2017)

- **facilitates co-articulation** of the morphemic

combination in reading aloud

Assembling the pronunciation of (bound) root and suffix after parsing implies re-assigning

Stress

to the complex word (relative to root stress) and planning a new co-articulation of the morphemic combination

'VETRO	VE'TRAIO
(glass)	(glazier)

Summary of results from the different studies

✓ For readers with dyslexia the availability of morphemic decomposition always results in faster reading speed. For

1) New and known words
2) High- and Low-frequency words
3) Long words irrespective of root length

✓ For typically developing readers morphemic decomposition has advantages mainly in the case of

1) New words
2) Low-frequency words
3) Words with long roots

Morpheme-based lexical reading

- Promotes decoding based on lexical access instead of sublexical correspondences

- Speeds up decoding when whole-word processing is less likely (low-frequency complex words, not in the reader's lexicon, but composed of familiar roots and suffixes; words too long to be identified with a single fixation)

- The morphological facilitation is larger in dyslexics than in skilled readers (see also Elbro & Arnbak, 1996; Carlisle & Stone, 2005; Suarez-Coalla & Cuetos, 2013)

A morphology-based compensatory reading strategy in dyslexics?

(Elbrö and Arnbak, 1996; Colè, Leuwers, & Sprenger-Charolles, 2005; Cavalli et al., 2017)

Training based on morpheme processing more efficient than training based on syllables or other units (Elbrö and Arnbak, 1996)

Several recent studies

Why no advantage of morphemic reading for skilled readers in reading familiar words?

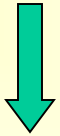
- ✓ Larger grain-size units speed up reading.
  Skilled readers can process the word as a whole (larger unit),
  thus no advantage of morphemes (smaller units)
- ✓ Morphemic parsing has <u>costs</u> as well as benefits
  (it does not necessarily speed up processing)
- ✓ Word-based reading avoids parsing and assembling costs associated with morpheme-based reading

Morphological effects indicate

use of **Roots** and **Suffixes**

as reading units of a larger grain size

than the single letter/phoneme



Morphemes
reduce the limitations in stimulus scanning
and increase
Fluency

Developmental Models of Reading

should include

. Lexical representations decomposed in morphemes

should account for

. Perceptual/formal properties of morphemes

. Differing reading abilities

Open issues

1. Morphological effects dissociable from Semantics?

2. Orthographic/Phonological transparency?

3. Morpheme-based Spelling ?

Grazie

Thank you

(1) Advantage of morpheme-based processing because morphemes help to get the word's meaning ?

It depends on the task:

Yes in

Text comprehension

Word comprehension

Lexical decision

Lexical decision: Morpho-semantic effects ?

- Morphological effects **ONLY** or **MOSTLY** in the presence of a semantic (or orthographic) transparent relation

  (*e.g.*, not with *segretario; department; concezione*) in

  - younger

  - less skilled (slower) readers

  (Beyersmann et al., 2012; Schiff et al., 2012)

- In adults or more skilled readers, morphological effects **ALSO** with opaque semantic (or orthographic) relations (Mc Cormick, Rastle & Davis, 2008)

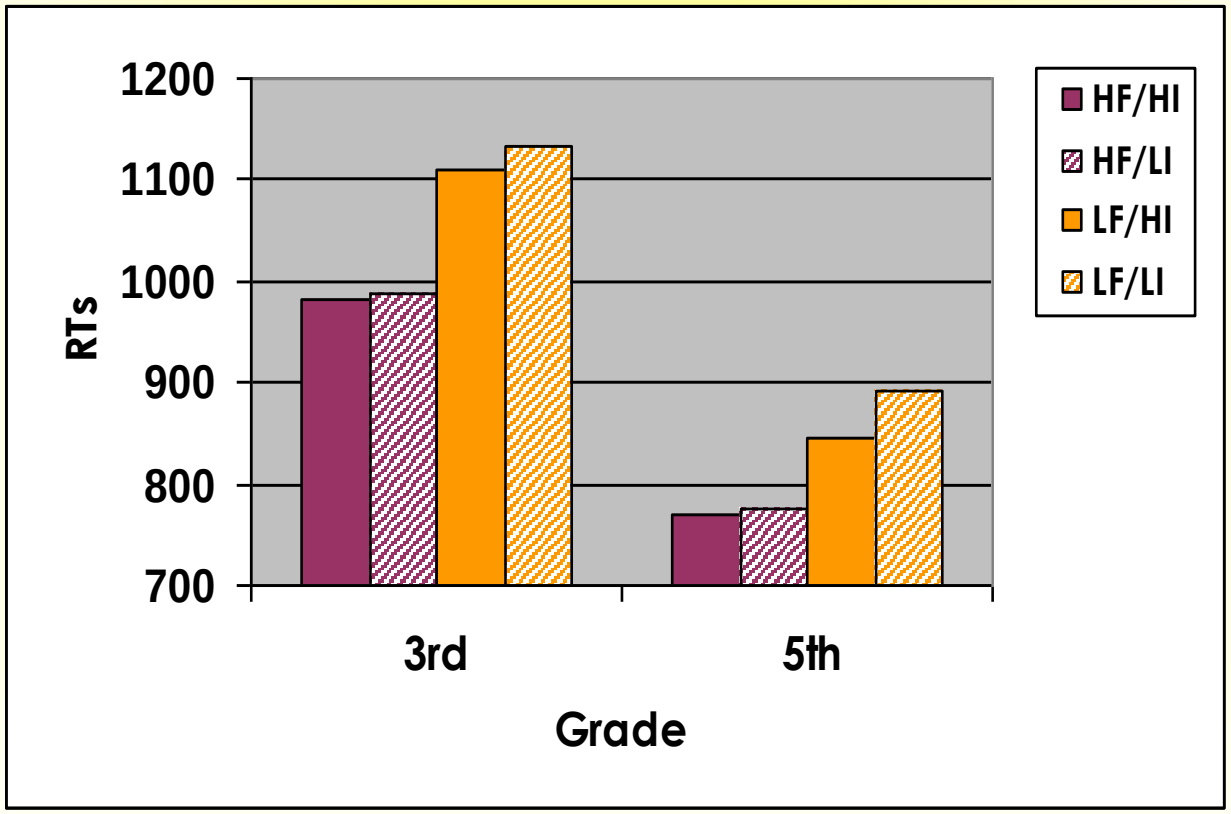
Does morpheme-based reading (aloud) involve semantics ?

Insensitivity of word naming to Semantics

(e.g., Balota et al., 2004; Baayen et al., 2006; 2007; Burani et al., 2007)

Frequency x Imageability

(Mazzotta, Barca, Marcolini, Stella, & Burani, 2005)



In Italian, imageability affects only children's naming of low-frequency words

Semantic interpretability

More interpretable

- GUERROSO (warous)
- DONNISTA (womanist)
- ……..
- ……..
- CODISMO (tailism)
- VETREZZA (glassness)

Less interpretable

(see Burani, Marcolini, & Stella, 2002, *Brain and Language;* Burani, Dovetto, Spuntarelli, & Thornton, 1999, *Brain and Language*)

Post-hoc Correlations

Semantic Interpretability of Morph. Pseudowords with Reading performance

			3rd	4th	5th	Adults
READING ALOUD	(RTs)	r =	-.24	.09	-.04	-.09
	(%Err)	r =	.02	-.02	.16	.24
LEXICAL DECISION	(%Err)	r =	.49*	.52*	.30^	.67**

Burani, Marcolini & Stella, 2002, *Brain and Language;*

Pseudoword Naming

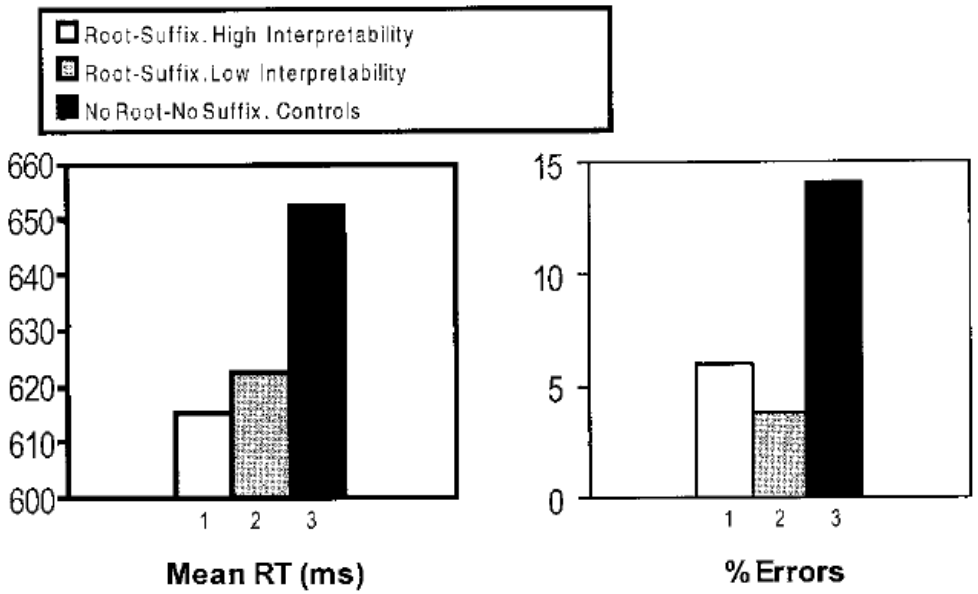


FIG. 2. Naming experiment: mean reaction times and percentage of errors for three types of pseudowords: (1) root–suffix combinations with high interpretability; (2) root–suffix combinations with low interpretability; and (3) no root–no suffix combinations.

Burani, Dovetto, Spuntarelli, & Thornton, *Brain and Language*, 1999

Lexical decision on Pseudowords

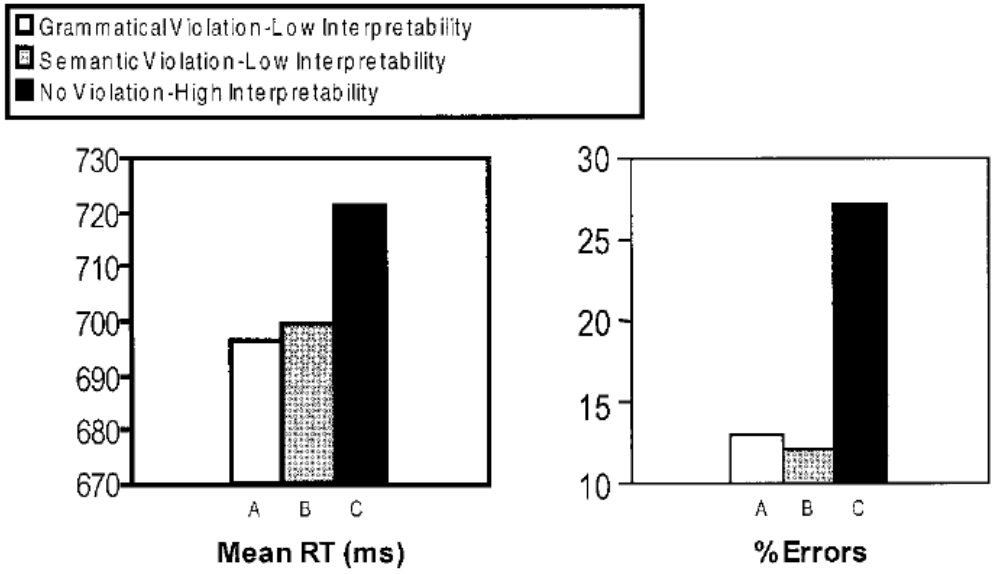


FIG. 1. Lexical decision experiment: mean reaction times and percentages of errors for three types of root–suffix pseudowords. (A) Violating the grammatical restrictions on the category of the base; low interpretability. (B) Violating the semantic restrictions on the base; low interpretability. (C) No violation; high interpretability.

