Contributions of Bilingualism and Public Speaking Training to Cognitive Control Differences Among Young Adults

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Abstract

The Flanker task, the Number Stroop task, and the Wisconsin Card Sorting Test (WCST) were adopted to examine how bilingualism and public speaking training contribute to cognitive control differences among young adults. Four groups of participants were tested: monolinguals, general bilinguals, Chinese (L1) public speaking bilinguals, and English (L2) public speaking bilinguals. ANOVA analyses showed that: 1) the speaking groups performed faster than the other two groups in the Flanker task (i.e., better in conflict monitoring), whereas the L2 public speaking group performed the fastest in the Number Stroop; 2) The three bilingual groups performed better than the monolinguals in the WCST (i.e., better in mental set shifting), and this advantage was more robust when L2 proficiency was higher. Further multiple regression analyses showed that public speaking experience significantly contributes to conflict monitoring, whereas L2 proficiency significantly contributes to mental set shifting. The results show that specific aspects of language experience may incur enhancement in specific aspects of cognitive control.

Introduction

1. Both homogenous background and multiple tasks should be considered when examining bilingual advantage (Han & Ma, 2014; Paap & Greenberg, 2013; van Heuven, Conklin, Coderre, Guo, & Dijkstra, 2011).
2. Some particular bilingual experience (e.g. public speaking) may enhance cognitive control in particular ways (Bialystok, Craik, Green, & Gollan, 2009; Valian, 2015) .
3. In public speaking (in L1 or L2), cognitive control plays important role in language management and in reducing performance anxiety (Jones, Fazio, & Vasey, 2012; Mueller, 2011).

Hypotheses

After controlling the homogeneity of bilinguals' and monolinguals' language and culture background and adopting multiple cognitive control tasks, our specific hypotheses are:

1. Bilinguals may outperform monolinguals in performing one or more tasks.
2. Public speaking bilinguals may outperform their counterparts in one or more tasks.
3. L2 public speaking group may outperform all the other groups in one or more tasks.

Method

Participants: unbalanced Chinese-English young adults (42 m/94 f, 21.27 years)
Bilingual group:43, English major university students, 22.4 years old;
L2 public speaking group:30, training for 2.8 years (SD = 0.9), 21.2 years old;
L1 public speaking group: 30, training for 2.9 years (SD=0.3), 19.5 years old;
Monolingual group: 33, extremely limited knowledge of L2, 21.5 years old.

Materials and Procedure:
A composite questionnaire concerning demographic characteristics;
Three computerized cognitive control tasks: the Flanker task, the Number Stroop task, and the Wisconsin Card Sorting Test (WCST);
Indexes for comparisons: RT in each condition (indicating conflict monitoring);
RT difference between congruent and incongruent trials (indicating conflict resolution);
WCST performance (indicating mental set shifting).

Results

Flanker Task

Repeated Measures Analysis showed significant main effect of Group, F (3, 129) =6.453, p<.001, η^2=.130, but no significant group differences in conflict resolution (F<1).
Multiple comparisons showed that L2 public speaking group was faster than the bilingual group and the monolingual group in all three conditions (*ps*<.005), and L1 public speaking group was faster than the bilingual group and the monolingual group in all three conditions (ps<.006).However, there were no differences between L1 speaking and L2 speaking (*ps*>.910), and no difference between the bilingual group and the monolingual group (*ps*>.470)
Multiple regression analysis showed that L2 proficiency, L2 history, years of education, L2 exposure, and L2 speaking did not contribute significantly to the effects in all conditions (*ps*>.216), whereas public speaking experience contribute significantly to the effects in all conditions (*ps*<.005).

Table 1. *Means (standard deviations) of participant characteristics in language history, language proficiency, and language experience etc. across groups.*

	Monolingual	L1 Speaking	L2 Speaking	Bilingual
	n=33	n=30	n=30	n=43
Age	21.5[b] (3.6)	19.5[a] (1.0)	21.2[b] (2.3)	22.4[c] (1.8)
Education (years)	11.3[a] (2.4)	13.5[b] (1.0)	15.2[c] (2.3)	16.4[d] (1.8)
Raven's Matrices	65.2 (5.5)	65.4 (4.9)	65.0 (5.0)	64.7 (4.1)
L2 Learning History (years)	4.1[a] (1.2)	11.8[b] (1.7)	11.2[b] (2.3)	12.4[c] (1.7)
L2 /L1 speaking Training (years)	/	2.9 (0.3)	2.8 (0.9)	/
L2 Proficiency	7.1[a](2.9)	19.5[b] (4.4)	24.5[c] (4.3)	23.2[c](4.5)
L2 Verbal Category Fluency	6.7[a] (1.7)	19.1[b] (8.1)	25.2[c] (5.2)	24.4[c] (4.2)
L2 Exposure (%)	/	7.6[a] (3.4)	41.1[b] (20.8)	43.3[b] (17.7)
L2 Speaking (%)	/	8.8[a] (9.1)	27.2[c] (13.4)	16.9[b](10.3)

Note: Means in the same row with different superscript letters differ from each other significantly at p<.01 or .05. The total language exposure and speaking percentage of L1 and L2 equals 100; the total score for L2 proficiency is 40.

