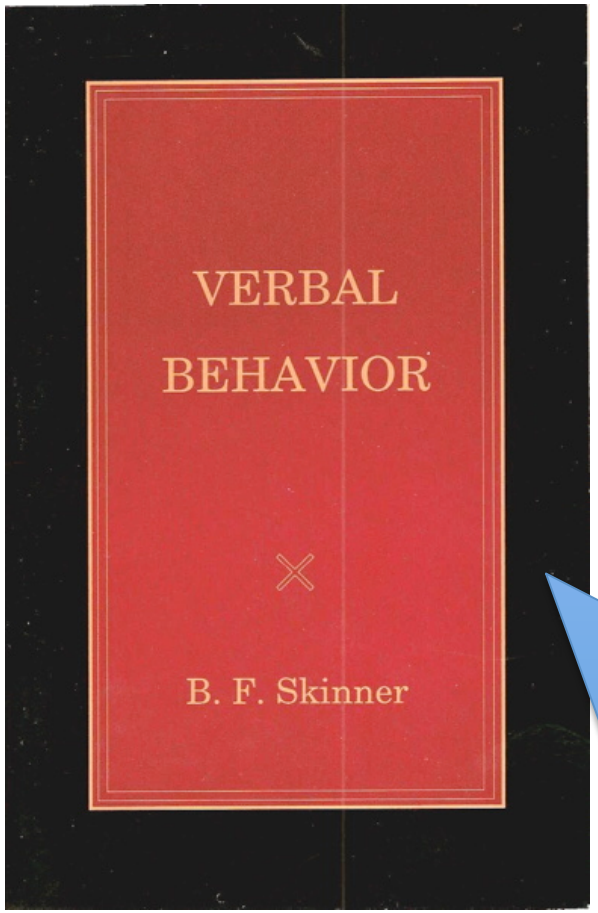
Equivalence and other stimulus control strategies: Exploratory studies on reading in neurotypical, autistic and dyslectic children

Giovambattista Presti*°, Melissa Scagnelli*°,Davide Carnevali*°, Melania Mazza*, Federica Catelli*

°IULM University, Milan, Italy

*IESCUM, Italy



Textual responding: Verbal behavior under the control of printed words

Textual behavior is reading, without any implications that the reader understands what is being read

Reading comprehension involves many other behaviors such as intraverbal behavior and receptive language.

My personal issues with this definition:

- Does it make sense separating reading (topography) from understanding (function)?
- From an applied point ov view, does it make sense to teach sound responses to text without teaching “meaning”?
- If we look at verbal behavior from an “arbitrary stimulus classes” point-of-view, does this definition still hold?

Aim

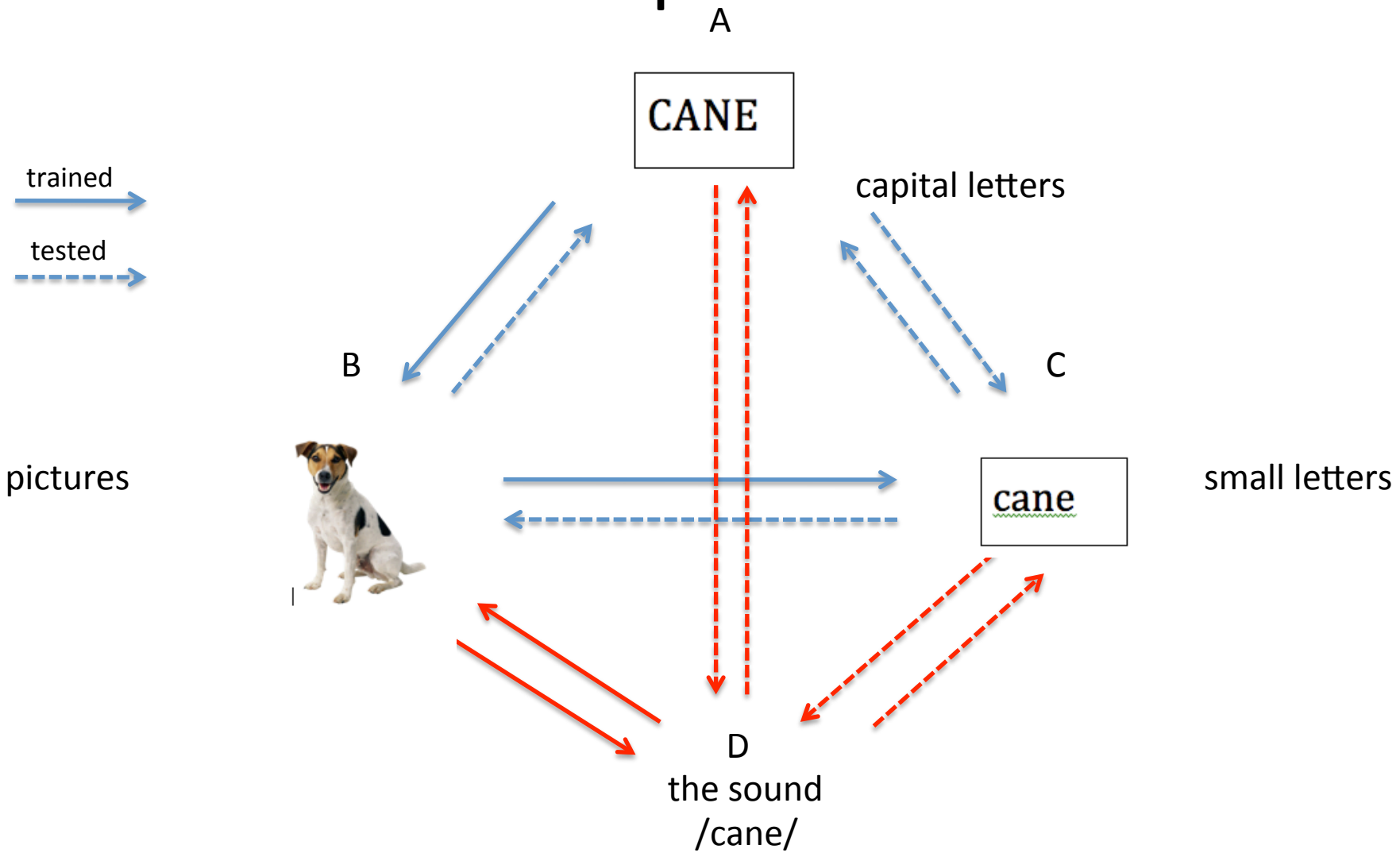
- The aim of these exploratory studies was to teach basic reading skills under a conditional-discrimination procedure and to test the feasibility of this procedure in Italian
- We tested reading printed and self-written words (see/hear the following presentation)
- We tested re-combinatorial strategy
  - At the syllable level
  - At the letter level

Prerequisite: tacting a picture

In the presence of…

produces

Basic procedure



Basic procedure

- Conditional discrimination procedure with arbitrary stimuli matching to sample task.
- Subject and therapist sit in front each other.
- The therapist puts on the table three cards as comparisons and gives the sample to child.
- A randomized data sheet (9 trials 3 stimuli array data sheet that prescribes the sample and the position of comparison stimuli, so that their rotation doesn't follow any predictable pattern) was used to keep track both of data and the position of comparisons.

Procedure

- 1 block: 9 trials
- 3 to 6 sessions per learning unit
- Reinforcement schedule:
  - FR 1 (on first trial)
  - VR 3
  - VR 5
  - FR 9 (last three blocks)
- Prompt delay (when necessary)
- Response: put picture/word on picture/word
- During testing: no prompt, no Rf

Conditions

- Phase 1
  - Teaching to read a number of words in upper and lower case
- Phase 2
  - Teaching/testing emerging of recombination at syllable level
- Phase 3 (one child)
  - Testing of recombination at the letter level

Words chosen…

- In the absence of monosyllabic words in Italian we chose bysillabic words of pictures they were able to tact

S1

- 5 years old autistic male kid
- 2.5 years of ABA intervention (around 20 hrs per week)

Phase 1
18 words

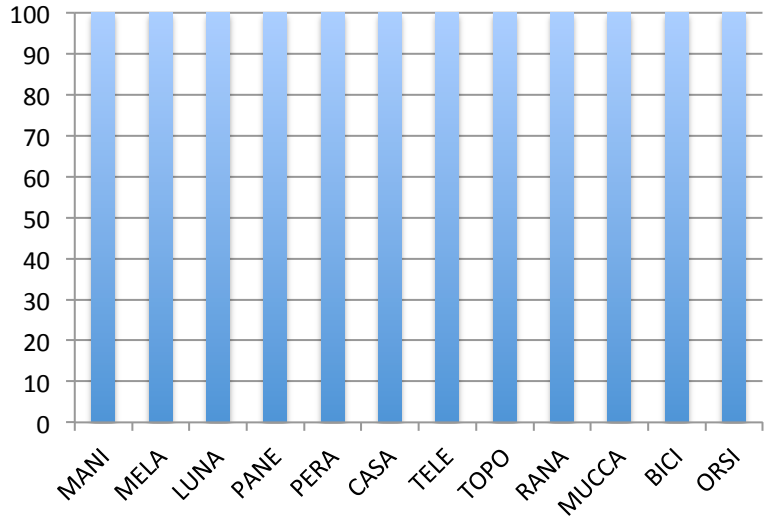
- Topo – Pera – Orsi
- Casa – Luna – Bici
- Tele – Rana – Mucca
- Mani – Mela – Pane
- Naso – Nave – Neve
- Sole – Cane – Toro

Stimulus classes

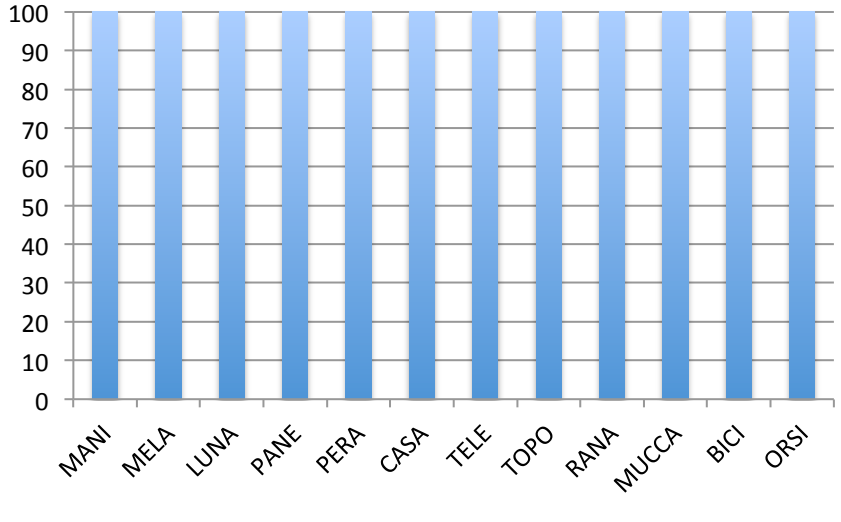
	A	B	C
1	MOUSE	picture	mouse
2	PEAR	picture	pear
3	BEAR	picture	bear
4	HOUSE	picture	house
5	MOON	picture	moon
6	BIKE	picture	bike
7	tv	picture	Tv
8	FROG	picture	frog
9	COW	picture	cow
10	HANDS	picture	hands
11	APPLE	picture	apple
12	BREAD	picture	bread
13	NOSE	picture	nose
14	SHIP	picture	ship
15	SNOW	picture	snow
16	SUN	picture	sun
17	DOG	picture	dog
18	BULL	picture	bull

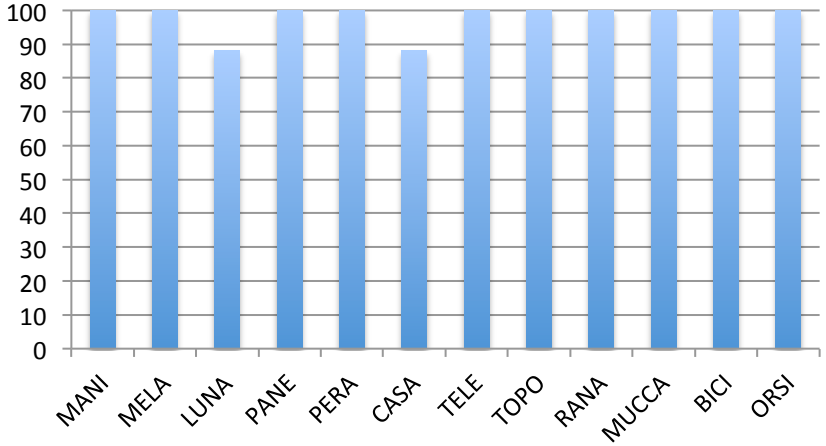
Tested derived relations

B-A

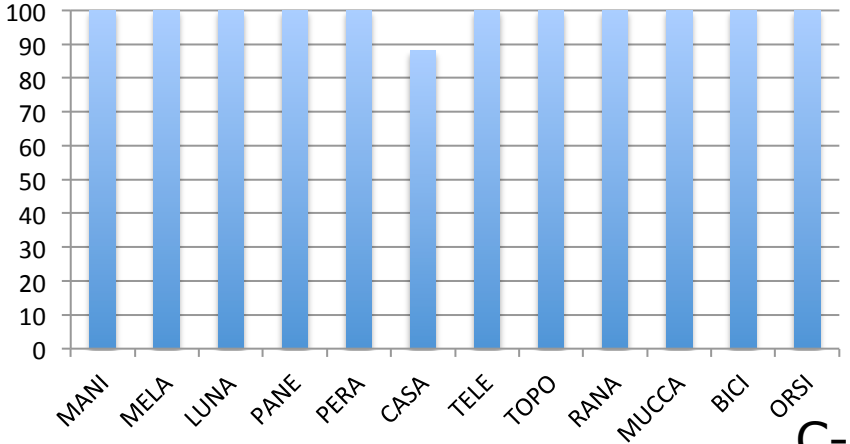


C-B





A-C



C-A

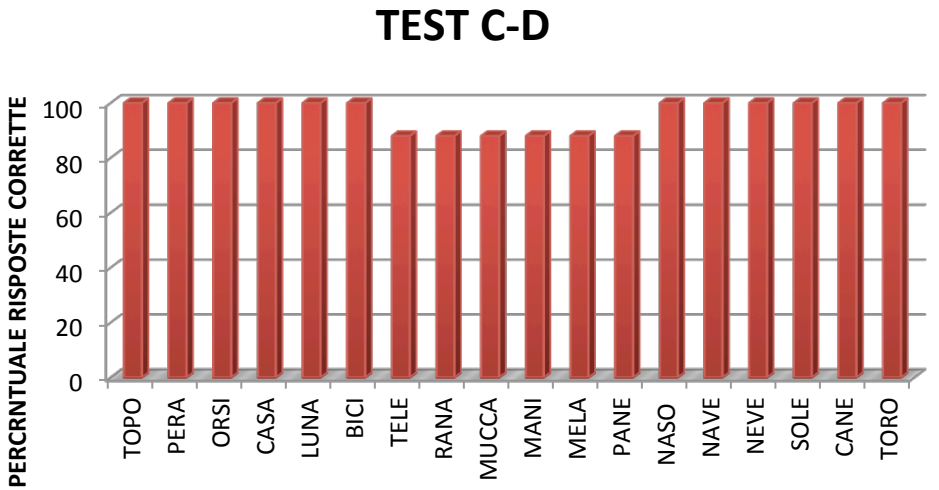
Tested derived relations

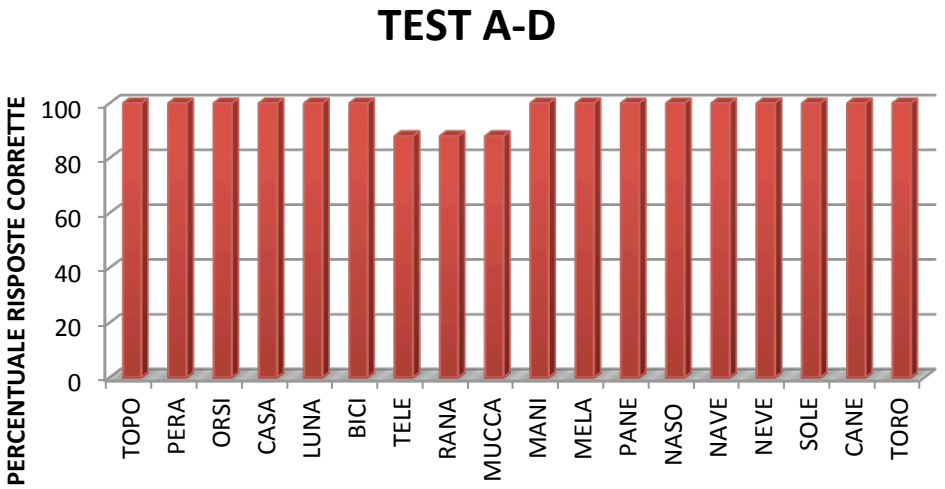
In the presence of

reproduces

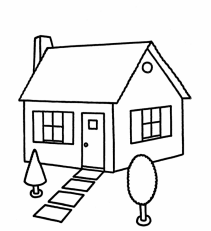
casa → /CASA/

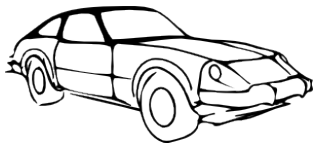
CASA → /CASA/

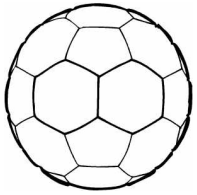


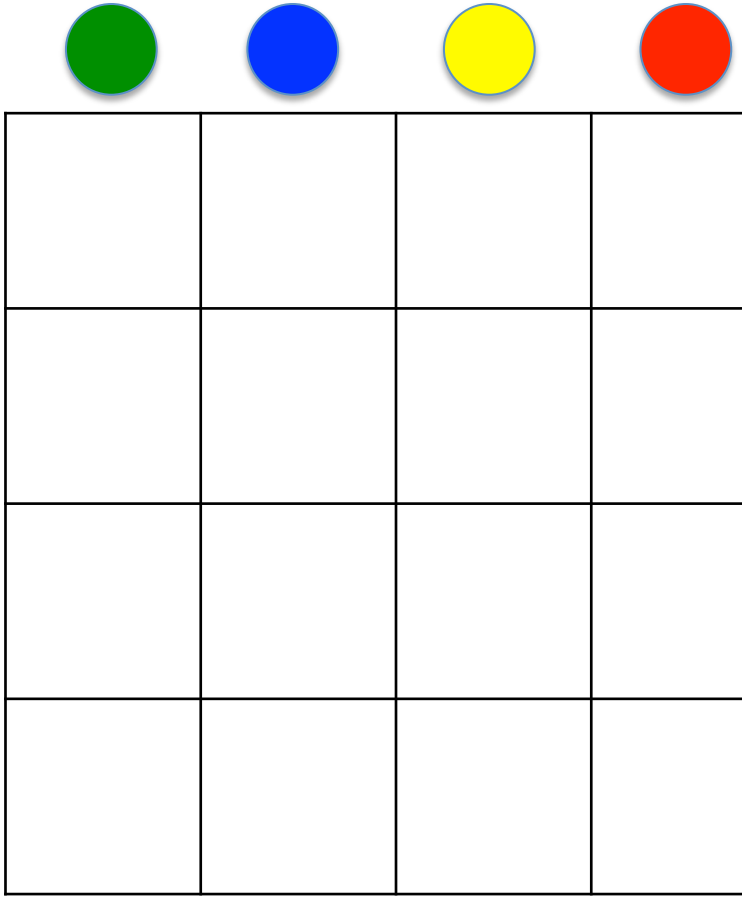


Generative strategies

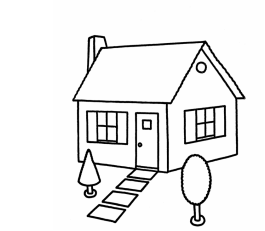


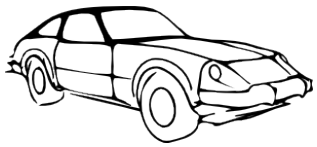


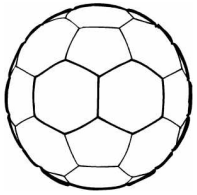




Generative strategies







X	X		
	X	X	
		X	X
X			X

Recombining

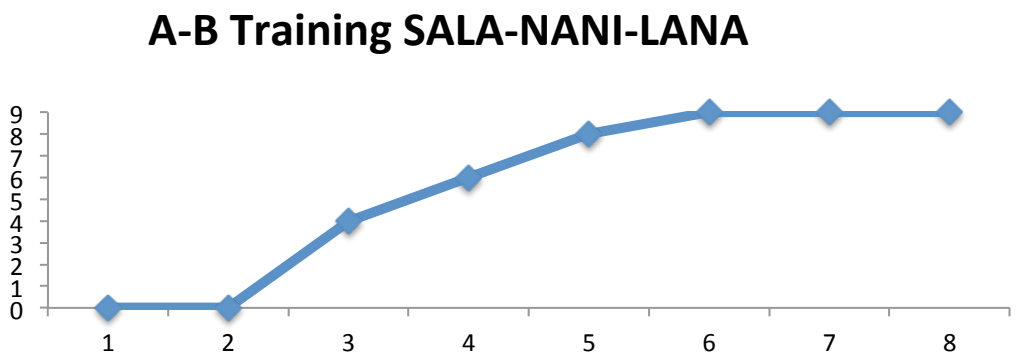
	BI	CA	CI	LA	LE	LU	MA	ME	MUC	NA	NE	NI	OR	PA	PE	PO	RA	SA	SI	SO	TE	TO	VE
BI			**BICI**																				
CA												CANI						**CASA**					
CI	CIBI						CIMA			CINA													
LA							LAMA			LANA													
LE																							
LU		LUCA	LUCI							**LUNA**	LUNE												
MA												**MANI**											
ME				**MELA**	MELE														MESI				
MUC		**MUCCA**																					
NA												NANI							NASI	**NASO**			**NAVE**
NE																							**NEVE**
NI																							
OR		ORCA					ORMA	ORME											**ORSI**	ORSO			
PA				PALA							**PANE**			PAPA									
PE															PEPE		**PERA**						
PO																							
RA										**RANA**	RANE												
SA				SALA	SALE					SANA							SARA						
SI																							
SO																							
TE					**TELE**																		
TO																**TOPO**							
VE					VELE						VENE												

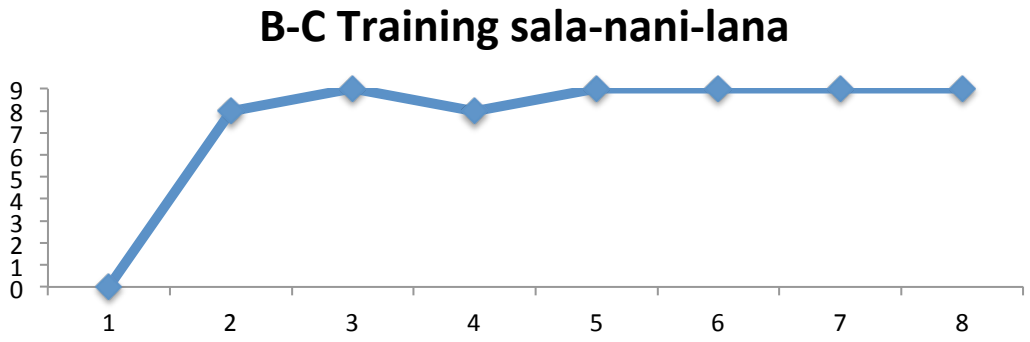
23 x 23 matrix; 529 combination; 42 Italian words (7,9%); 18 (3,4%; in red) were taught

Phase 2: adding new word taken from recombination

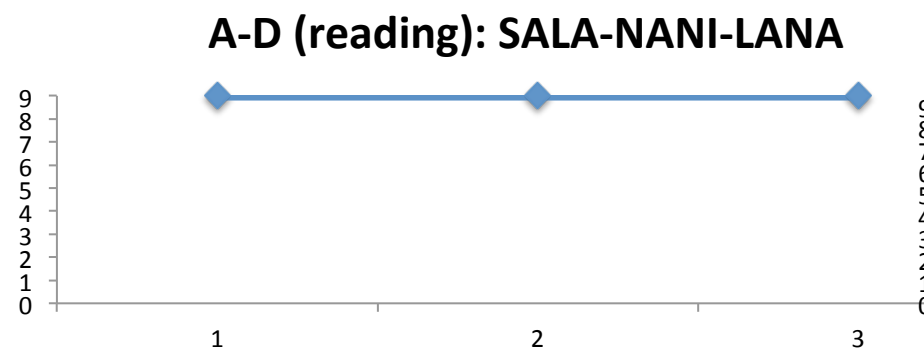
- Topo – Pera – Orsi
- Casa – Luna – Bici
- Tele – Rana – Mucca
- Mani – Mela – Pane
- Naso – Nave – Neve
- Sole – Cane – Toro
- Sala – Nani – Lana
- Orca – Orma - Cani

