Types of developmental dyslexia: directions for diagnosis and treatment

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seminar on "Developmental learning disorders and their remediation"

Dyslexias – different difficult words, different errors

form, could, trial	table, university
could, talk, now	smile, say, window
table, fork, smile	because, university
of, because, that	apple, fork, cloud

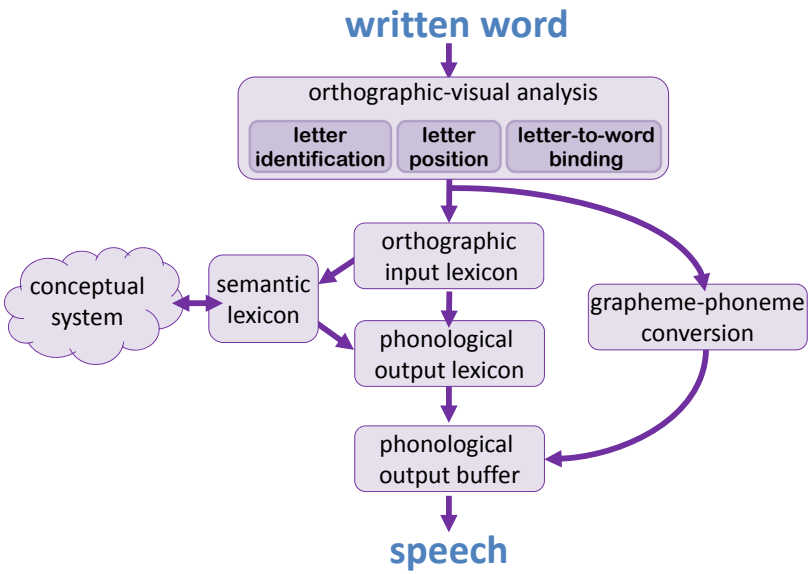
Dyslexias – different difficult words, different errors

form, could, signs	table, university ✓
from, cloud, sings	
could, talk, now	smile, say, window
cold, talc, know	
table, fork, smile	because, university
stable…cable, work, mile	
of, because, that	apple, fork, cloud
I don't know, why, hat	

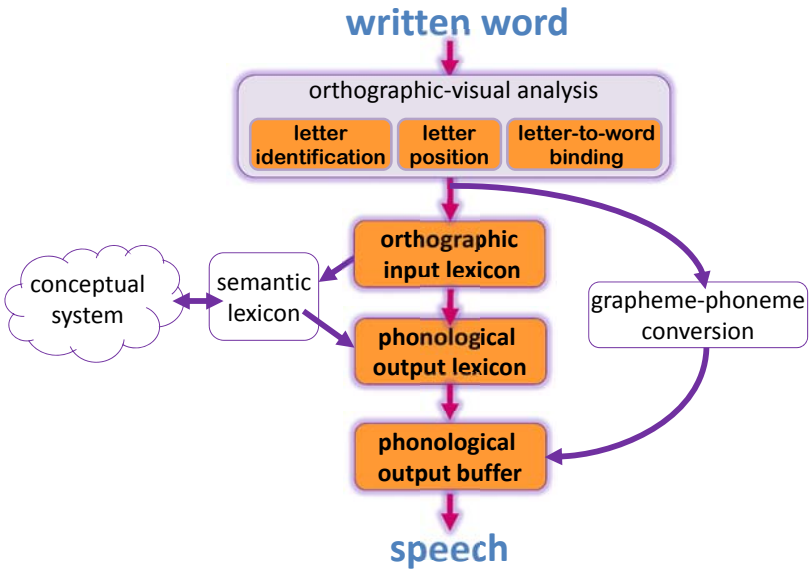
Dyslexias – themes of this talk

- Dyslexia is a deficit in reading.
- 19 types of dyslexia exist, each resulting from a different deficit in the reading model.
- What are the characteristics of these dyslexias?
- Diagnosis: are the best stimuli to detect each of them? It is crucial to identify the dyslexia to treat it correctly.
- Directions for treatment of various dyslexias
- Cognitive neuropsychology: models predict dyslexias, dyslexias modify models

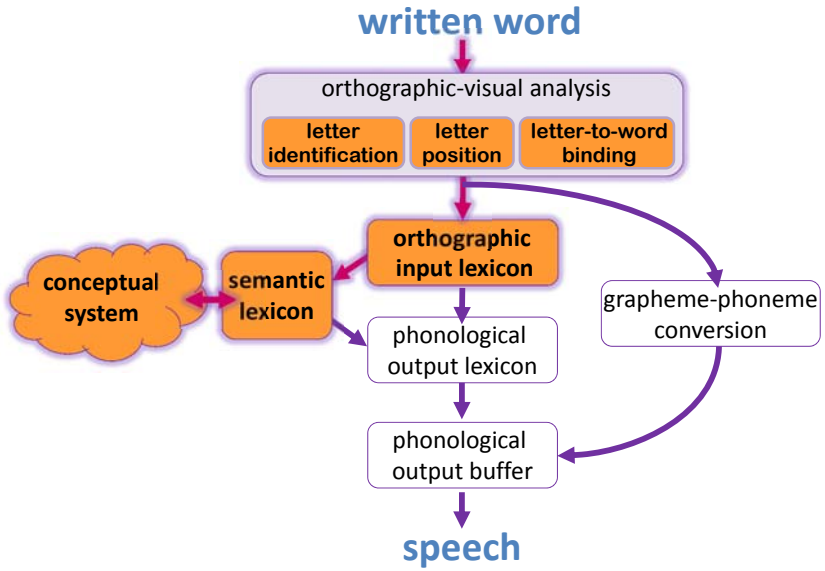
Single word reading process



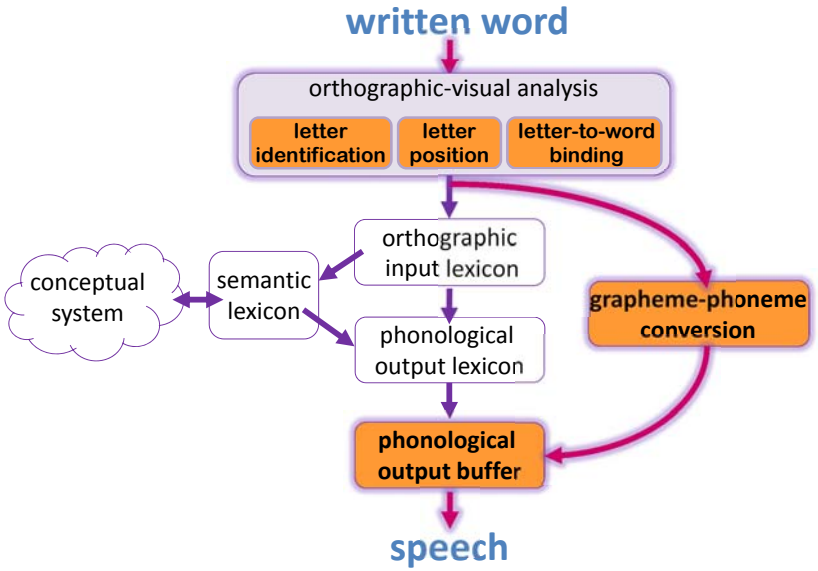
The direct lexical route: quick and accurate



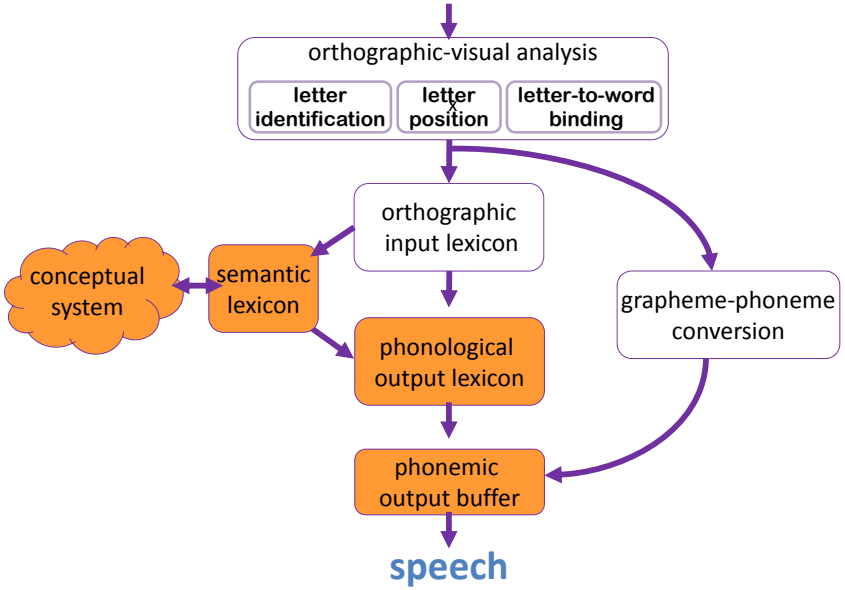
The semantic lexical route: comprehension



The sublexical route: reading nonwords

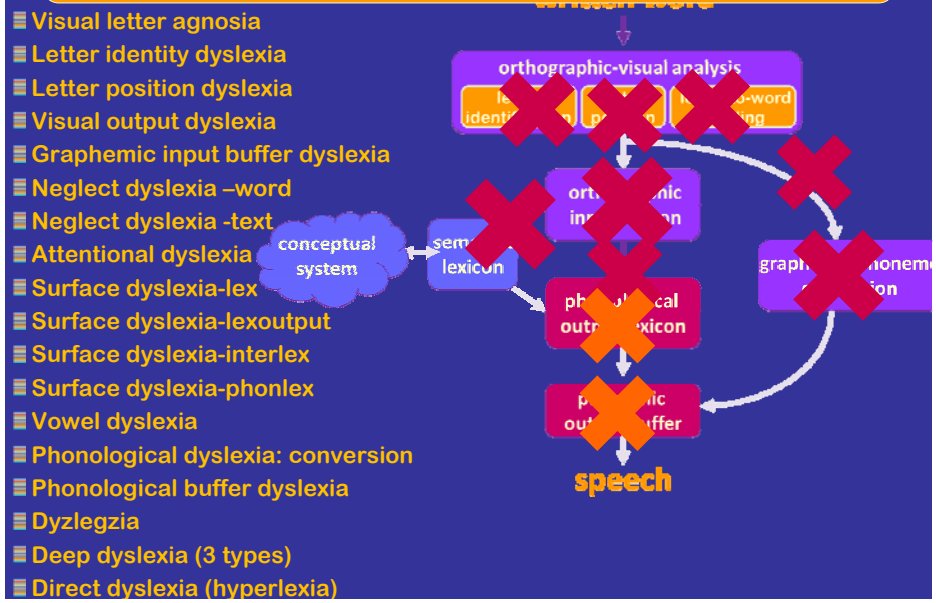


Components shared for reading and speech



A deficit in each of these components creates a different type of dyslexia

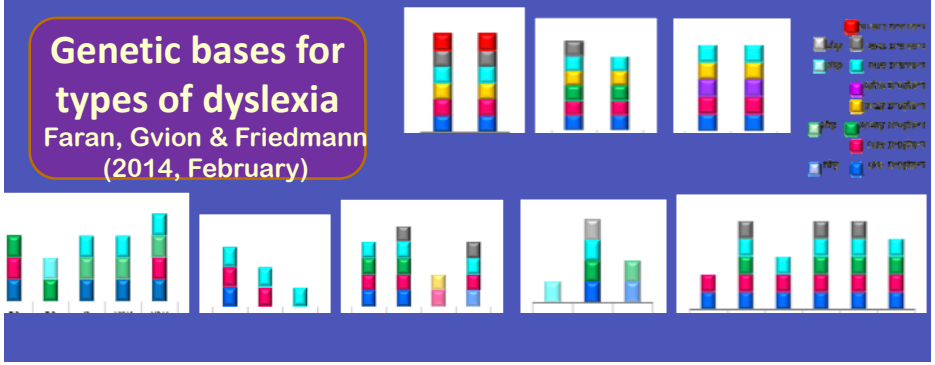
- Visual letter agnosia
- Letter identity dyslexia
- Letter position dyslexia
- Visual output dyslexia
- Graphemic input buffer dyslexia
- Neglect dyslexia –word
- Neglect dyslexia -text
- Attentional dyslexia
- Surface dyslexia-lex
- Surface dyslexia-lexoutput
- Surface dyslexia-interlex
- Surface dyslexia-phonlex
- Vowel dyslexia
- Phonological dyslexia: conversion
- Phonological buffer dyslexia
- Dyzlegzia
- Deep dyslexia (3 types)
- Direct dyslexia (hyperlexia)