Burani, Dovetto, Spuntarelli, & Thornton, *Brain and Language*, 1999

(2) Orthographic/phonological transparency

- Transparent with respect to the base:

- dominazione (domin-) ‘domination’
- imitazione (imit-) ‘imitation’

- Non transparent with respect to the base:

- distruzione (distrugg-) ‘destruction’
- aggressione (aggred-) ‘aggression’

Orthographic/Phonological transparency Naming studies

- Carlisle & Stones (2005): effects on accuracy in elementary school; effects on speed only in younger kids
- Deacon *et al.* (2011): effects only on low-frequency words
- Carlisle (2001):

stable words (e.g., CULTURAL)

better than

unstable words (e.g., MAJORITY)

in both typical and disabled adolescent readers

- Shiff et al. (2008):

masked priming on Hebrew third- and seventh-grade children. Morphological facilitation on targets when primes and targets contained all three letters of the root. No morphological facilitation when primes and targets did not overlap in the surface forms of the root

Scandinavian Journal of Psychology, 2015 DOI: 10.1111/sjop.12213

Health and Disability

How orthographic transparency affects morphological processing in young readers with and without reading disability

MIGUEL LÁZARO,[1] LAURA GARCÍA[1] and CRISTINA BURANI[2,3]

[1]*Department of Psychology, University of Castilla la Mancha, Toledo, Spain*
[2]*Institute of Cognitive Sciences and Technologies, Rome, Italy*
[3]*University of Trieste, Trieste, Italy*

Spanish children (8-9 ys. old)

Tasks:
- Word definition
- Lexical decision

- Transparent :

- jardinero (jardín)

  “gardener-garden”

- semanal (semana)

  “weekly-week”

- cantante (cantar)

  “singer-sing”

- Non transparent :

- obrero (obra)

  “labourer-work”

- dentista (diente)

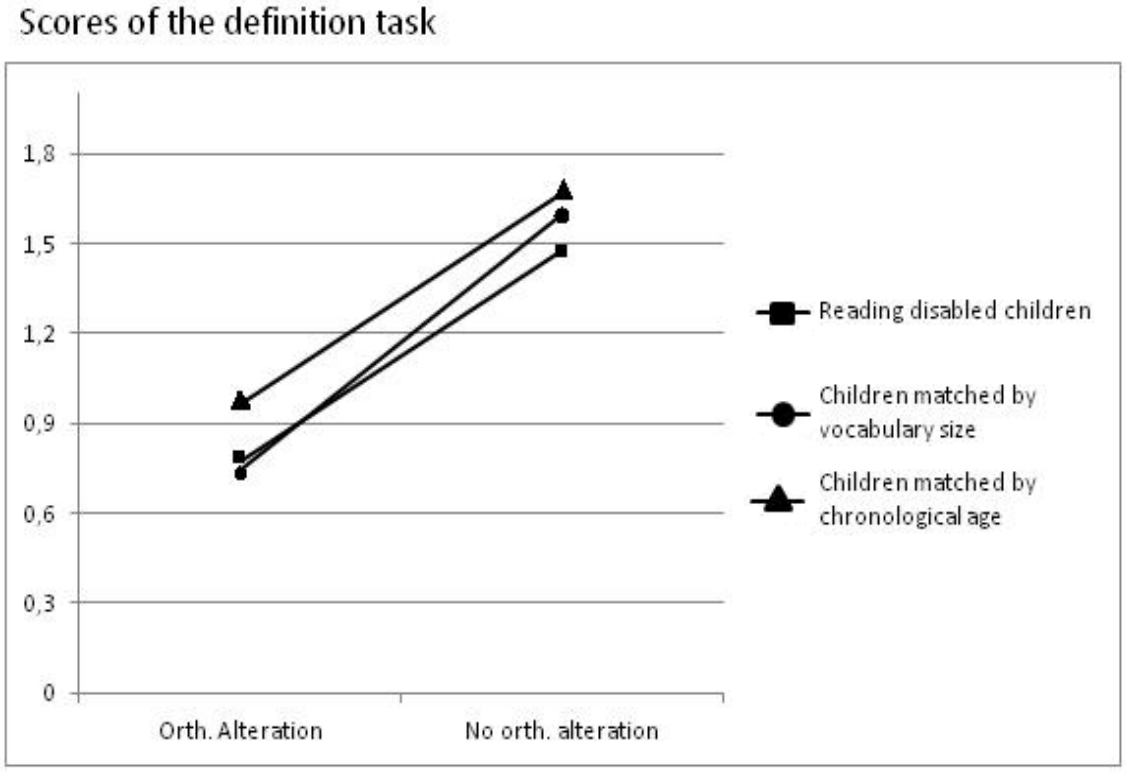
  “dentist-tooth”

- mortal (muerte)

  “mortal-death”

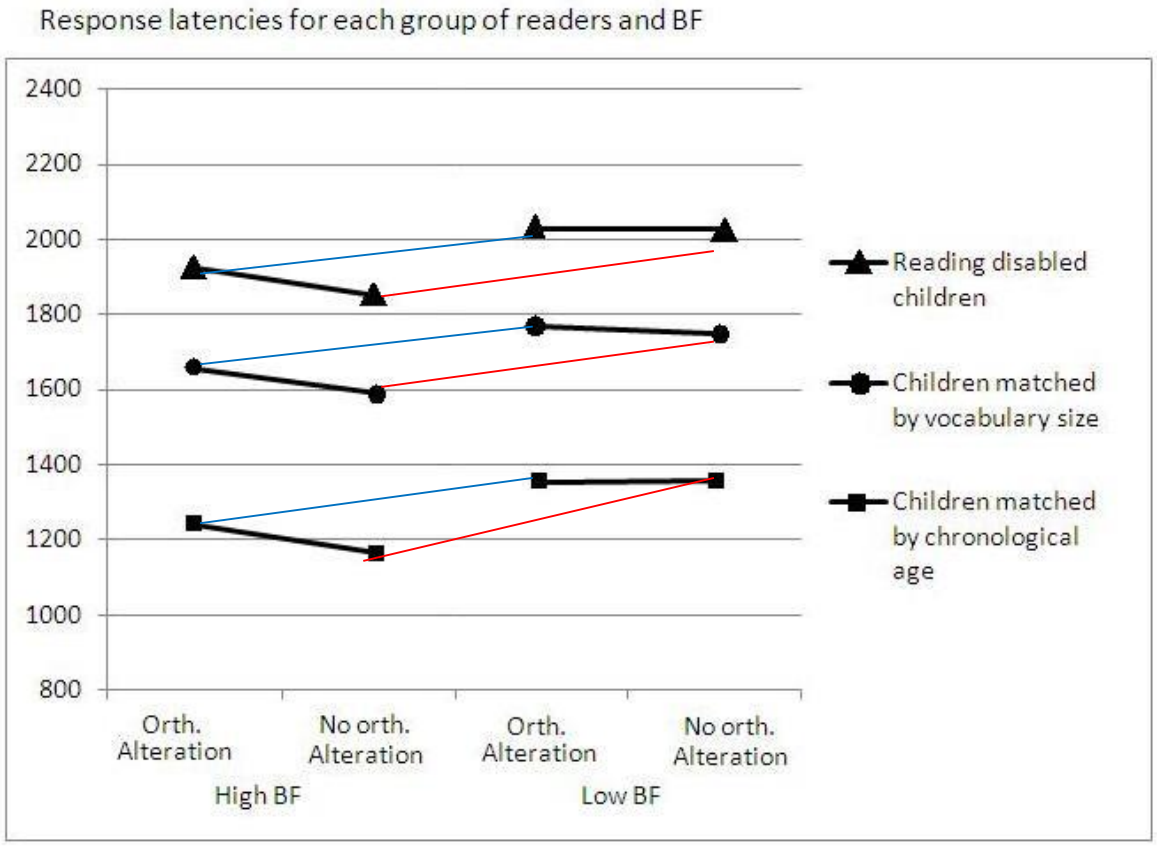
Lázaro *et al*. (2015)

Definition task



Lázaro *et al*. (2015)

Lexical decision task



Results

Definition task: all children, irrespective of reading skill, were worse at defining derived words that had an orthographic alteration of the base stem than words with no orthographic alteration

Lexical decision task: longer RTs for words with morpho-orthographic alterations than words without morpho-orthographic shifts (see also Quémart & Casalis, 2014; Carlisle et al., 2001); base frequency affected derived words with no orthographic alteration more than words with alterations, irrespective of reading skill

Overall: all children benefitted from a high frequency base, and morphological processing was affected by orthographic alterations similarly in proficient and impaired readers

(3) Morpheme-based spelling in Italian children with and without dyslexia

In Italian, morphological decoding is not necessary for correct spelling

(see Pacton & Deacon, 2008)

English	French	Italian
/e/ : bed, head, said, **health** (from 'heal', root consistency) MAGIC → Magician DISCUSS→Discussion EXPLAIN→Explanation	/et/ in diminutives: **-ette** (fillette, 'little girl'; maisonnette, 'little house') **Not –aite, -ète, -ête**	casetta 'little house' fretta 'hurry' purezza 'purity' carezza 'caress' pesata 'weighed' pirata 'pirate'

Do morphemes affect spelling accuracy ?

