Language Control and Nonlinguistic Shifting Skills in Bilingual Children

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BACKGROUND

- Effective bilingual communication requires **language control**, the ability to choose the appropriate language based on the situation.
- Monitoring context and inhibiting the language-not-in-use may recruit **executive functions** (e.g., Bialystok, 2009), including **task shifting**.
- Work in adults has yielded **mixed results** regarding the relationship between language control and nonlinguistic task shifting.
  - **Findings that support common mechanisms:** Prior & Gollan, 2011; Soveri et al., 2011; Festman & Münte, 2012
  - **Findings that support divergent mechanisms:** Calabria et al., 2012; Gollan et al., 2014; Weissberger et al., 2012
  - Unclear at what **level of language control** (language selection vs. lexical selection) shifting skills may play a role (e.g., Gollan et al., 2014).
- Unknown relationship between shifting and language control in **bilingual children**.

RESEARCH QUESTION

At what level of lexical production do nonlinguistic task shifting skills predict language control skills in bilingual children?

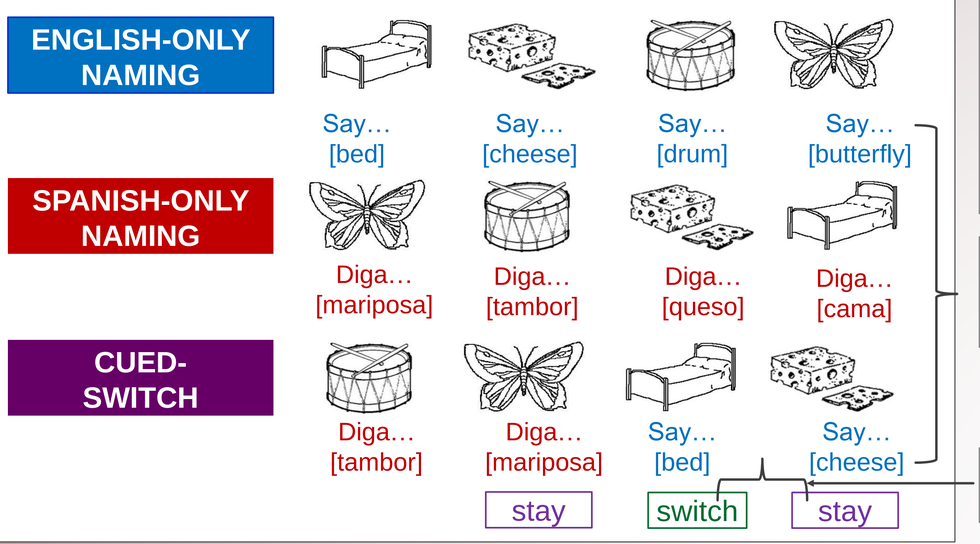
- Language selection: indexed by cross-language errors
- Lexical selection: indexed by naming speed for correctly produced words

PARTICIPANTS (*n*=68, 28 boys)

Characteristic		Mean (SD)
Age (years)		6.37 (0.79)
SES (years of education completed by parent)		16.67 (5.24)
Nonverbal Intelligence (Matrices, KBIT-2)		104.25 (12.85)
English Age of First Word Combinations (months)[a]		24.38 (13.66)
Spanish Age of First Word Combinations (months)[a]		31.09 (20.60)
Current Exposure to Spanish (% waking hrs/week)		50.26% (18.87)
Language of Instruction at School:[b]	English-only; ≥50% Spanish	37%; 63%
Parent-Reported Home Language:[b]	Mostly English	50%
	Mostly Spanish	40%
	Both	10%
English Expressive Vocabulary SS (WJ-III Picture Vocabulary)		95.18 (16.65)
Spanish Expressive Vocabulary SS (Batería III Vocabulario sobre dibujos)		71.07 (20.38)
Dominant Language:[b,c]	English	72%
	Spanish	28%

[a] Acquisition was indexed by the age in months at which the child began producing two-word phrases.
[b] Percentages reflect the percent of the sample in each category.
[c] Dominant Language determined by relative performance on Spanish vs. English expressive vocabulary.