Acquired

Developmental

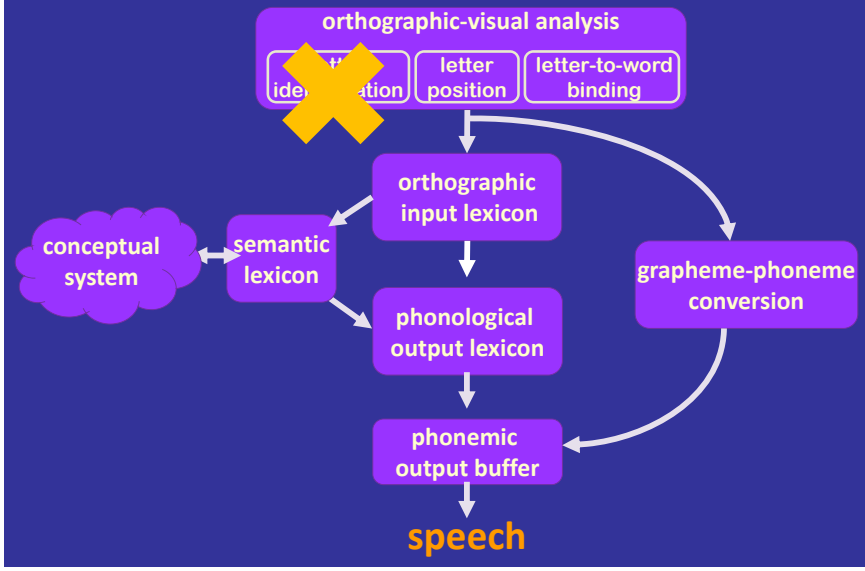
Genetic bases for types of dyslexia
Faran, Gvion & Friedmann (2014, February)



The model: impairments in its different components create different dyslexias

Let's go one by one

Impaired letter identity encoding



Letter identity dyslexia

A deficit in abstract letter identification

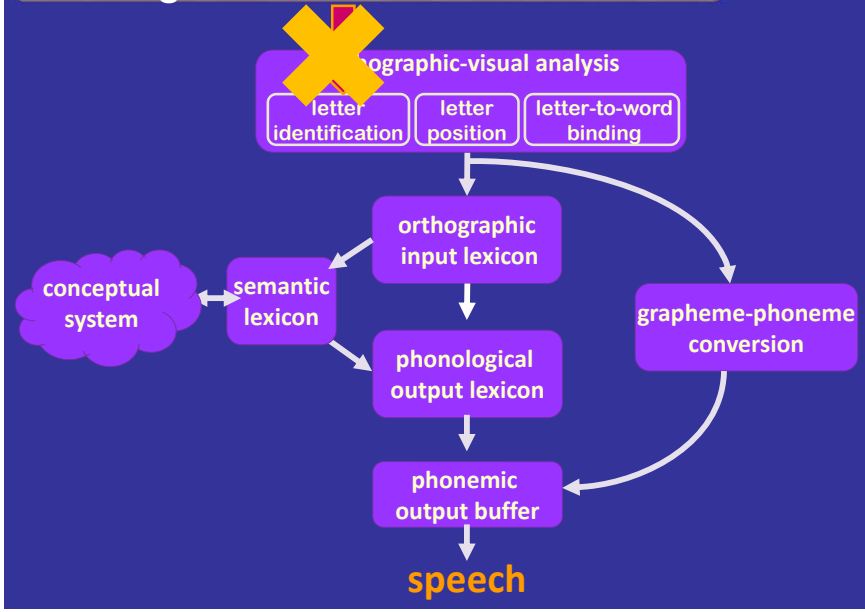
Word reading: letter substitution and omission

read ➲ road
tale ➲ take
brother ➲ broth
table ➲ cable

Letter level: A A, a a, Aa
✓ ✓ ✗

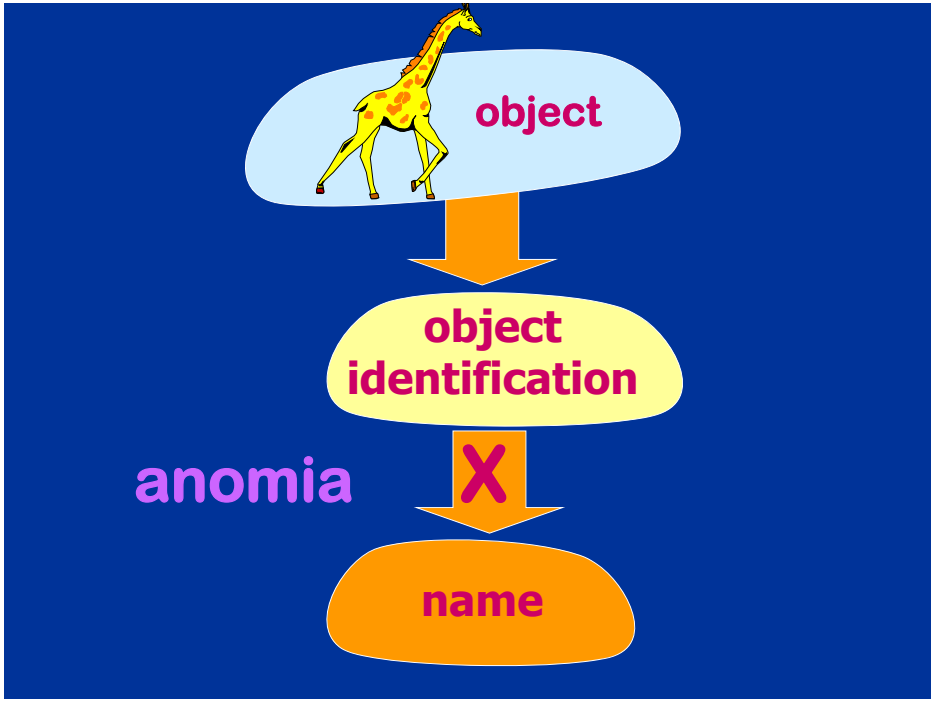
Brunsdon, Coltheart & Nickels (2006) Severe developmental letter-processing impairment: A treatment case study. *Cognitive Neuropsychology, 23:6*, 795-821.

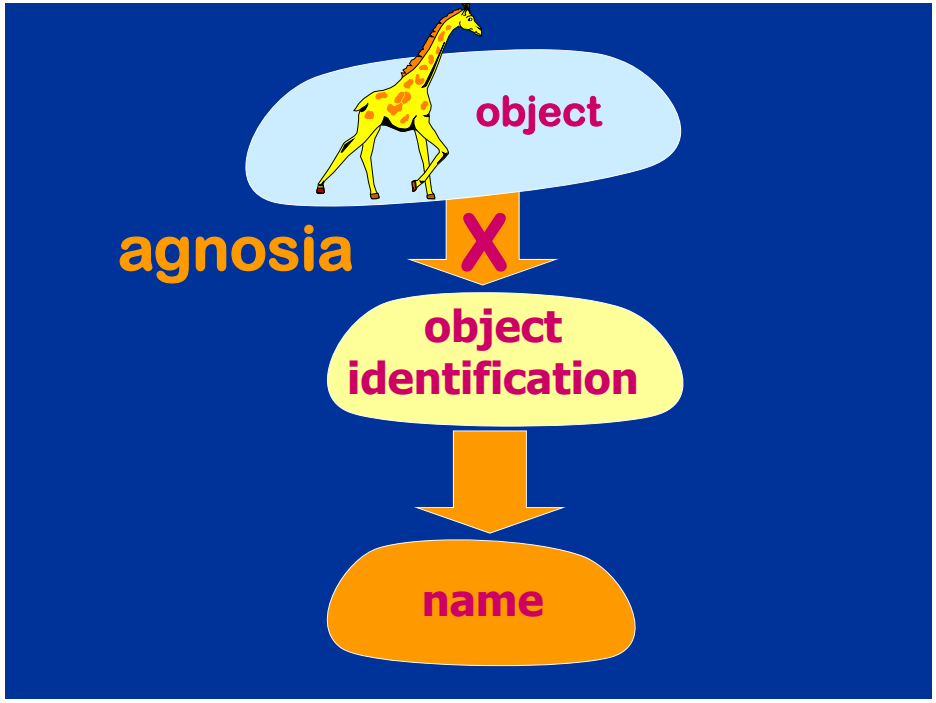
Impaired access to letter identity from vision: visual agnosia for letters



Visual letter agnosia

Visual agnosia is a deficit in visually identifying objects. Sensory perceptual functions are not impaired


object
object identification
anomia
X
name


object
agnosia
X
object identification
name


n
letter
letter agnosia
X
Letter identification
name


n
Ar..... En!

Treatment and teaching:

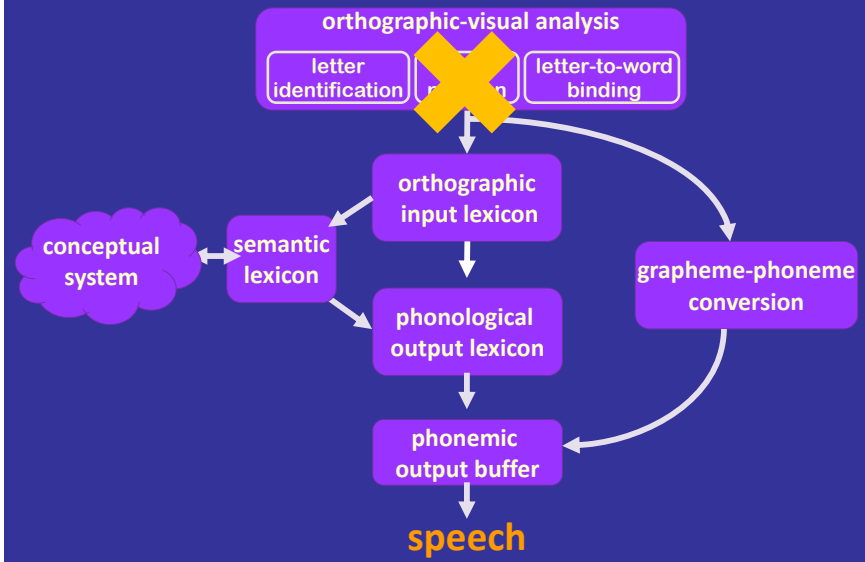
kinesthetic strategy

g

Letter position dyslexia

Friedmann & Gvion (2001), *Cognitive Neuropsychology*,
Friedmann & Gvion (2005), *Behavioral Neurology*,
Friedmann & Rahamim, (2007), *Journal of Neuropsychology*,
Friedmann, Dotan & Rahamim (2010), *Cortex*
Friedmann & Haddad-Hanna (2012), *Behavioral Neurology*
Friedmann & Rahamim (2014), *Journal of Research in Reading*

Impaired letter position encoding: Letter position dyslexia



LPD – letter position dyslexia

predominant error -
letter migrations within words

part ons

Deficits in visual analysis

Selective deficits have been identified:

- In letter identification
(Letter Agnosia, letter identity Dyslexia)

- In letter-to-word binding
(Attentional Dyslexia)

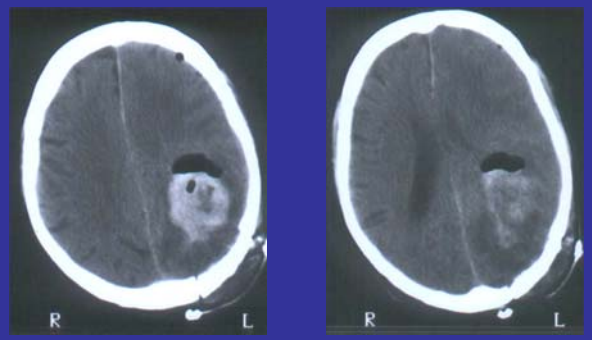
What about letter position?