DYSLEXIA
Published online 8 February 2017 in Wiley Online Library
(wileyonlinelibrary.com). DOI: 10.1002/dys.1554

Morpheme-based Reading and Spelling in Italian Children with Developmental Dyslexia and Dysorthography

Paola Angelelli[1*], Chiara Valeria Marinelli[1,2], Marinella De Salvatore[1] and Cristina Burani[3,4]

[1]*Department of History, Society and Human Studies, Lab of Applied Psychology and Intervention, University of Salento, Lecce, Italy*
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[3]*Institute of Cognitive Sciences and Technologies, CNR, Rome, Italy*
[4]*Department of Life Sciences, University of Trieste, Trieste, Italy*

Follow-up of…

frontiers in PSYCHOLOGY

ORIGINAL RESEARCH ARTICLE
published: 19 November 2014
doi: 10.3389/fpsyg.2014.01373

The effect of morphology on spelling and reading accuracy: a study on Italian children

Paola Angelelli[1], Chiara Valeria Marinelli[2] and Cristina Burani[3,4]*

[1] *Department of History, Society and Human Studies, University of Salento, Lecce, Italy*
[2] *Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS) Santa Lucia, Rome, Italy*
[3] *Istituto di Scienze e Tecnologie della Cognizione, Consiglio Nazionale delle Ricerche, Rome, Italy*
[4] *Department of Life Sciences, University of Trieste, Trieste, Italy*

Participants :

- **3rd grade children with dyslexia and dysorthographia (N= 16)**

  Marked reading and spelling delay on standard tests. IQ level within normal limits

- **3rd grade typically developing children (N= 16)**

  Matched to children with dyslexia and dysorthographia for chronological age (mean age = 8.57 year, sd = 0.31) , gender and non-verbal intelligence (Raven test)

Spelling to dictation:

Children repeat each item before writing it in capital letters. No feedback.

Accuracy (% correct spellings)

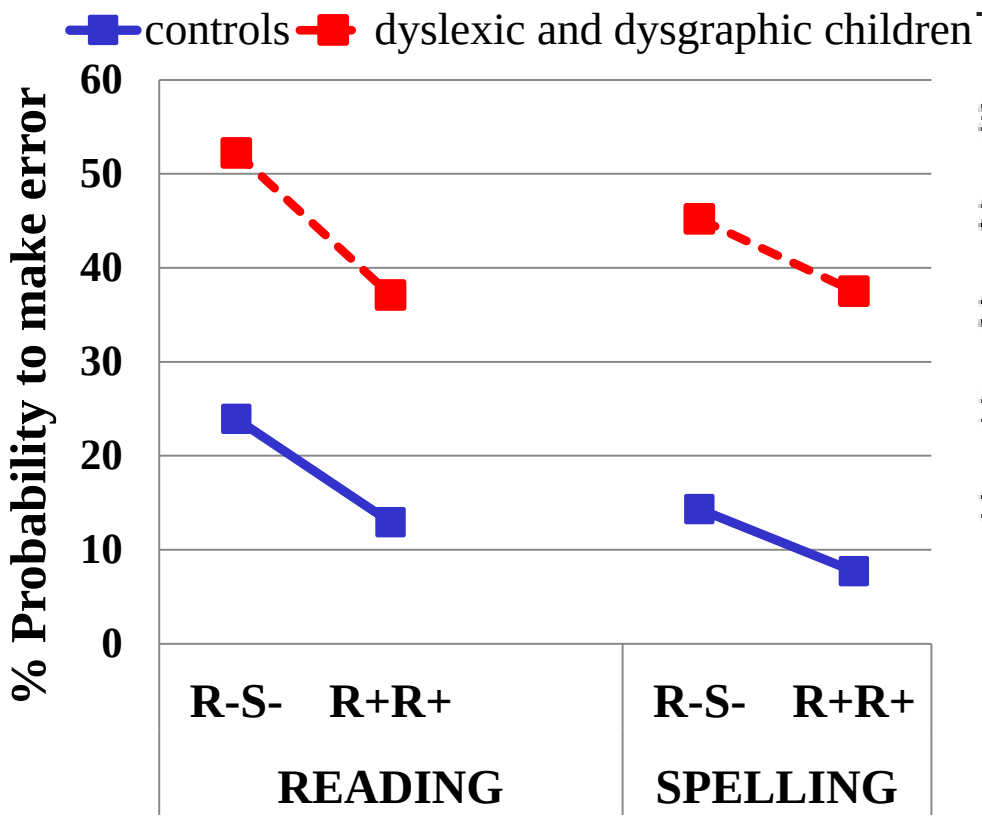
PSEUDOWORDS:

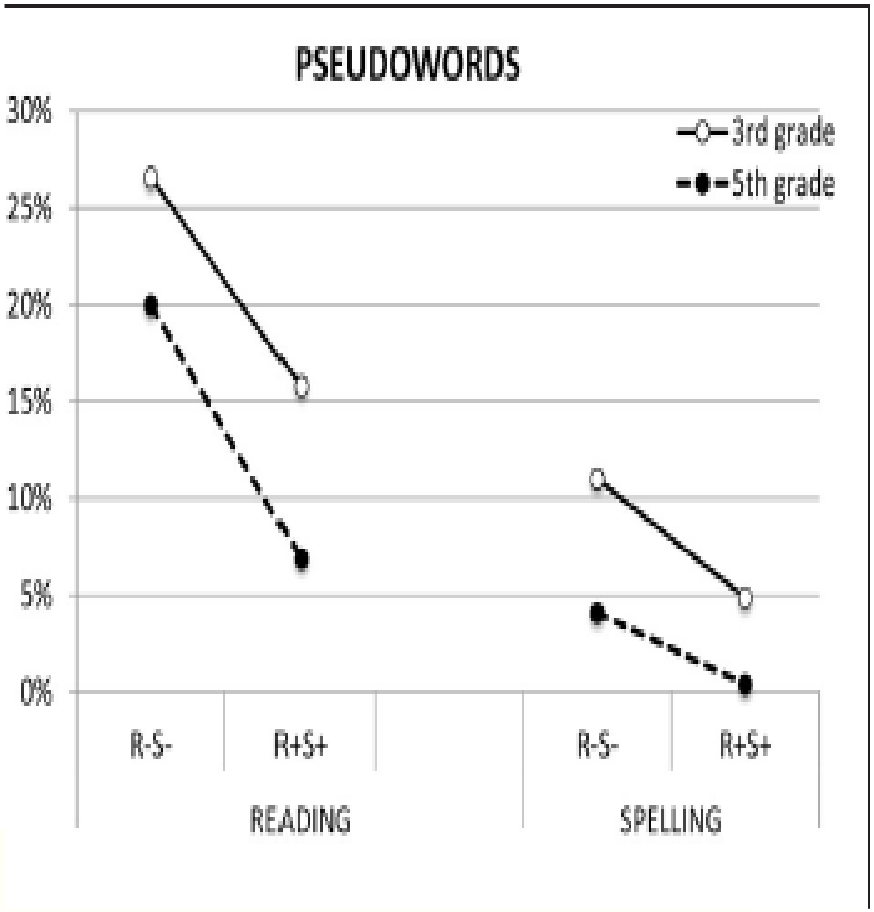
(Length: 8-10 letters)

R+S+ : Complex (Root + derivational Suffix)

R-S- : Simple (No Root – No Suffix)

PSEUDOWORDS





Angelelli et al., 2014

QUALITATIVE ANALYSIS OF ERRORS

(Angelelli et al., 2014; 2017)

frontiers in PSYCHOLOGY

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Target: POPPATOIO (feeding bottle)

Errors: POPPATO (sucked)
POPPA (breast)
*PAPPATOIO (PAPPA= din-dins)
*POMPATOIO (POMPA= pump)
*DOPPIATORIO(DOPPIO= double

Suffix substitution

Root substitution

Root and Suffix substitutions

TORIO = alternate suffix for TOIO

Spelling in transparent orthographies

Lexical units are used despite
-- sequential «left-to-right» processing
-- easiness of sub-lexical Ph/G correspondences

Access to morphemes:
retrieval of pre-assembled lexical units

Morpheme-based organization of lexicon
in morphologically rich languages and
attitude to parsing words in constituents ?
(see Lehtonen & Bryant, 2005 for Finnish)

Conclusions

Morphemes are used
as both reading and spelling units

Familiar morphemes not only
improve reading fluency
but also spelling accuracy
of new and low-frequency words

In both typically developing children and
children with dyslexia-dysorthography

Pseudowords (Burani et al., 2008)

ROOT + SUFFIX	NO ROOT + NO SUFFIX
MAMMISTA	MEMMOSTO
GITISTA	GETOSTO
ERBISTA	ERMOSTO
DONNISTA	DENNOSTO
ZAMPISMO	ZEMPOSTA
CODISMO	CUDOSTA
CARTISMO	CURTOSTA
PALLISMO	PILLOSTA
BAGNEZZA	BOGNALLE
VETREZZA	VATREZZO
SOGNEZZA	SANNEZZO
CORPEZZA	CURPEZZO
STRADOSO	STRODASA
CUOROSO	CUONEDE
STELLOSO	STOLLEDE
GUERROSO	GUARREDE

Derived words *vs.* Simple words (Burani et al., 2008)

DERIVED	
cantante	scaletta
bellezza	fioraio
vetrina	storiella
segnale	signorina
mancanza	conoscenza
dentista	insegnante
trenino	pescatore
maglione	importanza
cartina	autista
piattino	calciatore
tristezza	giovanotto
occhiata	vincitore
guerriero	negoziante
drogato	parolaccia
dolcezza	vicinanza
linguaggio	libreria
grandezza	camminata
balletto	gelataio
vecchiaia	terriccio
villetta	camionista
lupetto	speranza
nuotata	giretto
passante	suonatore
cassiere	pecorella

NON DERIVED	
discorso	panorama
ginocchio	labirinto
vicenda	sacerdote
cristallo	documento
lavagna	funerale
capanna	patrimonio
valigia	materasso
vergogna	nostalgia
prosciutto	pergamena
cammello	cimitero
galassia	cioccolato
corteccia	assassino
parrucca	tramonto
valanga	tragedia
scaffale	gorilla
salsiccia	diluvio
orchestra	soggetto
narciso	lombrico
tartaruga	castagna
continente	battaglia
intervallo	siringa
paradiso	stipendio
coccinella	vulcano
indirizzo	metallo

Frequency x Morphology (Marcolini et al., 2011)

Derived Words			Simple words	
High F.	Low F.		High F.	Low F.
divertimento	trattamento		programma	rinoceronte
popolazione	tentazione		monumento	filastrocca
personaggio	linguaggio		orologio	narciso
bellezza	pienezza		bicchiere	privilegio
conoscenza	maggioranza		finestra	pistacchio
dentista	velocista		problema	documento
giocatore	disegnatore		intervallo	materasso
cantante	aiutante		coccodrillo	patente
pensiero	ossario		biscotto	denuncia
pizzeria	prateria		caramella	galassia
amicizia	giustizia		tartaruga	patrimonio
maglietta	poveretto		merenda	pergamena
giornata	fermata		margherita	pantera
vestito	bigliettaio		petrolio	padella
risultato	caldaia		discorso	presepe
patatina	gattino		canarino	arlecchino
signorina	scarpone		giardino	alluvione
pallone	piedone		polmone	paragone
tavolino	tendina		stivale	funerale
uccellino	piantina		carnevale	scaffale