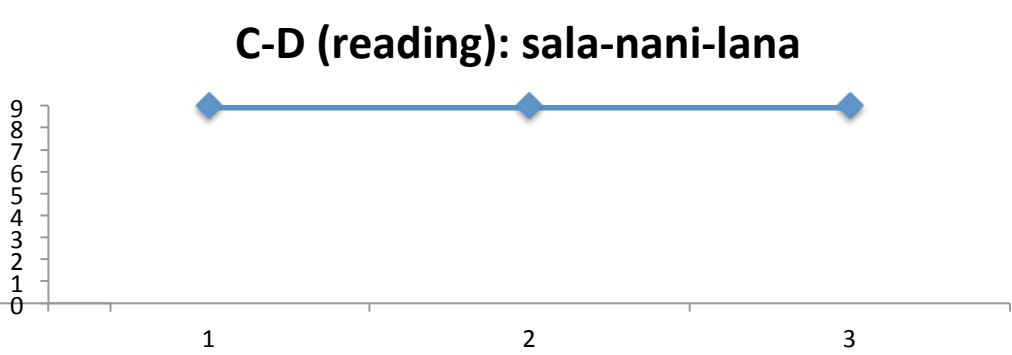
SALA – NANI – LANA

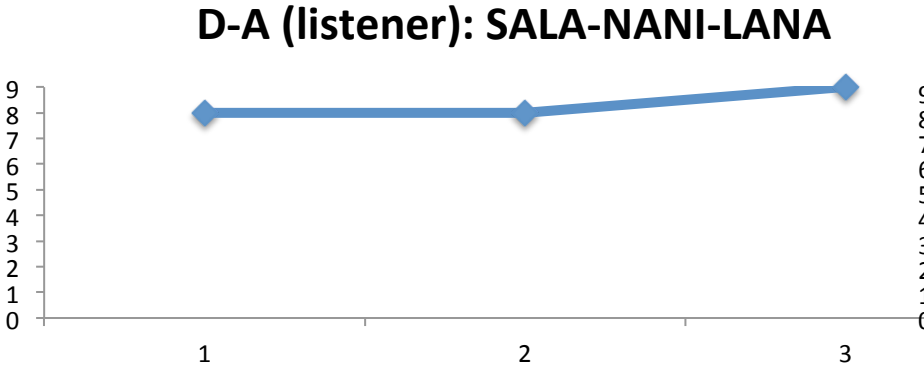


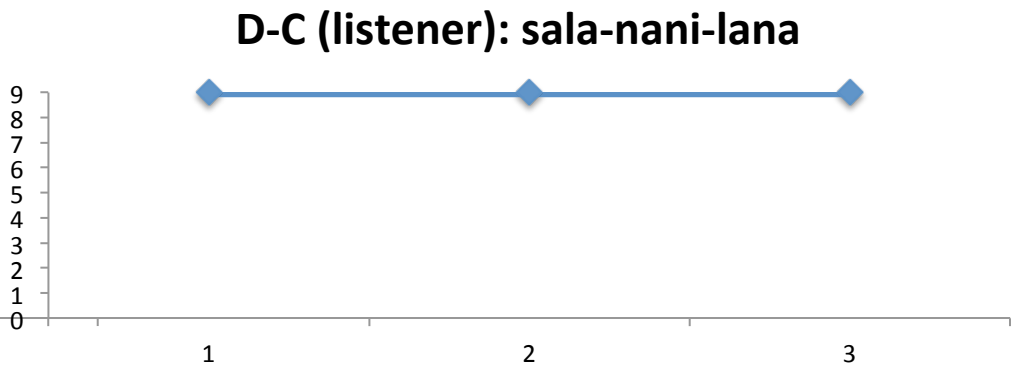


Test the first ricombination

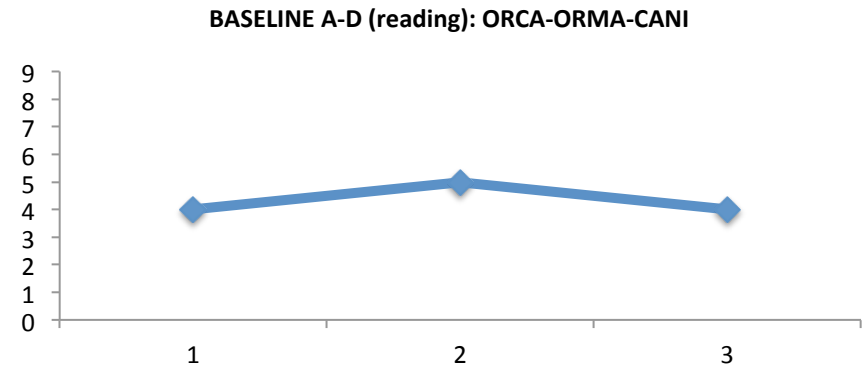


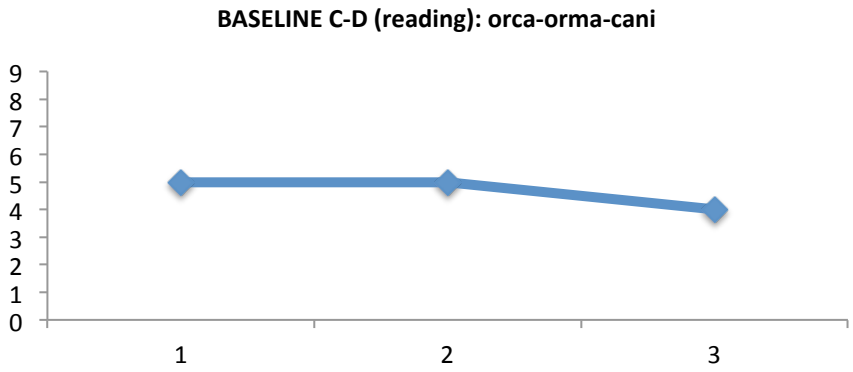


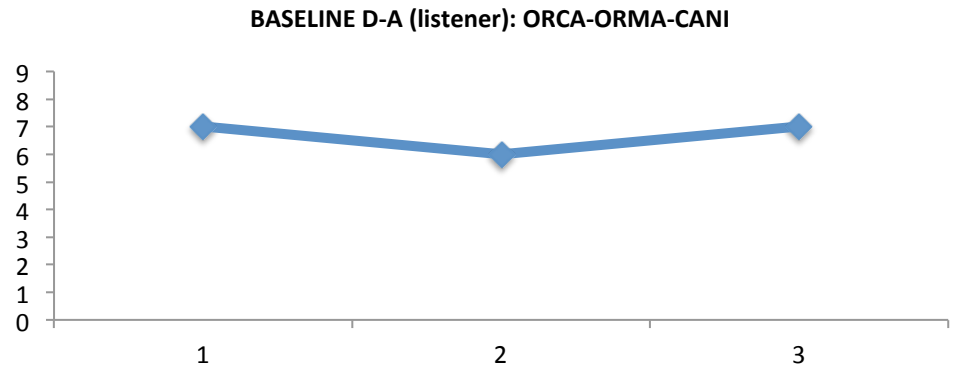


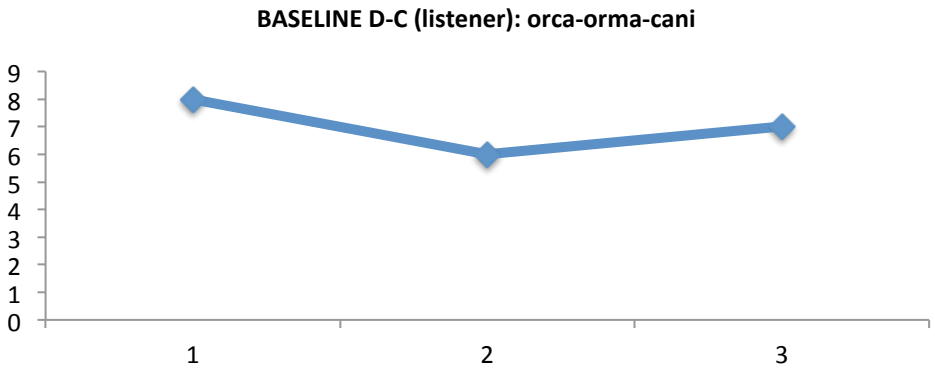


For the second recombination we tested the derived relations before any traning

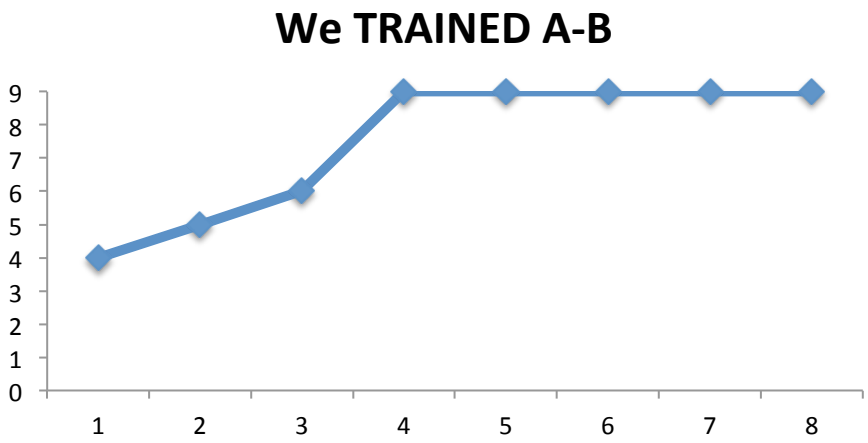




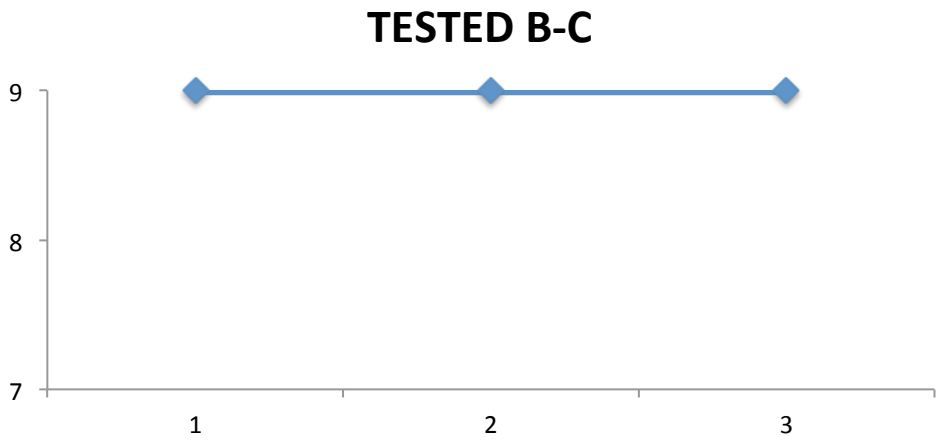




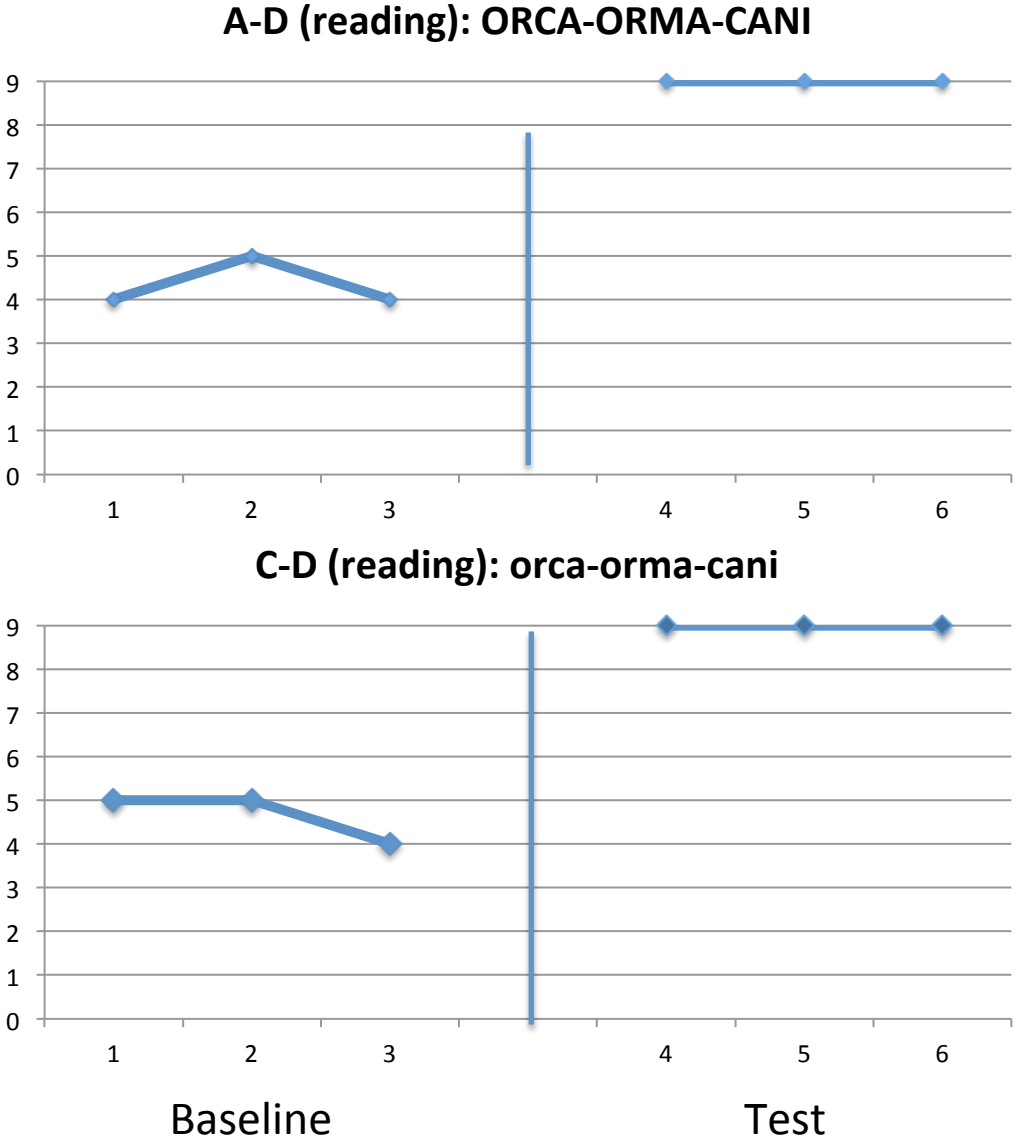
ORCA – ORMA - CANI



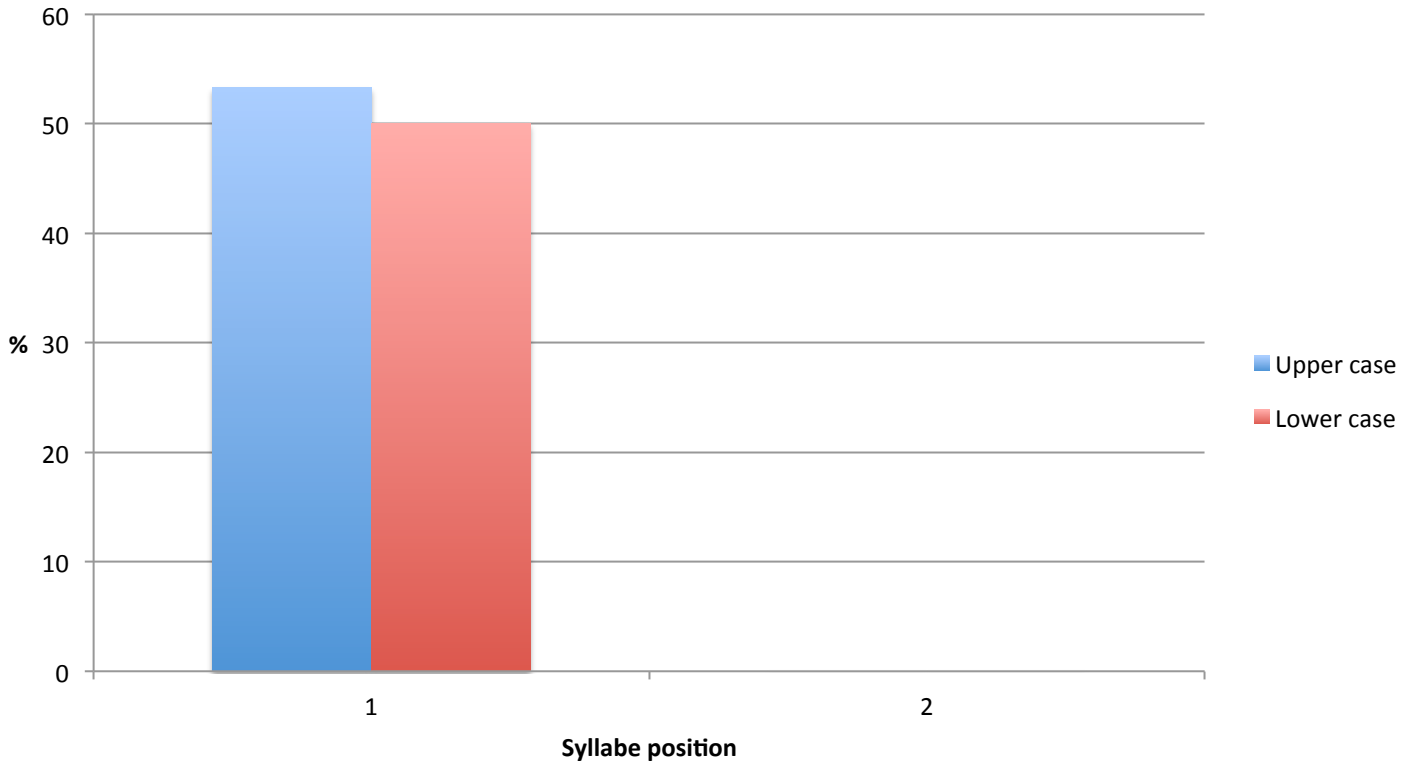
and simply tested...



Before and after AB training only



Non sense (words n=21; syllables n=42)



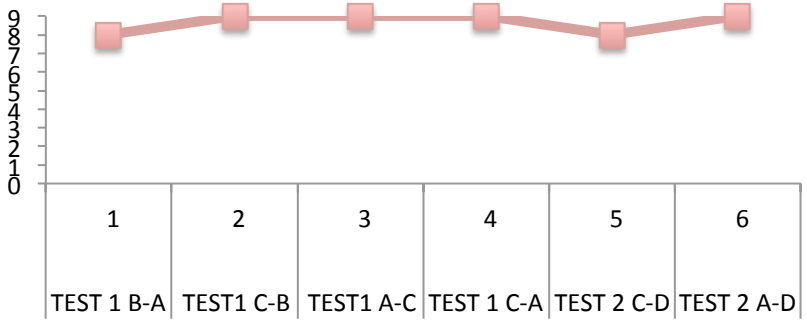
S2

- 10 years old ASD male kid
- IQ within the lower limits
- 1 session (45 min) per week

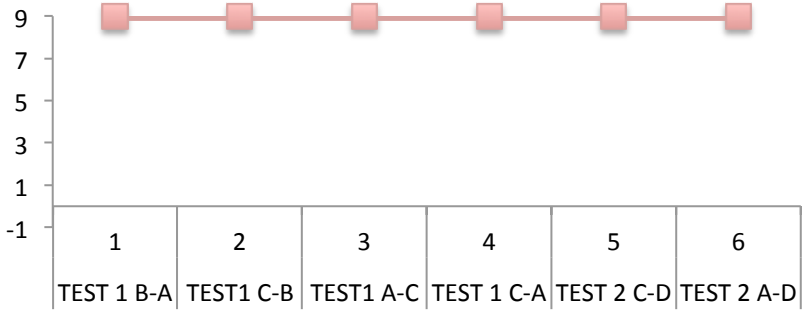
Words

- Sole – Mela - Cane
- Casa – Pera Nave
- Moto - Neve - Mano
- Auto – Mucca – Pesce
- Pane - Latte – Pizza
- Succo - Pasta - Pollo
- Riso – Gelato – Carne