The model predicts a selective deficit in letter position

Words that allow for the relevant error type to create a real word Are most sensitive stimuli for detection

dairy – diary
trial – trail
loin – lion
board – broad
tort – trot
stake – skate
trail- trial

Acquired dyslexia



Focus of hemorrhage in left parieto-occipital regions and inferior parietal lobule

Also: Developmental dyslexia

A detailed study of 65 Hebrew-speaking children and adolescents with letter position dyslexia

Reading aloud 418 migratable words

	%Transpositions
DV	14%
HN	43%
SL	16%
SN	37%
HA	28%
NS	16%
SP	39%
RM	12%
RI	28%
AN	27%
YS	15%
average	104 (25%)

Control group: less than 2% errors

Middle vs. first and last letters

middle migration from-form

exterior migration sing-sign

LPD participants	Middle migration	Exterior migration
LPD_Neta1	12	0
LPD_Neta2	13	0
LPD_Neta3	22	1
LPD_Neta4	22	0
LPD_Neta5	27	0
LPD_Neta6	21	1
LPD_Neta7	20	0
LPD_Neta8	31	0
LPD_Neta9	16	0
LPD-lilach1	20	0
LPD-lilach2	20	0
LPD-lilach3	12	1
LPD-lilach4	22	0
LPD-lilach5	18	0
LPD-lilach6	61	1
LPD_Rakefet1	38	2
LPD_Rakefet2	12	0
LPD_Rakefet3	15	0
LPD_Rakefet4	31	2
LPD_Rakefet5	13	1
LPD_Rakefet6	21	0
LPD_Rakefet7	41	1
LPD_Rakefet8	30	0
LPD_Rakefet9	14	0
LPD_Rakefet10	37	1
LPD_Rakefet11	22	1
LPD_Rakefet12	43	0
LPD_Rakefet13	8	0
LPD_Rakefet14	22	1
LPD_Rakefet15	21	0
LPD_Rakefet16	14	0
LPD_Rakefet17	9	0
LPD_Rakefet18	29	0
LPD_Rakefet19	24	1
LPD_Rakefet20	18	1
LPD_roni1	28	0
LPD_roni2	24	0
LPD_roni3	31	1
LPD_roni4	27	0
LPD_roni5	57	2
LPD_roni6	52	0
LPD_roni7	62	1
LPD_roni8	58	1
LPD_roni9	22	0
LPD_roni10	30	0
LPD_roni11	16	0
LPD_Einav1	33	1
LPD_Einav2	95	1
LPD_Einav3	71	0
LPD_Einav4	73	2
LPD_Einav5	37	0
LPD_Einav6	38	1
Total	1553	25

Position of letter position errors

52 individuals with developmental LPD

N=52	Middle migration	Exterior migration
Total	1553	25

From 5 studies of LPD In Hebrew

Transpositions in comprehension: definitions

diary – Something from a cow

could – Something that brings rain

parties - They are very brave. They are robbers of the sea.

Kohnen, S., Nickels, L., Castles, A., Friedmann, N., & McArthur, G. (2012). When 'slime' becomes 'smile': Developmental letter position dyslexia in English. *Neuropsychologia*, *50* (14), 3681–3692.

Reading comprehension in LPD

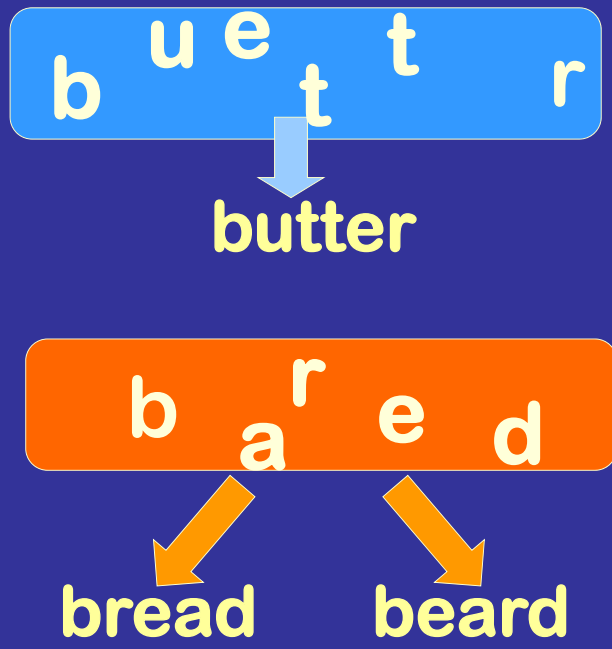
Because migration occurs in an early stage, before access to semantics, LPD causes not only errors in reading aloud, but also in comprehension.

Clinical implications

Reading comprehension problems can result from incorrect reading, such as in LPD.

Reliance on lexical knowledge

Aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe .



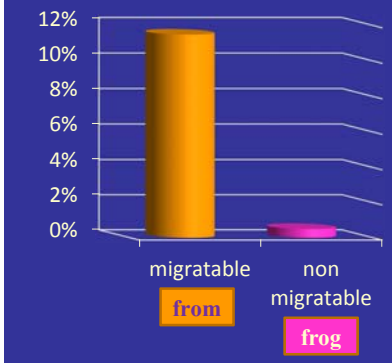
oral reading
migratable vs. nonmigratable

298 migratable words

70 non-migratable words

65 participants with developmental LPD

Migration in migratable and non migratable words from vs. frog



% migrations in migratable words	%migrations in nonmigratable words
4.7%	0.0%
5.1%	0.0%
7.7%	0.0%
9.1%	0.0%
11.1%	0.0%
8.8%	0.0%
8.1%	0.0%
13.8%	0.0%
6.4%	0.0%
8.4%	0.0%
8.4%	0.0%
4.7%	0.0%
9.4%	0.0%
8.4%	0.0%
25.6%	1.4%
17.5%	1.4%
6.7%	1.4%
5.4%	0.0%
14.8%	0.0%
16.5%	0.0%
8.8%	0.0%
5.4%	0.0%
14.8%	0.0%
6.4%	0.0%
14.8%	1.4%
9.1%	0.0%
18.2%	0.0%
3.0%	0.0%
10.4%	0.0%
8.8%	0.0%
5.7%	0.0%
4.0%	0.0%
13.5%	4.3%
12.1%	0.0%
10.4%	0.0%
11.4%	0.0%
12.5%	0.0%
15.5%	5.7%
11.4%	0.0%
24.6%	2.9%
23.2%	2.9%
26.3%	0.0%
27.3%	1.4%
9.1%	0.0%
13.1%	0.0%
7.7%	0.0%
11.5%	**0.5%**

What does it mean for diagnosis?

- We may miss LPD if the words are non-migratable.
- Words for diagnosis should include migratable words (like form-from, trail-trial).

LPD – letter position dyslexia

With migratable words, identified in

Hebrew

תירס	⇦ תריס
שופטת	⇦ שוטפת
רוחצים	⇦ רוצחים
שומר	⇦ שמור
בלשנית	⇦ בשלנית

Arabic

يعملون	→ يعلمون
يكتبون	→ يكبتون
يمشمون	→ يشمون
يصنع	→ ينصع
يحلمون	→ يحملون

English

dairy – diary
trial – trail
loin – lion
board – broad
flies – files
stake – skate
could- cloud

Italian

BORDO	BRODO
CAPRA	CARPA
COPRO	CORPO
LADRO	LARDO
OLIVE	OVILE
PERSO	PRESO
TARMA	TRAMA
TORTA	TROTA
RIAPRO	RIPARO
RILEVA	RIVELA
COLLARI	CORALLI
SALPARE	SPALARE
STIVANO	SVITANO

Turkish

dalma	damla
eskiz	eksiz
biraz	bariz
arka	akra
bakara	baraka
bakır	bıkar
anılma	alınma
etki	ekti
fark	frak

Examples for migratable words in French: From PARTONS TO PATRONS

patrie	partie
voilent	violent
signe	singe
piler	plier
frime	firme
cirer	crier
trier	tirer

Single words and text

%Migrations in developmental LPD

Participant	single words	words in text
DV	14*	6*
HN	43*	28*
SL	16*	11*
SN	37*	33*
HA	28*	8*
NS	16*	6*
SP	39*	21*
RM	12*	6*
RI	28*	7*
AN	27*	7*
YS	15*	3
LPD average (SD)	24.9* (11.1)	12.5* (10.2)
Control average (SD)	1.9 (1.3)	1.9 (1.1)

What does it mean for diagnosis?

- Words for diagnosis should appear isolated and not in text

How can we rule out vision problems?

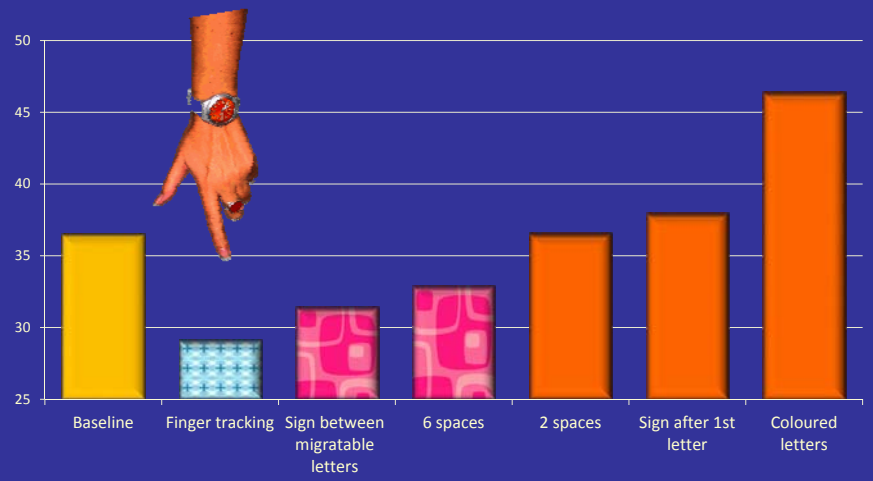
Test number reading

MIGRATIONS IN WORDS AND NUMBERS

X^2	Migrations in NUMBERS	Migrations in WORDS	LPD
8.93	2%	14%	DV
47.24	2%	43%	HN
9.98	1%	12%	SL
37.78	2%	37%	SN
26.21	2%	28%	HA
11.24	2%	16%	NS
48.80	0%	39%	SP
13.27	0%	12%	RM
15.34	7%	28%	RI
21.21	3%	27%	AN
0.24	12%	15%	YS
T = 0	3%	25%	average

COMPARING VARIOUS TREATMENT DIRECTIONS for LPD

- Spacing between letters כ ב א י ם כ ב א י ם
- Each letter in a different color כבאים
- Sign between migratable letters כב◊אים
- Sign after 1st letter כ◊באים
- Finger tracking כבאים



Friedmann, N., & Rahamim, E. (2014). What can reduce letter migrations in letter position dyslexia? *Journal of Research in Reading*, *37*(3), 297–315

General attention and LPD?

Lukov, L., Friedmann, N., Shalev, L., Khentov-Kraus, L., Shalev, N., Lorber, R., & Guggenheim, R. (2015). **Dissociations between developmental dyslexias and attention deficits.** *Frontiers in Psychology, 5*(1501), 1-18.

A dissociation between dyslexia and good attention: The types of dyslexia among individuals with intact attention and impaired reading (n=28)

Dyslexia	Number of participants with intact attention who showed these dyslexias
LPD	5
LPD, attentional dyslexia	3
Phonological buffer dyslexia	1

21 individuals with **letter position dyslexia**,
13 with attentional dyslexia,
2 with neglect dyslexia,
12 with surface dyslexia,
11 with vowel dyslexia,
1 with phonological buffer dyslexia

with good attention

A dissociation between attention disorders and good reading

The various attention deficits among individuals with intact reading and impaired attention (n=27)

Attention deficits	Number of participants with intact reading who showed these attention deficits
Sustained	5
Orienting	3
Executive	1
Selective	1
Sustained and Orienting	4
Sustained and Executive	4
Sustained and Selective	3
Orienting and Executive	2
Selective and Executive	1
Sustained, Orienting, and Executive	1
Sustained, Selective, Orienting, and Executive	2

does MPH (Ritalin) affect LPD?

Keidar, R., & Friedmann, N. (2011). Does Methylphenidate help readers with letter position dyslexia and attentional dyslexia? *Language and Brain, 10*, 195–214.

