The Efficacy of Nonlinguistic Cognitive Treatment on Bilingual Children with Primary Language Impairment

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INTRODUCTION

Children with Primary Language Impairment (PLI) have language learning difficulties in the absence of cognitive or developmental delays. Studies (e.g. Gallinat & Spaulding, 2014) have found that **these children show subtle deficits in Nonlinguistic Cognitive (NLC) skills** such as memory, attention and processing speed. Recently, some studies (e.g. Ebert & Kohnert, 2009) have shown that working on NLC skills can help improve the language skills of children with PLI.

RESEARCH QUESTIONS

1- Could treating nonlinguistic cognitive skills improve linguistic abilities?

- The hypothesis of cross-domain transfer is still controversial.
  - Some studies (e.g. Ebert, 2012) have found that **NLC intervention can lead to language gains** in children with PLI, however **these gains were not as significant as the ones obtained when using traditional linguistic intervention** alone.
  - In a recent meta-analysis, Melby-Lervåg and Hulme (2013) **found no evidence that working memory training was an effective intervention method** for children with ADHD and dyslexia.

2- In bilingual children, can skills from one language transfer to the other?

- Some studies (e.g. Verhoeven, Steenge & Balkom, 2012) have found evidence that, in bilingual children, cross-language transfer from first language (L1) to the second language (L2) is possible but that the opposite (L2 gains transferred to L1) is less likely.

The purpose of this study was to compare the efficacy of a combined linguistic and NLC approach to a traditional linguistic intervention in bilingual children with PLI.

METHODOLOGY

Participants:

- Eight bilingual French-English children aged 5;7 to 7;7 (mean 6;2) participated in this study.
- All participants had been previously identified as having a language impairment by their school Speech Language Pathologist. They scored 1.25 standard deviation under the mean for their age group in at least 2 of 5 sub-tests in their dominant language.
- Questionnaires were sent to the participants parents to confirm the child's language dominance and the absence of any comorbid disorders.

Table I. Participant characteristics at enrollment

Participants	P1	P2	P3	P4	P5	P6	P7	P8
Condition	1	1	1	1	2	2	2	2
Age	5;8	7;7	5;10	5;7	5;11	5;7	6;7	7;0
Sex	F	M	M	F	M	F	F	M
Dominance	FR	EN	EN	EN	EN	EN	EN	FR
IQ	88	92	112	105	93	101	104	100
Tests -1.25 STD	3	4	2	2	2	3	2	4

Note. In this table, 1 represents the group who received the the mixed cognitive-linguistic intervention and 2 represents the group who received the linguistic intervention. Also, FR stands for French and EN stands for English.

Measures:

Two types of measures were employed in this study: **repeated measures** and **pre-post standardized assessments**. Five repeated measures were used to track progress in targeted skills across the treatment period.

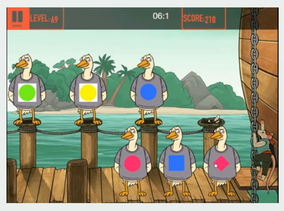
Table II. Repeated measures

Task Name	Construct of interest	Domain
Sentence repetition	Access to morphosyntaxic and lexical knowledge	French and English
Non-word repetition	Phonological working memory	French and English
Rapid automatic naming	Lexical processing efficiency	French only
Visual detection	NLC processing speed	NLC
Balance on one foot	Control task	Physical

Pre-post measures included linguistic assessments in both languages and NLC measures.

- **Linguistic assessments** targeted the comprehension of concepts and directions as well as expressive and receptive vocabulary and number repetition.
- **Cognitive measures** targeted cognitive flexibility, reasoning, categorization, spatial orientation, sustained attention, working memory, divided attention, response inhibition and speed of processing.

Interventions:



The cognitive software of the ACTIVATE program by C8 Sciences was used as the NLC intervention. Case studies (e.g. Wexler, 2013) have shown this program can improve working memory, processing speed and attention in children with ADHD.