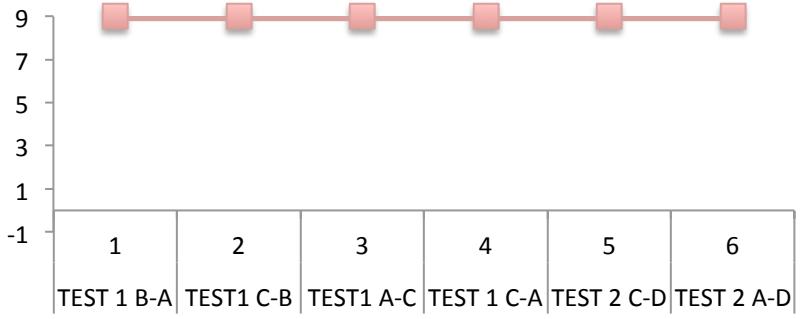
SOLE-MELA-CANE



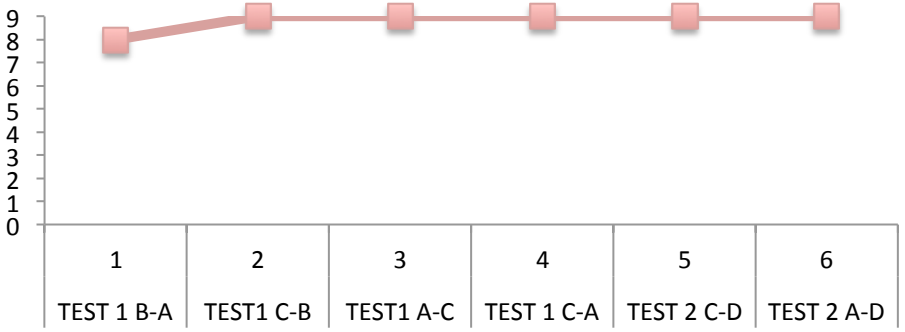
CASA-PERA-NAVE



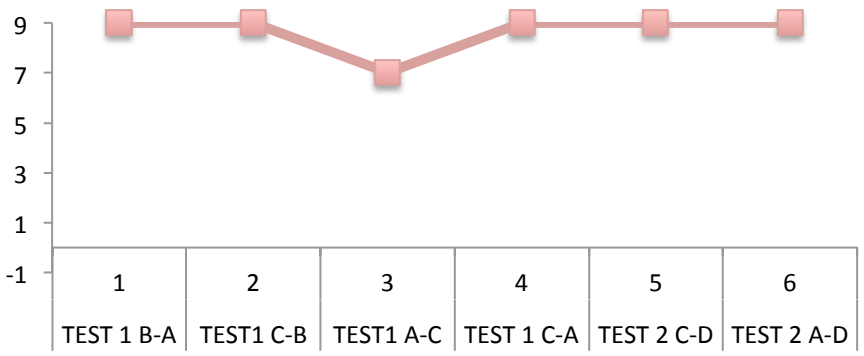
MOTO-NEVE-MANO



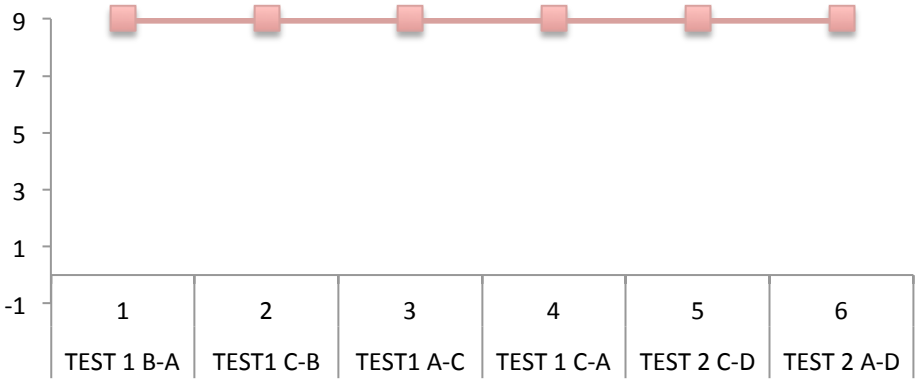
AUTO-MUCCA-PESCE



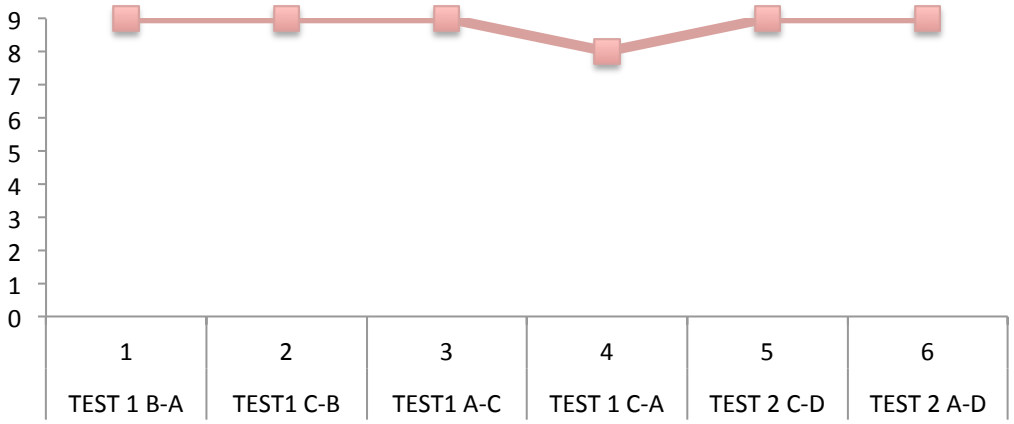
PANE-LATTE-PIZZA



SUCCO-PASTA-POLLO

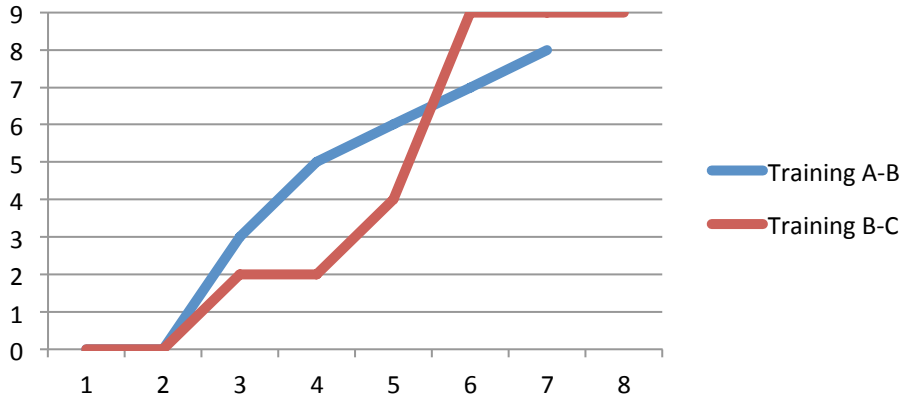


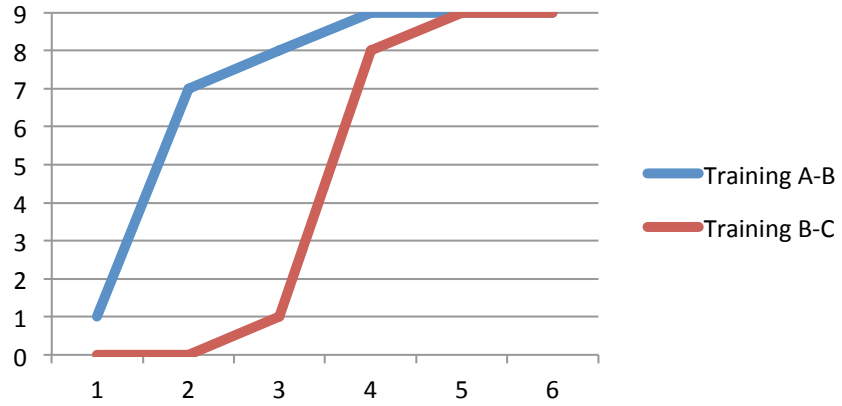
RISO-GELATO-CARNE

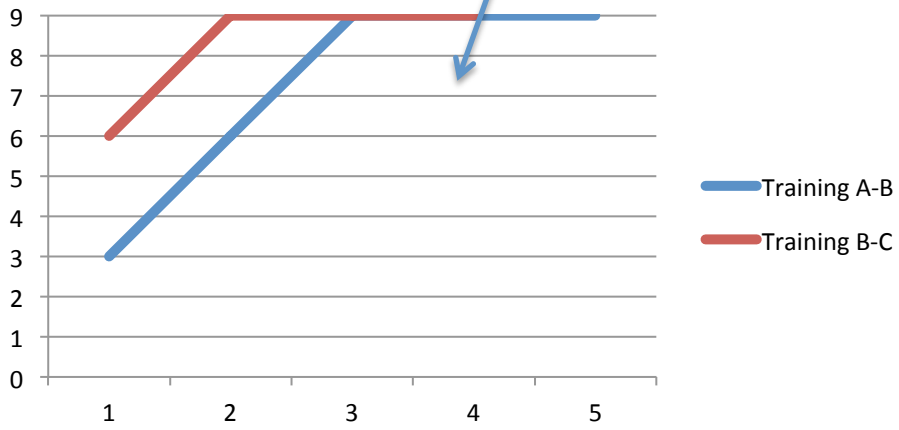


Something interesting to look at…

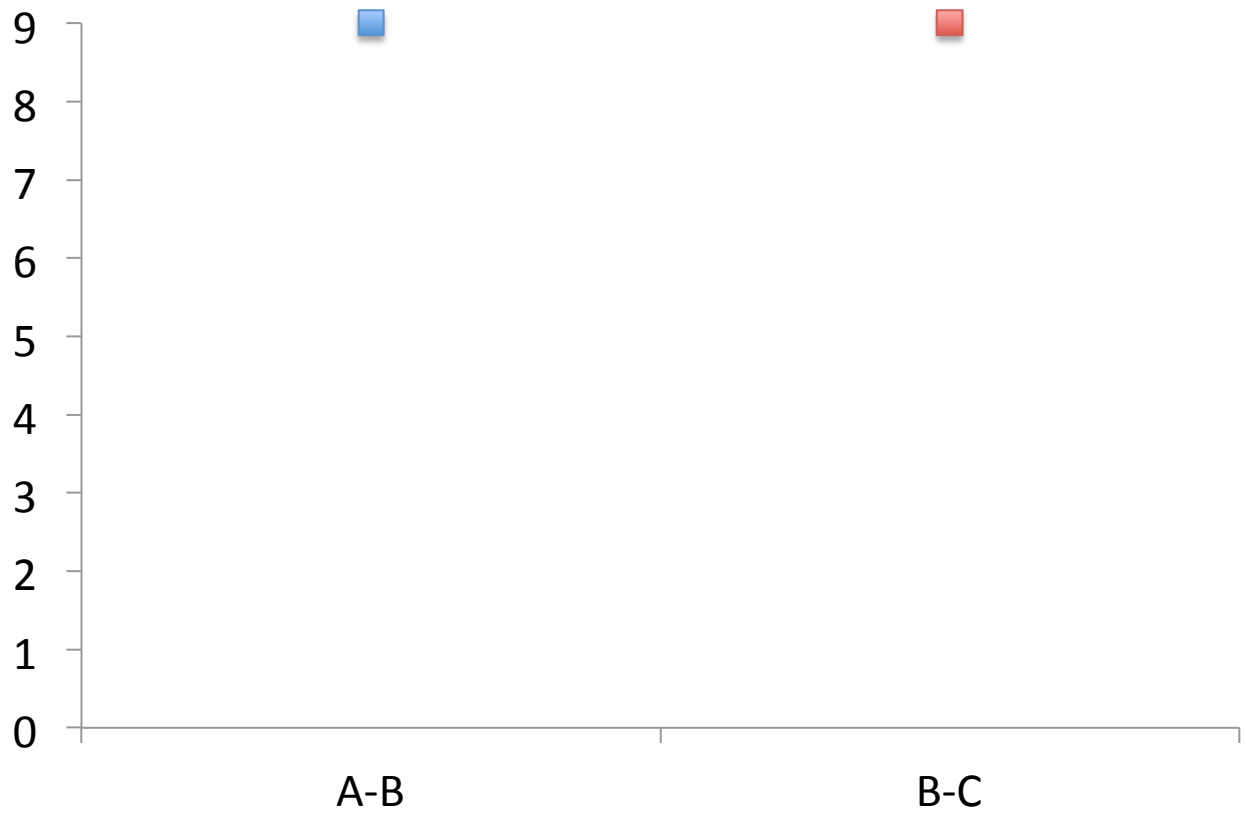
- Sole – Mela - Cane
- Casa – Pera Nave
- Moto - Neve - Mano
- Auto – Mucca – Pesce
- Pane - Latte – Pizza
- Succo - Pasta - Pollo
- Riso – Gelato – Carne







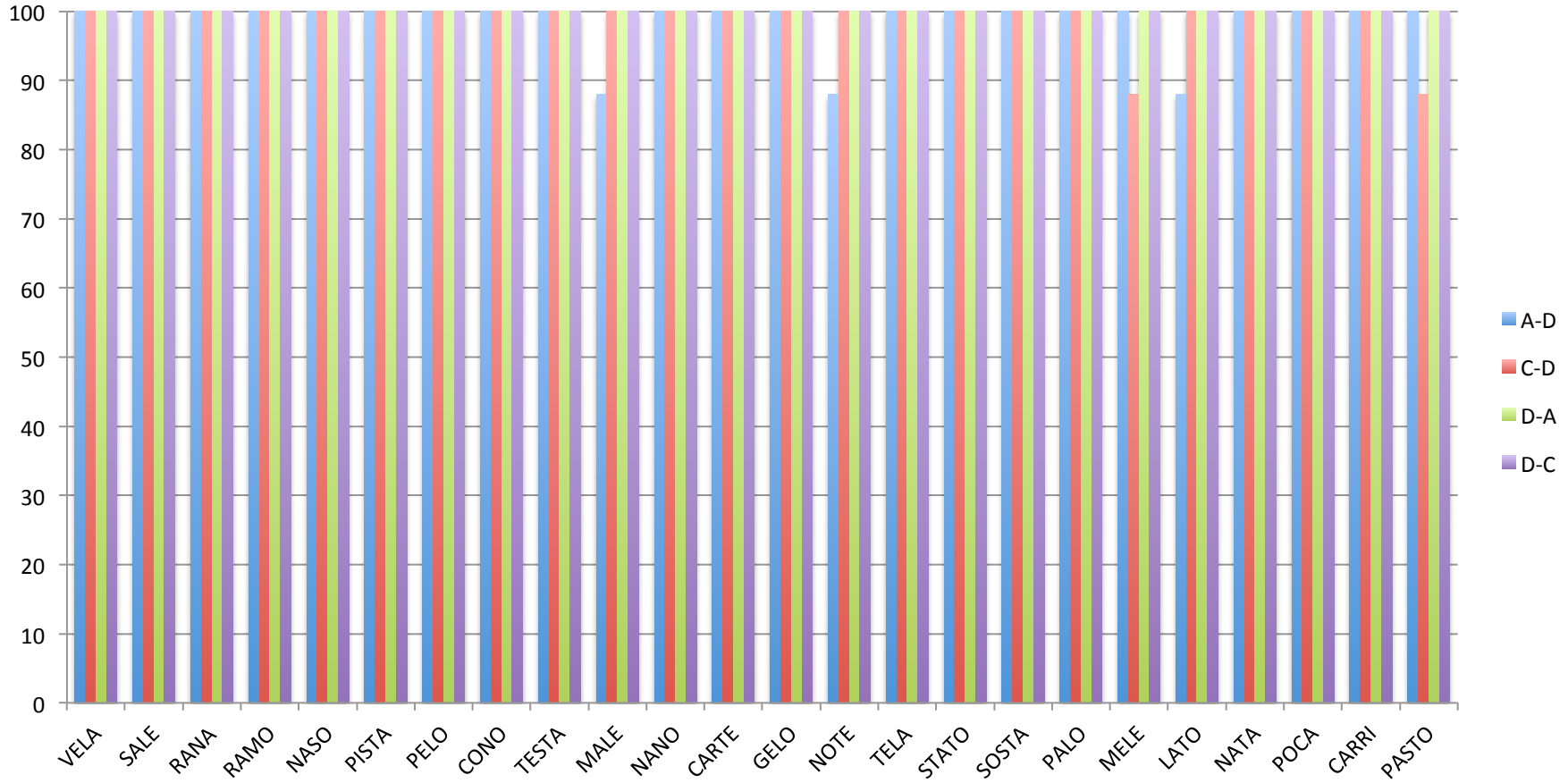
…and for the 7th triplet (RISO-GELATO-CARNE)



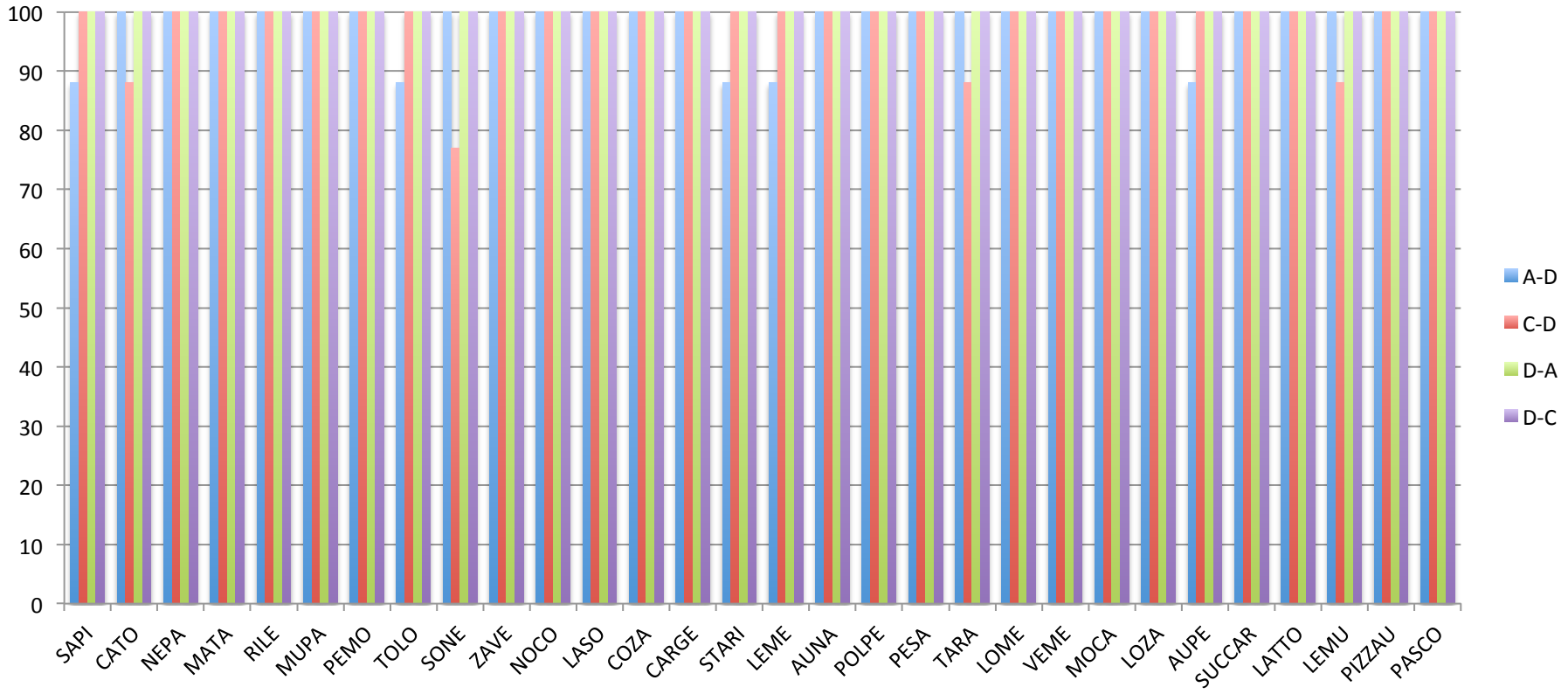
	CA	PE	SO	ME	MO	NA	NE	MA	AU	MUC	LAT	PIZ	PA	PAS	RI	SUC	POL	GE	CAR	RA	LE	LA	TO	VE	NO	TE	ZA	STA	CO	LO	TA
CA			CASO				CANE						CAPA		CARI					CARA		CALA		CAVE				CASTA	CACO	CALO	
PE		PEPE	PESO			PENA	PENE																								
SO																				PERA			PETO							PELO	
ME																					SOLE				SONO			SOSTA			
MO																					MELE	MELA			MENO						
NA			NASO			NANA	NANE																	NAVE	NANO						NATA
NE					NEMO										NERI					NERA				NEVE							
MA								MAM MA													MALE				MANO						
AU																					AULE	AULA	AUTO								
MUC	MUCC A																									LATTE					
LAT																									PINO		PIZZA	PISTA			
PIZ																															
PA							PANE						PAPA		PARI							PALA						PASTA		PALO	
PAS																							PASTO			PASTE					PASTA
RI			RISO	RIME				RIMA															RITO	RIVE							RITA
SUC																													SUCCO		
POL	POLCA												POLPA																	POLLO	
GE							GENE									GESU'						GELA	GELAT O					GESTA	GECO	GELO	
CAR		CARPE	CARSO				CARNE	CARMA					CARPA		CARRI							CARLA				CARTE				CARLO	CARTA
RA		RAPE	RASO	RAME	RAMO	RANA	RANE						RAPA		RARI					RARA						RATE		RASTA			RATA
LE																												LESTA			
LA				LAME		LANA		LAMA												LARA			LATO								
TO																												TOSTA			
VE						VENA	VENE													VERA	VELE	VELA	VETO						VELO	
NO				NOME		NONA																NOLA	NOTO	NOVE	NONO	NOTE					NOTA
TE			TESO																		TELE	TELA						TESTA			
ZA																							STATO				STAZZA				
STA																															
CO	COCA			COME	COMO			COMA														COLLA			CONO			COSTA	COCCO		
LO																													LOCO		
TA						TANA														TARA							TAZZA				TATA

961 recombinations: tested 24 italian words and 30 non sense words

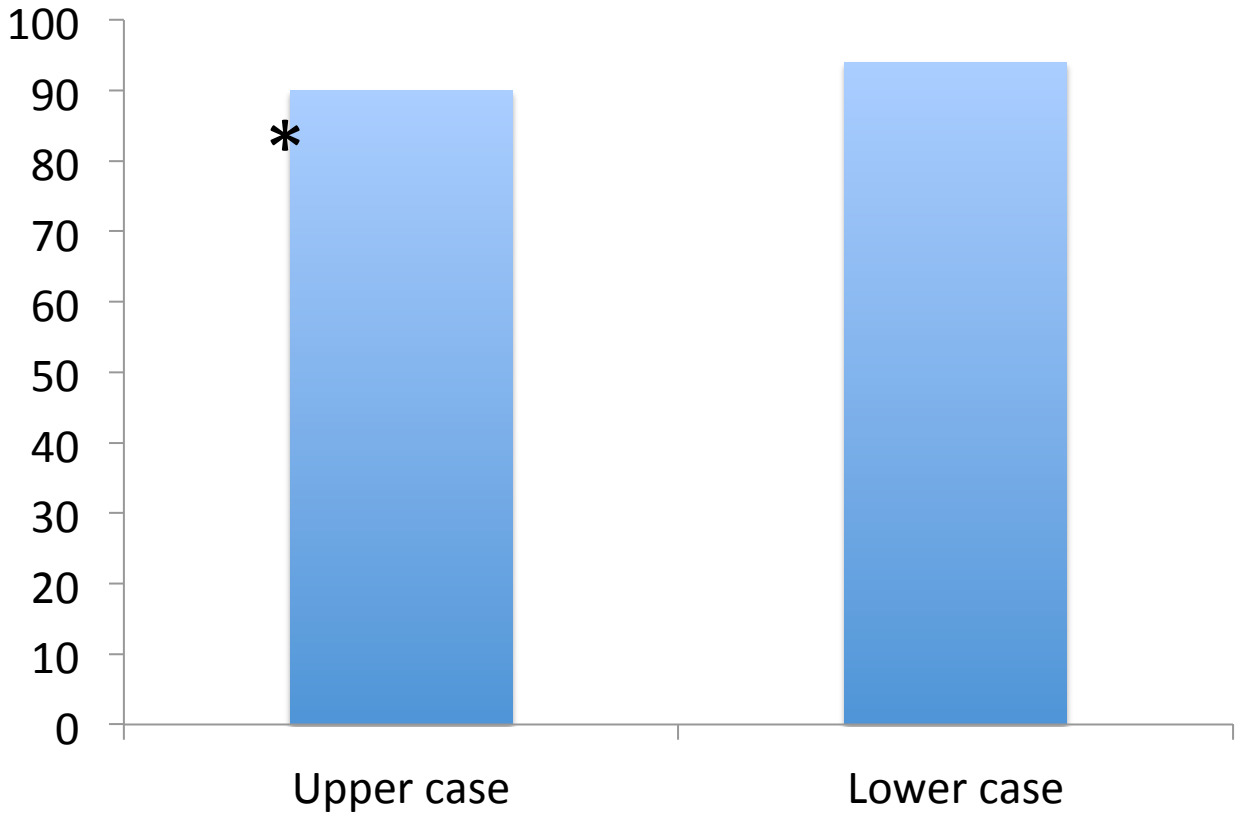
Testing new words (n=24)



Testing new non sense words (n=30)

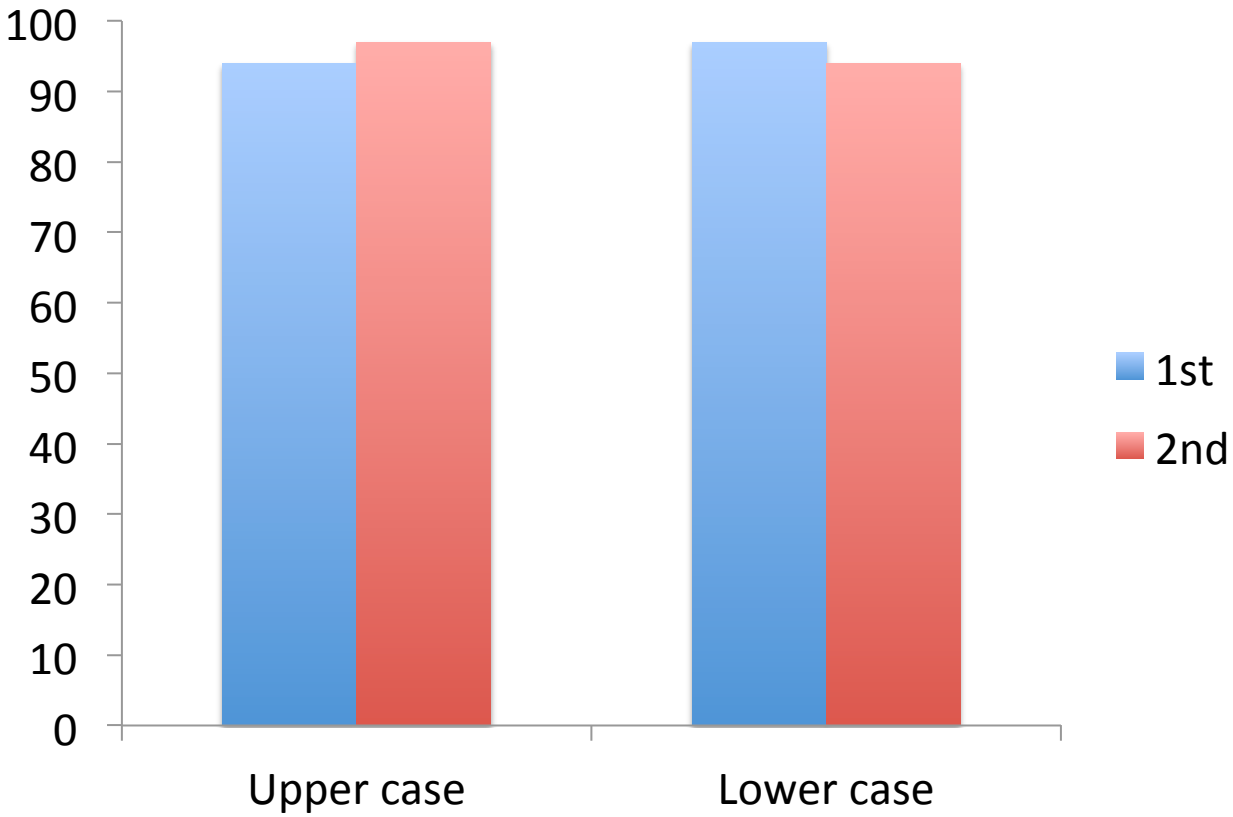


Recombination at the letter level (50 bisillabic words)