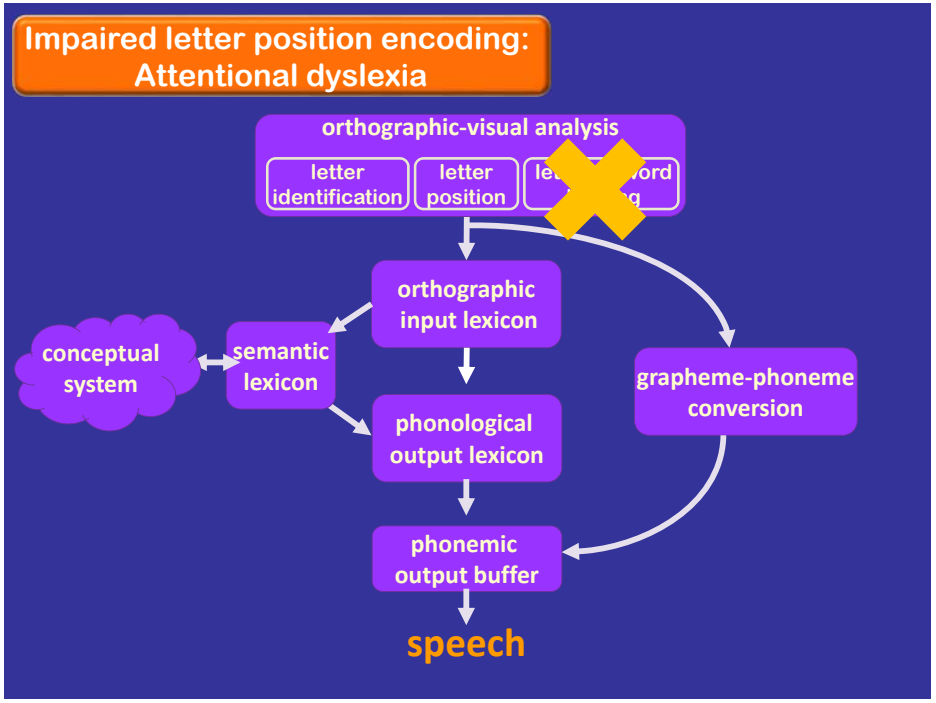
%migrations with and without MPH

Participant	MPH	No MPH	Significance
Arm	15.2	18.2	$\chi^2 = 0.29$, $p = .59$
Ngm	6.4	6.8	$\chi^2 = 0.01$, $p = .92$
Ashm²	9.5	5.1	$\chi^2 = 1.29$, $p = .26$
Aam	7.4	17.2	$\chi^2 = 4.06$, $p = .04$
Alm	11.5	16.9	$\chi^2 = 1.08$, $p = .30$
Shgm	6.4	8.8	$\chi^2 = 0.38$, $p = .54$
Rem	3.0	5.4	$\chi^2 = 0.67$, $p = .41$
Aax	13.9	14.9	$\chi^2 = 0.04$, $p = .85$
Dxz	5.4	6.4	$\chi^2 = 0.09$, $p = .77$
Aaz	15.9	15.9	$\chi^2 = 0$, $p = 1$
Axz	8.5	9.5	$\chi^2 = 0.06$, $p = .8$
Lxz²	20.3	18.2	$\chi^2 = 0.11$, $p = .7$
Nlu²	4.7	3.9	$\chi^2 = 0.09$, $p = .77$
Axa	9.1	11.2	$\chi^2 = 0.21$, $p = .65$
Sxa	5.1	9.1	$\chi^2 = 1.18$, $p = .28$
Rshu²	6.8	5.7	$\chi^2 = 0.09$, $p = .77$
Aau²	6.8	4.1	$\chi^2 = 0.69$, $p = .41$
Ava²	13.5	14.2	$\chi^2 = 0.02$, $p = .89$

NO EFFECT OF MPH

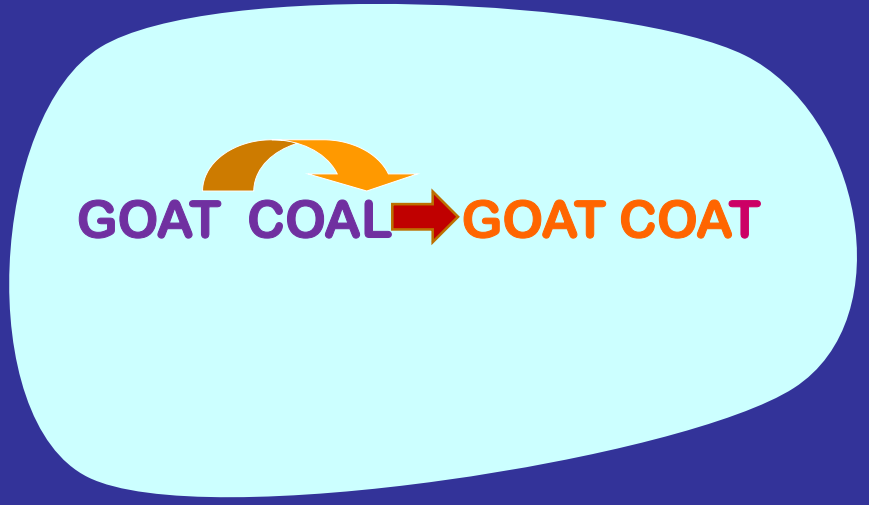
Attentional dyslexia

Impaired letter position encoding: Attentional dyslexia



GOAT
COAL

LETTER MIGRATIONS BETWEEN WORDS



Attentional dyslexia is a peripheral dyslexia, i.e., a dyslexia that results from a deficit at the early stage of orthographic-visual analysis.

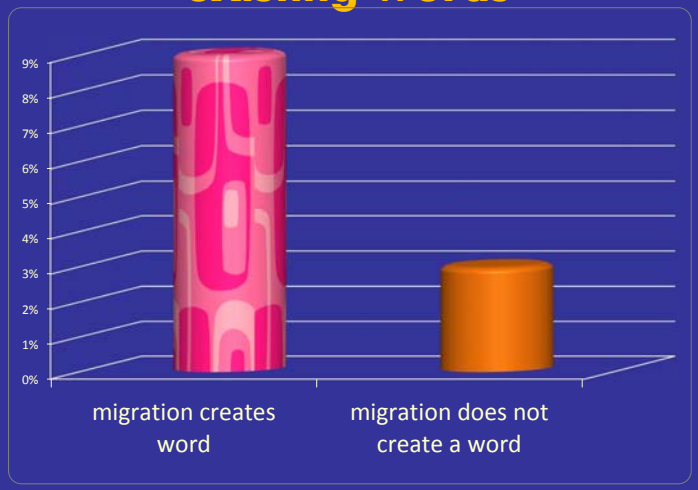
Attentional dyslexia is a deficit in letter-to-word binding, which results in migrations of letters between words.

Migrations of letters between words

target	*reading response*
MANIE MARGE	MARIE MARGE
MANIE MARGE	MANIE MANGE
MANIE MARGE	MARIE MANGE

Significant lexical effect:

Migrations occur when they create existing words



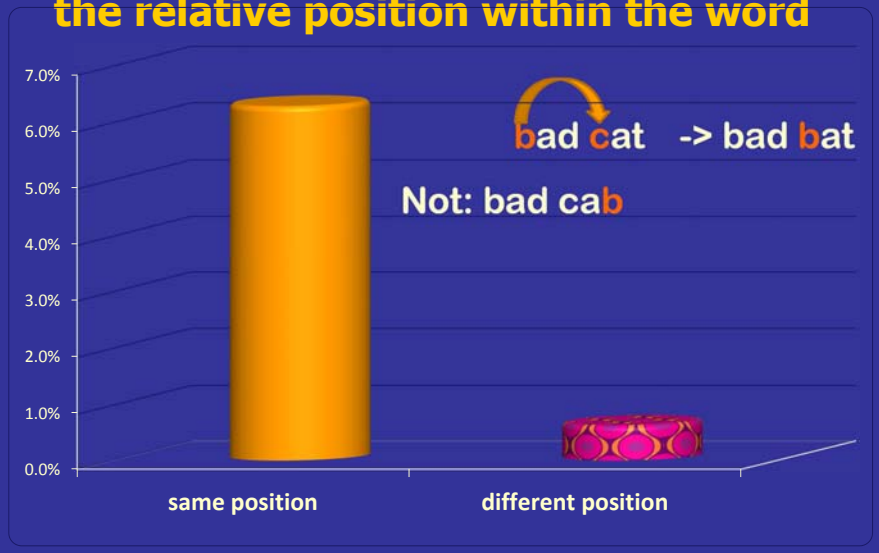
Implication for diagnosis :

Use word pairs in which Migrations create existing words

fend	rond
lame	rime
mont	sent
mûrs	sers
puis	sois
sait	toit
aide	vise
aire	pile
aire	cime
bons	sois
bout	toit
cape	page
dont	mort

sont ment

migrations preserve within-word position
most of the migrations (94%) preserve the relative position within the word



migrations preserve within-word position
most of the migrations (94%) preserve the relative position within the word

Two different functions:
letter position encoding
within words and between words

In a study we are doing now,
with **231 individuals** with developmental dyslexia,

79 have letter position dyslexia without attentional dyslexia
24 have attentional dyslexia without letter position dyslexia

Two different functions:
letter position encoding
within words and between words

Implication for treatment:
Once we know the dyslexia we can treat it

READING WINDOW

❖ Between-word migrations can occur without wi
sig
within-word migrations.

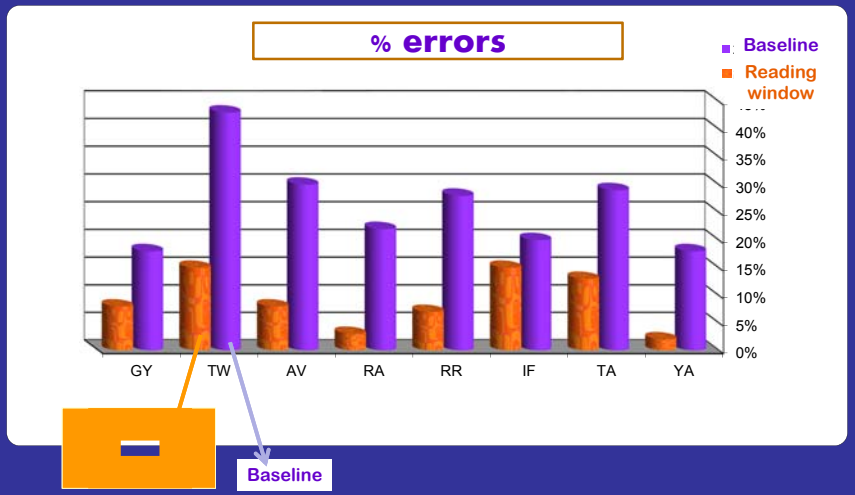
❖ Similarity: There was no significant difference betwe d pairs of the same and o the words in the with a or rate decreases word etter, this yielded the least n-shared letter yielded significantly more between-word errors.

❖ There was a significantly higher rate for between-word migrations in nonword pairs compared to word pairs (but no significant difference in the rate of other between-word errors).

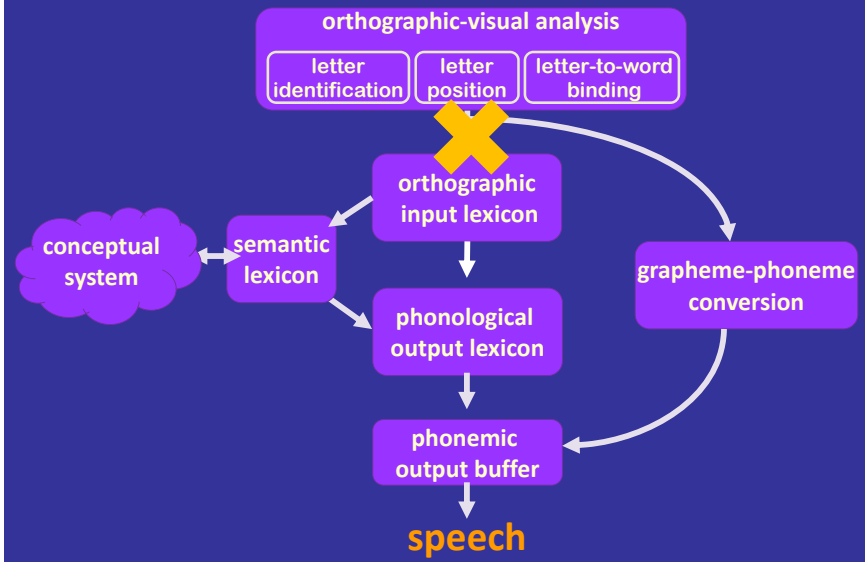
window

Treatment: reading window

Shvimer, L., Kerbel, N., & Friedmann, N. (2009). An empirical evaluation of various treatment directions in developmental attentional dyslexia. *Language and Brain, 8*, 87-118



Impaired output of visual analyser:
Visual analyzer output dyslexia



Visual output dyslexia

Friedmann, N., Biran, M., & Gvion, A. (2012). Patterns of visual dyslexia. *Journal of Neuropsychology, 6*(1), 1-30.