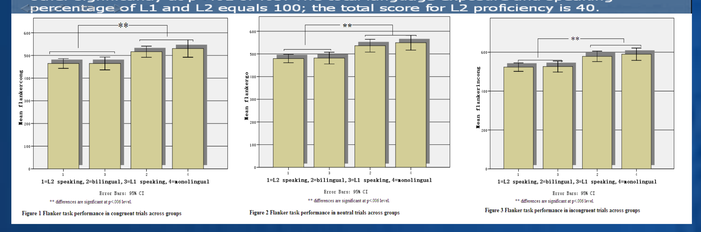

Figure 1 Flanker task performance in congruent trials across groups
Figure 2 Flanker task performance in neutral trials across groups
Figure 3 Flanker task performance in incongruent trials across groups

Table 2. *Means (standard deviations) of reaction times in each Flanker condition, means (standard deviations) of Flanker conflict in each group, multiple comparisons (p value) of the groups in each Flanker condition.*

	Monolingual (M)	L1 Speaking (L1)	Bilingual (B)	L2 Speaking (L2)
	n=32	n=30	n=43	n=28
Congruent	530.3(106.4)	465.4(78.3)	516.4 (80.6)	464.5 (55.5)
Neutral	549.3 (90.8)	481.3(71.9)	536.0(91.3)	479.5 (47.5)
Incongruent	589.7 (88.3)	525.6(78.4)	578.3(87.1)	523.3 (56.4)
Conflict*	59.4 (39.7)	60.2 (34.0)	61.9 (49.5)	58.8 (23.6)

	L2-B**	L2-M	L1-B	L1-M	L2-L1	B-M
Congruent	p = .011	p = .003	p = .011	p = .002	p = .995	p = .472
Neutral	p = .004	p = .001	p = .005	p = .001	p = .917	p = .475
Incongruent	p = .005	p = .002	p = .006	p = .002	p = .881	p = .544
Conflict*	p = .735	p = .951	p = .976	p = .814	p = .773	p = .776

Notes: *Conflict refers to the different response times between incongruent condition and congruent condition. **Abbreviations: "M" for monolingual group, "L1" for L1 public speaking group, "B" for bilingual group, "L2" for L2 public speaking group; "L2-B" for a comparison between the L2 public speaking group and the bilingual group.

Number Stroop Task

Repeated Measures Analysis showed significant main effect of Group, F (3, 119) =2.525, p=.061 (marginal), η^2=.051, but no significant group difference in conflict resolution, F (3,119) =1.182, p=.320).
Multiple comparisons showed L2 public speaking group performed faster than all the other groups in one or more conditions, but there were no differences across the other three groups (L1, bilinguals, monolinguals) (*ps*>.375).
Multiple regression analysis showed that L2 proficiency, L2 history, years of education, L2 exposure, and L2 speaking did not contribute significantly to the effects in all conditions (*ps*>.105), whereas public speaking experience contribute significantly to the effects in all conditions (*ps*<.024).

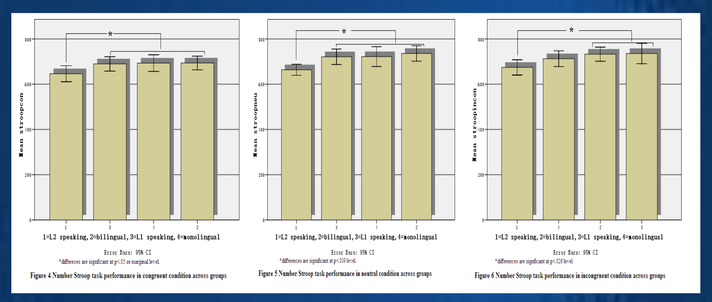

Figure 4 Number Stroop task performance in congruent condition across groups
Figure 5 Number Stroop task performance in neutral condition across groups
Figure 6 Number Stroop task performance in incongruent condition across groups

Table 3. *Means (standard deviations) of reaction times in each number Stroop condition, means (standard deviations) of Stroop conflict in each group, multiple comparisons (p value) of the groups in each Stroop condition.*