Table III. Interventions

Intervention	Group 1	Group 2
Linguistic: Targets vocabulary, syntax, morphology and story telling. **This intervention was given in FRENCH ONLY.**	Received 45 minutes per week for 8 weeks.	Received 45 minutes per week for 8 weeks.
Non-linguistic Cognitive: Targets sustained attention, working memory, speed of processing, cognitive flexibility, categorization, pattern formation and sustained and divided attention.	Received up to 120 minutes per week for 8 weeks.	----Did not receive---

RESULTS

Hypothesis 1

Children with PLI will show subtle deficits in NLC skills.

Table IV. Pre-test results

Leiter-3	Average	Standard deviation	Hypothesis
Processing speed composite	8,25	1,85	**ACCEPTED**
Attention divided	5,5	1,69	**ACCEPTED**
Attention sustained	9,875	2,23	REJECTED
Memory composite	9,625	3,29	REJECTED

Hypothesis 2

Children who received the combined linguistic-cognitive intervention will make more cognitive and linguistic gains than children who received only the linguistic intervention.

Table V . Pre-post measures

	P1		P2		P3		P4		P5		P6		P7		P8	
Condition	Combined		Combined		Combined		Combined		Linguistic		Linguistic		Linguistic		Linguistic	
Variable	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
CELF - CND - CED	5	7	4	6	6	5	4	9	4	3	4	9	6	11	6	7
CELF – CDN – VE	7	7	2	3	8	9	5	8	4	3	6	8	6	7	4	6
CELF – CDN - RN	3	8	6	6	7	7	5	10	5	6	3	8	7	10	5	6
ÉVIP	90	79	64	63	80	84	76	84	62	79	86	79	74	80	79	78
MAVA Exp	72	85	86	86	69	85	90	99	86	86	78	90	87	89	92	85
MAVA Rec	87	89	88	106	80	93	85	101	104	101	87	98	88	95	69	83
CELF 5 - LC	6	8	3	9	8	8	4	8	6	5	5	8	8	7	9	10
CELF 5 - FD	7	8	6	8	9	7	9	10	6	4	9	7	7	10	6	6
CELF 4 - NR	3	7	3	5	9	9	10	12	7	7	8	7	6	10	4	6
Leiter - NvIQ	*8*	*10*	*8*	*8*	*12*	*11*	*11*	*11*	*9*	*11*	*10*	*11*	*11*	*10*	*10*	*9*
Leiter - Mem	*8*	*8*	*9*	*10*	*12*	*10*	*13*	*15*	*3*	*7*	*13*	*14*	*9*	*10*	*10*	*10*
Leiter - PS	*7*	*7*	*6*	*5*	*8*	*15*	*8*	*11*	*7*	*11*	*11*	*10*	*11*	*10*	*8*	*8*
Number of tests under the mean (L1)	2	1	3	1	2	0	1	0	2	2	2	0	2	0	4	3
Number of tests under the mean (L2)	3	1	4	4	2	2	4	1	4	4	3	1	3	1	3	3

*Note: Confidence interval levels were used to access if the difference between pre and post measures was significant. In this table, yellow represents a positive significant change (progress) while blue represents a negative significant change (regression) between pre and post measures.

An ANCOVA was used.

There were NO significant differences between groups.