A deficit in all outputs of the visual analysis stage
As a result, individuals with visual dyslexia produce mainly visual errors in reading: letter omission, substitution, migration within and between words. For example, reading

read ➲ road / lead / red
tale ➲ take / pale
brother ➲ broth/ rather
form ➲ from/ farm/ fork

Neglect dyslexia

- at the word level
- at the sentence and text level

word-based neglexia

Friedmann, N., & Nachman-Katz, I. (2004). Developmental neglect dyslexia in a Hebrew-reading child. *Cortex, 40,* 301-313.

Nachman-Katz, I., & Friedmann, N. (2007). Developmental neglect dyslexia: Characteristics and directions for treatment. *Language and Brain, 6*, 75-90

Nachman-Katz, I., & Friedmann, N. (2010). An empirical evaluation of treatment directions for developmental neglect dyslexia. *Procedia Social and Behavioral Sciences, 6*, 248-249

single word reading

Target ⇒	Reading
שַׁתַּ	שתא
רַשַׁ	רשא
אַרגַש ?	ארגא
אַחַ	אחת

Neglect of left (final) letters: 21(!) children with neglexia

Participant	% correct reading words	Left letter substitution	Left letter omission
NT	**42%**	55%	40%
IZ	**32%**	42%	53%
ID	**30%**	57%	43%
VL	**71%**	55%	30%
SP	**8%**	2%	92%
SS	**54%**	33%	58%
AR	**58%**	56%	23%
ST	**63%**	30%	70%
DN	**59%**	27%	41%
AB	**48%**	39%	44%
TM	**28%**	24%	71%
AO	**41%**	42%	33%
DR	**21%**	21%	78%
AD	**37%**	30%	40%
NO	**57%**	36%	40%
LR	**36%**	57%	11%
OM	**54%**	53%	17%
Average	**43%**	**39%**	**46%**

Reading characteristics in various tasks

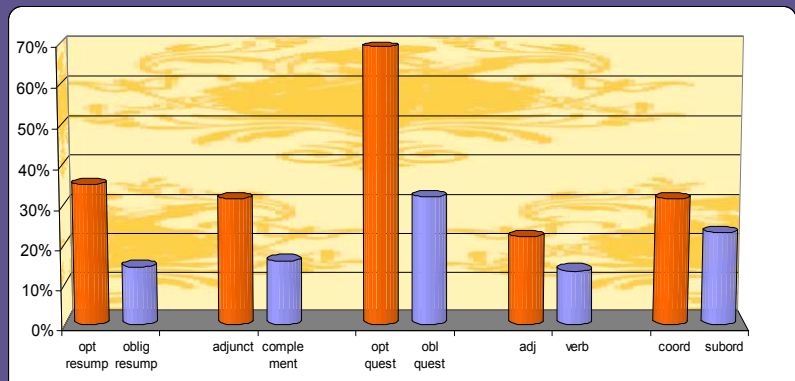
Participant	Word reading	Left letter substitution	Left letter omission	Letter-by letter naming	Number reading	Nonword reading	Vertical presentation	Synthesis
NT	(42%) 36/85	55%	40%	100%	100%	87%	90%	10%
IZ	(32%) 32/100	42%	53%	90%	100%	77%	66%	60%
ID	(30%) 30/100	57%	43%	93%	100%	---	63%	70%
VL	(71%) 71/100	55%	30%	100%	100%	63%	76%	40%
SP	(8%) 8/100	2%	92%	73%	73%	73%	57%	0%
SS	(54%) 78/144	33%	58%	100%	100%	83%	70%	40%
AR	(58%) 58/100	56%	23%	87%	93%	10%	80%	10%
ST	(63%) 63/100	30%	70%	93%	100%	70%	90%	50%
DN	(59%) 59/100	27%	41%	87%	100%	60%	83%	60%
AB	(48%) 63/130	39%	44%	83%	100%	57%	57%	50%
TM	(28%) 45/161	24%	71%	90%	33%	10%	13%	10%
AO	(41%) 49/120	42%	33%	93%	100%	60%	53%	10%
DR	(21%) 25/120	21%	78%	80%	100%	7%	33%	0%
AD	(37%) 37/100	30%	40%	83%	100%	27%	40%	30%
NO	(57%) 57/100	36%	40%	87%	100%	50%	57%	70%
LR	(36%) 36/100	57%	11%	87%	100%	17%	---	10%
OM	(54%) 54/100	53%	17%	70%	100%	47%	73%	50%
Average	**43%**	**39%**	**46%**	**88%**	**94%**	**50%**	**62%**	**33%**

Text- based Neglexia and syntactic structure

Friedmann, N., Tzailer-Gross, L., & Gvion, A. (2011). The effect of syntax on reading in neglect dyslexia. Neuropsychologia, 49(10), 2803-2816.

The research question

Does syntactic structure modulate reading in text-based neglexia?



syntax modulates reading in neglexia

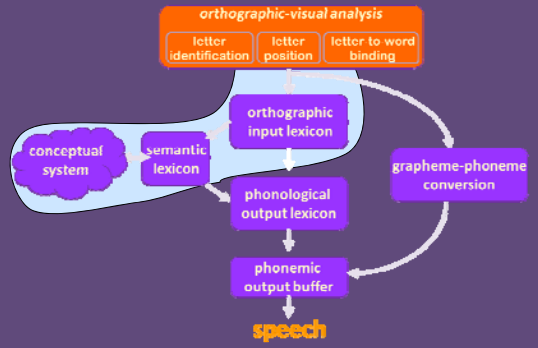
Namely…

Patients with text-based neglexia tend to omit optional elements but not obligatory elements that are required by the syntactic structure or by the lexical-syntactic requirements of the verbs.

Syntactic structure modulates reading in text neglexia.

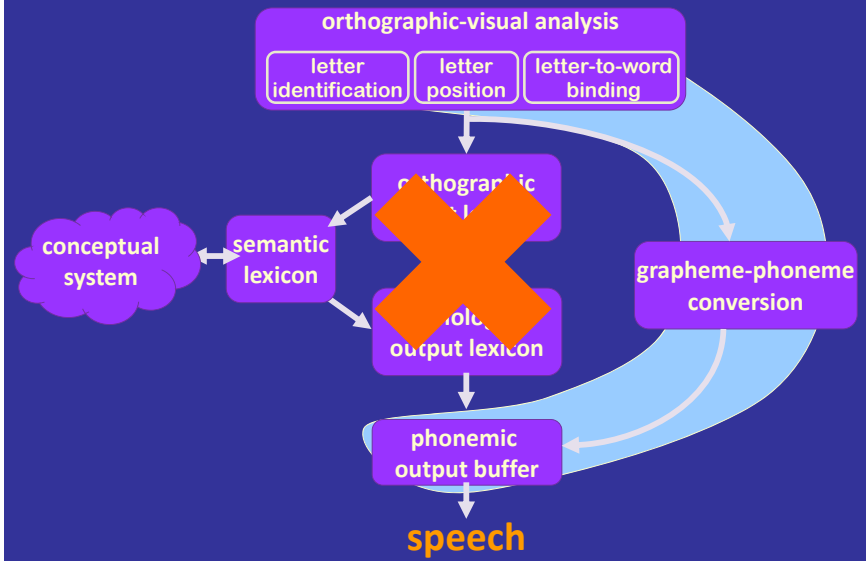
Reading comprehension in dyslexias of the visual analysis stage

Impaired.



Surface dyslexia

Impaired lexical route: surface dyslexia



Kan yu reed watts riten hir in thi prezentaishn?

Slow reading

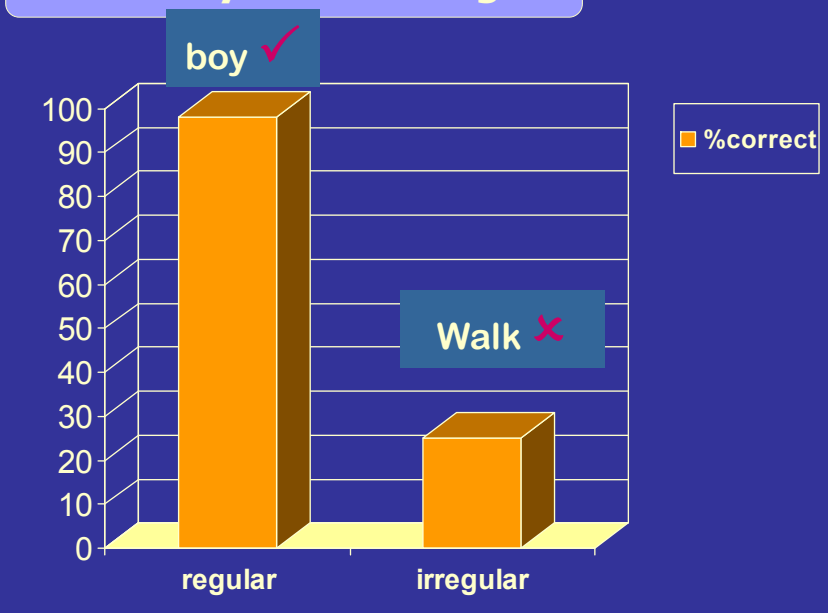
Inaccurate reading of words that cannot be unambiguously converted from letters to sound “irregular words”

talk
walk
sword
door
knight

Impaired comprehension of homophones (depending on the type of surface dyslexia)

(Write-right)

Surface dyslexia in English



READING ALOUD %errors due to non-lexical reading

Participant	% errors
SH	35
GL	38
OF	25
YR	52
TM	49
NT	51
OM	35
BZ	23
AS	26
OS	44
AK	22
AM	33
AL	20
KR	24
NF	33
IR	14
YD	12
control	1-5%

An important predictor to whether there was an error in reading the words aloud: whether they had a potentiophone

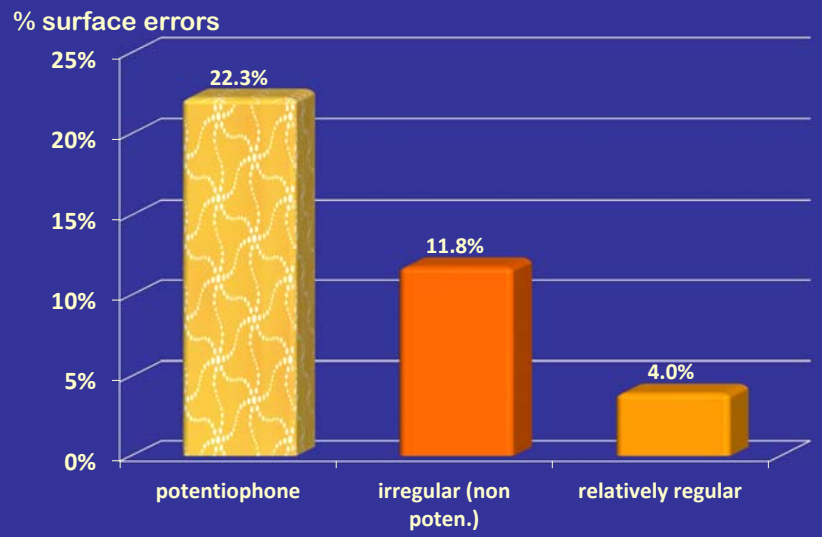
Potentiophones

- now-know
- come-comb
- resent-recent
- bear-beer
- angle-angel
- talk-talc
- whose-hose

POTENTIOPHONES

All surface dyslexics had more errors when reading via grapheme-phoneme conversion created a word.
Some ONLY made errors in such words