*corrected himself immediately after giving wrong response

Recombination at the letter level (50 words)



Letters and vowels taught

A
C
E
G
I
L
M
N
O
P
R
S
T
U
V
Z

Over 7 triplets we taught 16/21 letters in the Italian alphabet

Recombination at the letter level (n=83 words)

CANTO	ok	canto	ok
VINO	ok	vino	ok
COME	ok	come	ok
PERO	ok	pero	ok
PENNA	ok	penna	ok
COLLO	ok	collo	ok
LIMONE	ok	limone	ok
PECORA	ok	pecora	ok
TAVOLO	ok	tavolo	ok
PISTOLA	pizzola*	pistola	ok
CARTONE	ok	cartone	carote
MELONE	ok	melone	ok
STELLA	ok	stella	ok
POSARE	ok	posare	ok
GALLINA	giallina	gallina	ok
PASTELLO	pastelo	pastello	ok
MATITA	ok	matita	ok
CARAMELLA	ok	caramella	ok
MAIALE	ok	maiale	ok
LINEA	ok	linea	ok
PELOSO	ok	pelosa	ok
PORTA	ok	porta	ok
TETTO	ok	tetto	ok
CAPELLI	ok	capelli	ok
MOSCA	ok	mosca	ok
PAPERA	ok	papera	ok
RULLO	ok	rullo	ok
CALCIO	ok	calcio	ok
CORSA	ok	corsa	ok
FELPA	ok	felpa	ok
AEREO	ok	aereo	ok
TROTTOLA	ok	trottola	ok
VIOLA	ok	viola	ok
FORBICE	ok	forbice	ok
TELEFONO	ok	telefono	ok
TAPPO	ok	tappo	ok
ARANCIA	ok	arancia	ok
FIORE	ok	fiore	ok
BOLLA	balla	bolla	ok
GONNA	conna	gonna	ok

RUOTA	ok	ruota	ok
CENA	ok	cena	chena
PALA	ok	pala	palla
SETE	ok	sete	ok
MOSCA	ok	mosca	ok
LEGO	leggo	lego	ok
ORSO	ok	orso	ok
CONO	ok	cono	ok
GALLO	calo	gallo	ok
SOLO	ok	solo	ok
TORO	ok	toro	ok
TELE	ok	tele	ok
MALE	ok	male	ok
PELO	ok	pelo	ok
ROSSO	rosa	rosso	ok
CARTA	ok	carta	ok
LETTO	ok	letto	ok
NOTA	ok	nota	ok
MORA	ok	mora	ok
SEME	ok	seme	ok
RIMA	ok	rima	ok
GATTO	gito	gatto	ok
TELO	ok	telo	ok
PISTA	ok	pista	ok
SANO	ok	sano	ok
PINO	ok	pino	ok
ROSA	ok	rosa	ok
PUZZA	ok	puzza	ok
GOLA	cola	gola	ok
MIELE	ok	miele	ok
FAME	ok	fame	ok
TOPO	topa	topo	ok
LANA	ok	lana	lona
NERO	ok	nero	ok
TANA	ok	tana	ok
VOLA	ok	vola	ok
ZUCCA	ok	zucca	ok
MAGO	ok	mago	ok
CARTA	conta*	carta	ok
MENO	ok	meno	ok
ZERO	ok	zero	ok
SONNO	ok	sonno	ok
MINA	ok	mina	ok
REMO	ok	remo	ok

Over 7 triplets we taught 19/21 letters in the Italian alphabet (errors 12/166)

READING AND WRITING

- They are fundamental skills that are essential for effective interactions with one's environment.

- They are the skills on which schools curriculum is based on.

- Dyslexia is a diagnosis that affects 5% of the italian population

NEURO-COGNITIVE perspective

Topographic analysis

- Theory of cerebellar deficit (Fawcett and Nicolson, 1996; Nicolson, 2001)
- Theory of the temporal processing deficit (Tallal et al., 1993)
- Theory of attention deficit (Plaza & Cohen, 2006)

BEHAVIOR ANALYTIC perspective

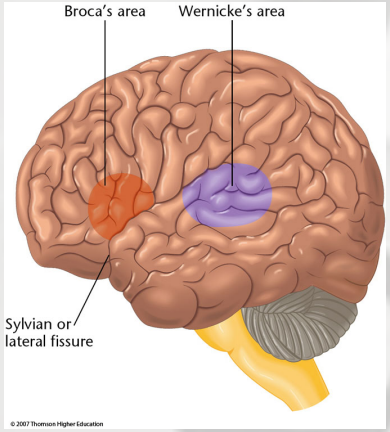
Functional analysis

Reading is a verbal operant (complex skills with multiple components)

PROBLEM OF SYMBOLIC BEHAVIOR:
comprehension and semantics

Reading as a mental process

Reading disorder = brain damage



Reading as a complex learning skill with multiple components

Reading disorder = deficit in stimulus control

(de Rose, de Souza, 1996)

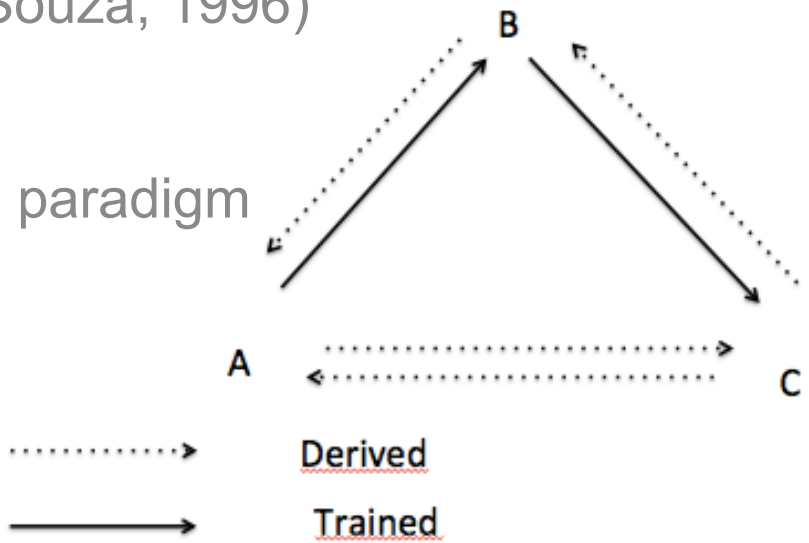
OUR RESEARCH GOALS

- Explore how we could teach reading and writing
- Observe if applying the equivalence paradigm could change the maladaptive learning of children with dyslexia and other language impairments

READING TRAINING BASED ON STIMULUS EQUIVALENCE PARADIGM

- Reading Comprehension
  (Sidman, 1971)
- Integrate reading and spelling performance
  (Mackay and Sidman, 1985)
- Reading and trascription performance
  (de Rose, de Souza, 1996)

Equivalence paradigm



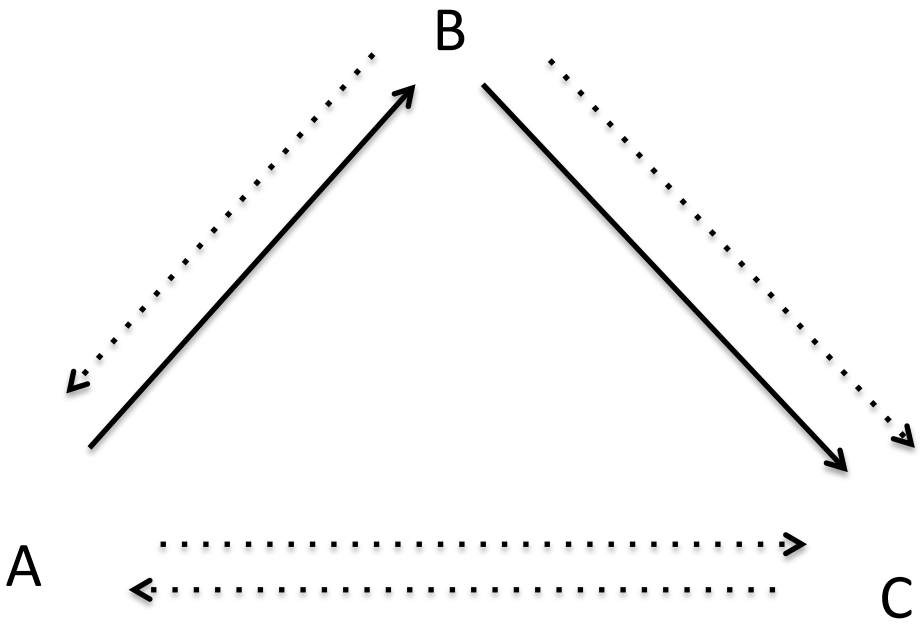
THREE PILOT STUDIES:

1. Reading and writing words with double consonants;

2. Reading and writing words with embedded “h” sound;

3. Reading and writing target words.

Equivalence paradigm



Derived

Trained

pala

palla

1. Reading and writing words with double consonants

PARTICIPANT

- 2 Children
- **Child 1:**
  - 8 years old
  - ADHD diagnosis
  - Learning disorder
- **Child 2:**
  - 7 years old
  - Learning difficulties

Both:

- Difficult in reading and writing words with double consonants

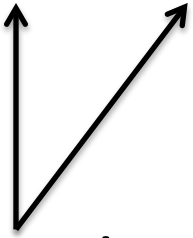
PALLA /PALA

PRE-REQUISITES

- Tact of the target stimuli
- Listener of the target stimuli

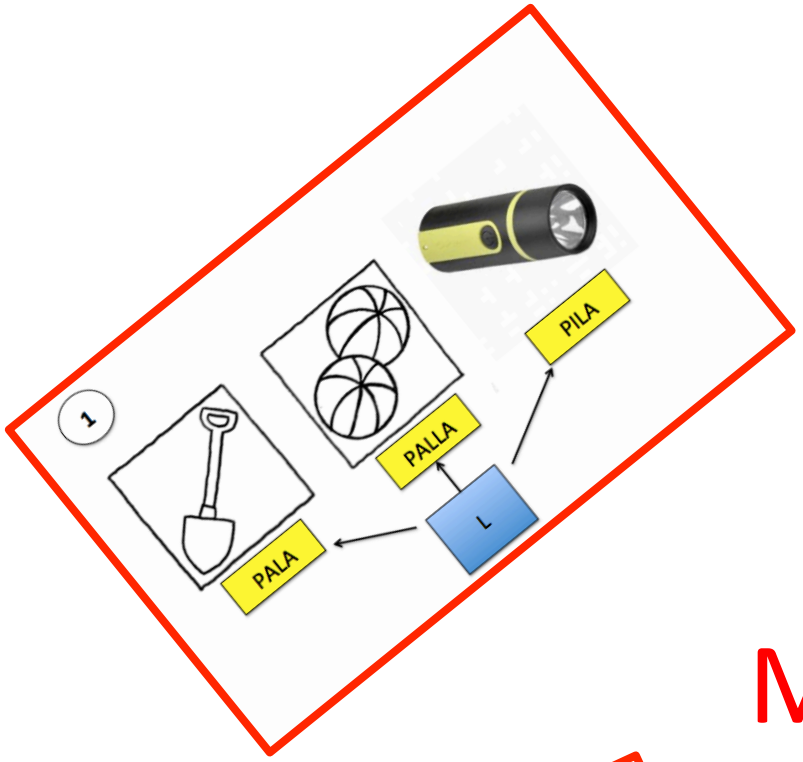
MATERIALS

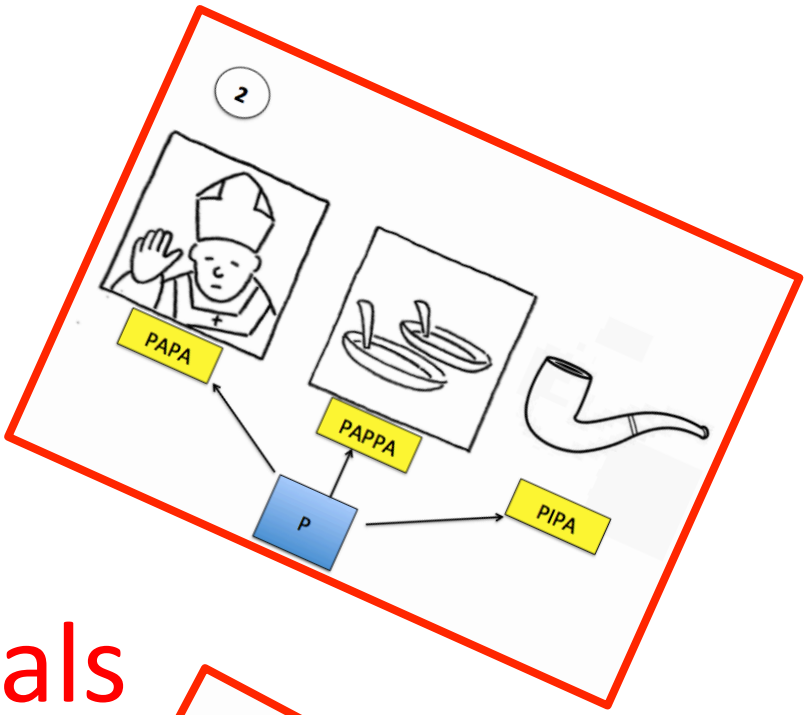
- Stimuli: 9 triplets (eg. PALA, PALLA, PILA) => 27 words – 18 picture.

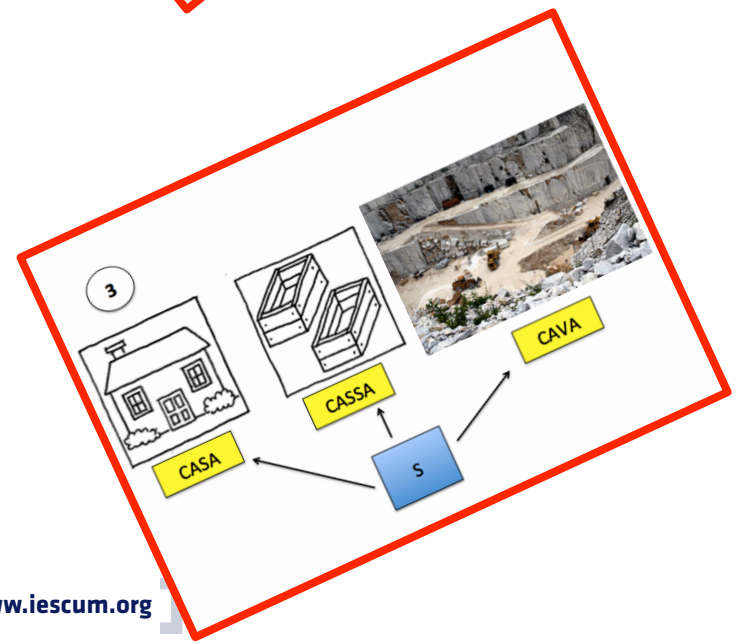


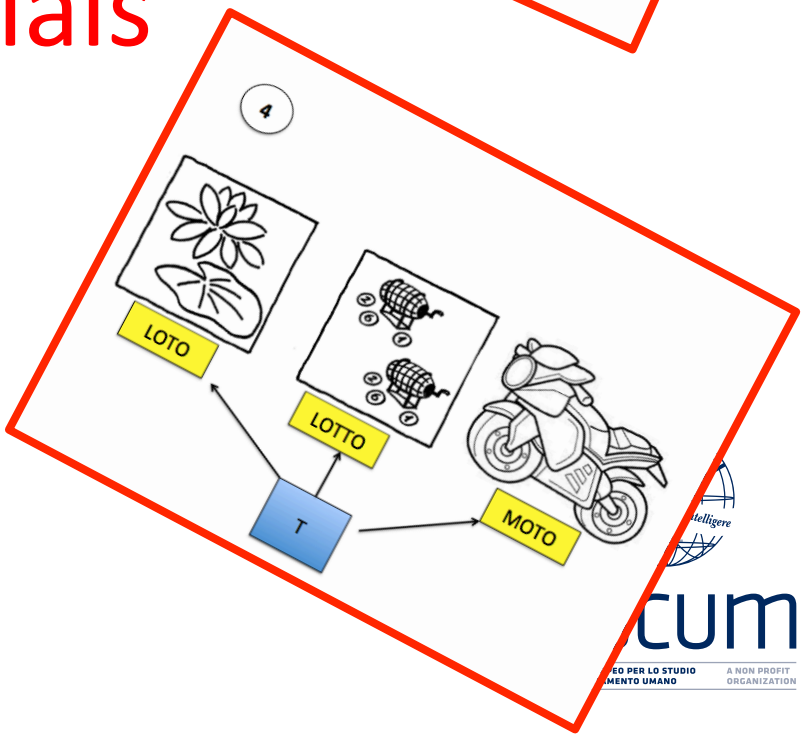
- Each triplet is formed by two stimuli topographically similar except for the presence of double consonants going to alter the meaning of the word stimulus (eg. PALA / PALLA) and a third stimulus selected according to the classes of the most frequent errors in the repertoire of reading the child (eg. PALA / PILA)

Materials


1
PILA
PALLA
PALA
L


2
PAPA
PAPPA
PIPA
P


3
CAVA
CASSA
CASA
S


4
LOTO
LOTTO
MOTO
T

PROCEDURE
READING AND WRITING

Procedure:

PALLA

MTS PICTURE-PRINTED WORD

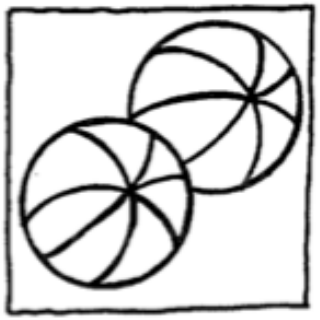
MTS PRINTED WORD - PICTURE

: selecting printed word as listener

READING

MTS thier own written – printed word

COPYING PRINTED WORD



MTS picture - theIr own written

MTS ther own written – picture

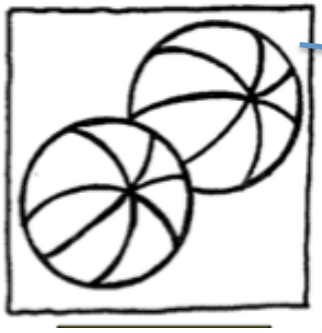
TAKING DICTATION

Writing in presence of picture

Derived

Trained

Visual prompt

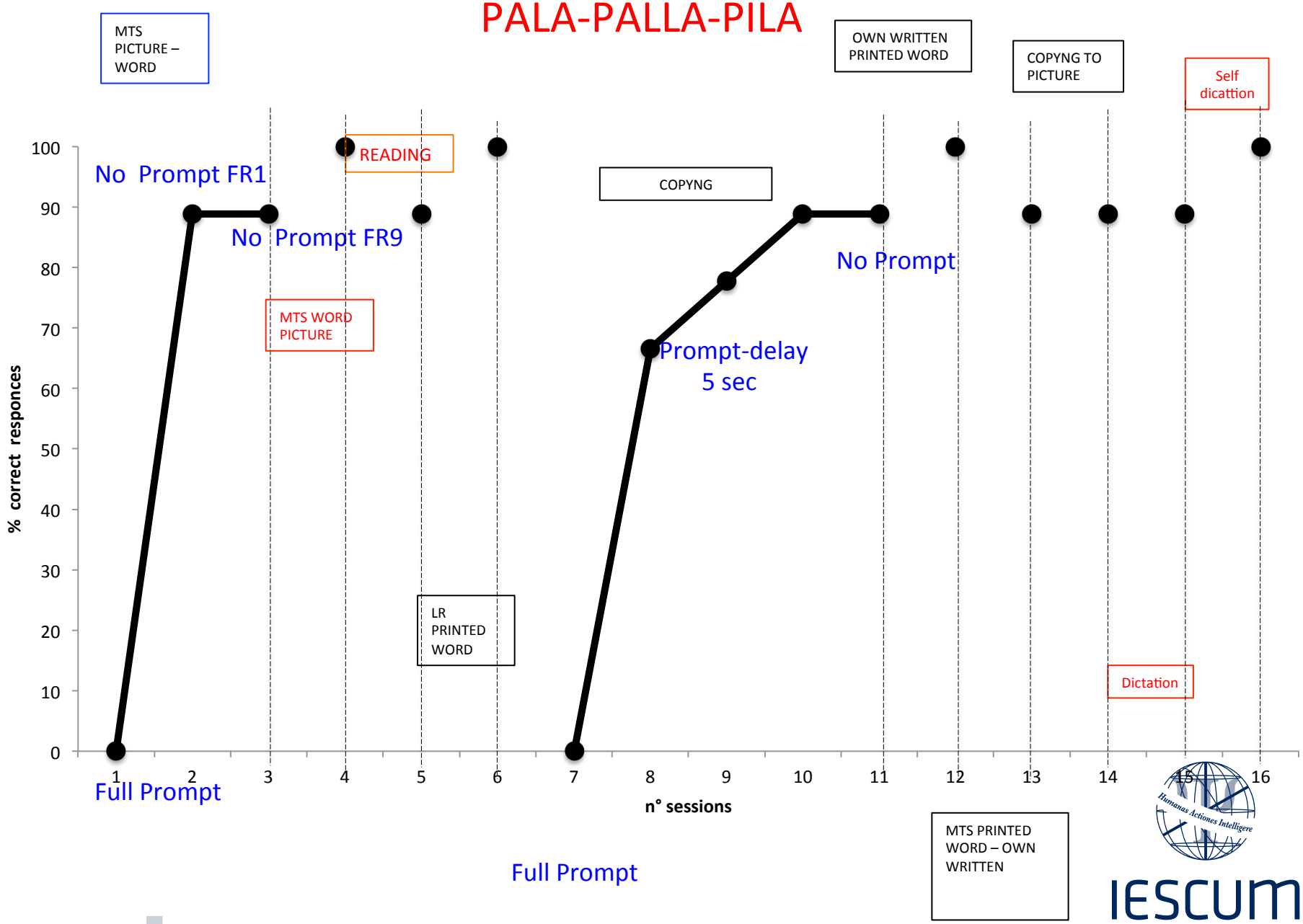


PALLA

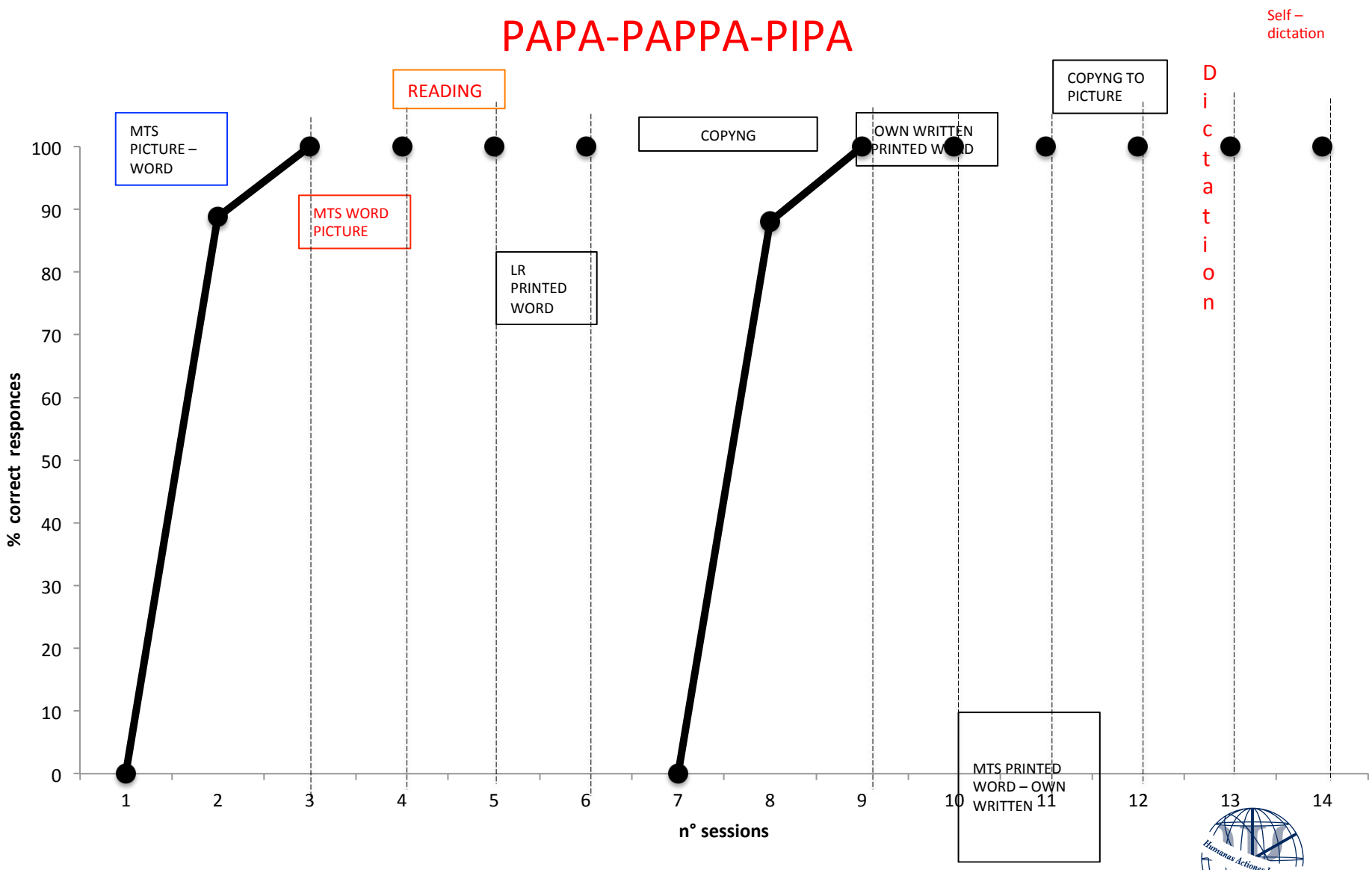
PALA

GRAPHS
child 1

PALA-PALLA-PILA

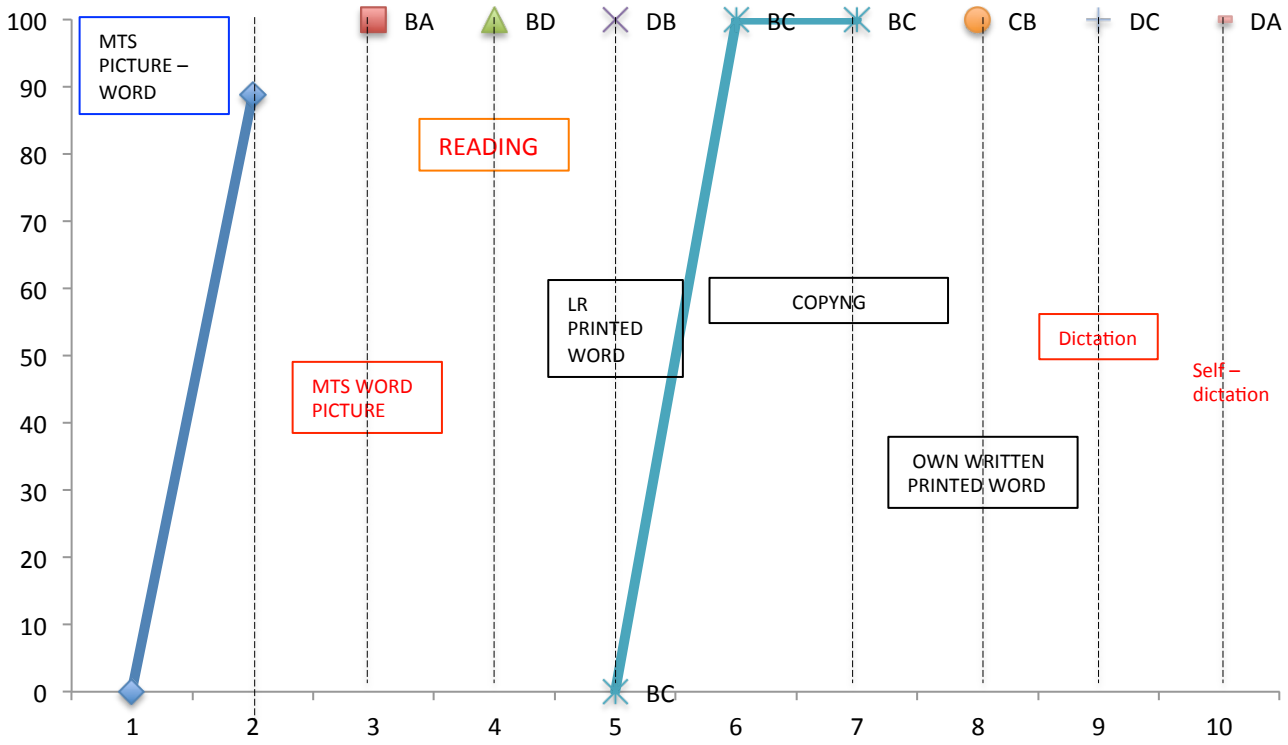


PAPA-PAPPA-PIPA

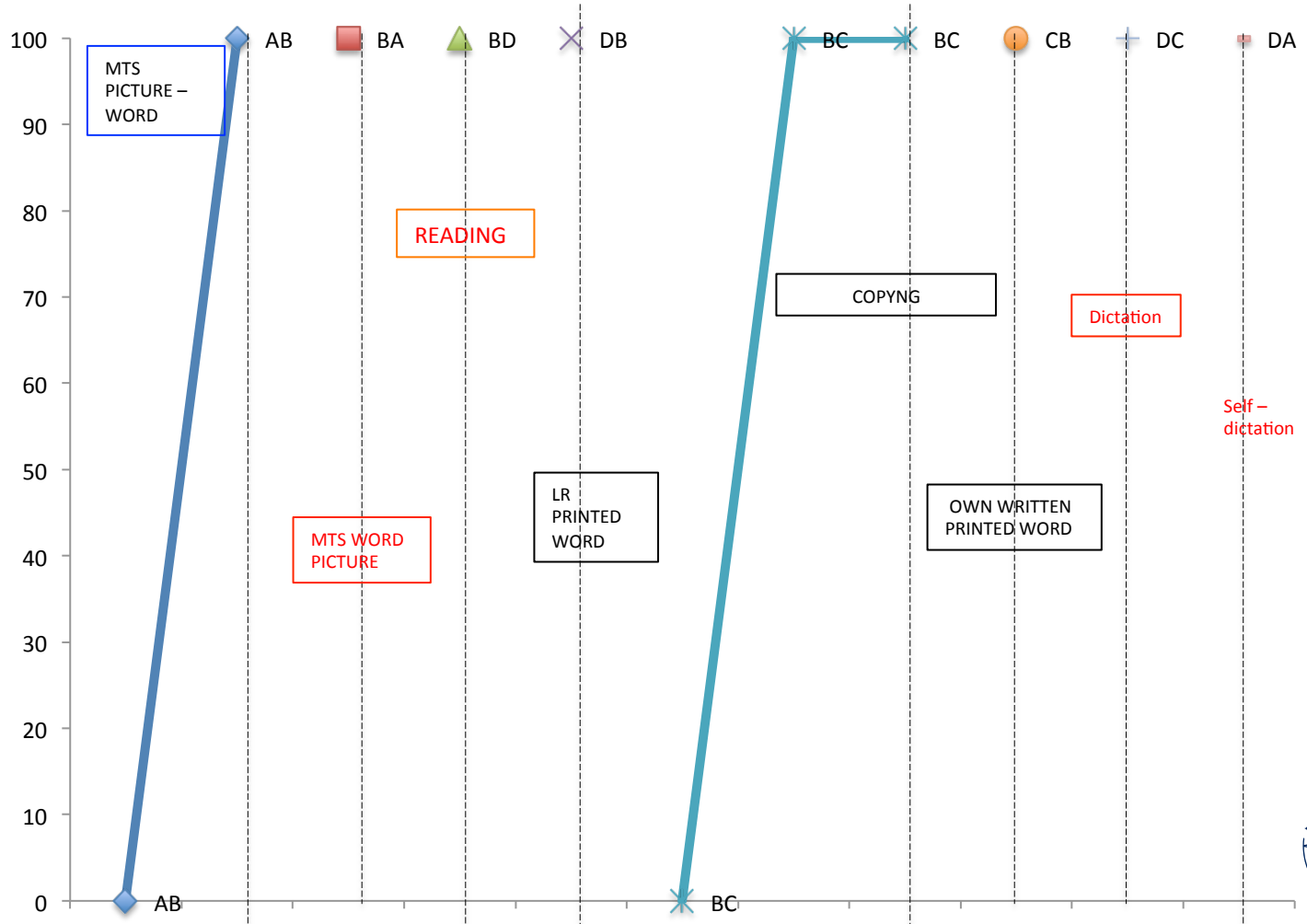


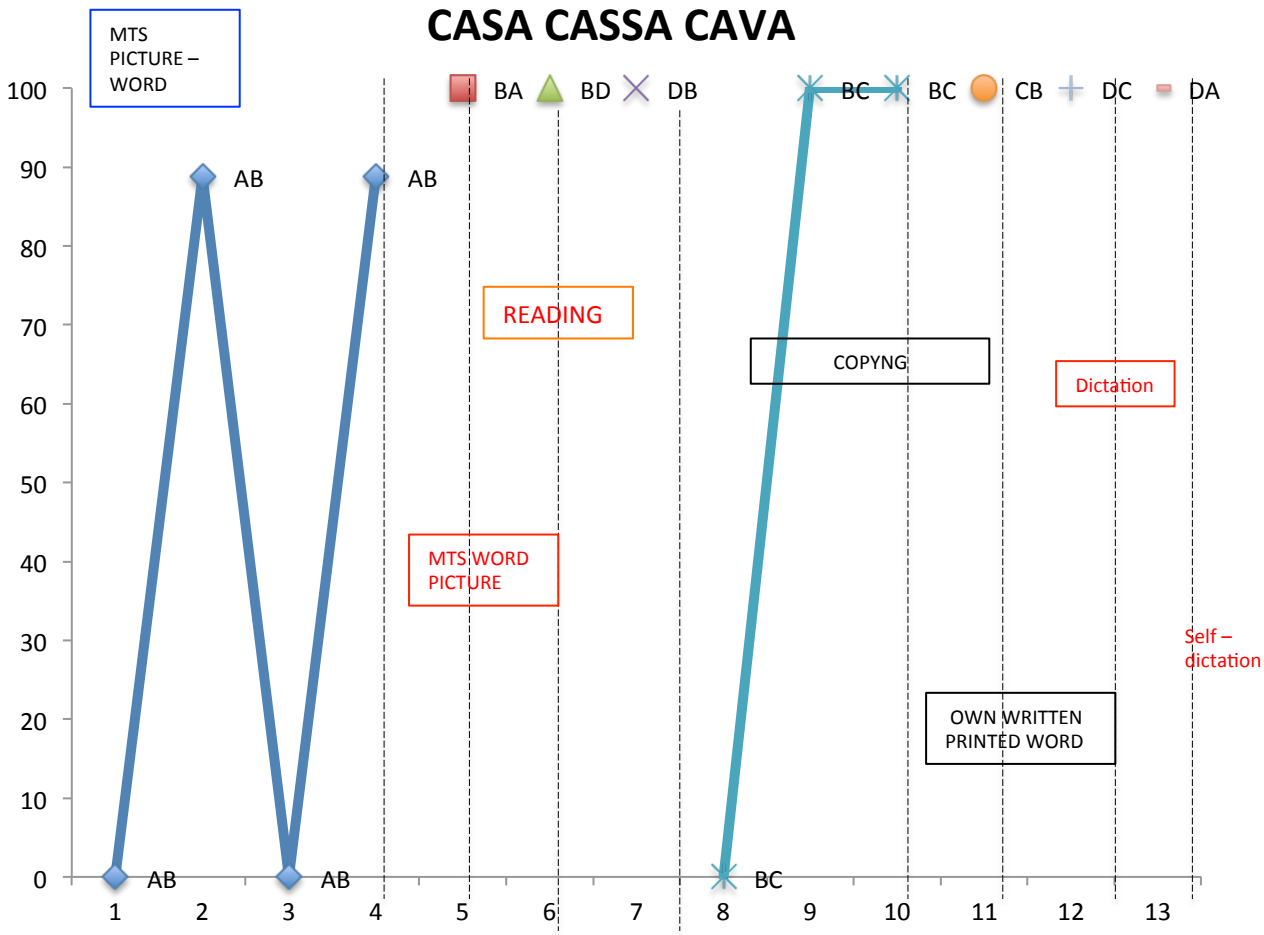
Graphs child 2

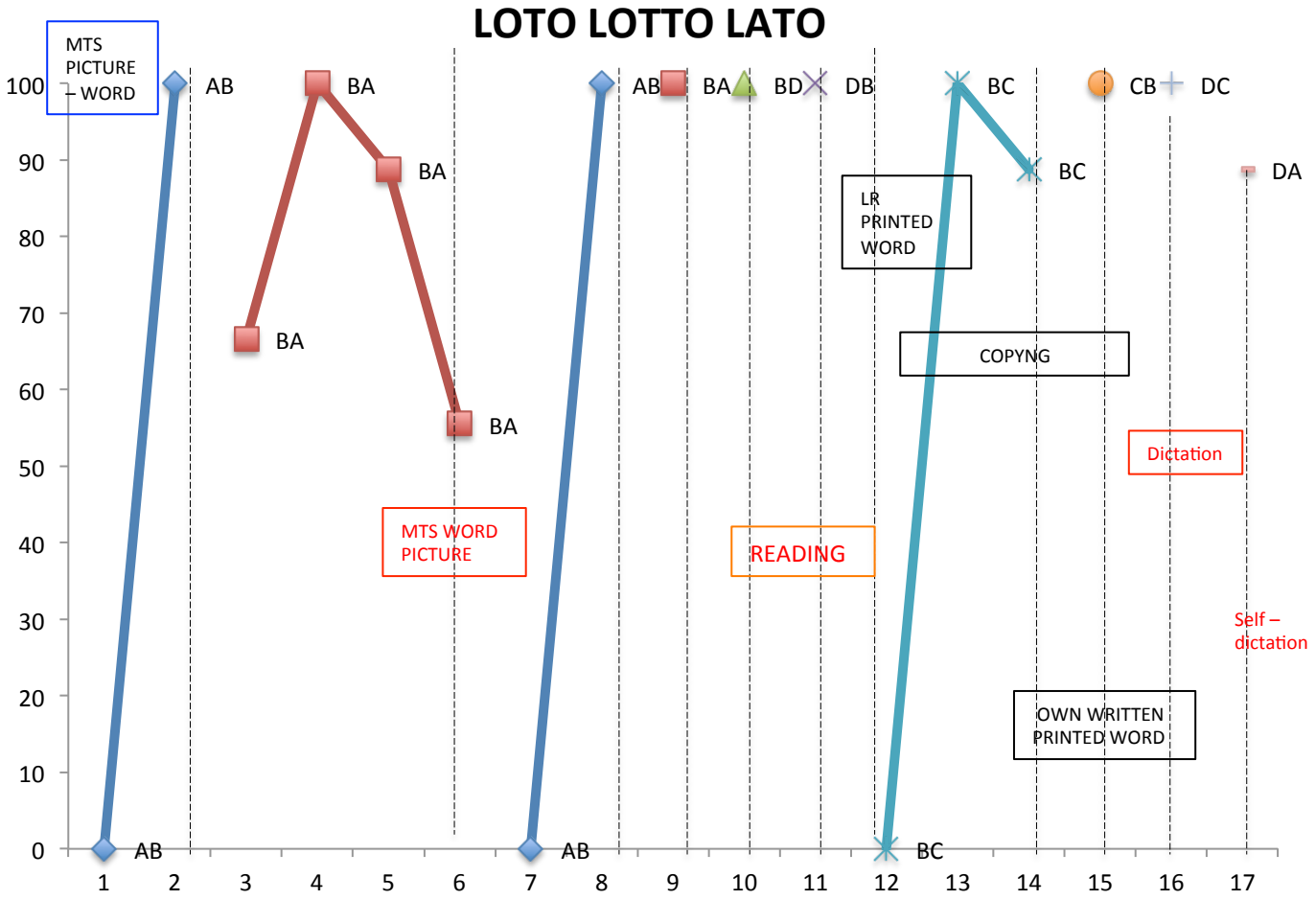
PALLA PALA PILA

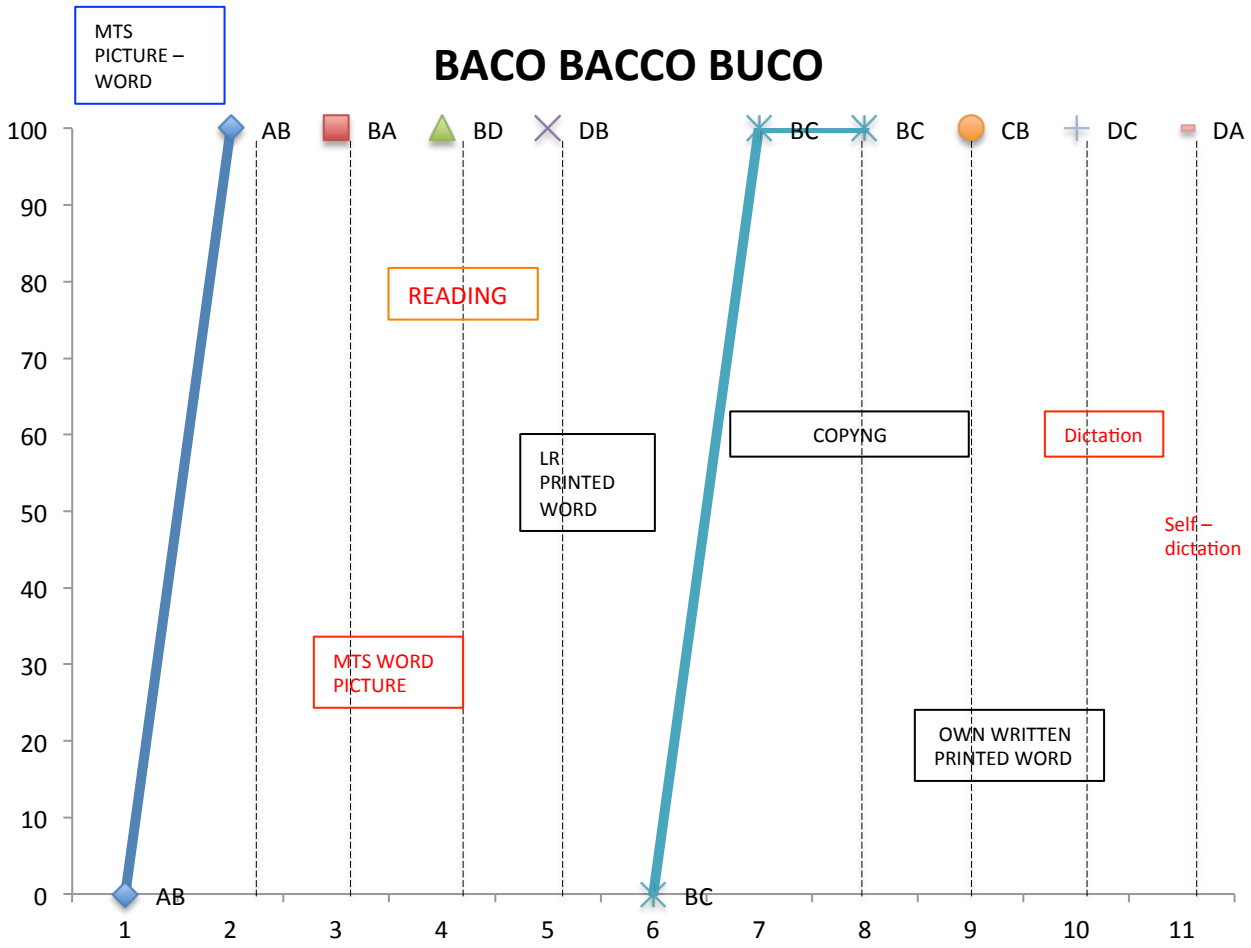


PAPA PAPPA PIPA

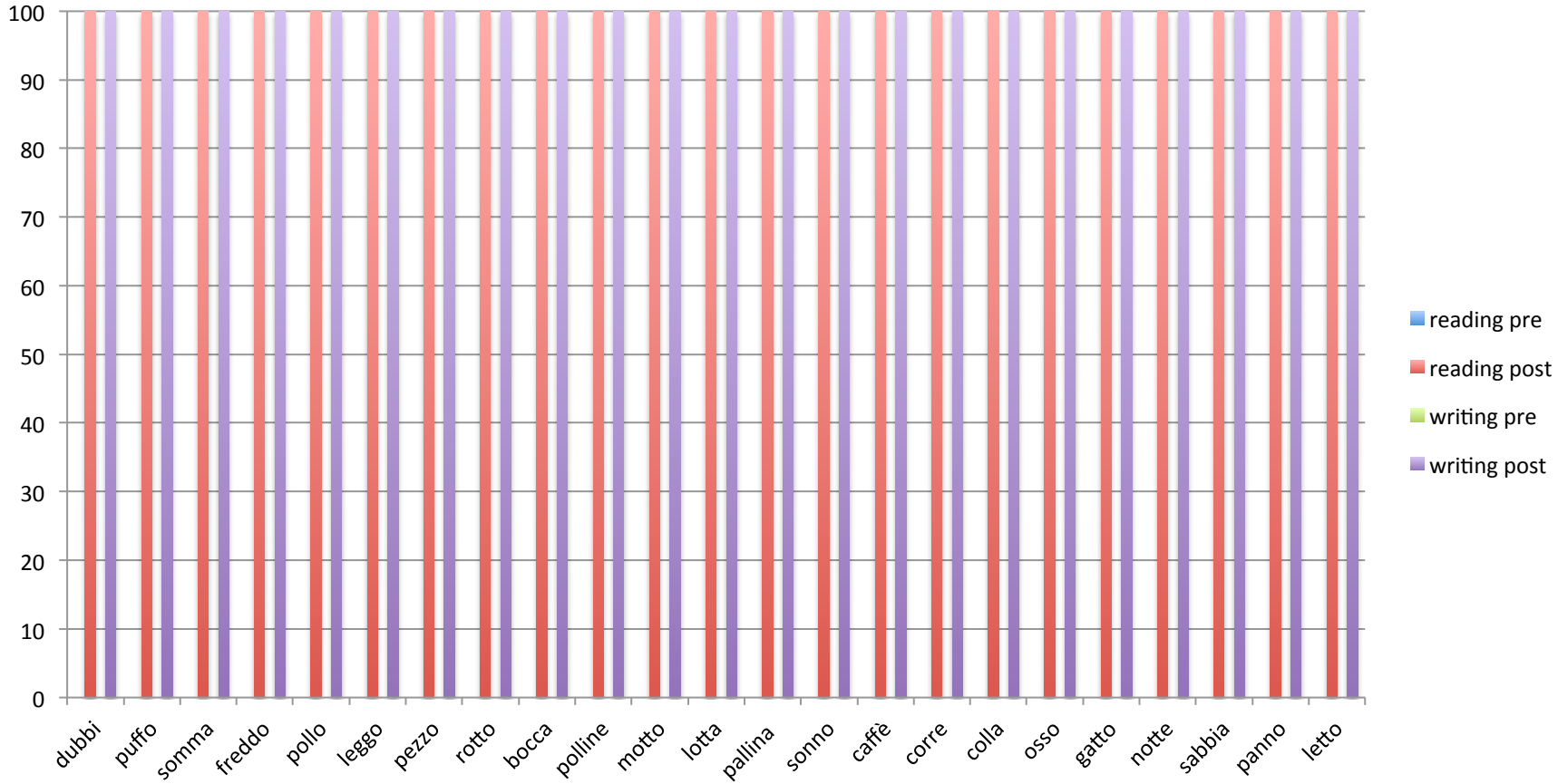








PRE AND POST TEST



2. TRAINING word with “H” sound

PARTICIPANT

- 8 years old
- Specific learning disorders diagnosis
- Difficoult in reading and writing words sound “H”