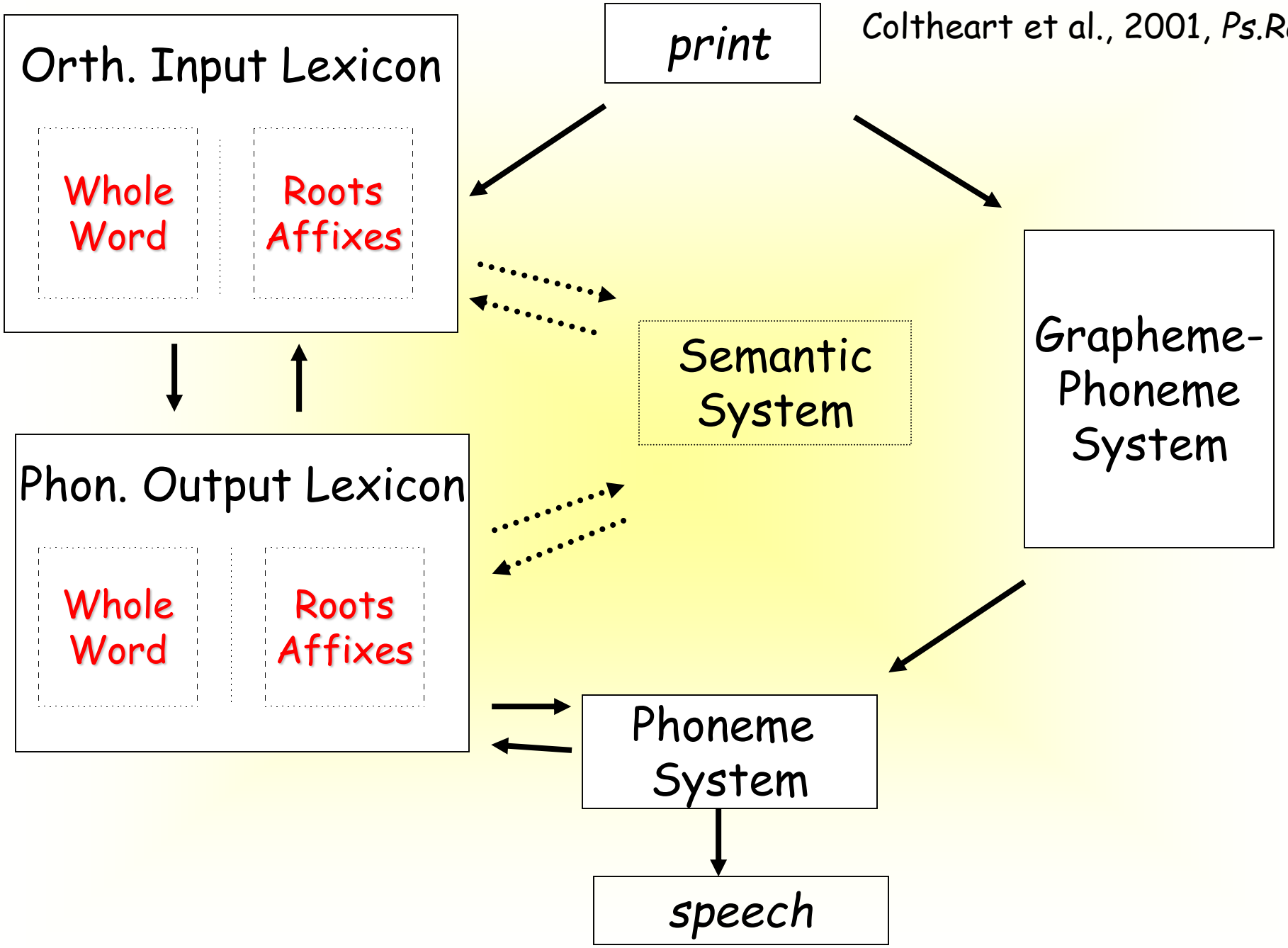
Root length
(Burani et al., 2018)

Parole sperimentali derivate

DER RAD 3	DER RAD 4	DER RAD 5	DER RAD 6
pagamento	rendimento	trattamento	divertimento
fumatore	servitore	parolaccia	osservatore
muratore	mancanza	calciatore	conoscenza
potenza	salvezza	esistenza	importanza
durezza	partenza	guerriero	lontananza
ossario	acquario	grandezza	negoziante
visiera	villetta	storiella	bambolotto
autista	corsetta	foglietto	scherzetto
casetta	dolcetto	maglietta	giovanotto
giretto	entrata	gelataio	pastorello
finale	fioraio	occhiata	mattinata
sedile	libraio	scarpone	vecchiaia
serata	gattino	stellina	ragazzino
ditone	piedino	nipotino	sorellina
nasino	zampina	regalino	cavallino

Parole filler semplici

commento	documento	monumento	complimento
oriente	sergente	sbadiglio	recipiente
docente	denuncia	occidente	ghirlanda
recinto	ciliegio	labirinto	privilegio
padella	menzogna	ciambella	gabinetto
cicogna	cotoletta	barzelletta	singhiozzo
civetta	ricetta	traghetto	coccodrillo
difetto	soggetto	marmellata	zafferano
sultano	vulcano	spavento	assassino
tumore	accento	paragone	mandarino
faraone	istinto	grissino	nicotina
vaccino	cuscino	arlecchino	filastrocca
mimosa	canarino	proteina	rinoceronte
letame	morfina	minestra	scarafaggio
imbuto	materasso	stipendio	intervallo


print
Coltheart et al., 2001, Ps.Rev.
Orth. Input Lexicon
Whole Word
Roots Affixes
Semantic System
Grapheme-Phoneme System
Phon. Output Lexicon
Whole Word
Roots Affixes
Phoneme System
speech