A new study with 94 surface dyslexics



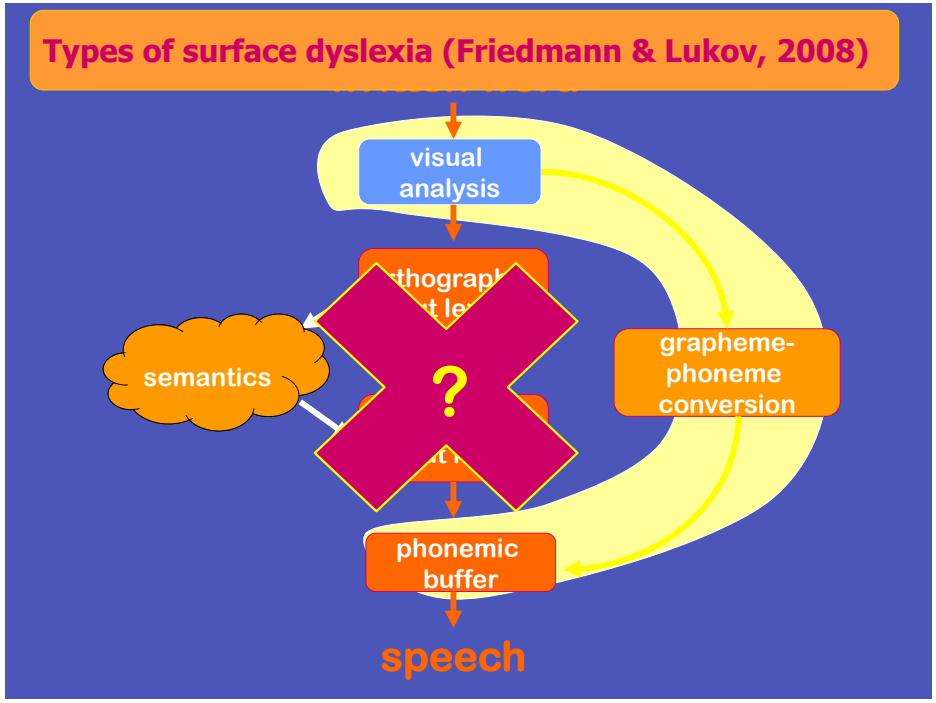
Implication for diagnosis

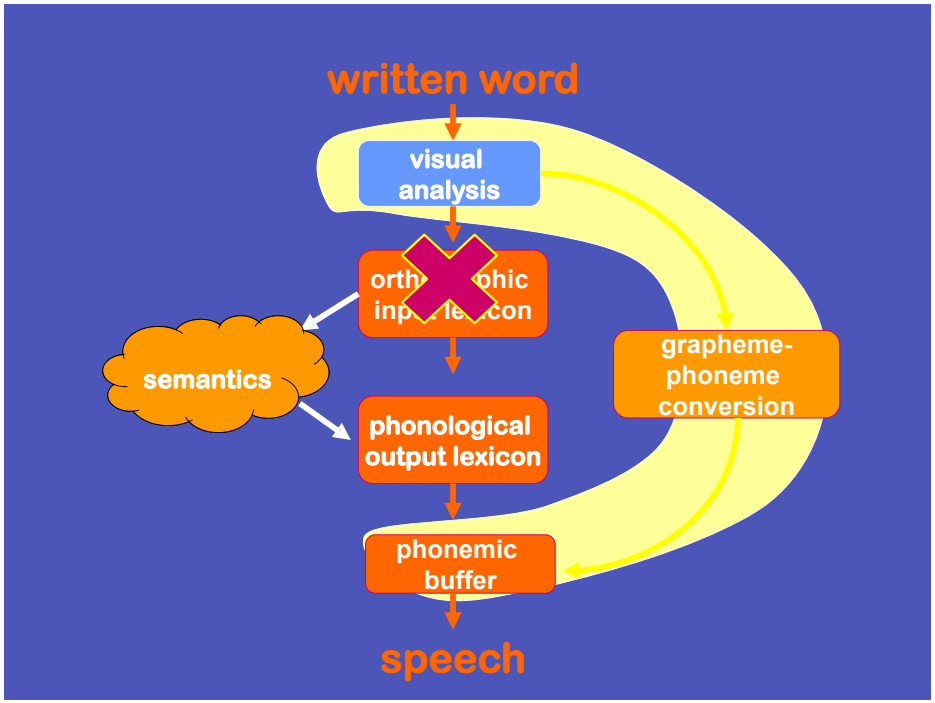
Present irregular words that are potentiophones
Namely, that create other words

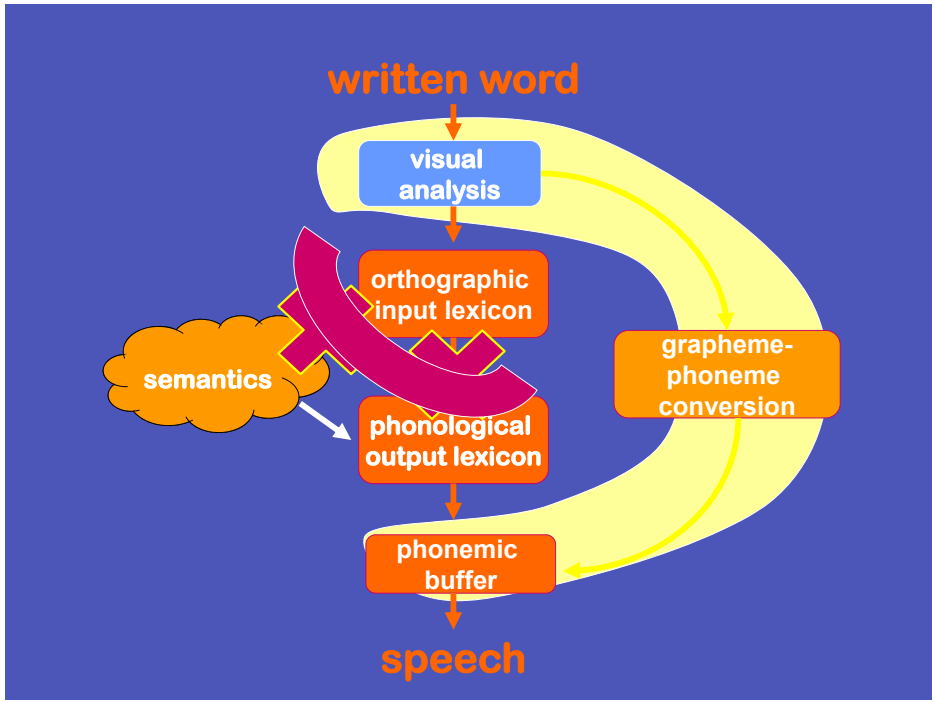
Where exactly is the deficit in surface dyslexia?

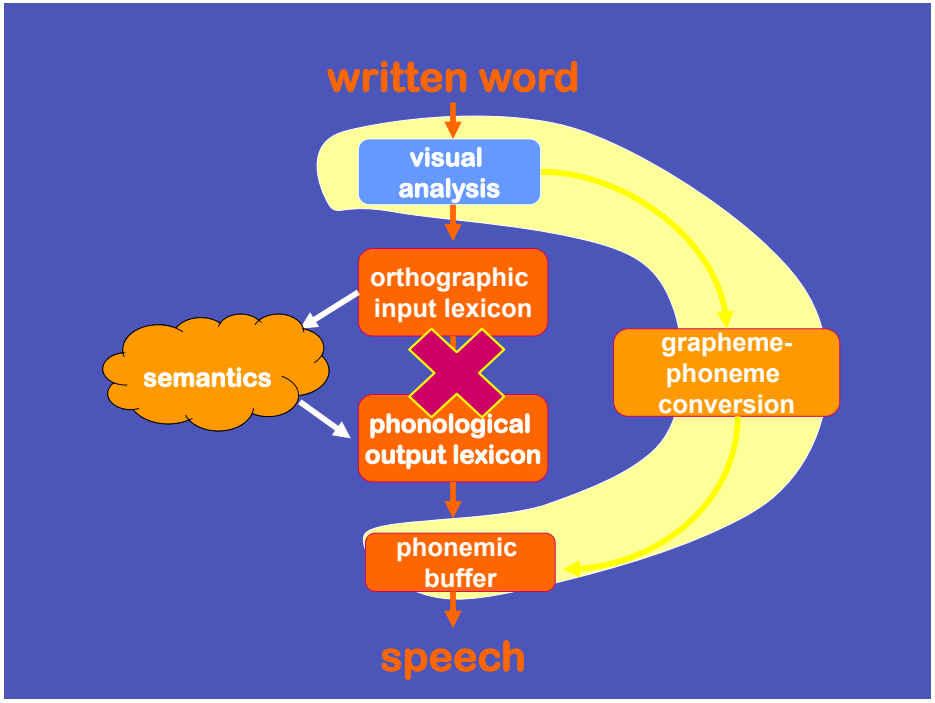
Subtypes of surface dyslexia

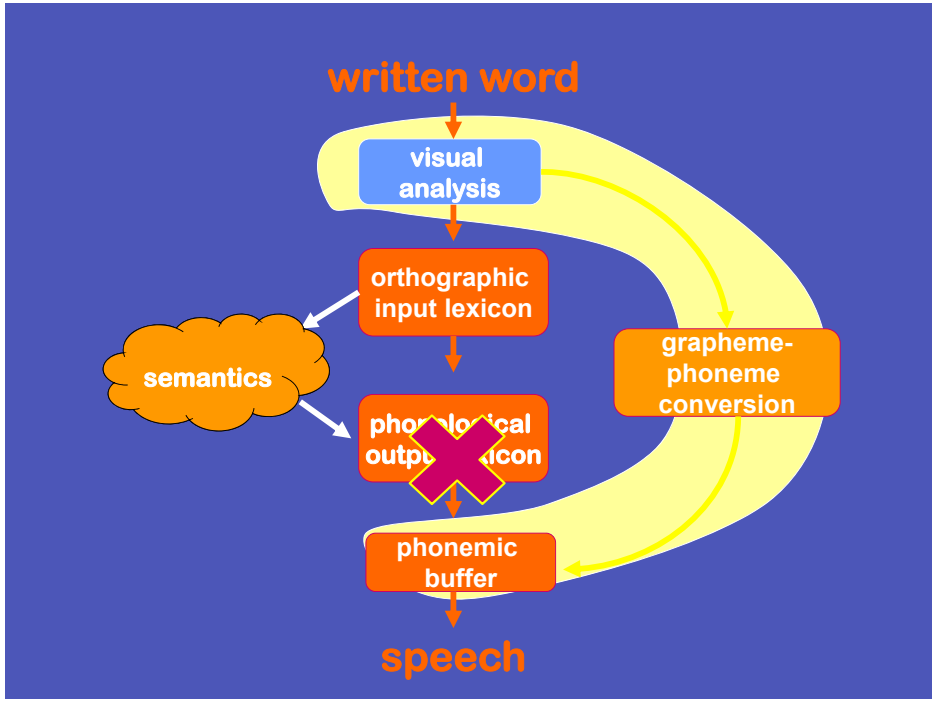
Friedmann, N., & Lukov, L. (2008). Developmental surface dyslexias. *Cortex*, *44(9)*, 1146-1160









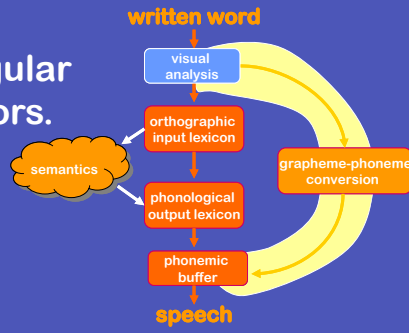


Predictions for the different subtypes

- Reading aloud via grapheme-to-phoneme-conversion
- All subtypes will show impaired reading aloud

-> impaired reading of irregular words, regularization errors.

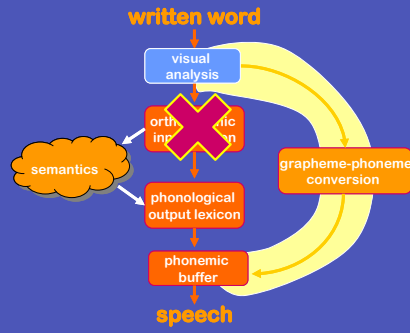
Errors in underspecified phonemic features: stress position etc.



Predictions for the different subtypes

Impaired Orthographic Lexicon SD

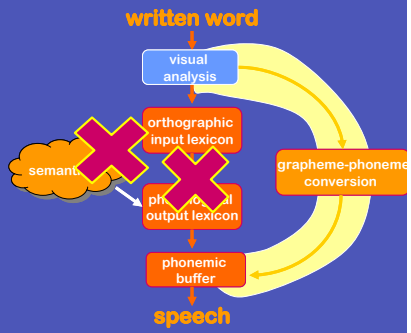
- Poor lexical decision (leksikal)
- Impaired homophone comprehension (which-witch)



Predictions for the different subtypes

Orthographic Lexicon output SD

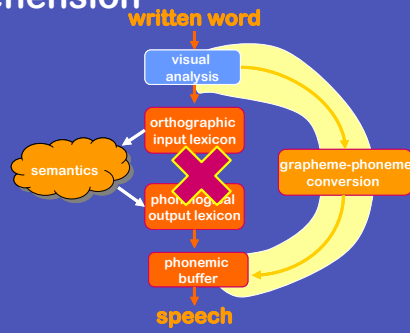
- Good lexical decision (leksikal)
- Impaired homophone comprehension (which-witch)



Predictions for the different subtypes

Interlexical SD
(impaired connection between lexicons)

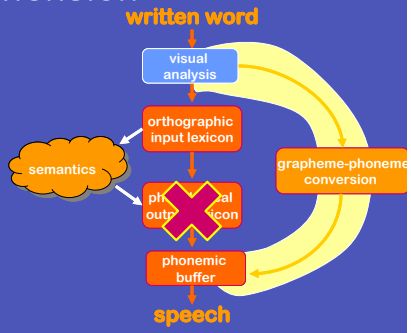
- Good lexical decision (leksikal)
- Good homophone comprehension (which-witch)



Predictions for the different subtypes

SD in the phonological lexicon

- Good lexical decision (leksikal)
- Good homophone comprehension (which-witch)
- Poor picture naming



TASKS

- Reading aloud — Do they read via grapheme-to phoneme conversion?
- Lexical decision — Can they recognize a word in the lexicon?
- Homophone comprehension — Can they access semantics from the lexicon?