Table VI. Repeated measures

	Group 1								Group 2							
	P1		P2		P3		P4		P5		P6		P7		P8	
Task	Type	Effect size	Type	Effect size	Type	Effect size	Type	Effect size	Type	Effect size	Type	Effect size	Type	Effect size	Type	Effect size
Sentence repetition, French	*d*	-0,33	*d*	-0,52	*d*	-0,39	*d*	-0,93	*d*	0,03	*d*	0,05	*d*	-0,55	*d*	-0,45
	$SMD_{initial}$	-0,02	$SMD_{initial}$	-0,20	$SMD_{initial}$	-0,47	$SMD_{initial}$	-7,47	$SMD_{initial}$	-0,11	$SMD_{initial}$	-0,03	$SMD_{initial}$	-0,24	$SMD_{initial}$	-0,40
	SMD_{pooled}	-0,01	SMD_{pooled}	-0,13	SMD_{pooled}	-0,38	SMD_{pooled}	-0,69	SMD_{pooled}	-0,04	SMD_{pooled}	-0,02	SMD_{pooled}	0-,24	SMD_{pooled}	-0,43
Sentence repetition, English	*d*	0,21	*d*	-0,19	*d*	0,76	*d*	0,55	*d*	0,93	*d*	-0,28	*d*	-1,07	*d*	-0,03
	$SMD_{initial}$	-0,14	$SMD_{initial}$	-0,14	$SMD_{initial}$	0,10	$SMD_{initial}$	0,27	$SMD_{initial}$	0,32	$SMD_{initial}$	0,08	$SMD_{initial}$	-0,46	$SMD_{initial}$	-0,54
	SMD_{pooled}	-0,09	SMD_{pooled}	-0,11	SMD_{pooled}	0,13	SMD_{pooled}	0,37	SMD_{pooled}	0,29	SMD_{pooled}	0,07	SMD_{pooled}	-0,61	SMD_{pooled}	-0,20
Rapid Automatic Naming (time)	*d*	-0,25	*d*	-0,88	*d*	1,12	*d*	0,75	*d*	1,54	*d*	-0,54	*d*	-0,37	*d*	-1,23
	$SMD_{initial}$	-1,17	$SMD_{initial}$	-0,33	$SMD_{initial}$	0,81	$SMD_{initial}$	0,45	$SMD_{initial}$	0,64	$SMD_{initial}$	-8,92	$SMD_{initial}$	-1,83	$SMD_{initial}$	-2,36
	SMD_{pooled}	-0,59	SMD_{pooled}	-0,43	SMD_{pooled}	0,54	SMD_{pooled}	0,29	SMD_{pooled}	0,66	SMD_{pooled}	-0,64	SMD_{pooled}	-0,60	SMD_{pooled}	-0,70
Rapid Automatic Naming (errors)	*d*	0,00	*d*	-0,07	*d*	-1,34	*d*	0,89	*d*	1,84	*d*	-0,45	*d*	-0,36	*d*	-0,71
	$SMD_{initial}$	-0,14	$SMD_{initial}$	-0,32	$SMD_{initial}$	ERR	$SMD_{initial}$	0,38	$SMD_{initial}$	2,06	$SMD_{initial}$	-0,14	$SMD_{initial}$	-2,5	$SMD_{initial}$	-0,69
	SMD_{pooled}	-0,18	SMD_{pooled}	-0,30	SMD_{pooled}	-0,70	SMD_{pooled}	0,50	SMD_{pooled}	0,99	SMD_{pooled}	-0,05	SMD_{pooled}	-0,68	SMD_{pooled}	-0,49
Non-Word Repetition, French	*d*	0,97	*d*	1,15	*d*	1,4	*d*	0,63	*d*	1,10	*d*	1,15	*d*	0,40	*d*	1,03
	$SMD_{initial}$	0,06	$SMD_{initial}$	0,35	$SMD_{initial}$	0,88	$SMD_{initial}$	-0,04	$SMD_{initial}$	0,5	$SMD_{initial}$	0,51	$SMD_{initial}$	0,09	$SMD_{initial}$	0,53
	SMD_{pooled}	0,03	SMD_{pooled}	0,27	SMD_{pooled}	0,62	SMD_{pooled}	-0,04	SMD_{pooled}	0,34	SMD_{pooled}	0,20	SMD_{pooled}	0,15	SMD_{pooled}	0,59
Non-Word Repetition, English	*d*	0,78	*d*	-0,4	*d*	0,466	*d*	1,16	*d*	0,31	*d*	0,56	*d*	0,02	*d*	0,54
	$SMD_{initial}$	0,25	$SMD_{initial}$	-0,94	$SMD_{initial}$	0,27	$SMD_{initial}$	0,82	$SMD_{initial}$	-0,6	$SMD_{initial}$	0,18	$SMD_{initial}$	-0,00	$SMD_{initial}$	-0,12
	SMD_{pooled}	0,3	SMD_{pooled}	-0,48	SMD_{pooled}	0,42	SMD_{pooled}	0,77	SMD_{pooled}	-0,06	SMD_{pooled}	0,31	SMD_{pooled}	-0,00	SMD_{pooled}	0,11
Visual Detection	*d*	-0,96	*d*	1,37	*d*	0,94	*d*	-1,56	*d*	1,80	*d*	-0,17	*d*	0,50	*d*	0,1
	$SMD_{initial}$	-1,31	$SMD_{initial}$	7,30	$SMD_{initial}$	1,59	$SMD_{initial}$	-0,32	$SMD_{initial}$	-2,09	$SMD_{initial}$	-3,30	$SMD_{initial}$	0,422	$SMD_{initial}$	1,96
	SMD_{pooled}	-0,69	SMD_{pooled}	0,97	SMD_{pooled}	0,38	SMD_{pooled}	-0,95	SMD_{pooled}	0,80	SMD_{pooled}	-0,24	SMD_{pooled}	-0,16	SMD_{pooled}	0,01
Balance on one foot	*d*	0,85	*d*	-0,23	*d*	-0,72	*d*	-1,01	*d*	1,28	*d*	0,34	*d*	0,47	*d*	0,10
	$SMD_{initial}$	0,97	$SMD_{initial}$	0,09	$SMD_{initial}$	-0,17	$SMD_{initial}$	-0,55	$SMD_{initial}$	0,45	$SMD_{initial}$	0,16	$SMD_{initial}$	-0,23	$SMD_{initial}$	-0,21
	SMD_{pooled}	0,322	SMD_{pooled}	0,11	SMD_{pooled}	-0,15	SMD_{pooled}	-0,56	SMD_{pooled}	0,35	SMD_{pooled}	0,20	SMD_{pooled}	-0,19	SMD_{pooled}	-0,17