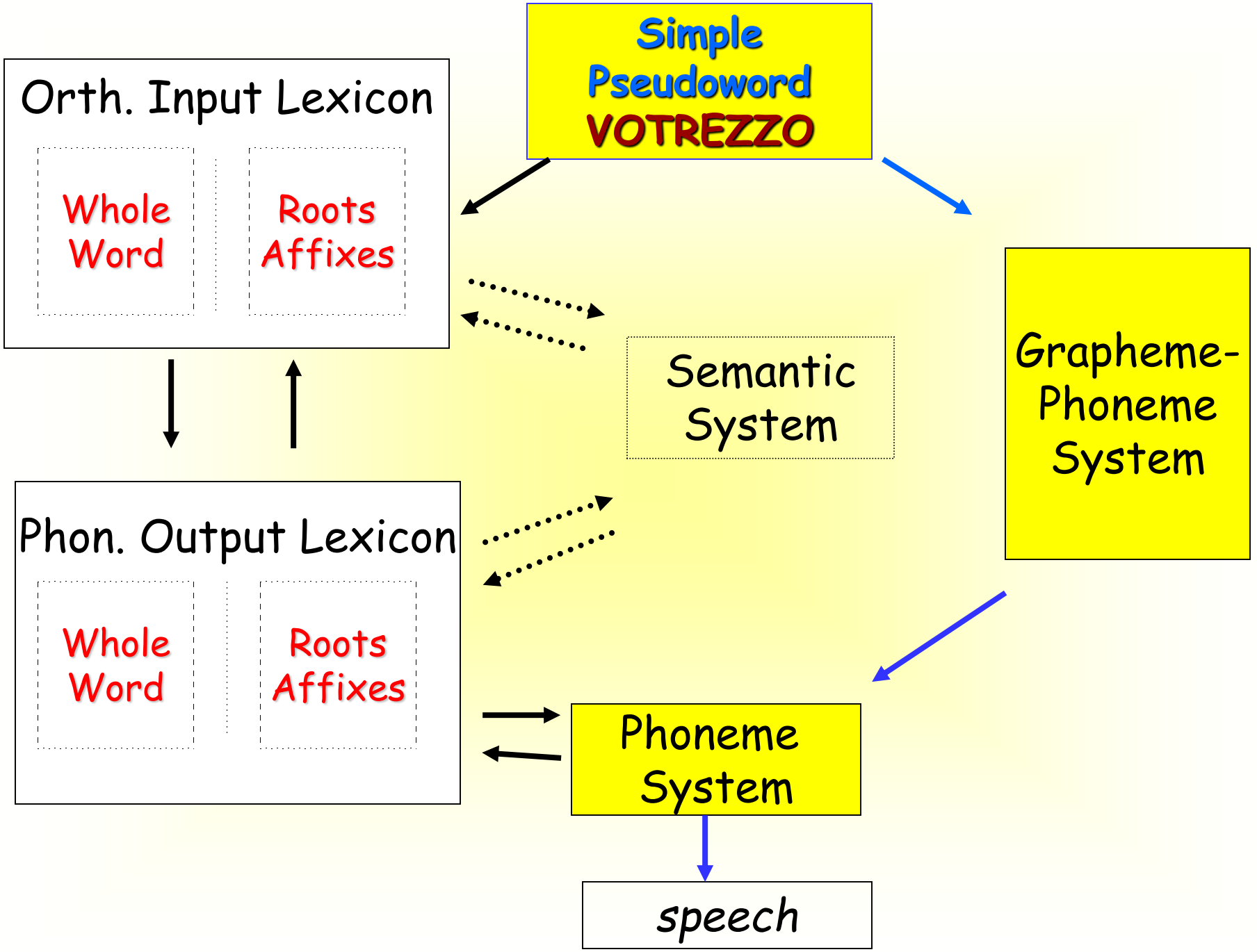
Pseudowords

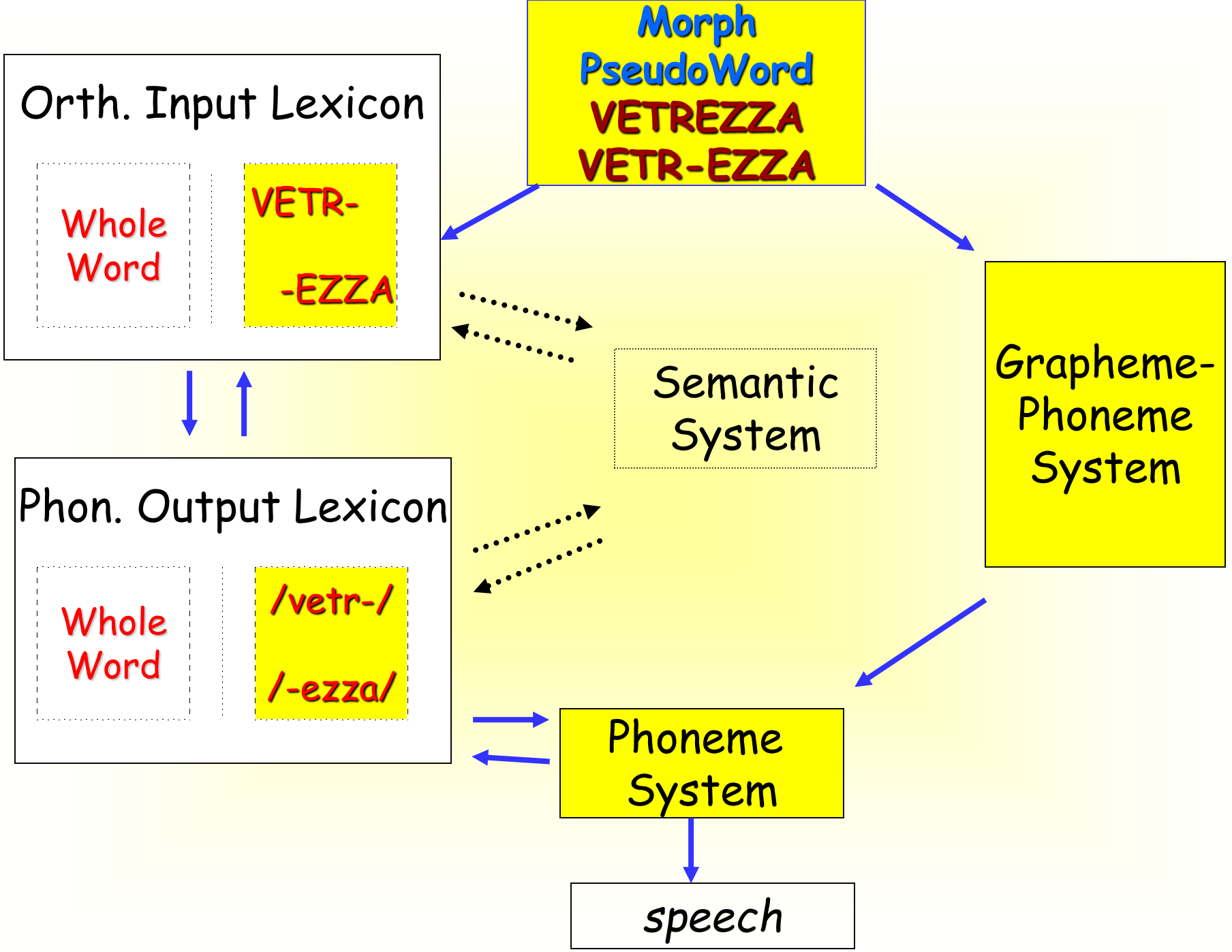
VETREZZA VOTREZZO

VETR - EZZA < VOTREZZO

Real Root + Real Suffix ("glass" - "ness")

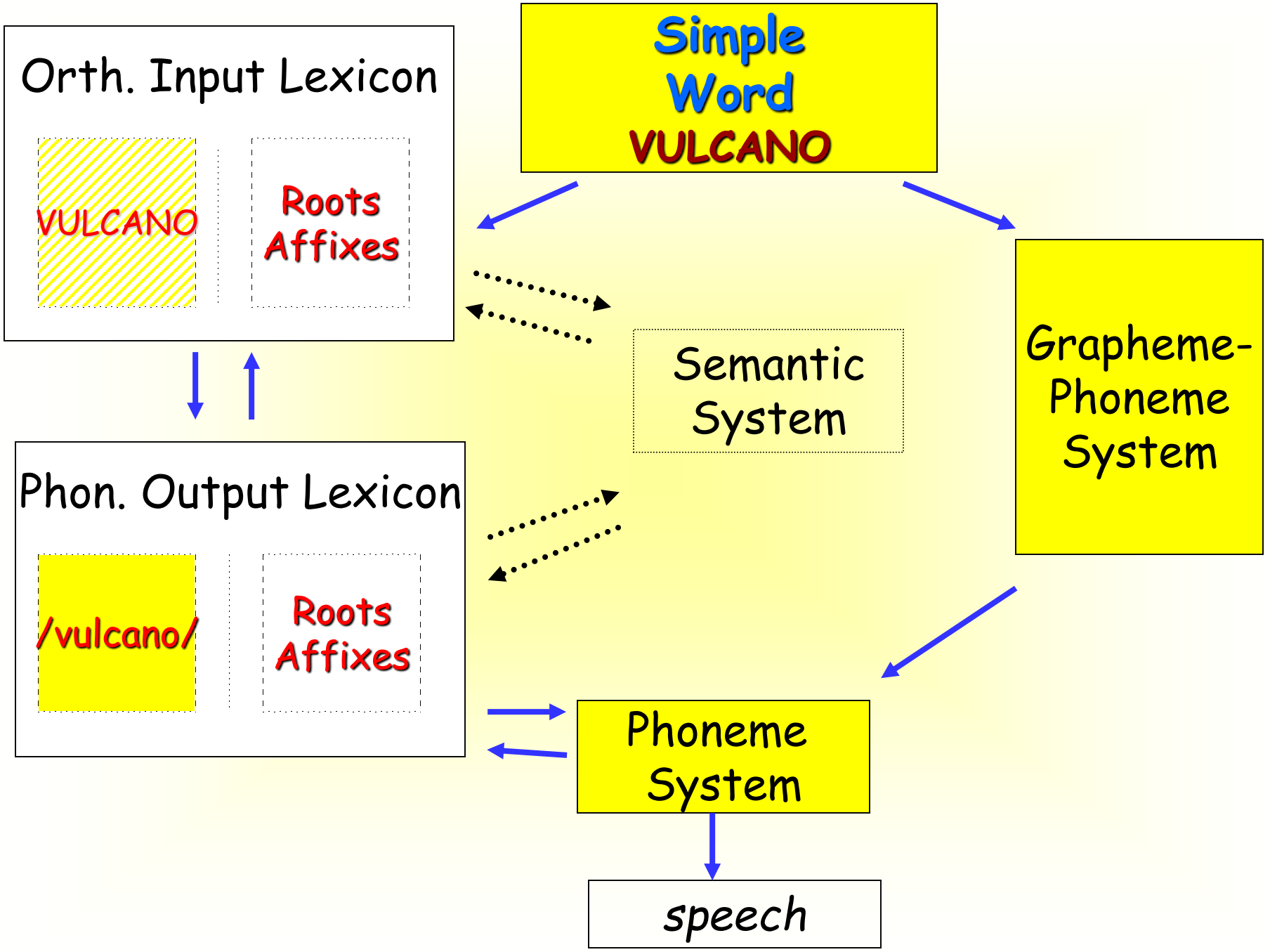
Non Root + Non Suffix (-) (-)

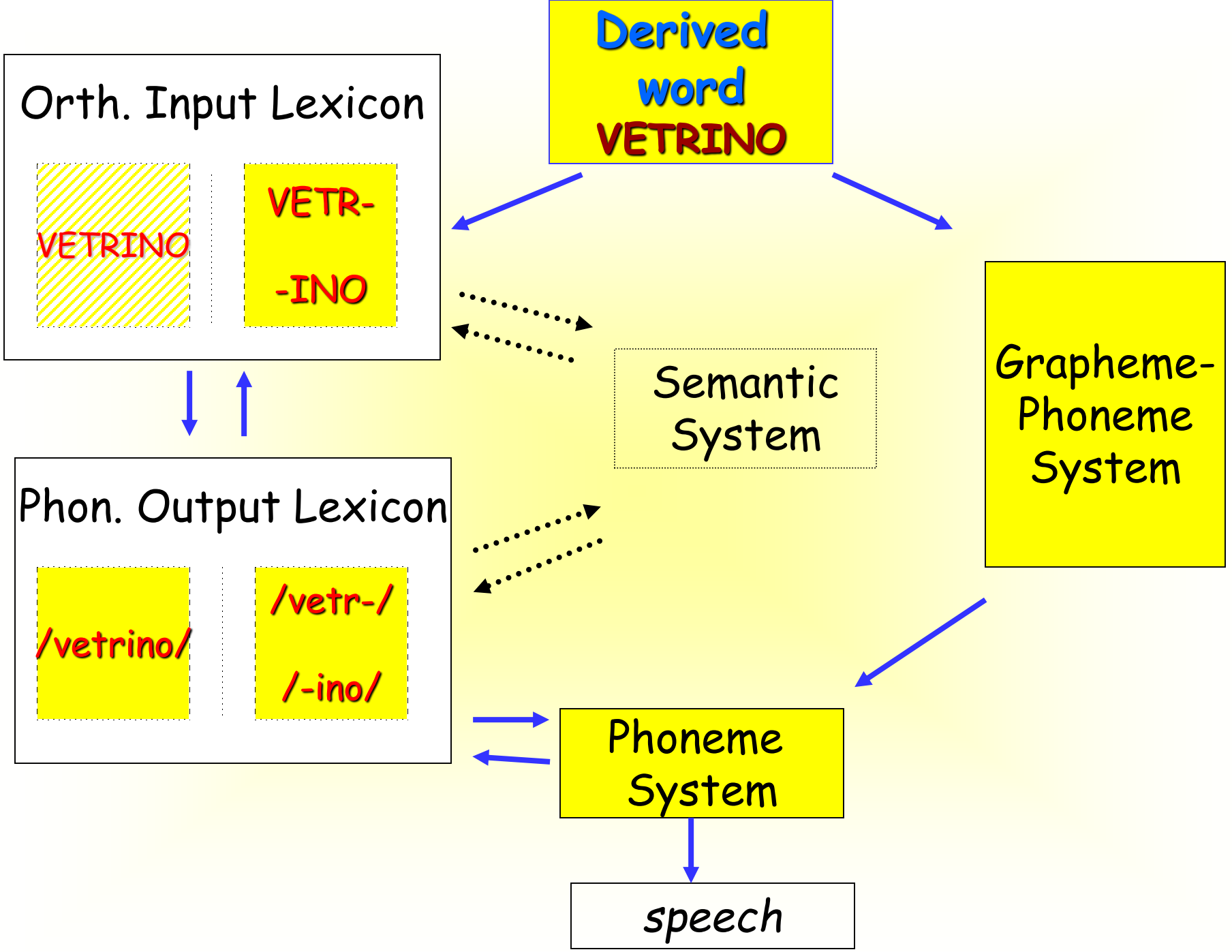

Simple
Pseudoword
VOTREZZO
Orth. Input Lexicon
Whole Word
Roots Affixes
Semantic System
Grapheme-Phoneme System
Phon. Output Lexicon
Whole Word
Roots Affixes
Phoneme System
speech