Clinical implications

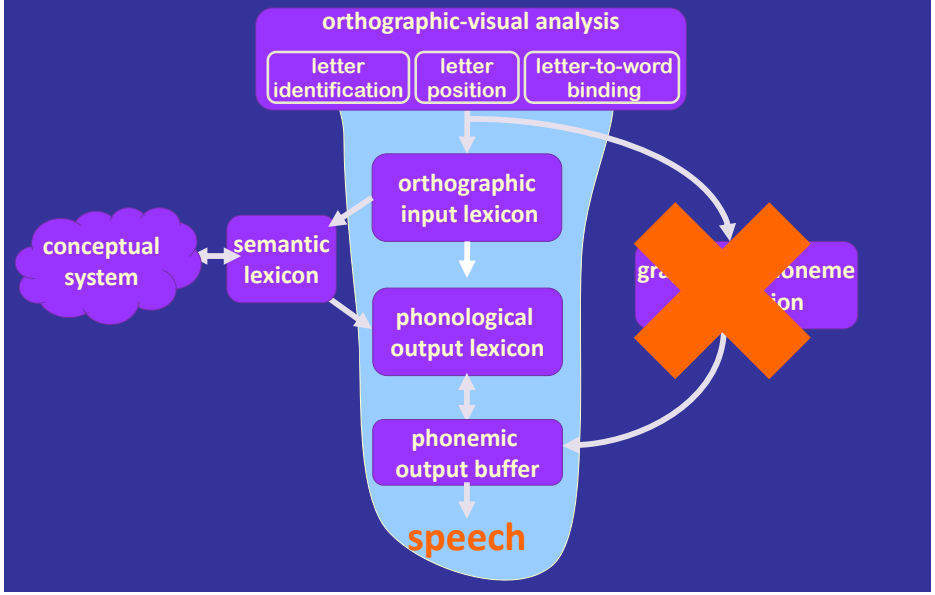
Surface dyslexia:

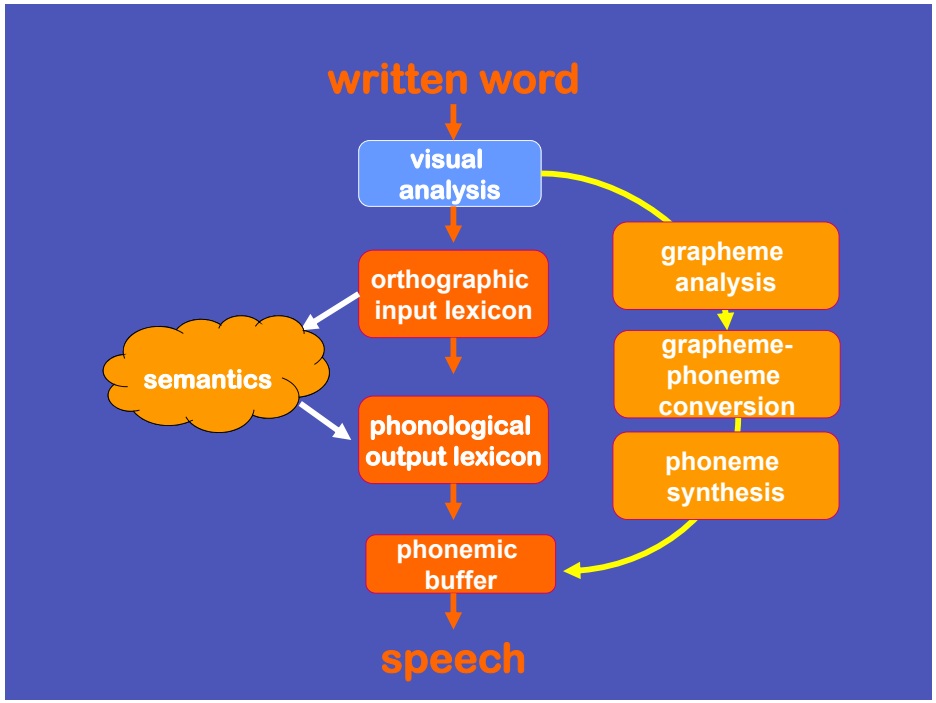
All impaired in reading aloud (irregular, potentiophones)

- Impaired orthographic lexicon – work on the lexicon.
- Good orthographic lexicon and good access to semantics – good comprehension when not reading aloud – clinician should recommend: Try to understand, do not read aloud!

Phonological dyslexias

Impaired sublexical route: phonological dyslexia





phlaitch
grirque
swoans
knirm
sn
slu
os
phreafed
gloathed
thutts
rarbs

drelse
grompts
gedge
slerked
th
br
smoach

pheach
spact
trox
Scryle
twints
swourged
soam
dwessed

Phonological dyslexics cannot read nonwords or new words

זלית
זכומית
רין
צולדק
ריזה
אקלמיה
אבוריום
דא
בטגיה

בנריים
בריקה
בשג
גאקה
הוז
הסובה
השכפה
התונע
זשת

אבישה
ביך
חטג
חדב
מקוער
ימוא
יגשכר
כיל
מרתים

Learning to read in a new language

Good word reading

book ✓
walk ✓
read ✓
door ✓
taxi ✓
stomach ✓

Impaired reading of nonwords

BOG X
DANO X
FIGE X
BACHA X
DOL X
BER X
PARID X

Stimulus type most appropriate for detecting phonological dyslexia?

- nonwords .

Types of phonological dyslexia

- Impaired letter-phoneme conversion
- Impaired multi-letter conversion
  (ch, sh, made)
- Impaired conversion selective to a specific feature
- Impaired phonological output buffer

Types of phonological dyslexia

- Impaired letter-phoneme conversion

Impairment even in single letters

Types of phonological dyslexia

- Impaired multi-letter conversion

ch, sh,

made

-ons

gn

Types of phonological dyslexia

- Impaired conversion selective to a specific feature

PACK-BAG

GOAT- COAT

TOWN- DOWN

b-p g-k t-d voicing

dyzlegzia

Gvion, A., & Friedmann, N. (2010). Dyscravia: Voicing substitution dysgraphia. *Neuropsychologia, 48,* 1935-1947.

Types of phonological dyslexia

- Impaired conversion selective to a specific feature

BAD-MAD

NOT-DOT

b-m d-n nasality

nazalexia

Types of phonological dyslexia

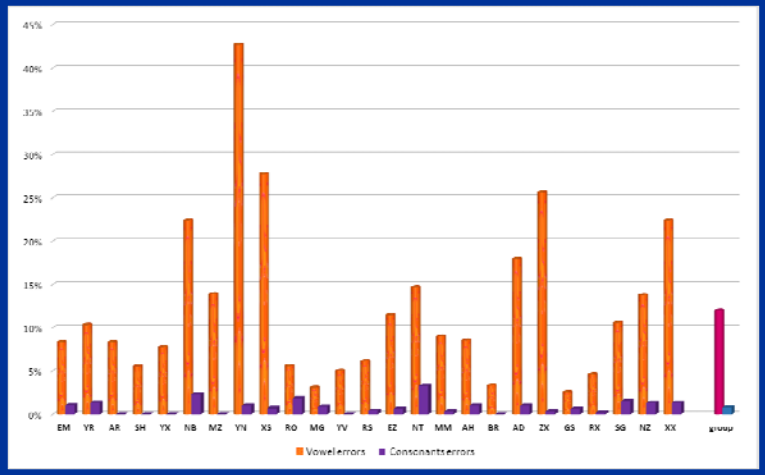
- Impaired conversion selective to a specific feature

BOAT- bat, bit, bate, bet

FORM- farm, from, frame, forum

Vowel letter dyslexia

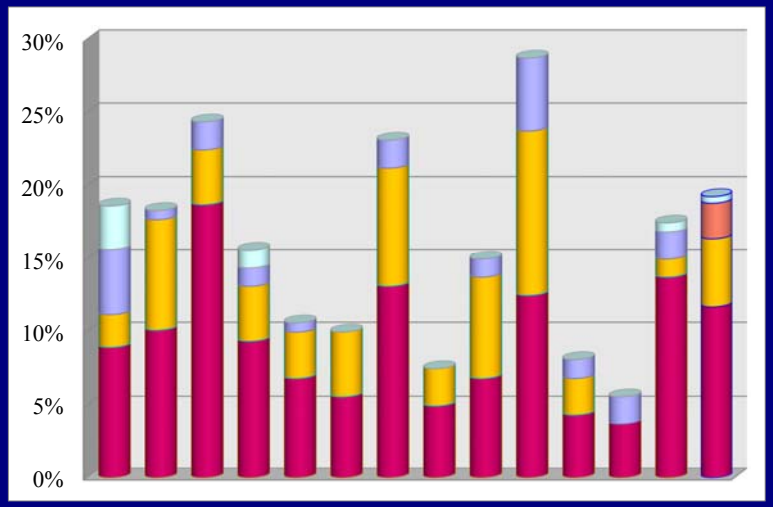
Errors almost exclusively in vowel letters



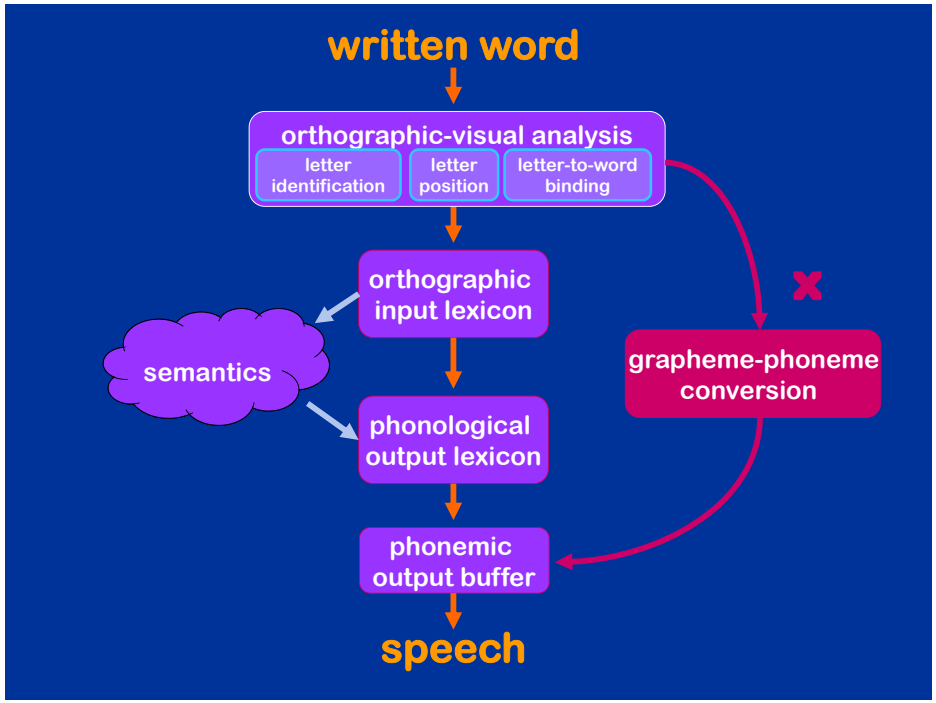
ERM, Barbieri, Marelli, Zonca, Saletta, Friedmann, Luzzatti

target	response
stremba	stra, stramba
gupico	gua, gu, +
nemmeno	nema, +
comango	comaga, comanga, +
zura	zu, zu, +
sfogo	sfago
lirica	liri, +
peravotto	peravatto…+
anagrafe	ano, anagràfe
cortile	cort, +
limite	li, +
debito	debi, +
fosforo	fo, fo, +
mensile	mansile, +
mentolo	mèntola
porcile	por-ci, +
corsaro	cor, +
bibita	bibite, +