  CHIESA /BACIO

MATERIAL

chiesa; bacio; occhi (CHI/CI)

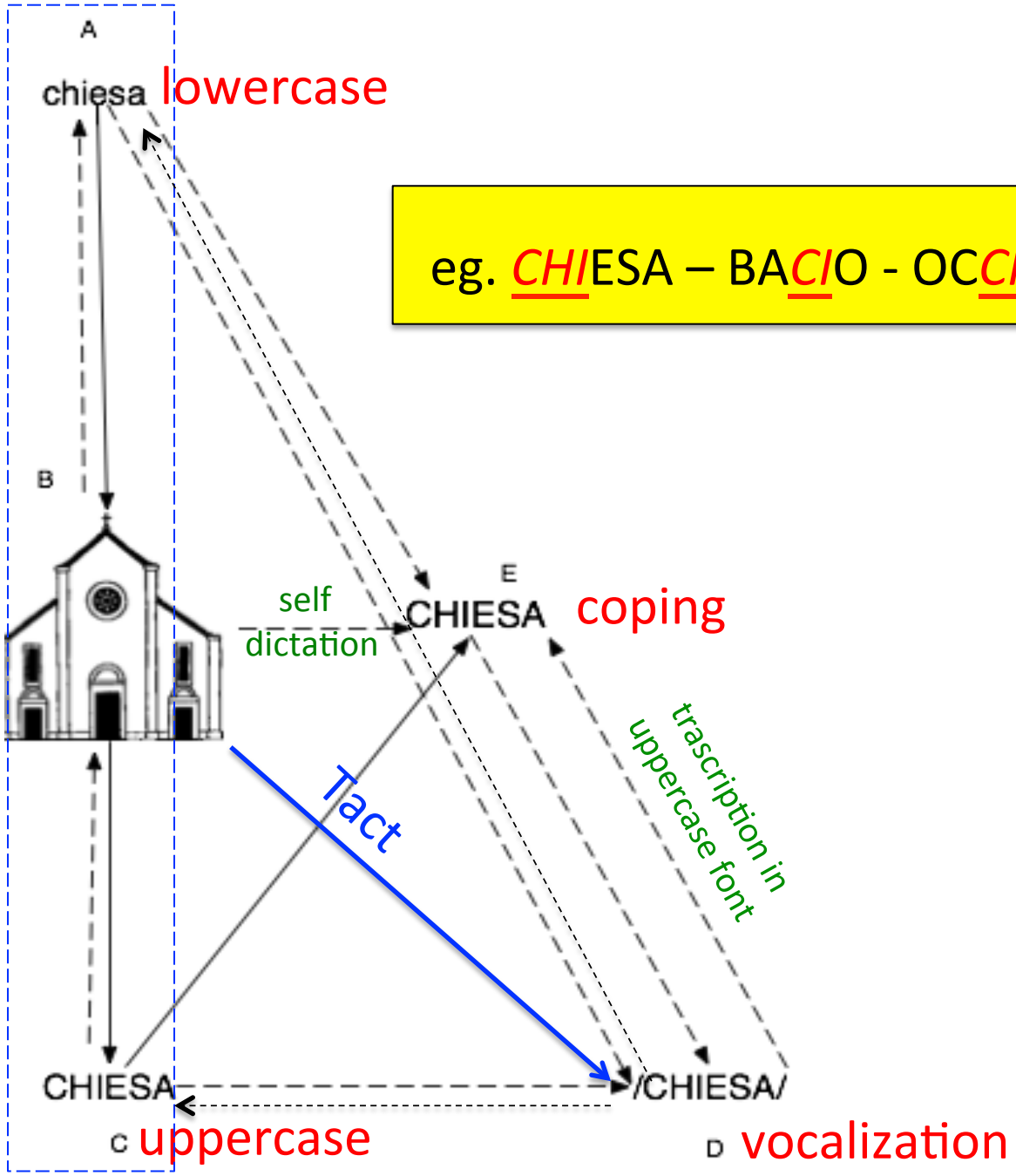
alghe; alce; righello (GHE/CE)

chiave; secchio; micio (CHI/CI)

streghe; aceto; ghepardo (GHE/CE)

chitarra; civetta; macchia (CHI/CI)

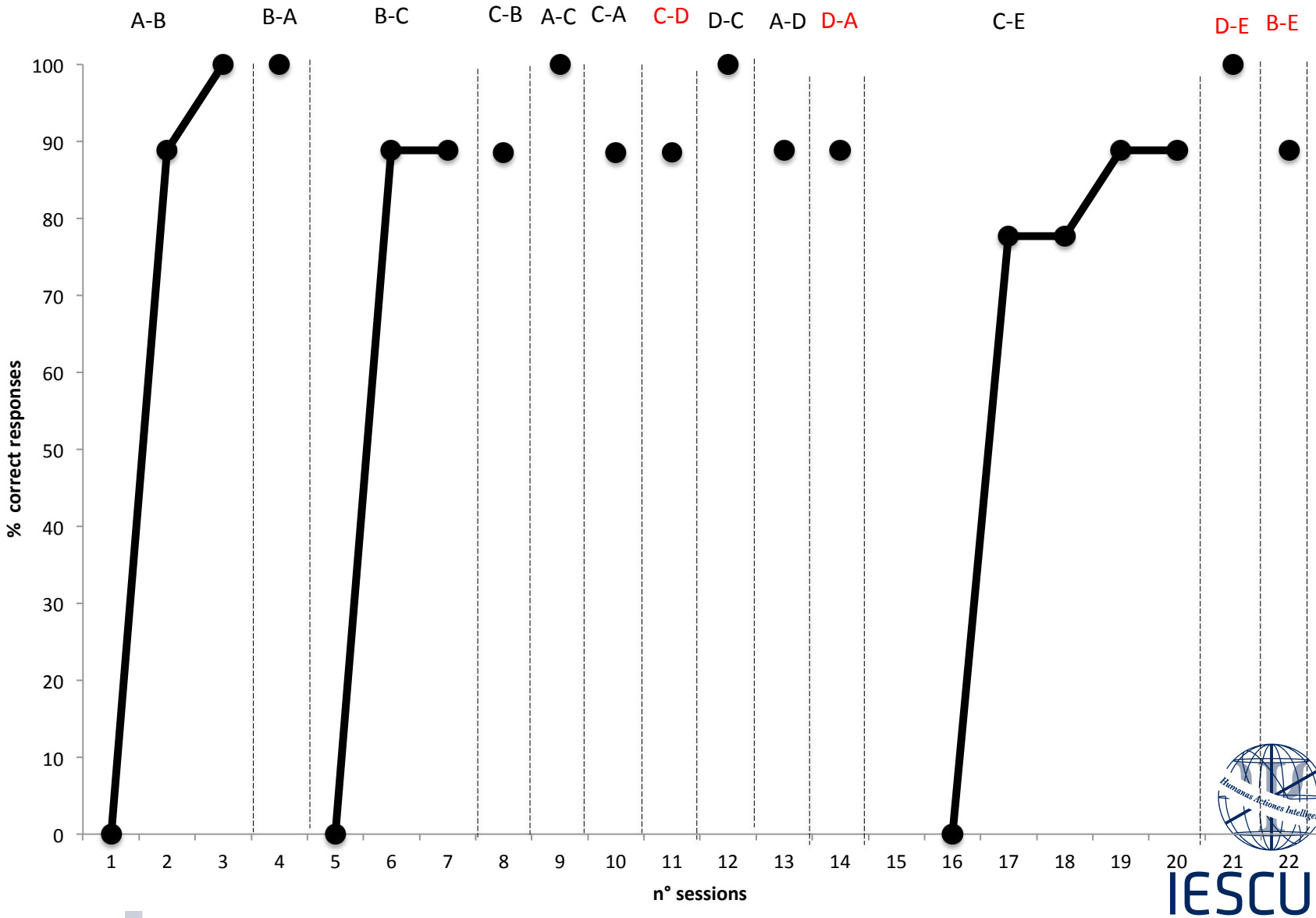
seghe; cerotto; laghetto (GHE/CE)



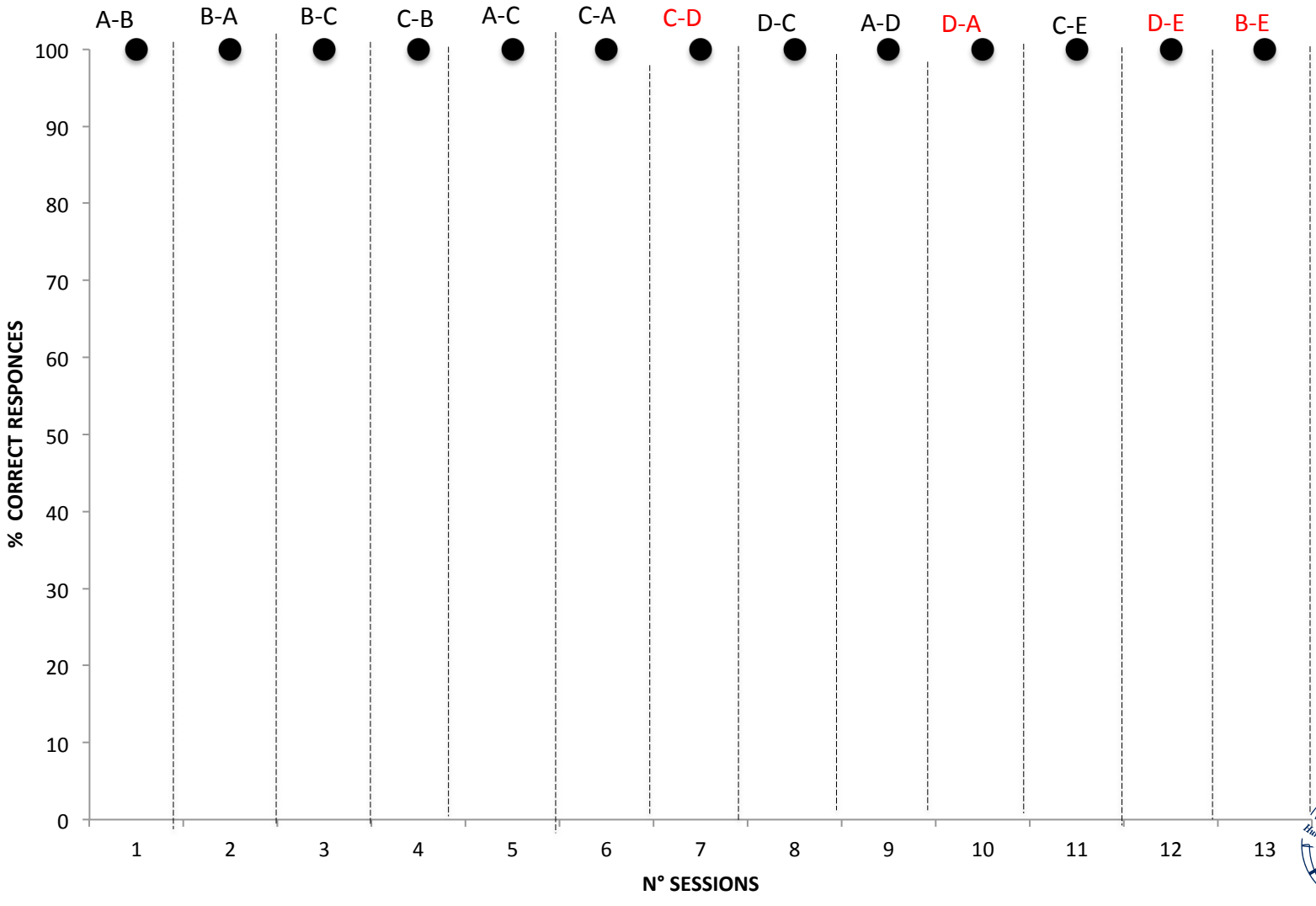
ISTRUCTIONAL TRAINING STEPS:

1. TRAINING A-B (LOWERCASE to PICTURE)
2. TEST B-A
3. TRAINING B-C (PICTURE to UPPERCASE)
4. TEST C-B (UPPERCASE to PICTURE) → simmetry
5. TEST A-C (LOWERCASE to UPPERCASE) → transitivity
6. TEST C-A (UPPERCASE to LOWERCASE) → equivalence
7. TEST C-D (**reading uppercase font**)
8. TEST D-C (LISTENER UPPERCASE)
9. TEST A-D (**reading lowercase font**)
10. TEST D-A (LISTENER LOWERCASE)
11. TRAINING C-E (COPYING to UPPERCASE)
12. TEST D-E (**Trascription in uppercase font**)
13. TEST B-E (COPYING to PICTURE)

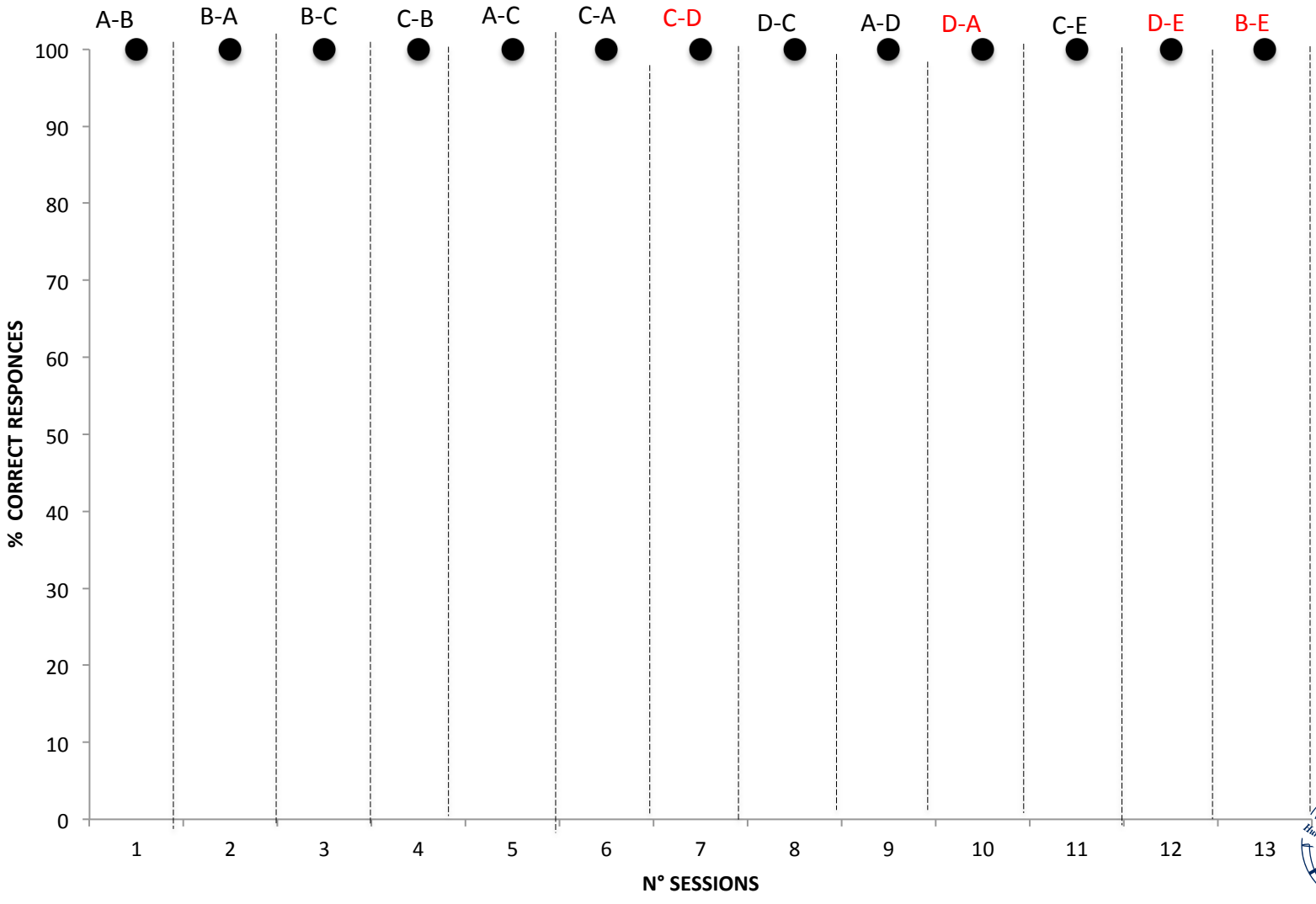
CHIESA / BACIO /OCCHI



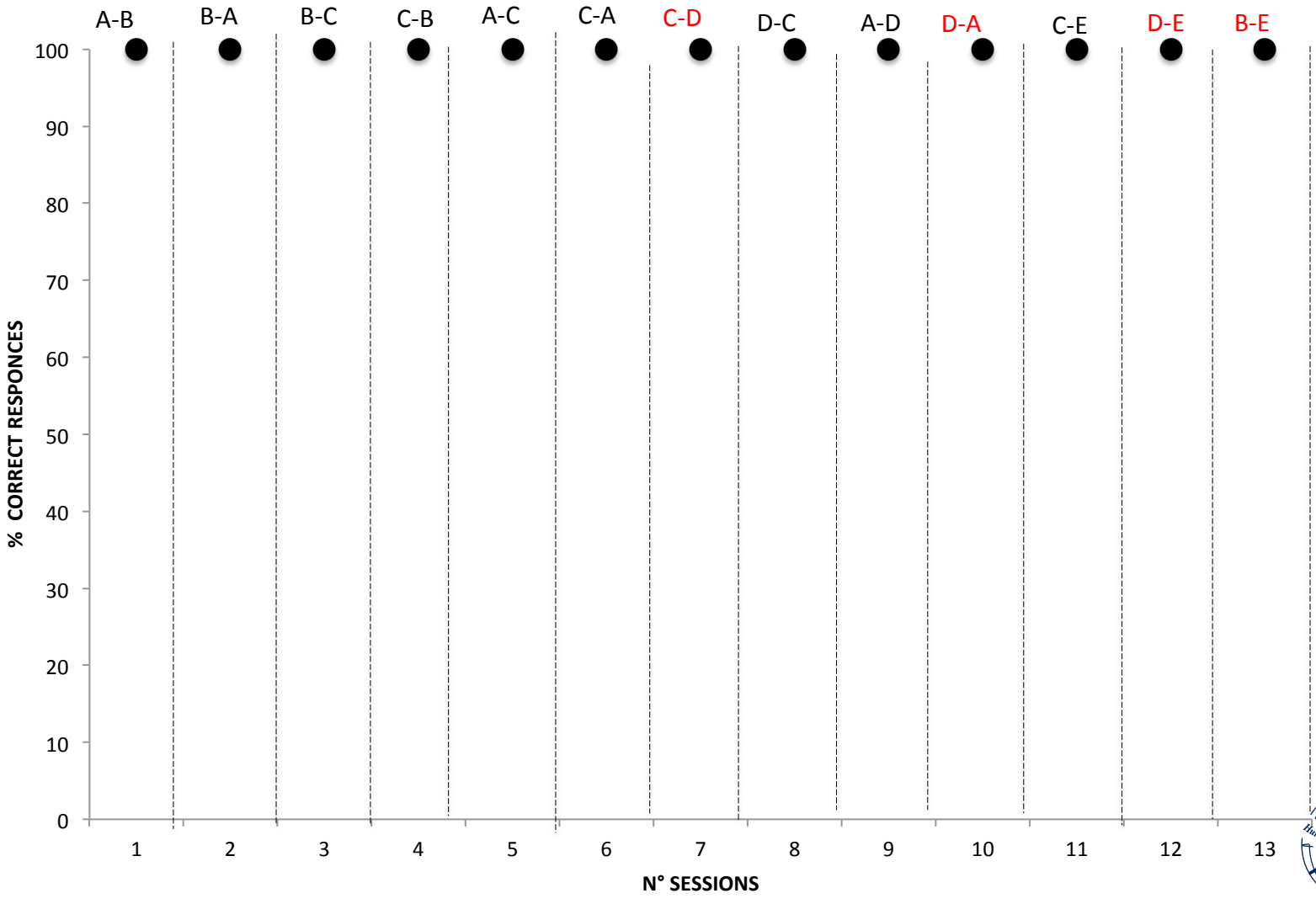
ALCE/ALGHE/RIGHELLO



CHIAVE/SECCHIO/MICIO



STREGHE/ACETO/GHEPARDO



3. Training skills of reading and writing words with different sound

PARTICIPANT

- 8 years old
- Specific learning disorders diagnosis
- Difficoult in reading and writing: omission and inversion

89,3% read correctly

Errors

Omitting or adding the /h/ sound

/t/ for /d / sound or viceversa

Writing half of them (160)

Correct 83,1%

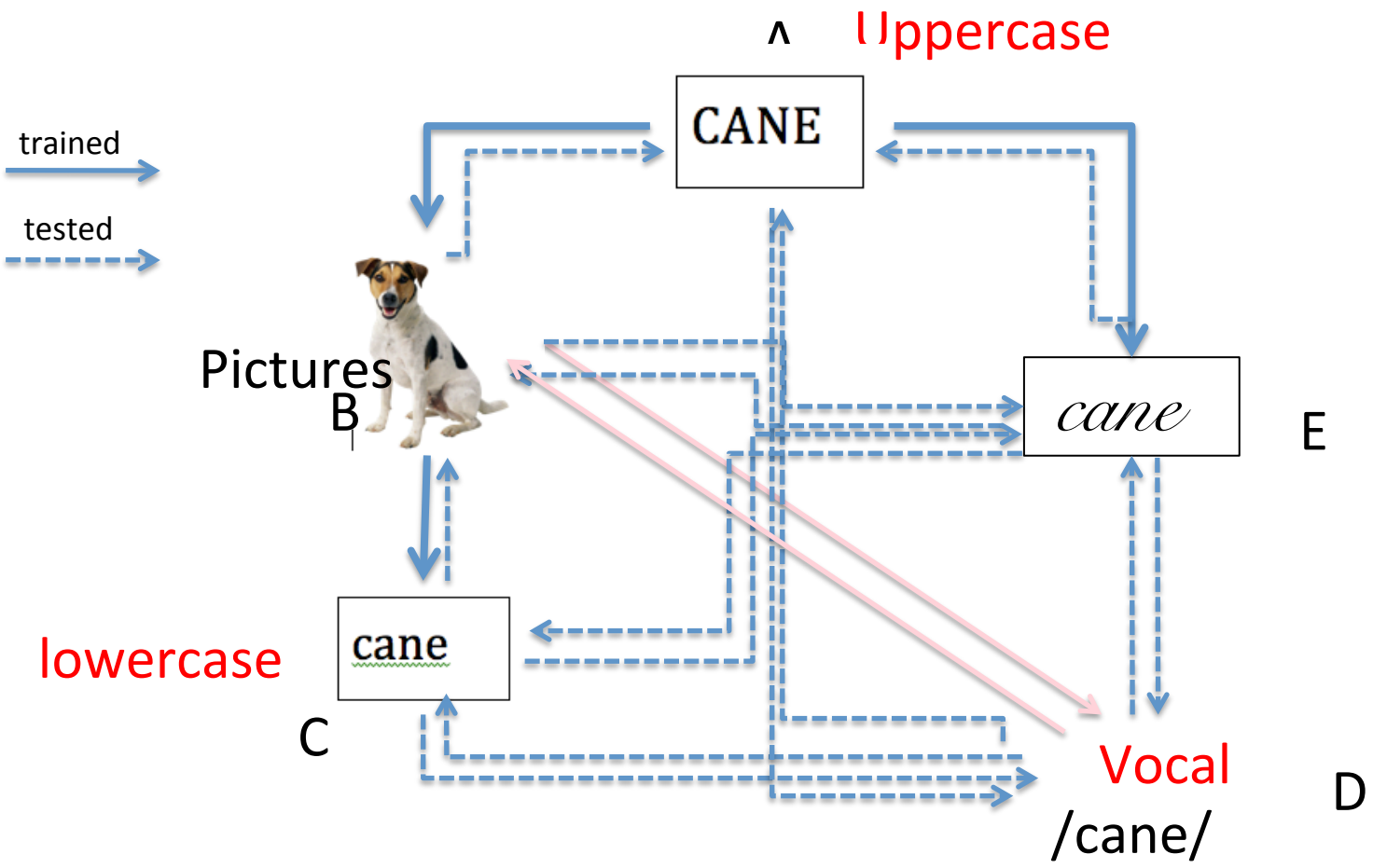
Errors were

g for c (33%)