	Monolingual (M)	L1 Speaking (L1)	Bilingual (B)	L2 Speaking (L2)
	n=31	n=26	n=41	n=25
Congruent	693.2 (100.0)	689. 7(79.6)	693.7 (95.9)	646.3 (86.0)
Neutral	721.8(119.3)	721.21(85.0)	735.9(107.9)	683.6(59.2)
Incongruent	712.5 (95.2)	735.6(111.2)	732.7 (98.3)	674.2(82.2)
Conflict*	19.3 (50.7)	45.9(68.1)	39.0 (64.3)	27.9 (45.0)

	L2-B**	L2-M	L1-B	L1-M	L2-L1	B-M
Congruent	p = .044	p = .060	p = .862	p = .887	p = .094	p = .980
Neutral	p = .003	p = .030	p = .554	p = .983	p = .039	p = .549
Incongruent	p = .020	p = .146	p = .906	p = .375	p = .026	p = .386
Conflict*	p = .458	p = .589	p = .640	p = .092	p = .276	p = .162

Notes: * Conflict refers to the different response times between incongruent condition and congruent condition. ** Abbreviations: "M" for monolingual group, "L1" for L1 public speaking group, "B" for bilingual group, "L2" for L2 public speaking group; "L2-B" for a comparison between the L2 public speaking group and the bilingual group.

WCST

ANOVA Analysis showed no differences across the groups on global RTs, F (3,131) =1.510, p=.215, but significant group differences on the number of *completed categories*, F (3, 131)=10.155, p<.001; *overall errors*, F (3, 131)=10.769, p<.001; *perseverative errors*, F (3, 131) =9.990, p<.001; and *immediate pervious category errors*, F (3, 131) =13.111, p<.001. Groups with **higher L2 proficiency** performed **better** than the lower L2 proficiency group (L2 speaking=bilingual>L1 speaking>monolingual) (*ps*<.015).
Multiple Regression Analysis showed that public speaking experience, L2 history, years of education, L2 exposure, and L2 speaking did not significantly contribute to the differences (*ps*>.199), whereas L2 proficiency significantly contributed to the group differences on all the indexes (*ps*<.022).

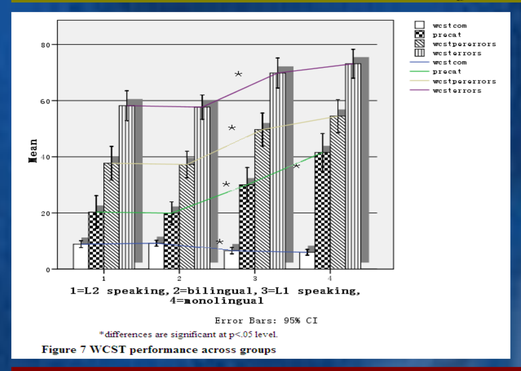

Figure 7 WCST performance across groups

Table 4. *Means (standard deviations) of global performance and types of errors in the WCST across groups, multiple comparisons (p value) of the groups in each index.*

	Monolingual (M)	L1 Speaking (L1)	Bilingual (B)	L2 Speaking (L2)
	n=32	n=30	n=43	n=30
Global RTs	1383.7(549.8)	1354.9(450.9)	1555.5(526.3)	1347.4(429.7)
C-Categories*	5.7 (2.8)	6.4 (3.2)	9.2 (3.4)	8.8 (3.3)
Overall errors	73.2 (13.4)	70.3(15.1)	57.7 (14.1)	58.2 (14.3)
Per-errors*	54.4(15.4)	50.0(16.9)	37.3 (15.3)	37.7 (16.1)
Pre-Cat-errors*	41.6 (17.7)	30.5 (18.0)	19.9 (13.1)	20.3 (15.7)

	L2-B**	L2-M	L1-B	L1-M	L2-L1	B-M
Global RTs	p = .079	p = .775	p = .076	p = .801	p = .966	p = .142
C-Categories*	p = .656	p = .000	p = .000	p = .364	p = .004	p = .000
Overall errors	p = .882	p = .000	p = .000	p = .428	p = .001	p = .000
Per-errors*	p = .907	p = .000	p = .001	p = .286	p = .003	p = .000
Pre-Cat-errors*	p = .922	p = .000	p = .006	p = .009	p = .015	p = .000

Notes: * "C-Categories" refers to completed categories, "Per-errors" perseverative errors; "Pre-Cat-errors" previous category errors. ** Abbreviations: "M" for monolingual group, "L1" for L1 public speaking group, "B" for bilingual group, "L2" for L2 public speaking group; "L2-B" for a comparison between the L2 public speaking group and the bilingual group.

Conclusion

The results show that public speaking (esp. in L2) significantly contributes to conflict monitoring, whereas L2 proficiency significantly contributes to mental set shifting. These results indicate that bilingual advantage is closely associated with specific features of language use experience and that only certain specific aspect(s) of cognitive control that are related to language use experience can be significantly affected. Further follow-up studies are encouraged to identify the specificity of bilingual language experience and its possible effect on specific aspect(s) of cognitive control.