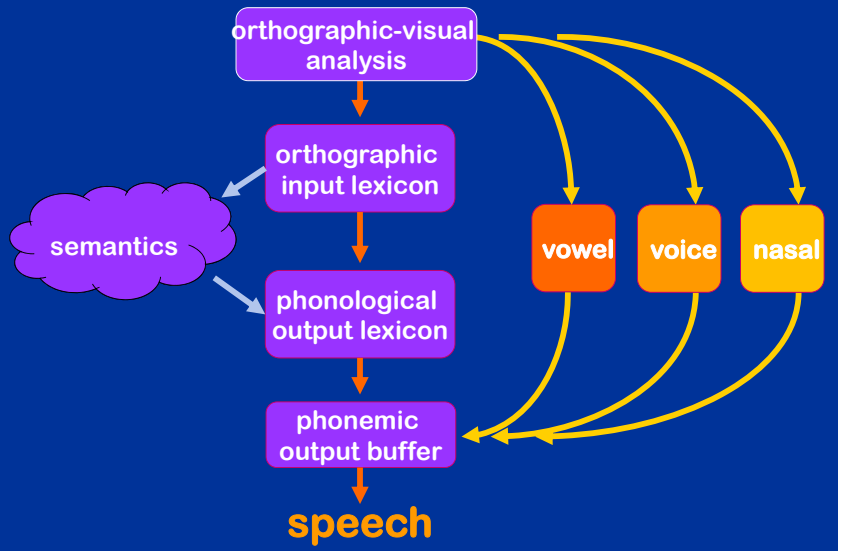
Vowel error distribution



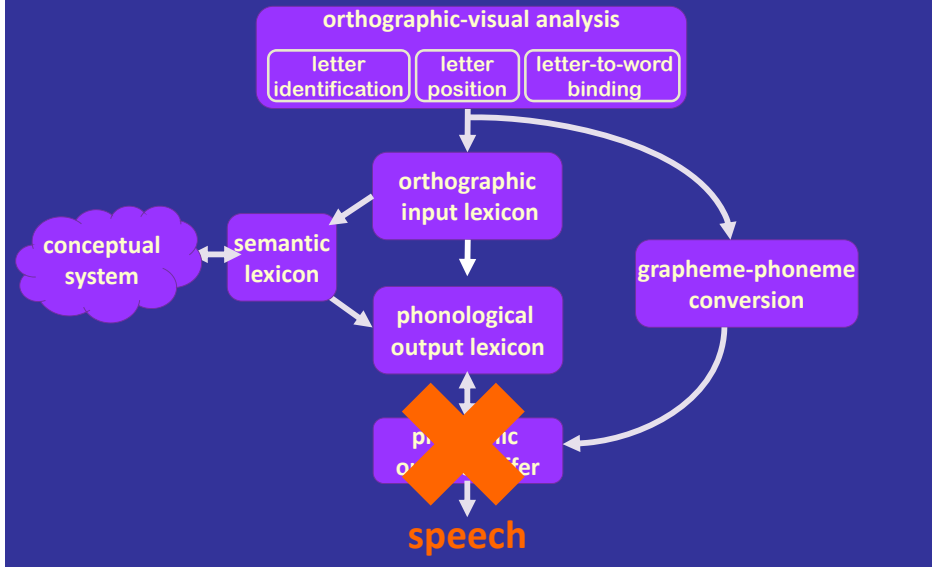
Vowel migration	Vowel addition	Vowel omission	Vowel substitution
11.2%	6.3%	2.2	0.5%



Implication for the model: modification needed

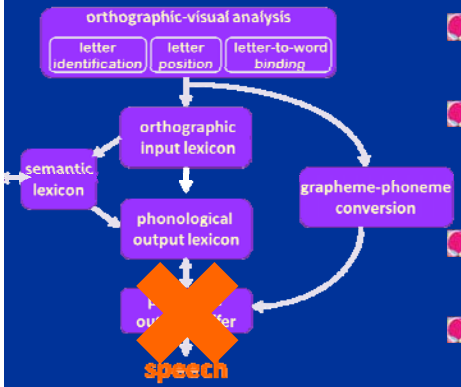


Another types of phonological dyslexia: impaired phonological buffer



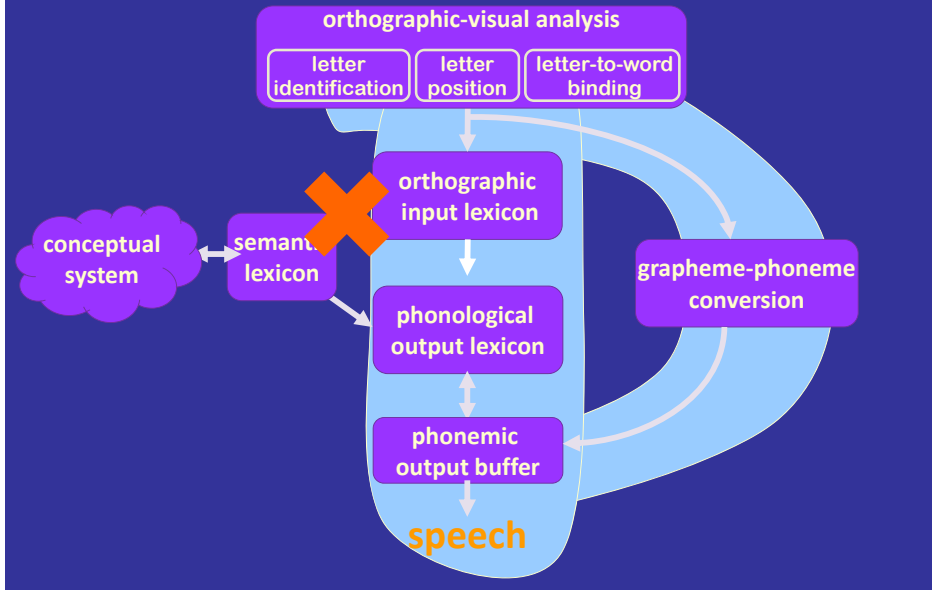
Types of phonological dyslexia

Impaired phonological output buffer



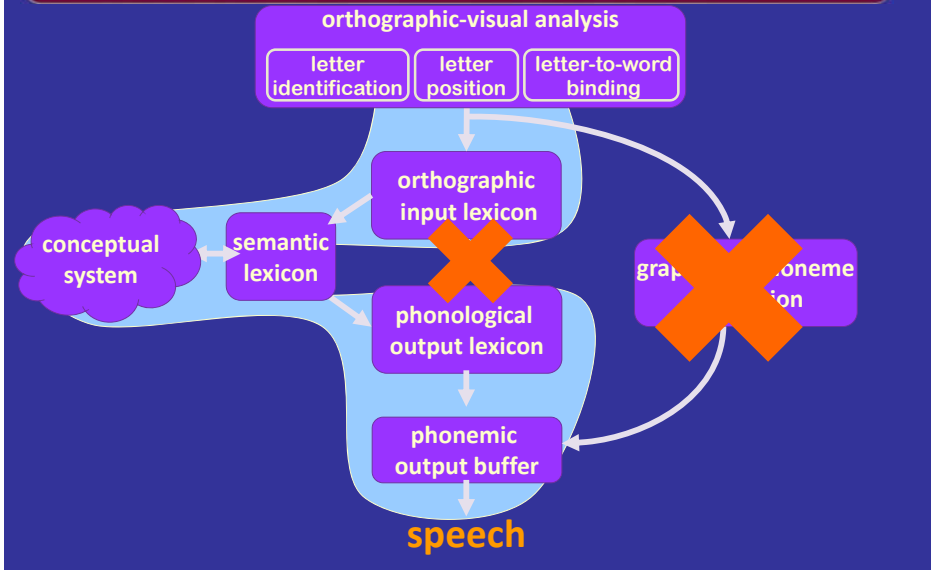
- Impaired reading of nonwords
- Impaired reading of morphologically complex words
- Impaired reading of multi-digit numbers
- Impaired repetition of the same items.

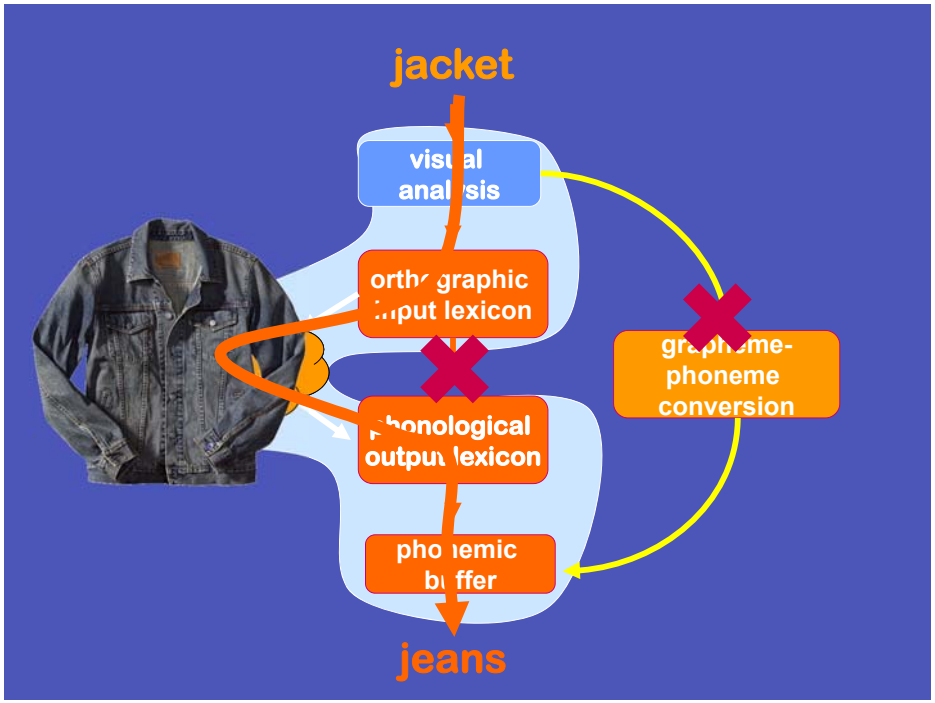
Impaired access to semantics: "direct dyslexia"



Deep dyslexia

Impaired sublexical route and interlexical disconnection: deep dyslexia





Semantic errors

gift	present
round	circle
style	dress
happy	smile
sorry	sad
of	I don't know…
because	for
jacket	jeans

Diglossia and reading in deep dyslexia

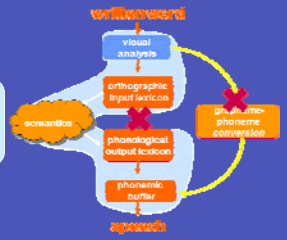
Friedmann, N., & Haddad-Hanna, M. (2014). Types of developmental dyslexia in Arabic. In E. Saiegh-Haddad & M. Joshi (Eds.), Handbook of Arabic literacy: Insights and perspectives (pp. 119-152). Springer

Palestinian Arabic differs substantially in lexical items and syntax from Standard Arabic.

Standard Arabic serves as the written language.

Standard Arabic "is nobody's mother tongue". It is mainly learned through schooling and used exclusively for official, academic, or formal functions.

What is to be expected if such reading via semantics is employed?



SU, a 16 year old, with developmental deep dyslexia

SU is 16 years old female, 10th grader, a native speaker of Palestinian Arabic, with Hebrew and Standard Arabic as a second language. Studies in an Arabic-speaking school.

"classic" semantic errors

Blackboard → eraser	لوح - محاي
Blind → eye	اعور - عين
Port → water	ميناء - مي
Driver → taxi	سائق - تكسي

Diglossia and reading in deep dyslexia

she often read the Palestinian Arabic counterpart of the target

TBIB-DKTOR	طبيب – دكتور
GLS-K?D	جلس – قعد

FA , Participant with developmental Deep Dyslexia

diglossia

we presented FA with a list of words in Standard Arabic that have common synonyms in Palestinian Arabic or in Hebrew. FA could not read correctly even a single word from this list.

FA read دار , DAR 'house' in SA, as "bet", house in PA,

he read هاتف HATF 'phone' in SA as "telefun"

Dyslexias – summary

- 19 types of dyslexia exist, each resulting from a different deficit in the reading model.
- Each dyslexia affects different word types, and causes different error types, and hence – requires different diagnosis.
- To diagnose different dyslexias, one has to use the appropriate stimuli: migratable words (form) for LPD, migratable word pairs (goat coal), irregular words (walk) for surface dyslexia, nonwords for phonological dyslexia, etc.
- Directions for treatment depending on the dyslexia– reading window, finger tracing, silent reading etc.
- Fruitful interaction between the cognitive model and dyslexias: predictions and modifications.