PICTURE-NAMING TASK



Single Context
- 40 English / 10 Color
- 40 Spanish / 10 Shape

Mixed Context – 40 trials
- 20 stay, 20 switch, pseudorandomized
- 20 Eng, 20 Span / 20 Color; 20 Shape

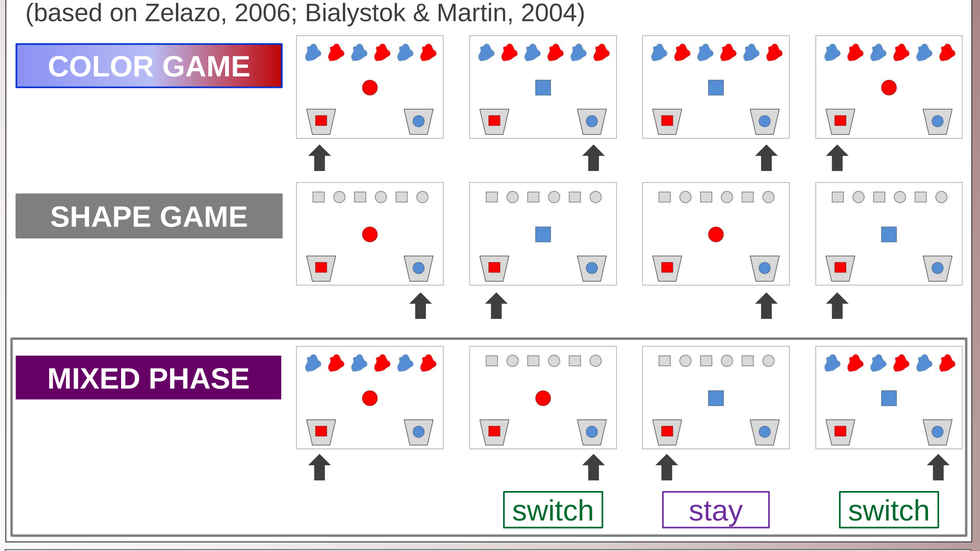
Mixing costs:
Stay trials from **Cued-Switch** block vs. **Single-Language** block

Switching costs:
Stay vs. Switch trials in Cued-Switch

Outcome measures: Cross-language error (word in un-cued language)
Naming latency (ms) for correctly produced words
Cued-Switch trade-off: slower → fewer cross-language errors (R^2=.075)

DIMENSIONAL CHANGE CARD SORT (DCCS)

(based on Zelazo, 2006; Bialystok & Martin, 2004)



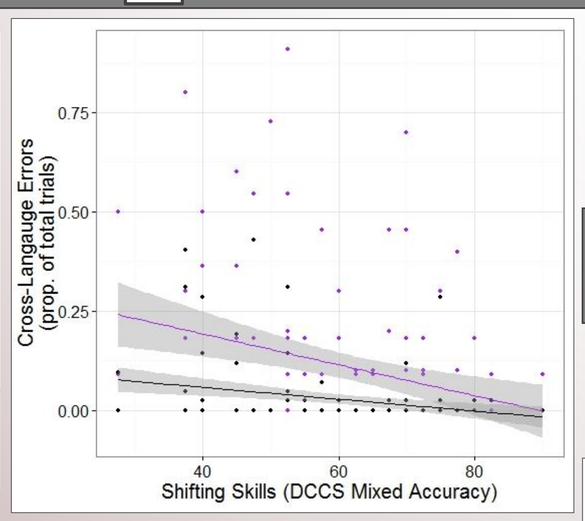
Outcome measure: Overall accuracy (% correct) during Mixed Phase
Speed-accuracy trade-off: slower → higher accuracy (R^2=.064)

RESULTS: ROLE OF NONLINGUISTIC SHIFTING AT DIFFERENT LEVELS OF LANGUAGE CONTROL

MIXING COSTS: SINGLE VS. MIXED CONTEXT

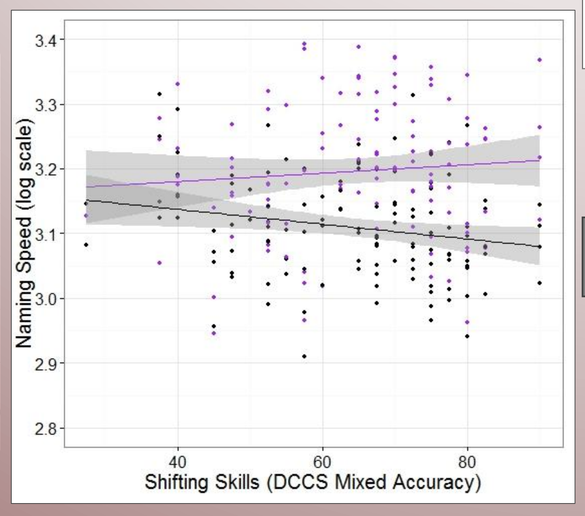
Variable	β (*SE*)	*z*
Intercept	-5.73 (0.45)	-12.75
Context	**2.57 (0.80)**	**3.20**
Language	**3.09 (0.85)**	**3.65**
Language x Context	0.81 (1.46)	0.56
Shifting (DCCS)	**-0.07 (0.02)**	**-4.56**
Shifting x Context	0.02 (0.03)	0.77

Significant mixing costs. Better shifters make fewer cross-language errors overall, but shifting skills do not significantly modulate mixing costs.