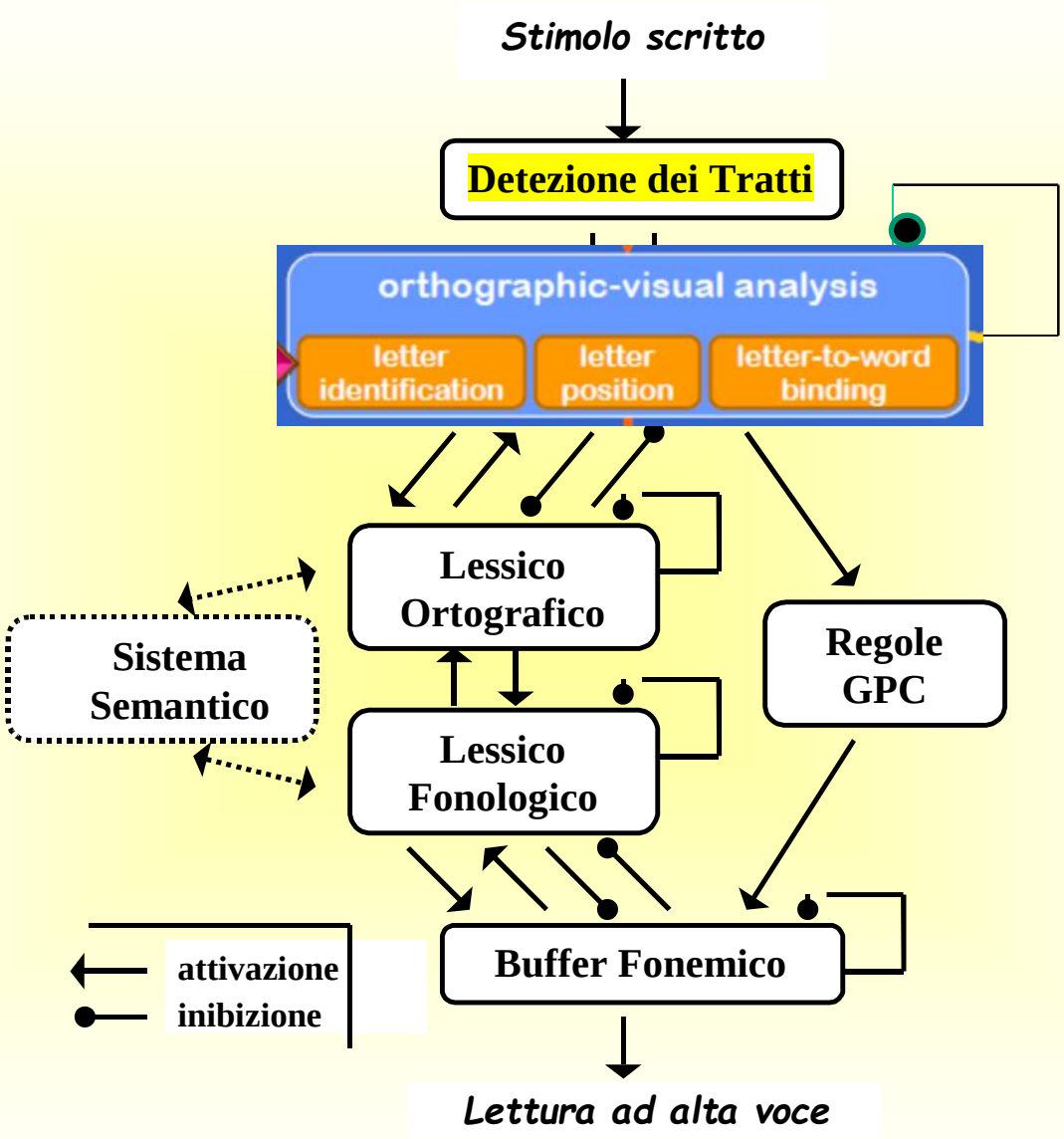

Morph
PseudoWord
VETREZZA
VETR-EZZA
Orth. Input Lexicon
Whole Word
VETR-
-EZZA
Semantic System
Grapheme-Phoneme System
Phon. Output Lexicon
Whole Word
/vetr-/
/-ezza/
Phoneme System
speech

Words

SIMPLE	DERIVED
VULCANO (volcano)	VETR-INO (glass- small)


Simple Word
VULCANO
Orth. Input Lexicon
VULCANO
Roots
Affixes
Semantic System
Grapheme-Phoneme System
Phon. Output Lexicon
/vulcano/
Roots
Affixes
Phoneme System
speech


Derived word VETRINO
Orth. Input Lexicon
VETRINO
VETR-
-INO
Semantic System
Grapheme-Phoneme System
Phon. Output Lexicon
/vetrino/
/vetr-/
/-ino/
Phoneme System
speech


Stimolo scritto
Detezione dei Tratti
orthographic-visual analysis
letter identification
letter position
letter-to-word binding
Lessico Ortografico
Sistema Semantico
Regole GPC
Lessico Fonologico
Buffer Fonemico
attivazione
inibizione
Lettura ad alta voce

(1) Word comprehension of Low-frequency (derived and simple) words by child readers (2nd to 4th grade) and young readers with Williams Syndrome

WORD DEFINITION TASK "What does this mean?" (see Bertram et al., *SJP*, 2000)

Burani, Bimonte, Barca, & Vicari, *Brain and Language*, 2006

Word comprehension of Low-frequency (derived and simple) words by child readers (2nd to 4th grade) and young readers with Williams Syndrome

WORD DEFINITION TASK "What does this mean?" (see Bertram et al., *SJP*, 2000)

DERIVED word

The meaning of a new word

COLOR-ISTA

(*root - suffix*)

can be obtained by combining the meanings of the two morphemes

COLOR	-E
	-I
	-ARE
	-ATO
	-ANTE
ART	-ISTA
DENT	-ISTA
UMAN	-ISTA

SIMPLE word

only the inflectional suffix is known

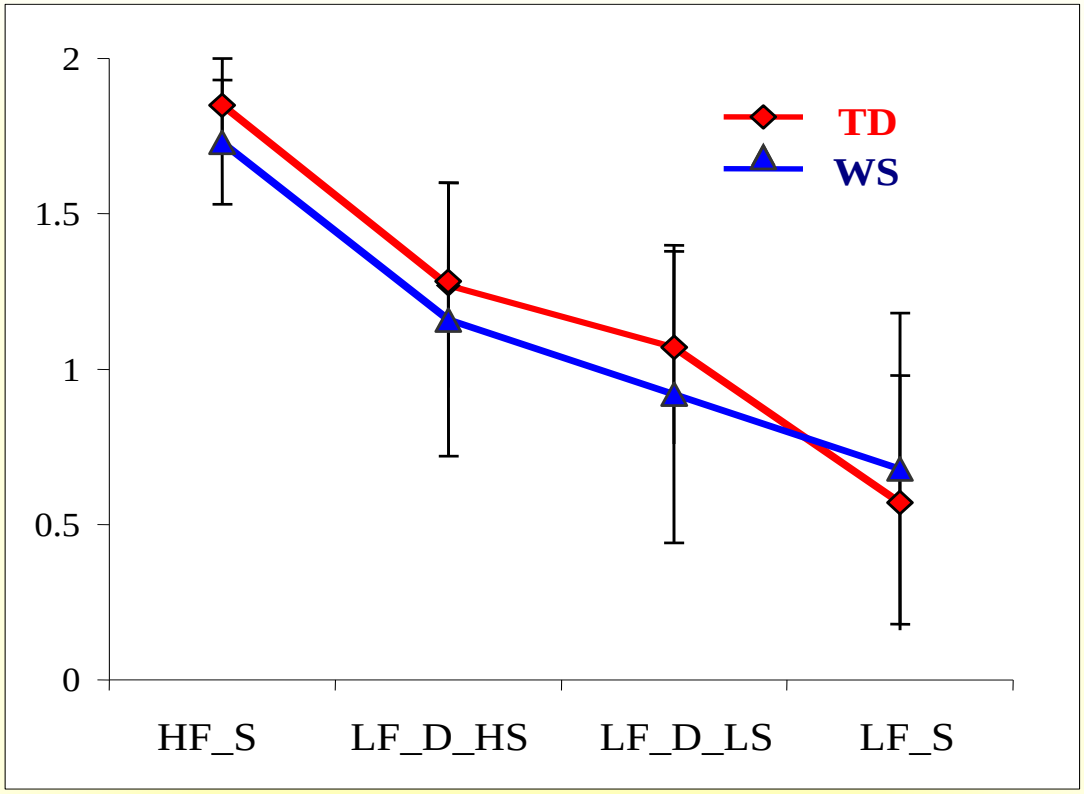
FARABUTT-O

(rascal)

Its meaning cannot be inferred, when encountered for the first time as an isolated word

Burani, Bimonte, Barca, & Vicari, *Brain and Language*, 2006

Mean definition scores for TD and WS as a function of Word type



HF_S = **H**igh **F**requency **S**imple words

LF_D_HS = **L**ow **F**requency **D**erived words - **H**igh productivity **S**uffix

LF_D_LS = **L**ow **F**requency **D**erived words - **L**ow productivity **S**uffix

LF_S = **L**ow **F**requency **S**imple words

Burani, Bimonte, Barca, & Vicari, *Brain and Language*, 2006

Word comprehension.

Children as young as 7 – 10 years old know the word's morphological constituents (roots and derivational suffixes) and use morphology to understand the meaning of a new (semantically and phonologically) transparent derived word.

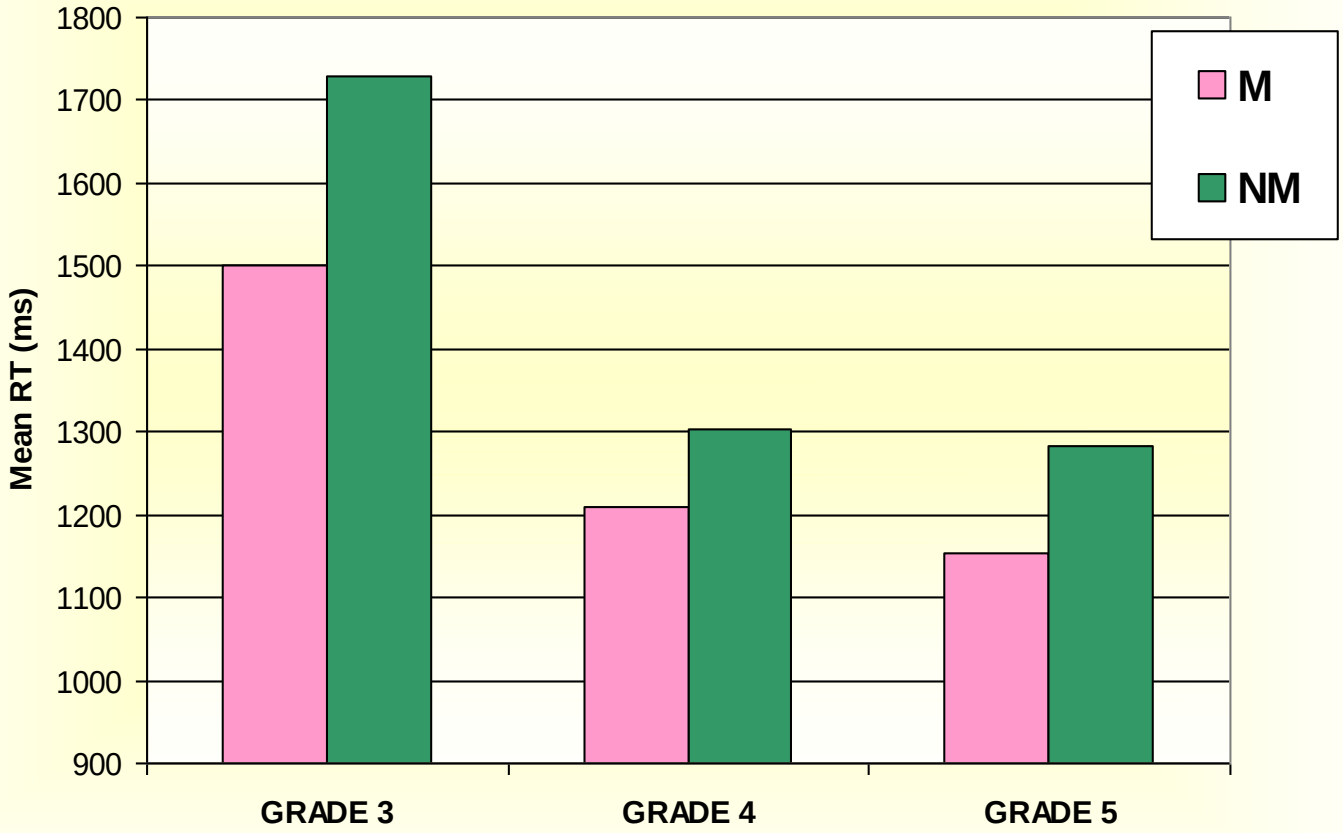
They are sensitive to frequency/productivity of suffixes