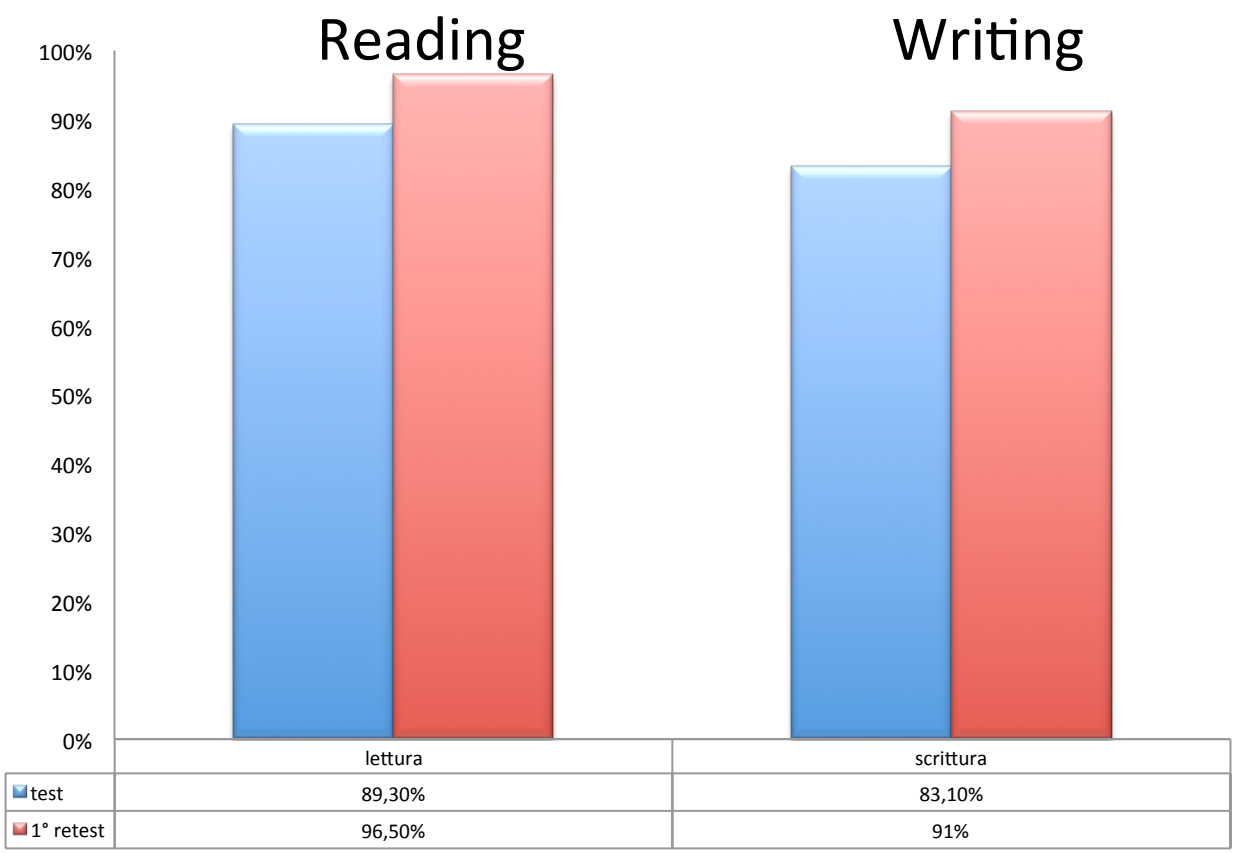
v for f (22%)

Omitting or adding H(14%

Basic procedure

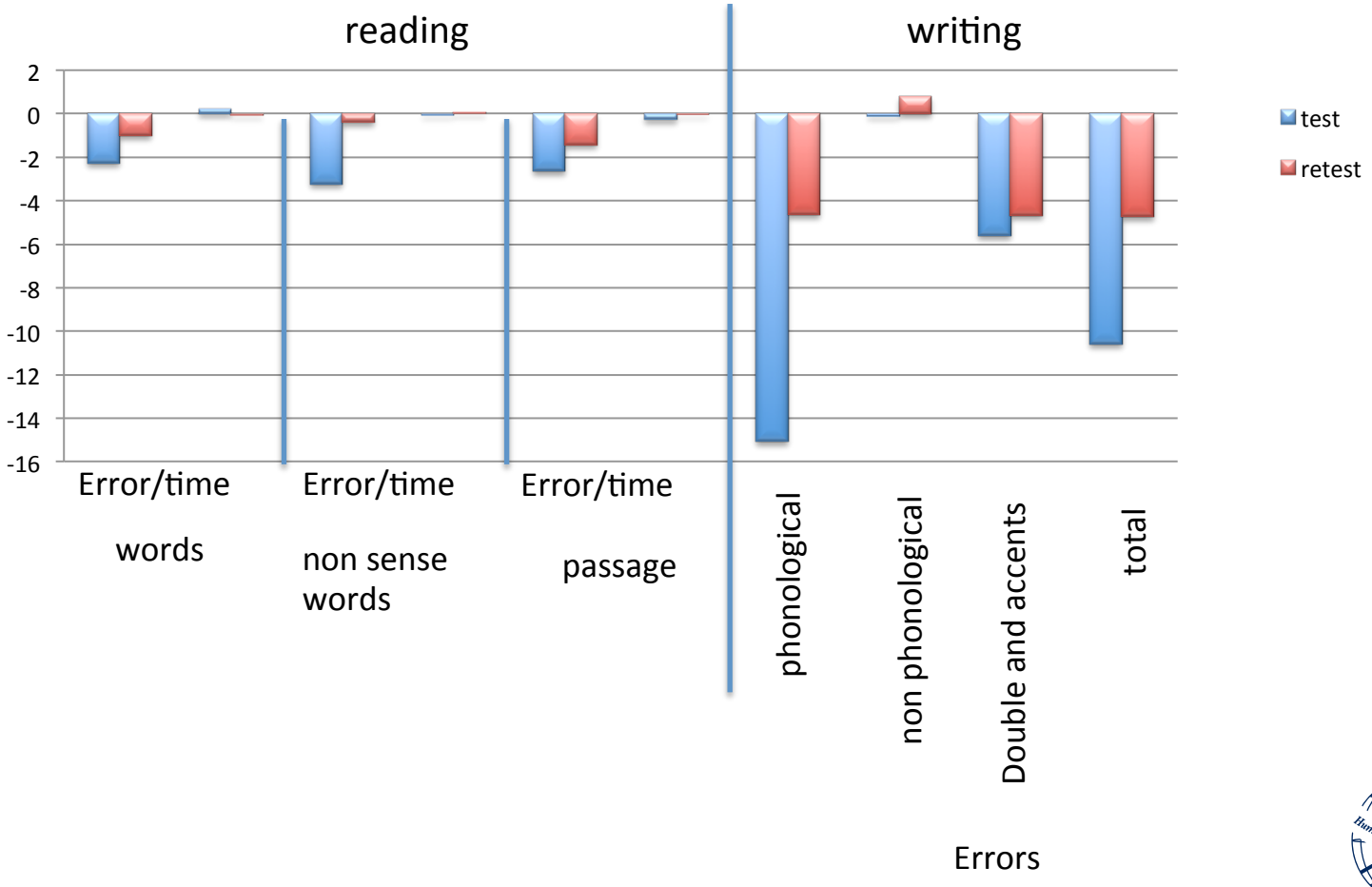


Reading and writing



	lettura	scrittura
test	89,30%	83,10%
1° retest	96,50%	91%

Standard testing

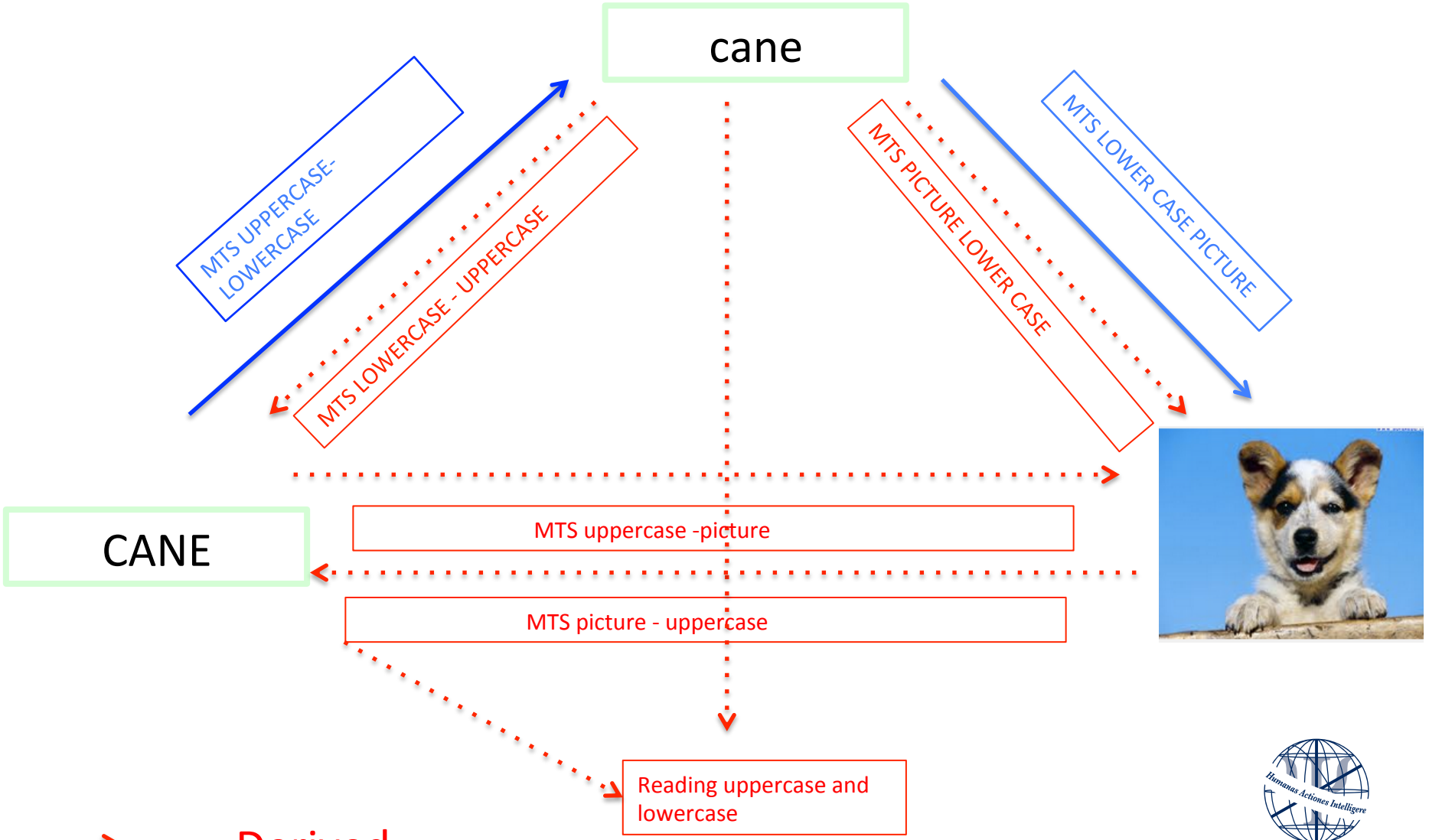


4. Training skills of reading lowercase word

Participant

- 10 years old
- Diagnosis of autism
- He makes mistakes with uppercase word
- He doesn't read lowercase word

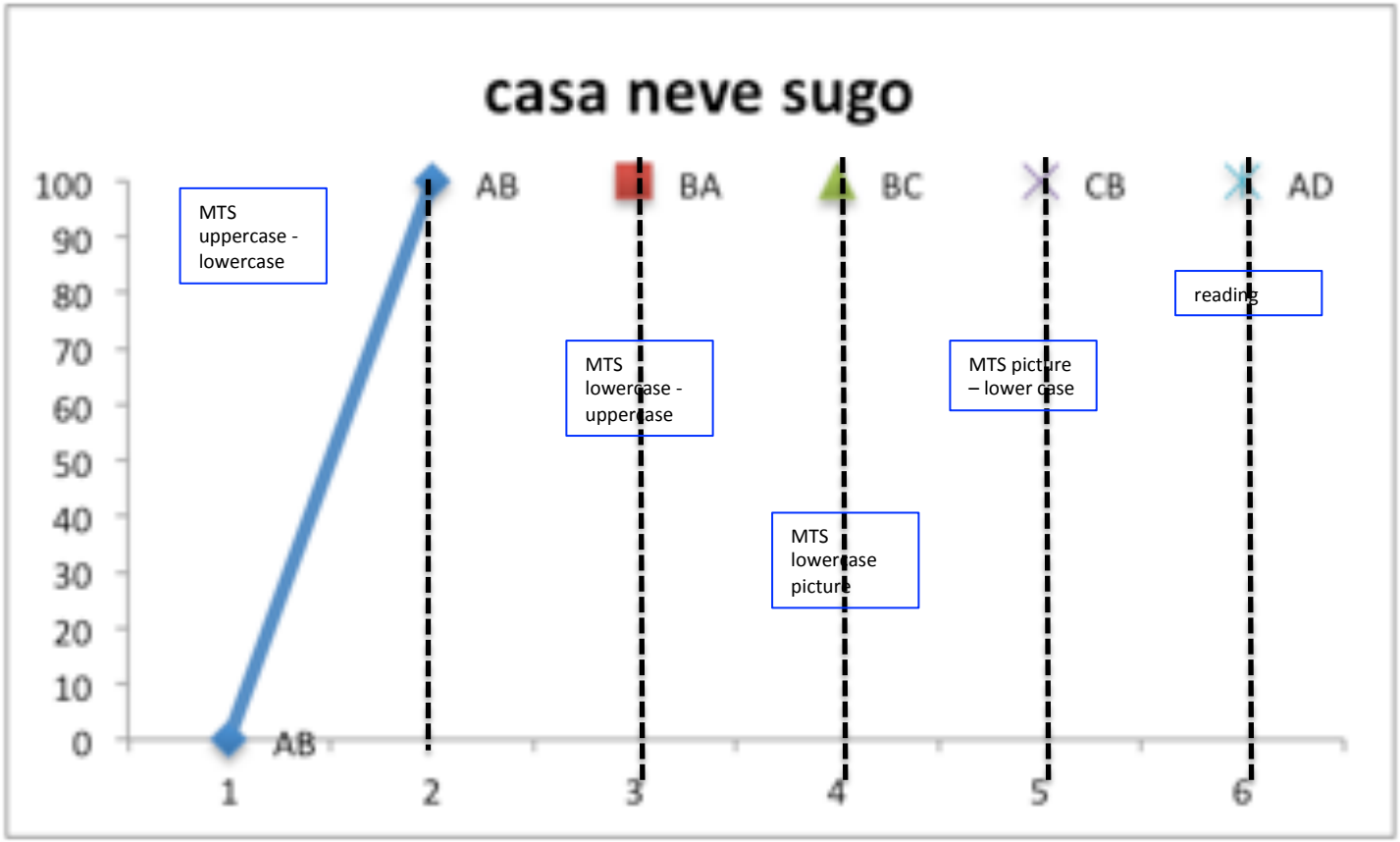
Procedure:

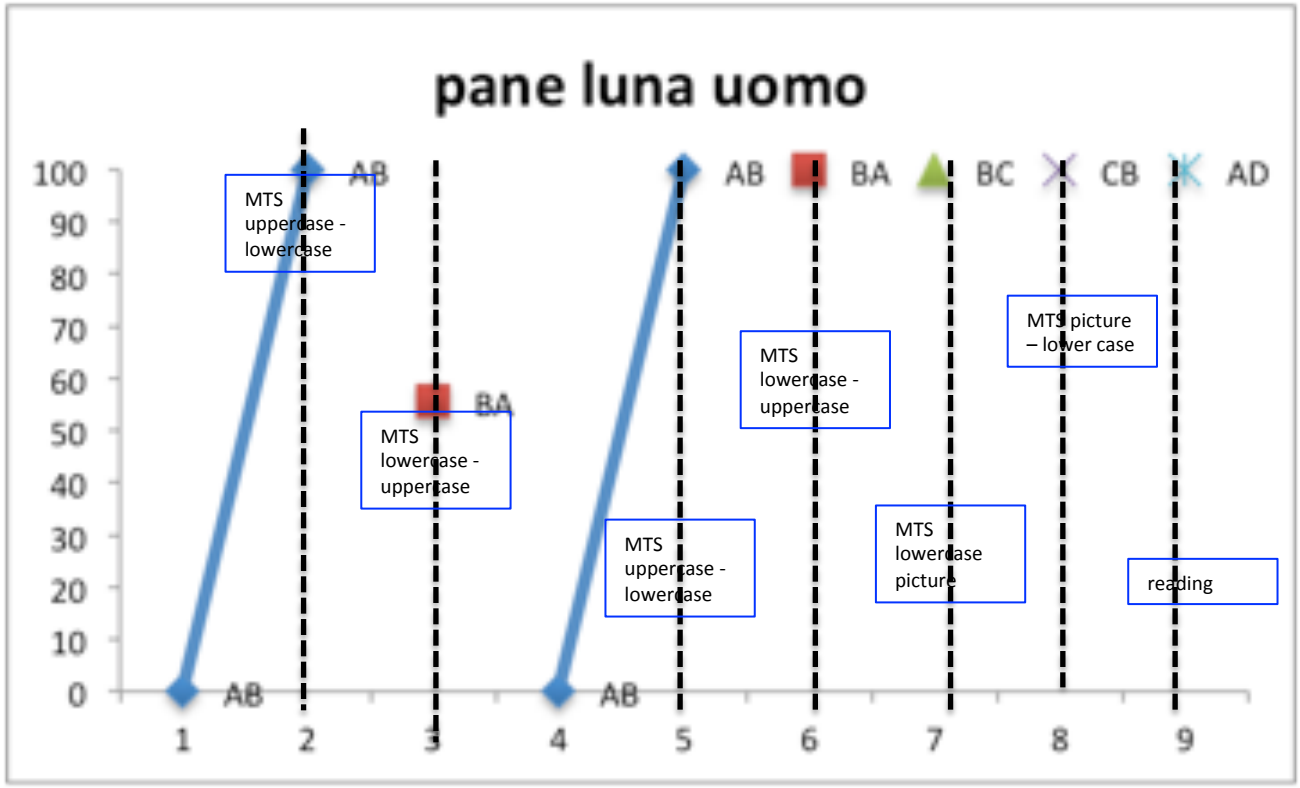


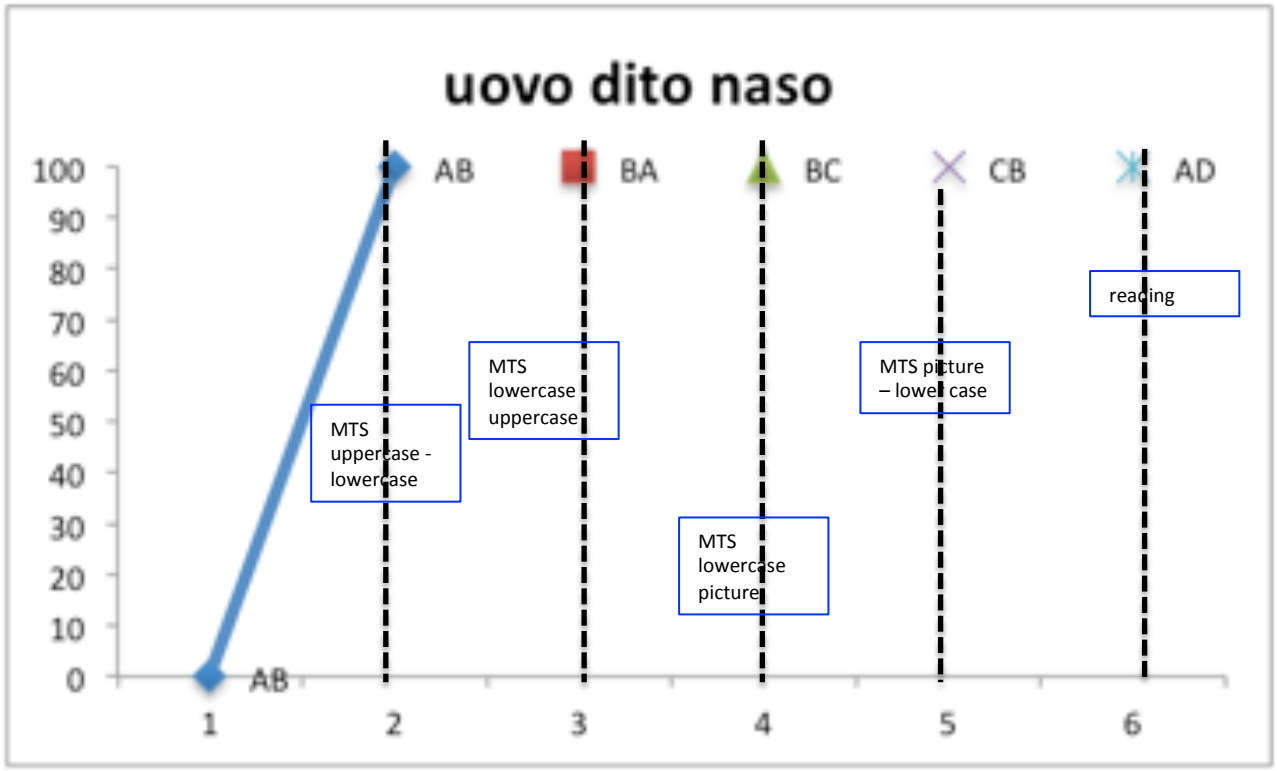
Derived

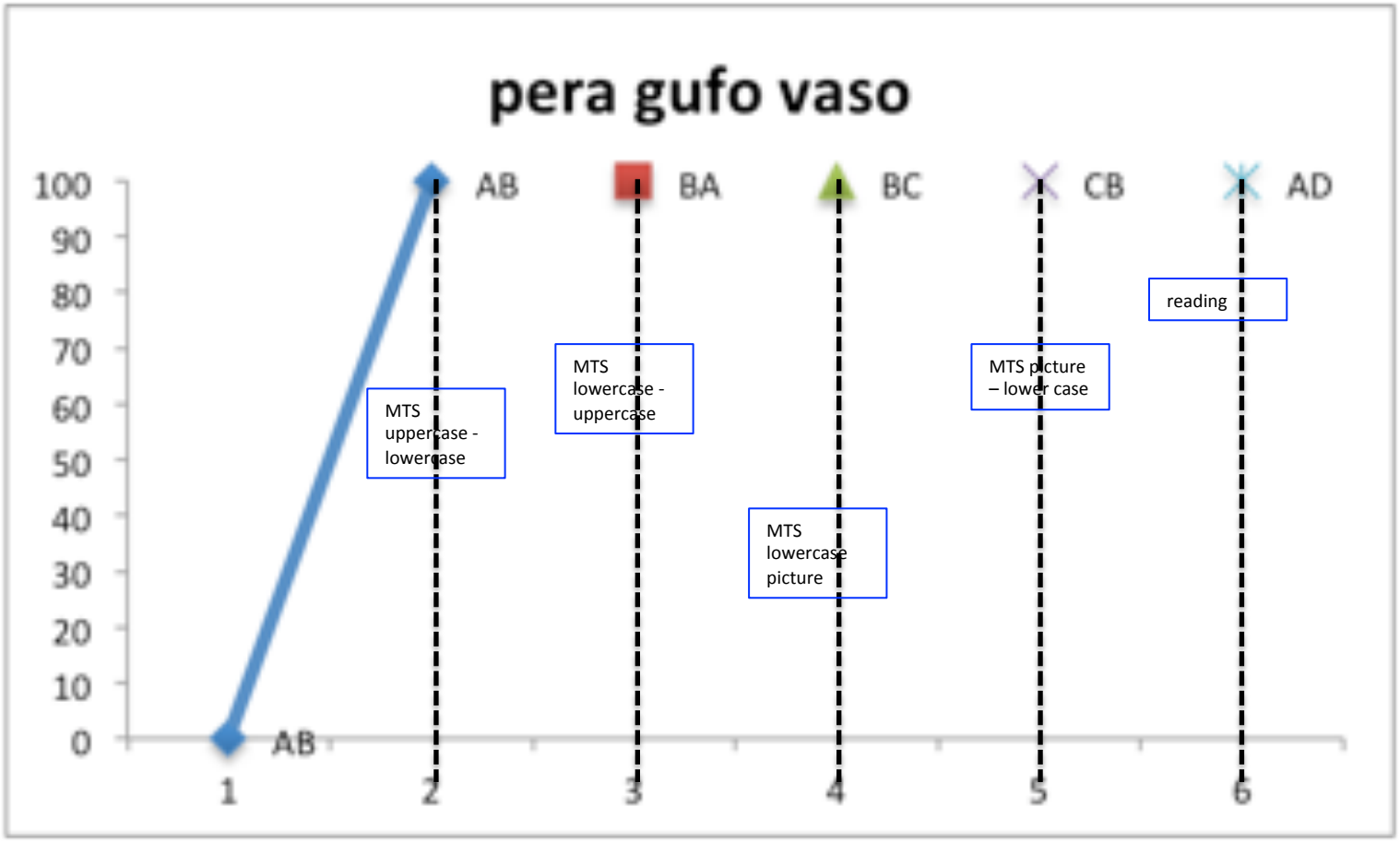
Trained

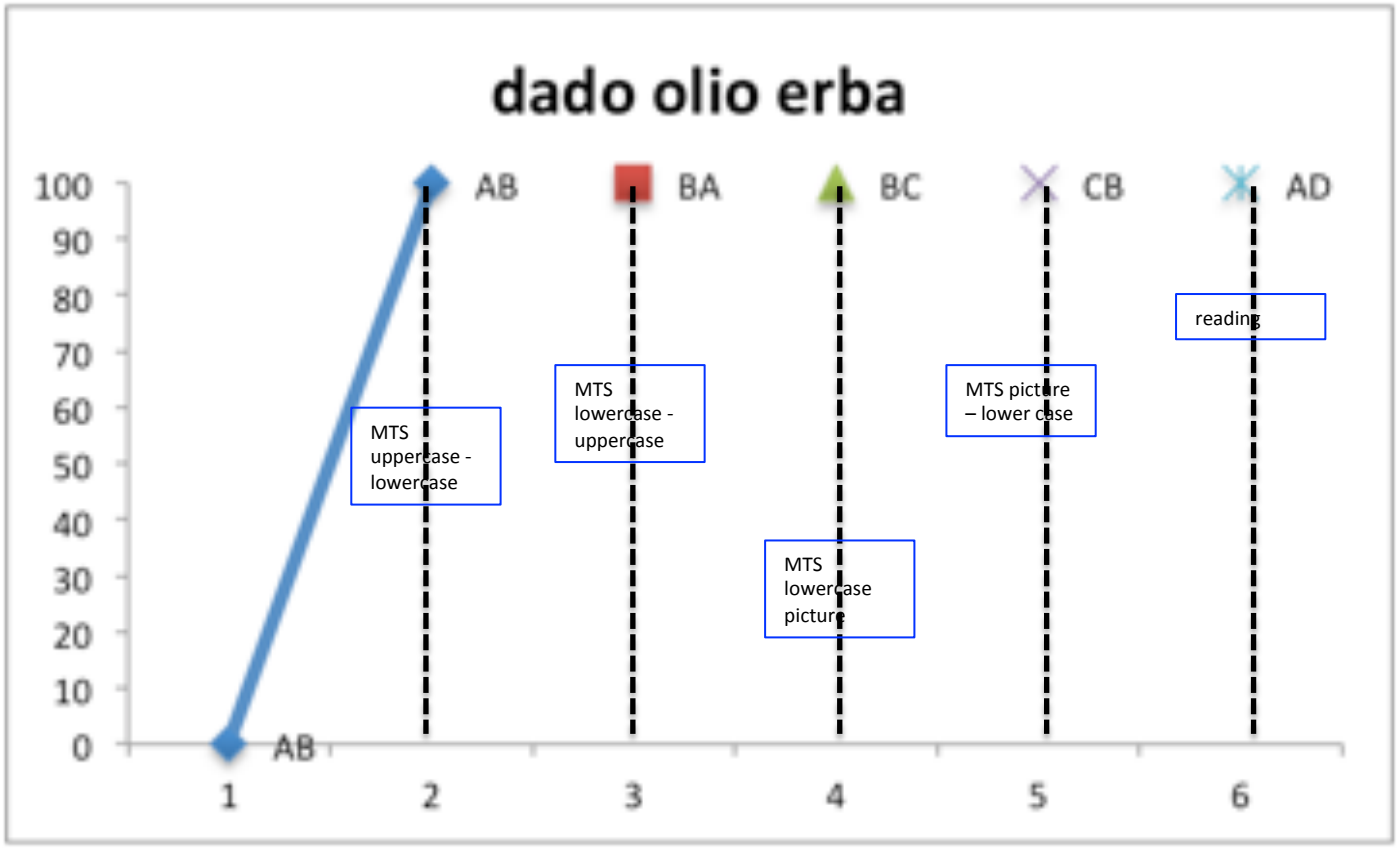
Graphs

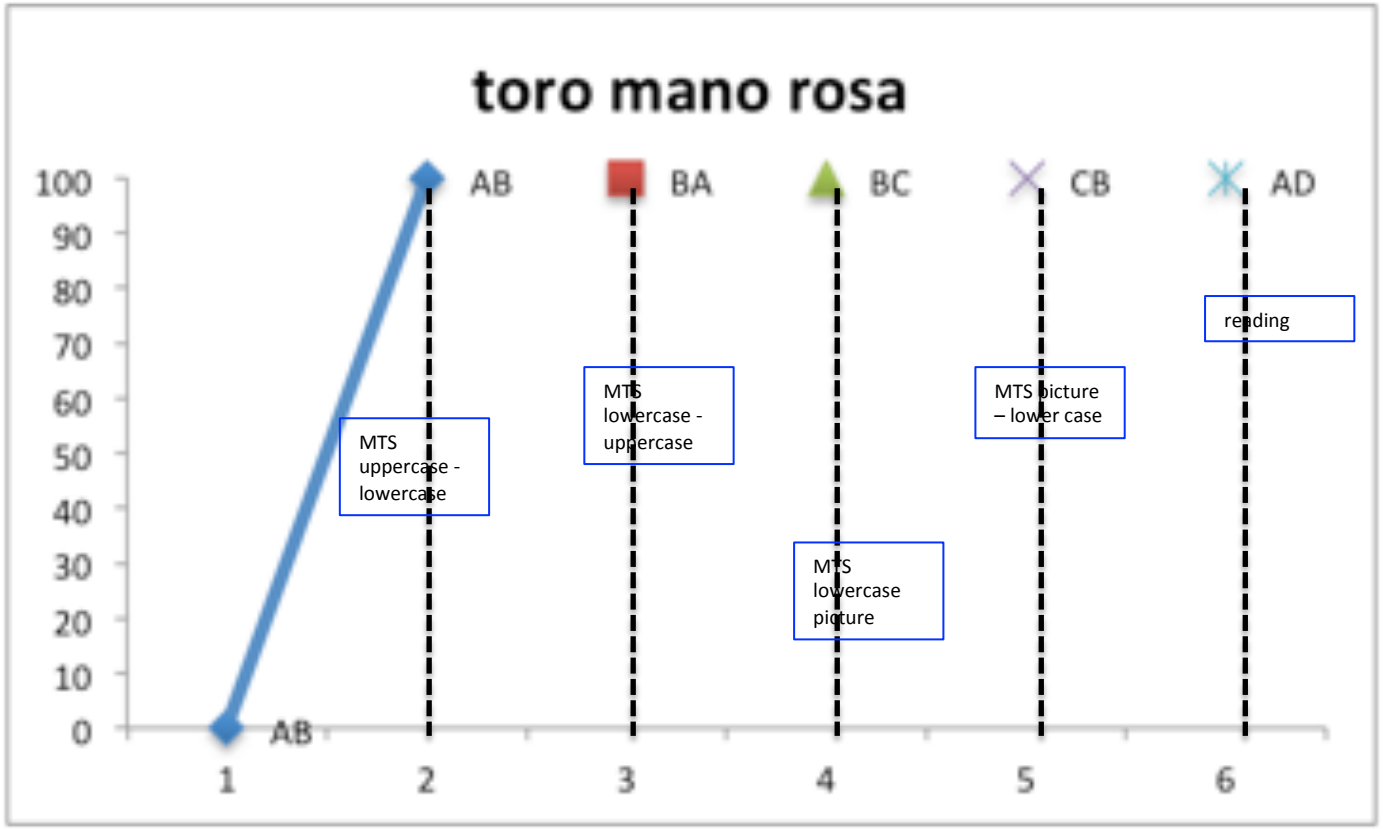












5. Training skills of reading uppercase and lowercase

Participant

- 6 years old
- Learning difficulties
- He makes mistakes with uppercase word
- He doesn't read lowercase word

Procedure:

CANE
MTS picture -uppercase
MTS uppercase picture
MTS LOWER CASE UPPERCASE
MTS UPPERCASE LOWER CASE
MTS LOWERCASE – picture
cane
MTS picture - lowercase
Reading uppercase and lowercase
Derived
Trained
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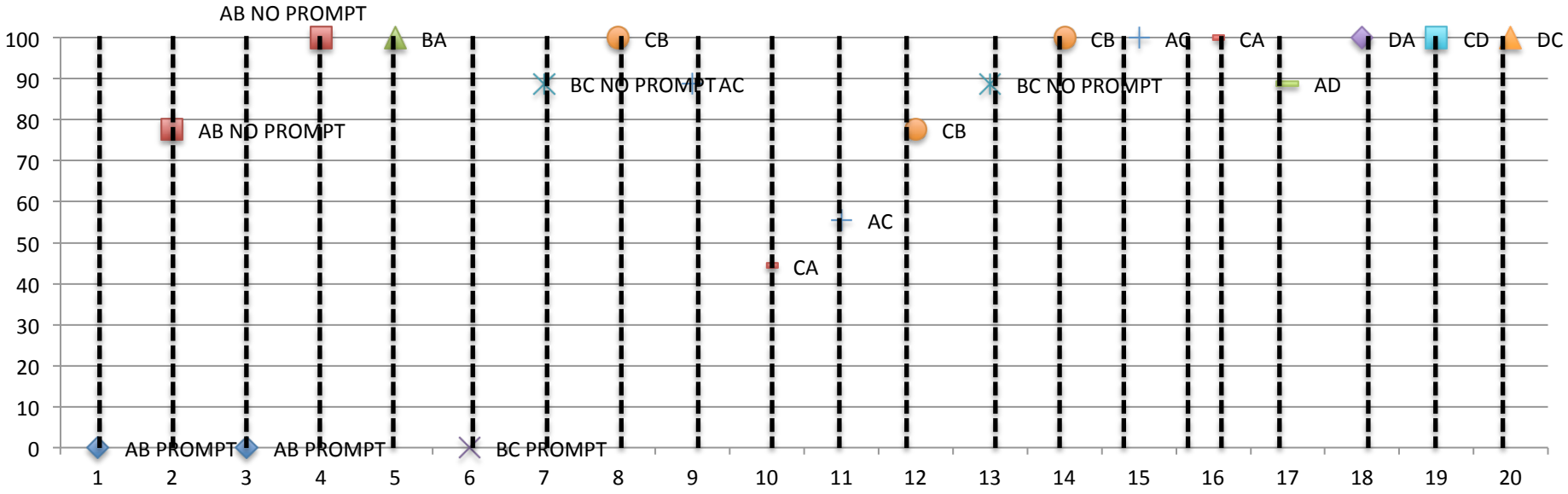
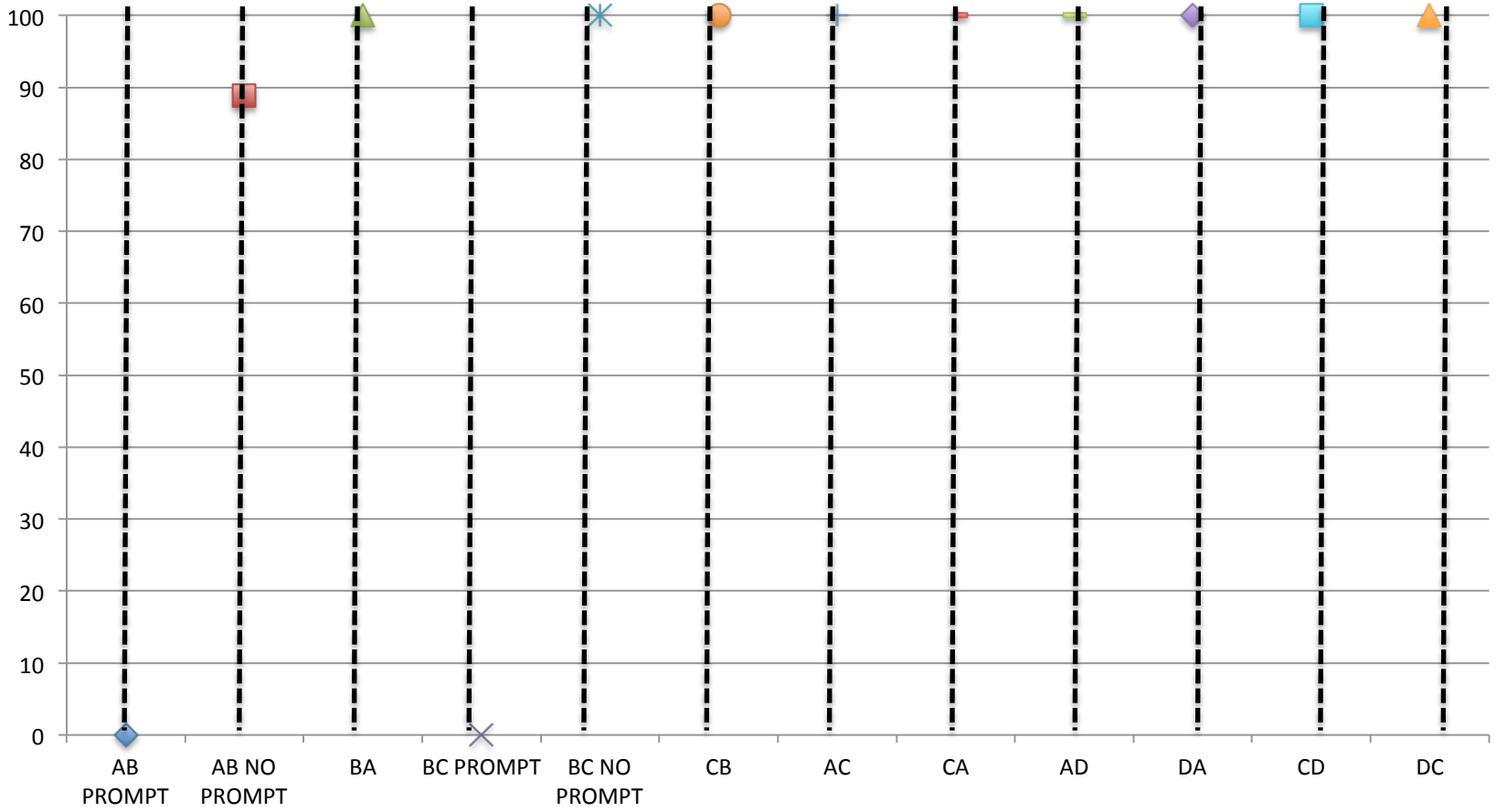
A NON PROFIT ORGANIZATION

Graphs

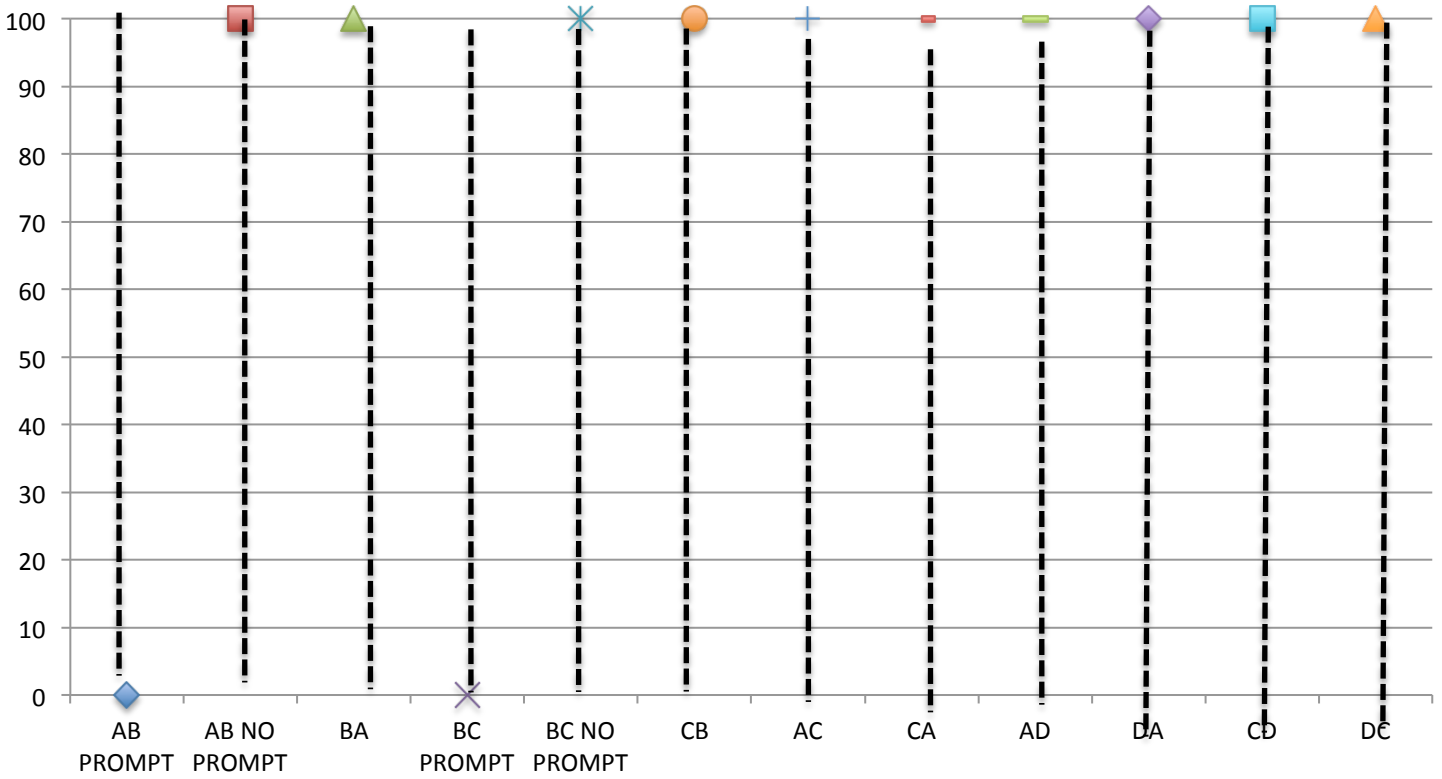
mano fiore toro



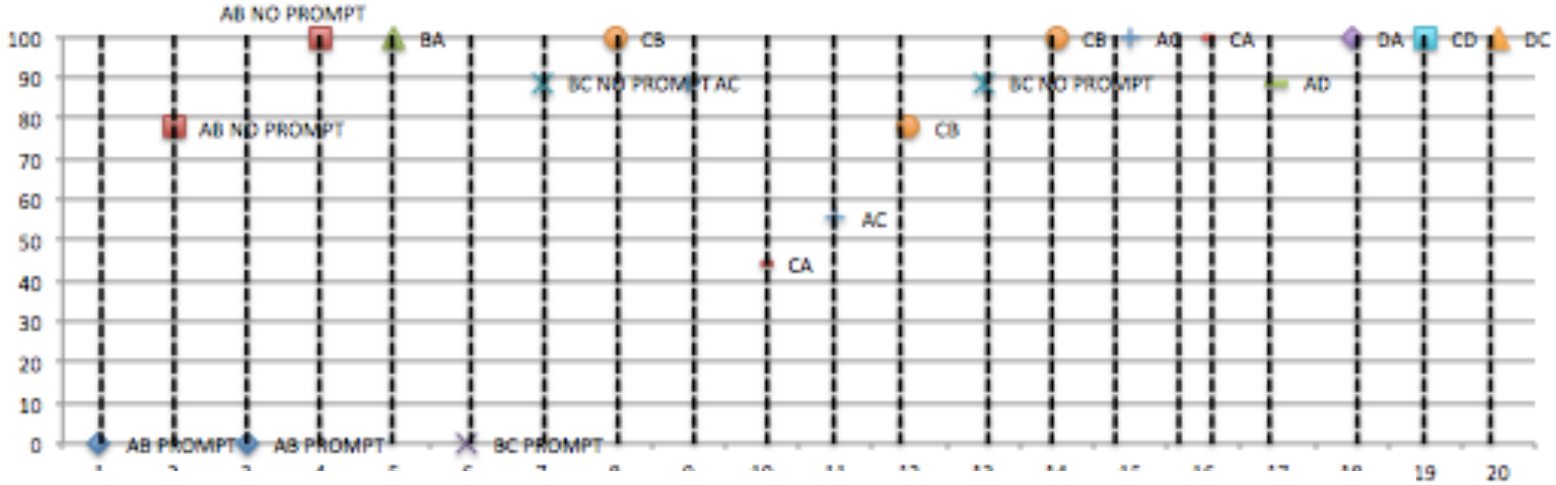
VISO, MARE, LUPO



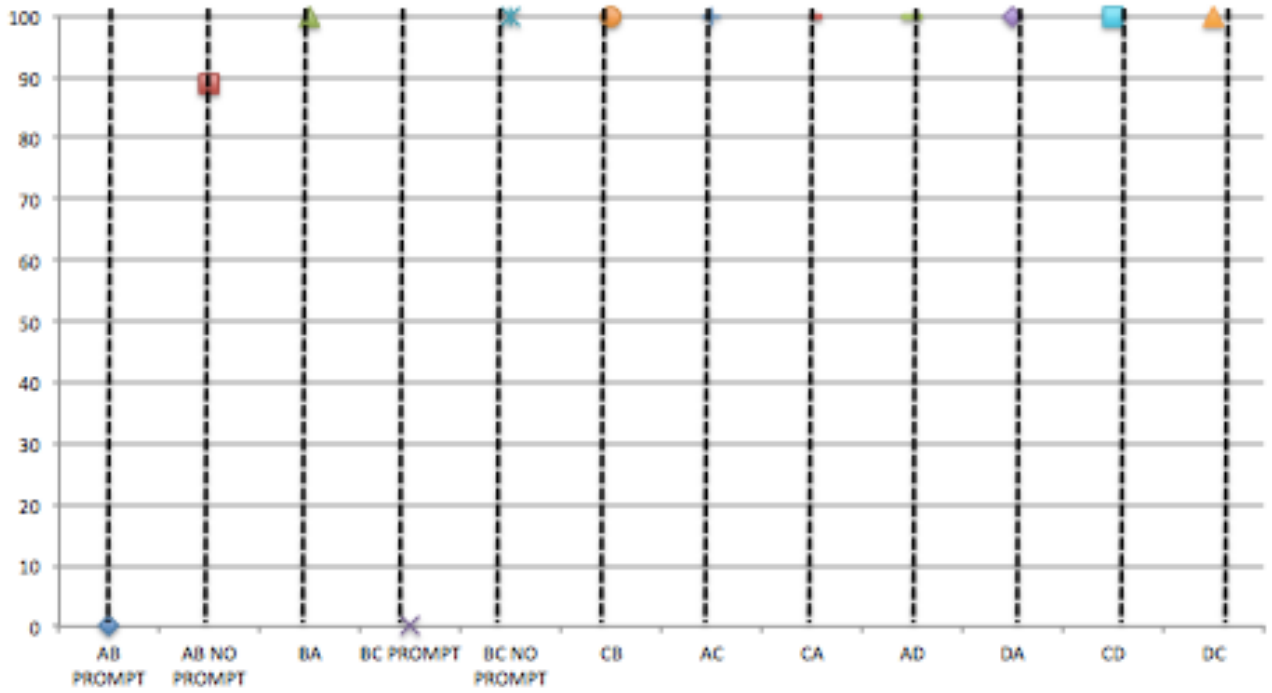
OLIO DADO ERBA



mano fiore toro



VISO, MARE, LUPO



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Advantages:

- Generative learning trend (without specific direct training)
- Motivational Learning trend (fast and low effort)
- The procedure described here can help to make instruction effective and pratical whether conducted on a tabletop (eg. i-pad) or a computer

Suggestions for future research:

- Analyzing results with standardized tests (test / re-test)
- Investigate the different role of child's prerequisites (component learning skills) that can facilitate the emergence of derivatives