Variable	β (*SE*)	*t*
Intercept	3.17 (0.01)	304.73
Context	**0.08 (0.01)**	**6.68**
Language	**0.06 (0.01)**	**5.65**
Language x Context	-0.02 (0.02)	-1.19
Shifting (DCCS)	-0.001 (0.001)	-0.93
Shifting x Context	0.001 (0.001)	1.69

Significant mixing costs. No effect of shifting.

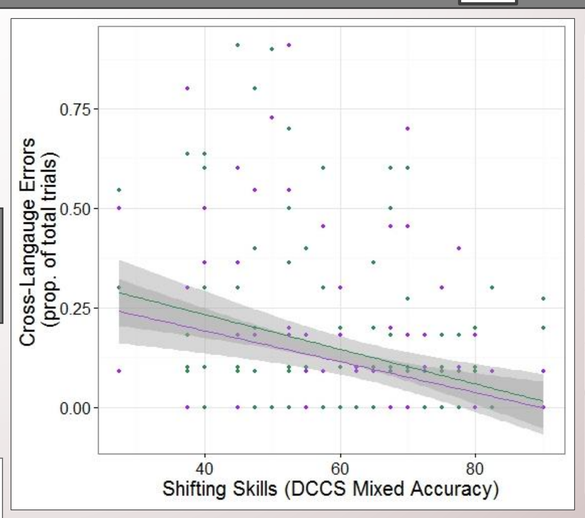


Cross-Language Errors

Ribbons = 95% CI
Bold = sig, alpha < .05

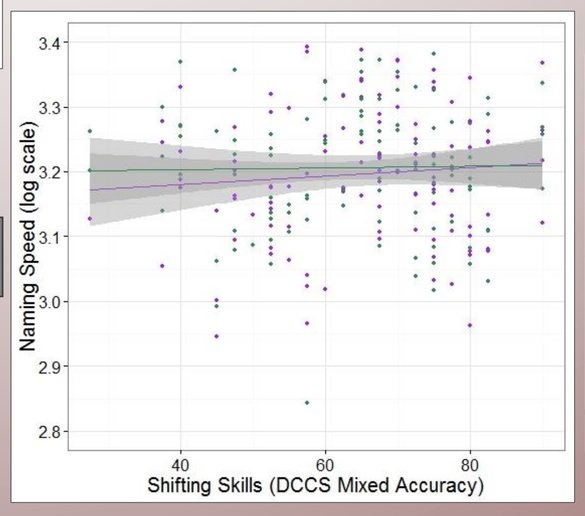
Naming Speed

SWITCHING COSTS: STAY VS. SWITCH TRIALS



Variable	β (*SE*)	*z*
Intercept	-3.55 (0.27)	-13.17
Switch	**1.06 (0.40)**	**2.66**
Language	**2.48 (0.59)**	**4.18**
Language x Switch	-0.70 (0.77)	-0.91
Shifting (DCCS)	**-0.04 (0.01)**	**-3.94**
Shifting x Switch	0.001 (0.01)	0.09

Significant switching costs. Better shifters make fewer cross-language errors overall, but shifting skills do not significantly modulate switching costs.



Variable	β (*SE*)	*t*
Intercept	3.22 (0.01)	266.53
Switch	0.02 (0.02)	1.57
Language	**0.04 (0.01)**	**3.22**
Language x Switch	-0.02 (0.02)	-0.97
Shifting (DCCS)	0.001 (0.001)	0.74
Shifting x Switch	-<0.001 (0.001)	-0.08

No significant switching costs. No effect of shifting.

SUMMARY/DISCUSSION

1. **Level of Language Control:** Nonlinguistic shifting (as indexed by the DCCS) played a significant role in predicting cross-language errors, with better shifters producing fewer cross-language errors. However, nonlinguistic shifting did not significantly predict language control at the level of naming speed.
2. **Mixing and Switching Costs:** The effect of shifting skills on the production of cross-language errors did not differ for the single-language blocks vs. the cued-switch block; better shifters did not show significantly smaller linguistic mixing costs. Within the cued-switch block, shifting skills influenced performance on stay and switch trials equally; better shifters did not show smaller linguistic switching costs.

CONCLUSION

In bilingual children, nonlinguistic shifting skills contribute to the ability to select the correct language. However, once the correct language has been selected, nonlinguistic shifting skills do not appear to influence the speed with which the correct lexical item is produced, even under more challenging mixed-language conditions.

ACKNOWLEDGMENTS

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