High-frequency roots

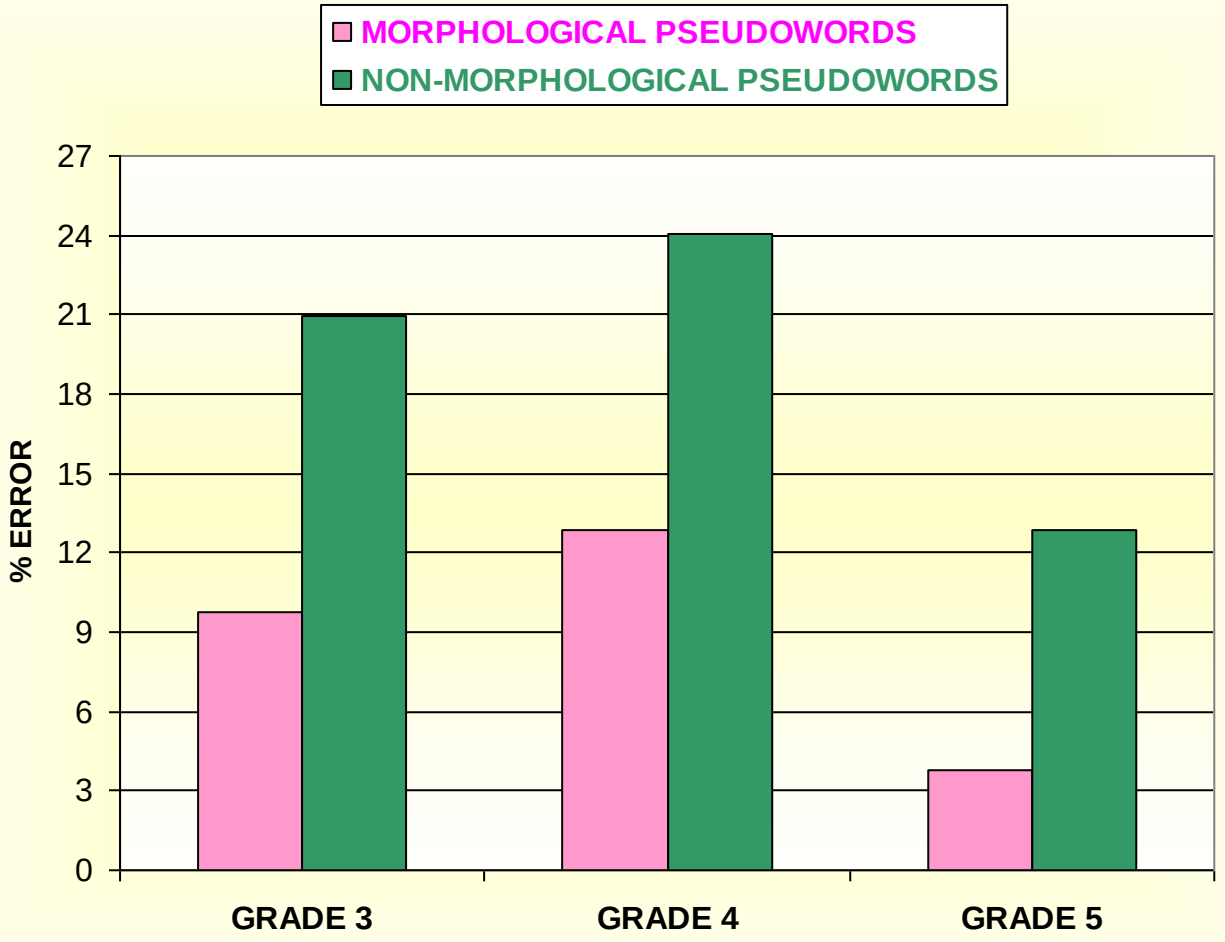
Burani, Bimonte, Barca, & Vicari, 2006

A	B	C	D
GONFIABILE	VIOLACEO	SBILENCO	CATTIVO
LAVABILE	ANIMALESCO	LOGORO	DIFFICILE
SCUSABILE	BAMBINESCO	SCHIETTO	FACILE
ASTRALE	BURLESCO	AGUZZO	GROSSO
ALBERATO	CAMPESTRE	FASULLO	IMPROVVISO
ARGENTATO	AMMIREVOLE	SPILORCIO	MAGGIORE
DESERTICO	LACRIMEVOLE	MESCHINO	PERFETTO
SCHELETRICO	SCHERZEVOLE	COSPICUO	PICCOLO
ODOROSO	MATTINIERO	MANSUETO	PROFONDO
OMBROSO	SANGUIGNO	ARZILLO	SOTTILE
PIETROSO	GUARDINGO	PETTEGOLO	STANCO
DUBBIOSO	PAZZOIDE	BIZZARRO	VIOLENTO
PESTAGGIO	BRODAGLIA	ASCESSO	ALBERGO
MAGLIERIA	BIRRAIO	CALCAGNO	BICCHIERE
VALIGERIA	LATTAIO	CARCASSA	BIGLIETTO
VETRERIA	OMBRELLAIO	BURRASCA	CAVALLO
AFFARISMO	AGRUMETO	CORTECCIA	COLTELLO
MAMMISMO	BANANETO	TRAPEZIO	FAZZOLETTO
SPIRITISMO	FRUTTETO	DAMIGIANA	GIARDINO
COLORISTA	ROSETO	GIAGUARO	MERAVIGLIA
MOTORISTA	CONIGLIERA	PULEDRO	OSPEDALE
ISOLAMENTO	OLIERA	FARABUTTO	PALAZZO
ORNAMENTO	AVARIZIA	TARTUFO	POLTRONA
RIEMPIMENTO	STENDITOIO	ZAMPOGNA	POLVERE
ADORAZIONE	MARCIUME	OVATTA	POMERIGGIO
PENSATORE	SUDICIUME	PALUDE	PRIGIONE

TABLE 3. Mean Reaction Times and Error Percentages in Children Pseudoword Reading



Burani, Marcolini, & Stella (2002), *Brain & Language*



Burani, Marcolini, & Stella (2002), *Brain & Language*

- Typically developing readers also benefit of morphemes (reading units shorter than the whole stimulus) but only in:

  - Pseudowords
  - Low-frequency words

i.e., stimuli that would be read via smaller units (graphemes and phonemes) in case morphemic constituents were absent

- Readers with dyslexia read consistently faster morphologically complex stimuli, both

  - Pseudowords and Words (Burani et al., 2008)
  - High- and Low-frequency words (Marcolini et al., 2011)

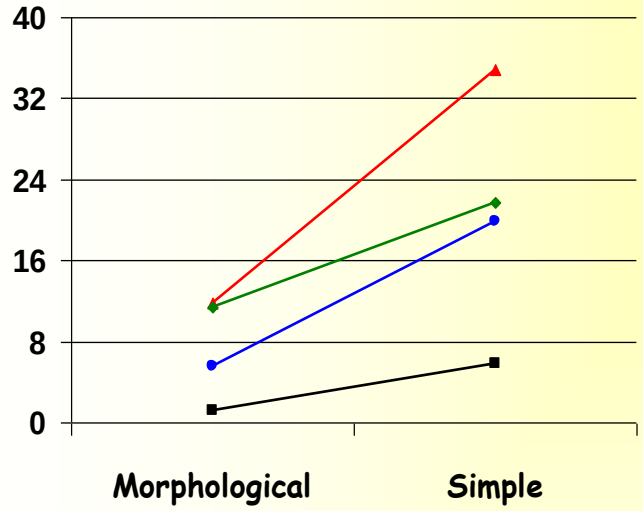
Italian Basic Dictionary

(Thornton, Iacobini, & Burani, 1997)

Low-frequency words:

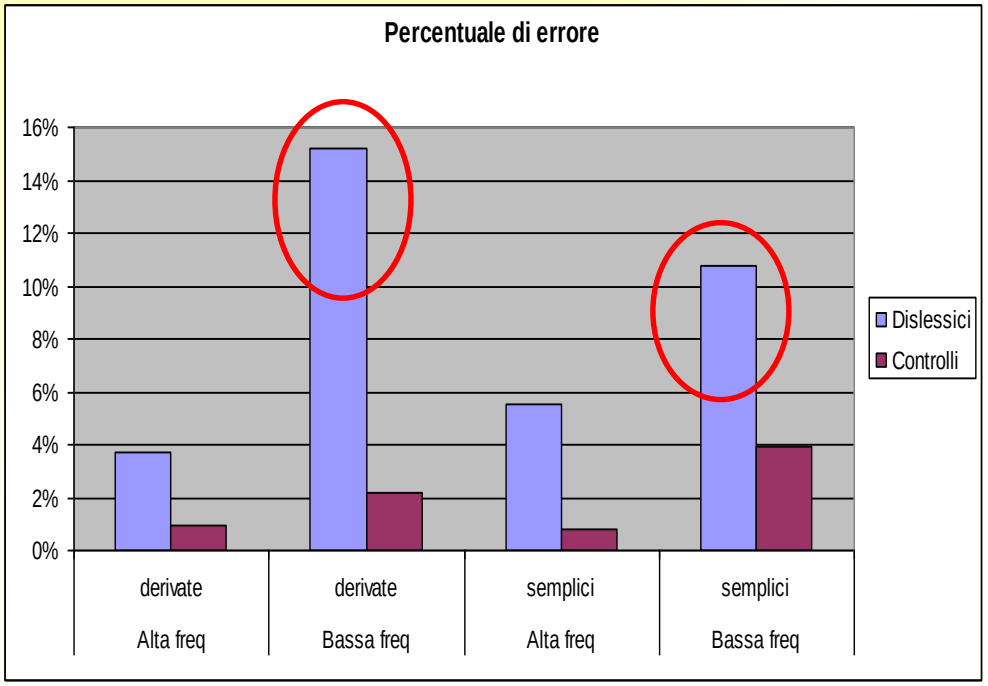
NON DERIVED (simple)		**31 %**
DERIVED (complex)	- Suffixed	**41 %**
	- Prefixed	**11 %**
	- Conversion	**10 %**
COMPOUNDS		**7 %**