Note: Yellow highlighting represents an effect size higher than 0.8 while blue highlighting represents an effect size lower than -0.8.

A descriptive analysis showed NO significant differences between groups.

Hypothesis 3

There will be cross-linguistic transfer.

Table VII. Cross-linguistic transfer

	L1 = French	L1 = English
N	2	6
L1 to L2	Improved on 4/10 tests in English	-
L2 to L1	-	Improved on 15/30 tests in English

Results suggests **cross-linguistic transfer might be possible**. However, since English is the majority language in Sudbury, Ontario, these improvements might be due to a high exposure to English rather than to the effect of the treatment.

CONCLUSIONS

1. NLC intervention as a complement to linguistic intervention provided NO significant additional gains in the linguistic and cognitive domains.
2. NLC intervention did not significantly improve non-linguistic cognitive skills.
3. Linguistic intervention in French lead to improvements in the targeted language as well as the untargeted language for most of the participants.

THESE RESULTS EMPHASIZE THE NEED TO CONTINUE TARGETING LINGUISTIC SKILLS DIRECTLY WHEN TREATING BILINGUAL CHILDREN WITH PLI.

REFERENCES

Ebert, K. D., & Kohnert, K. (2009). Non-linguistic cognitive treatment for primary language impairment. *Clinical Linguistics & Phonetics, 23*(9), 647-664.

Ebert, K. D. (2012). *A comparison between nonlinguistic cognitive processing treatment and traditional language treatment for bilingual children with primary language impairment* Available from PsycINFO. (1021142905; 2012-99080-084).

Ebert, K. D. (2014). Nonlinguistic cognitive effects of language treatment for children with primary language impairment. *Communication Disorders Quarterly, 35*(4), 216-225.

Ebert, K. D., Kohnert, K., Pham, G., Disher, J. R., & Payesteh, B. (2014). Three treatments for bilingual children with primary language impairment: Examining cross-linguistic and cross-domain effects. *Journal of Speech, Language, and Hearing Research, 57*(1), 172-186.

Gallinat, E., & Spaulding, T. J. (2014). Differences in the performance of children with specific language impairment and their typically developing peers on nonverbal cognitive tests: A meta-analysis

Melby-Lervåg, M., & Hulme, C. (2013). Is working memory training effective? A meta-analytic review. *Developmental Psychology, 49*, 270-291.

Verhoeven, L., Steenge, J., & van Balkom, H. (2012). Linguistic transfer in bilingual children with specific language impairment. *International Journal of Language & Communication Disorders, 47*(2), 176-183.

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