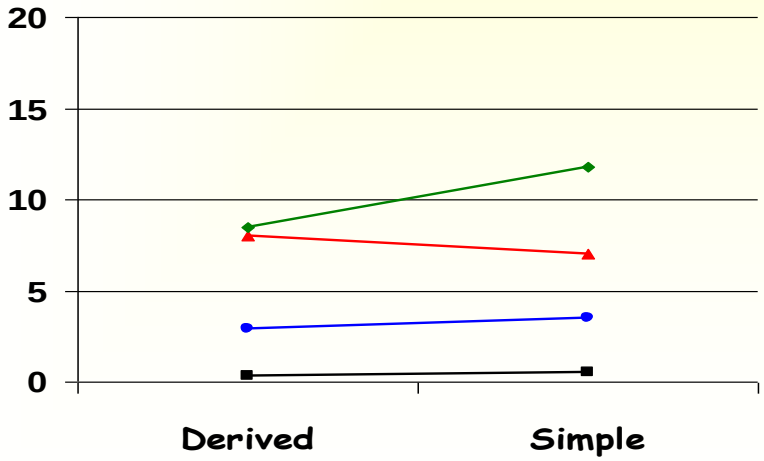
(5) Morphological effects on reading accuracy?



- Effects on pseudowords

- Less effects on words





Speed/Accuracy trade-off in readers with dyslexia ?

Root → Head-start to morphemic decomposition → Faster reading

But this can result in word-form substitutions, mainly on low-frequency derived words

e.g.:	OCCHIATA	→	OCCHIALI
	VECCHIAIA	→	VECCHIACCIA
	BIGLIETTAIO	→	BIGLIETTO
	OSSARIO	→	OSSO
	TENTAZIONE	→	TENTARE

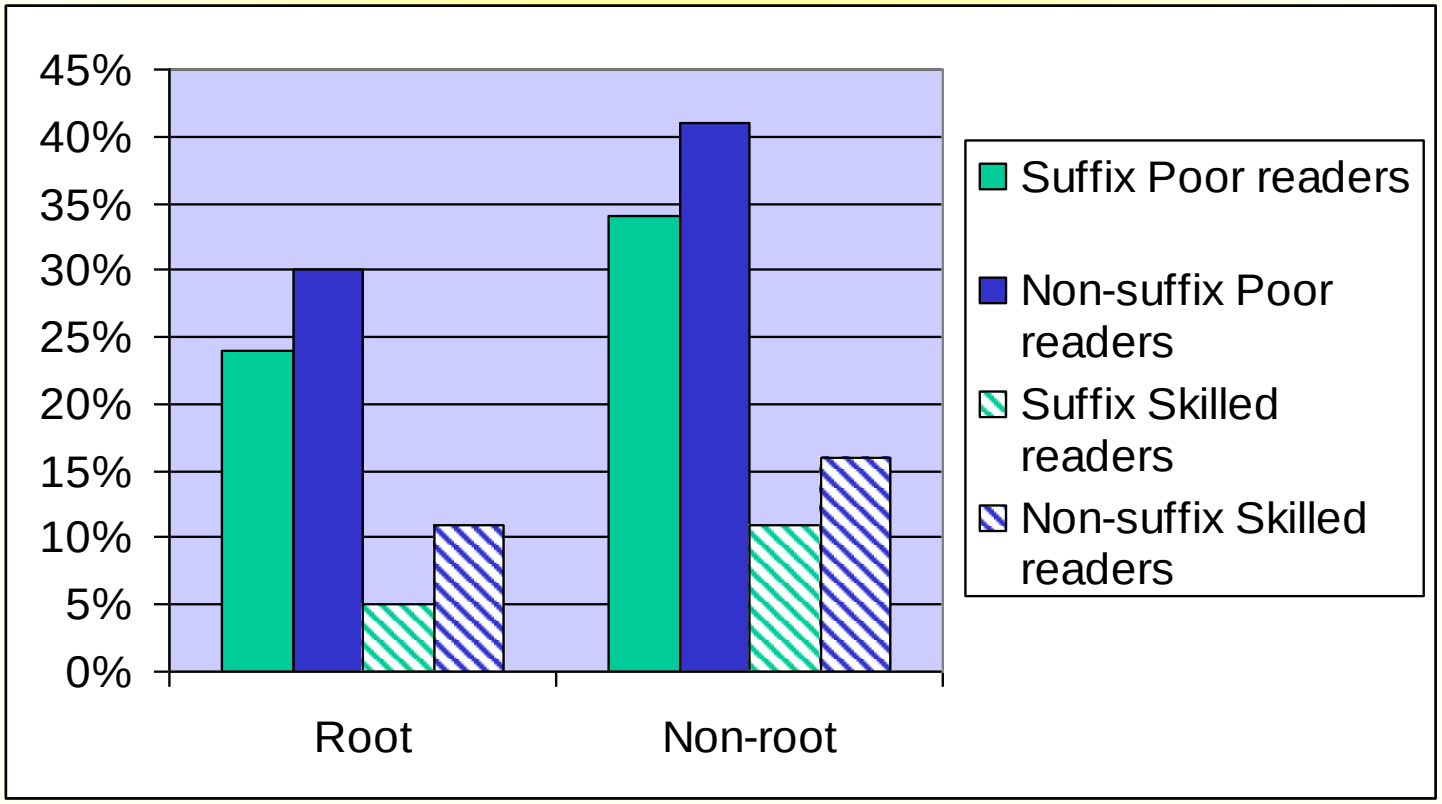
Marcolini, Traficante, Zoccolotti, & Burani (2011)

Pseudowords

(Traficante, Marcolini, Luci, Zoccolotti, & Burani, 2011, *Language and Cognitive Processes)*

	Root	*vs*	No Root
Suffix	VETREZZA		VOTREZZA
No Suffix	VETREZZO		VOTREZZO

Root Vs. Suffix *Pseudowords* ***ERROR %***

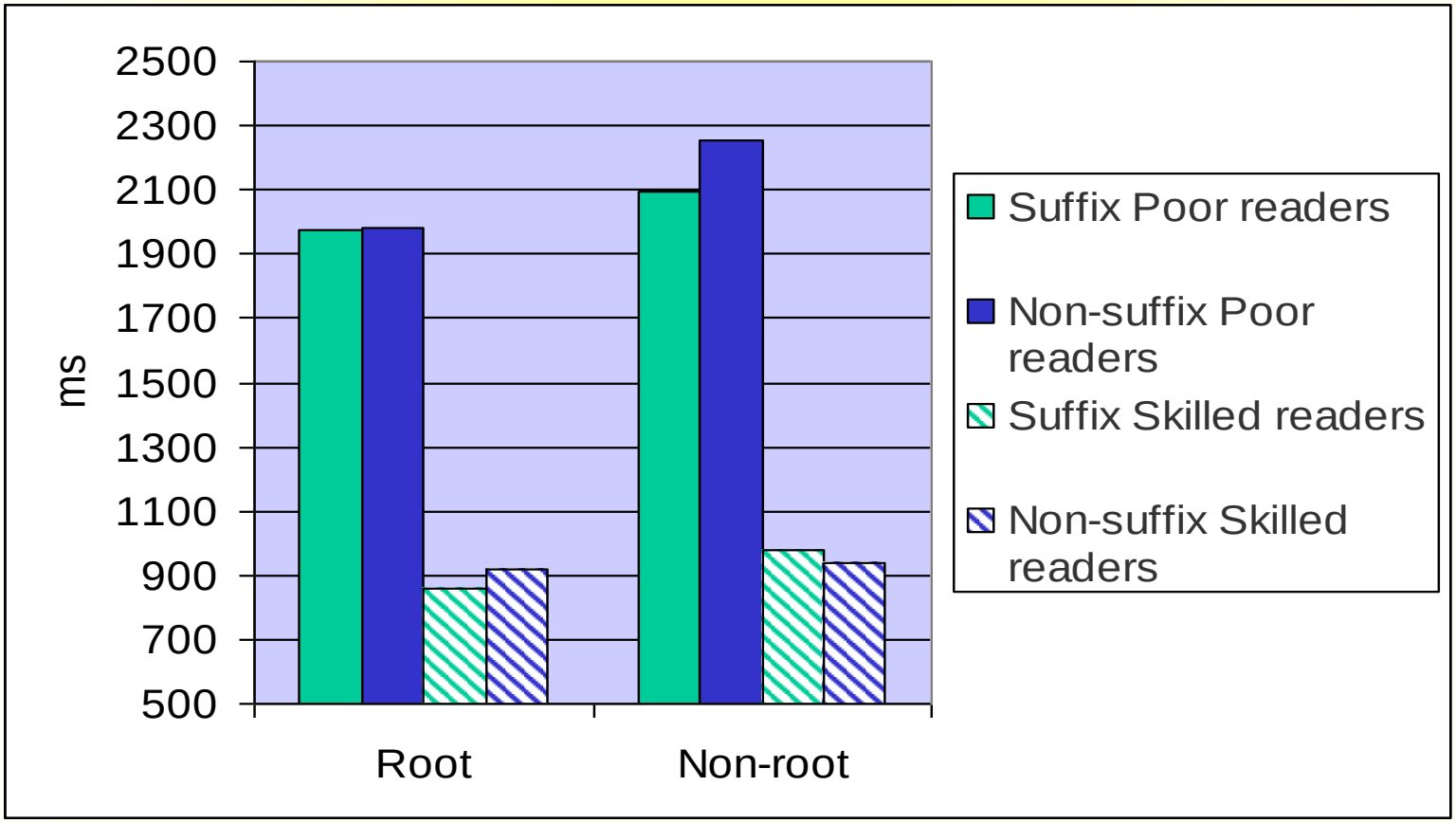


	Poor	**Skilled**	**Adults ***
Root effect (*%Err*):	**- 10.5**	- 5.5	- 0.3
Suffix effect(*%Err*):	-5.5	- 5.5	- 1.5

Traficante, Luci, Marcolini, Zoccolotti, & Burani, 2010

*Burani, Arduino, & Marcolini, *The Mental Lexicon Journal*, 2006

Root *vs.* Suffix *Pseudowords* **RTs**



	Poor	**Skilled**	**Adults ***
Root effect (*ms*):	- **181**	- 76	- 35
Suffix effect(*ms*):	-50	- 10	- 15

Traficante, Luci, Marcolini, Zoccolotti, & Burani, 2011;
*Burani, Arduino, & Marcolini, *The Mental Lexicon Journal*, 2006