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# Effects of bilingualism and age on verbal fluency performance



CIHR IRSC  
Canadian Institutes of Health Research / Instituts de recherche en santé du Canada



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## Introduction

- Bilinguals show superior performance on executive function tasks relative to monolinguals [1], and this advantage is greater in older adults [2]. However, the robustness and specificity of these findings has been questioned [3].
- The bilingual advantage is thought to arise due to constant use of general executive control processes to engage in one language while inhibiting the other.
- Monolinguals typically show superior performance relative to bilinguals in tasks of verbal fluency [4].
- Letter fluency tasks are believed to rely more on executive function than do semantic fluency tasks [5].
- We sought to explore how the presence of the bilingual advantage in healthy young and older adults affects performance on verbal fluency tasks requiring varying levels of executive function.

## Hypotheses

- Monolinguals will outperform bilinguals in tasks of lexical access (i.e., Boston naming test (BNT), letter fluencies, and category fluencies).
- Bilinguals will show superior performance on tasks of executive function relative to their monolingual peers (i.e. Stroop interference and Wisconsin Card Sort Test (WCST)).
- The bilingual advantage would improve performance on switching fluency tasks relative to monolinguals.
- Bilinguals should perform better on letter fluency tasks than semantic fluency tasks relative to monolinguals.

## Methods

- Two letter fluency tasks were used: letter fluencies for the letters F, A, and S and switching letter fluencies (i.e., switch between A and F).
- Two semantic fluency tasks were used: category fluency for animals and switching category fluency (i.e., switch between vegetables and musical instruments).
- Monolinguals completed the fluency tasks in English; bilinguals in both English and French. The verbal fluency scores of bilinguals' self-reported L1 were used in all analyses.
- Two types of Stroop interference were calculated by subtracting the number of correct responses on the incongruent trial from the number of correct responses on congruent trials.

**Acknowledgements:** This research was funded by a CIHR grant awarded to VT and an Alzheimer's Society Grant awarded to VT and SK. Thanks to Courtney Lord, Anne-Marie Lavoie, Chalice Walker, and Laura Thompson for their assistance with data collection.

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## Participants & Results

Table 1. Participant characteristics and neuropsychological test results (SD).

\* Animal fluency showed a trend toward a main effect of language group ( $F_{(1,220)} = 3.84, p = .051$ ).

	Young monolinguals (YM; n=59; 27 males)	Young bilinguals (YB; n=56; 19 males)	Older monolinguals (OM; n=61; 28 males)	Older bilinguals (OB; n=45; 19 males)	Results
Age	21.5 (1.9)	21.1 (2.0)	71.6 (6.1)	70.2 (5.3)	N.S
Education	15.6 (1.3)	15.6 (1.6)	15.2 (2.80)	16.5 (2.7)	OB>OM
MoCA	28.3 (1.4)	27.9 (1.6)	27.8 (1.5)	27.4 (1.7)	N.S
Digit Span					N.S
Forward	11.1 (2.1)	10.9 (2.4)	10.7 (1.9)	10.2 (2.1)	N.S
Reverse	7.0 (2.0)	7.9 (2.2)	7.5 (2.2)	7.6 (2.6)	N.S
Letter-Number	11.4 (2.0)	11.3 (2.4)	10.2 (2.7)	9.2 (2.0)	N.S
WCST	4.5 (0.9)	4.7 (0.6)	3.6 (1.2)	3.9 (1.1)	B>M
Stroop interference					N.S
WR-INC	50.8 (16.0)	54.6 (13.6)	61.2 (13.5)	60.5 (14.8)	N.S
WN-INC	24.8 (8.9)	24.3 (9.8)	32.0 (11.1)	25.3 (10.6)	OB>OM
Boston naming	54.1 (6.4)	48.0 (6.5)	55.4 (3.3)	48.4 (5.8)	M>B
FAS fluency	13.8 (4.0)	12.3 (3.5)	14.4 (3.6)	12.4 (3.7)	M>B
AF switch	14.2 (3.5)	13.5 (3.5)	13.2 (3.5)	11.9 (3.3)	M>B
Animal Fluency*	24.4 (6.0)	23.3 (6.2)	21.2 (4.6)	19.3 (5.7)	M>B
Vegetable-Instrument	14.8 (2.8)	15.3 (3.0)	14.1 (3.0)	12.8 (3.1)	OM>OB

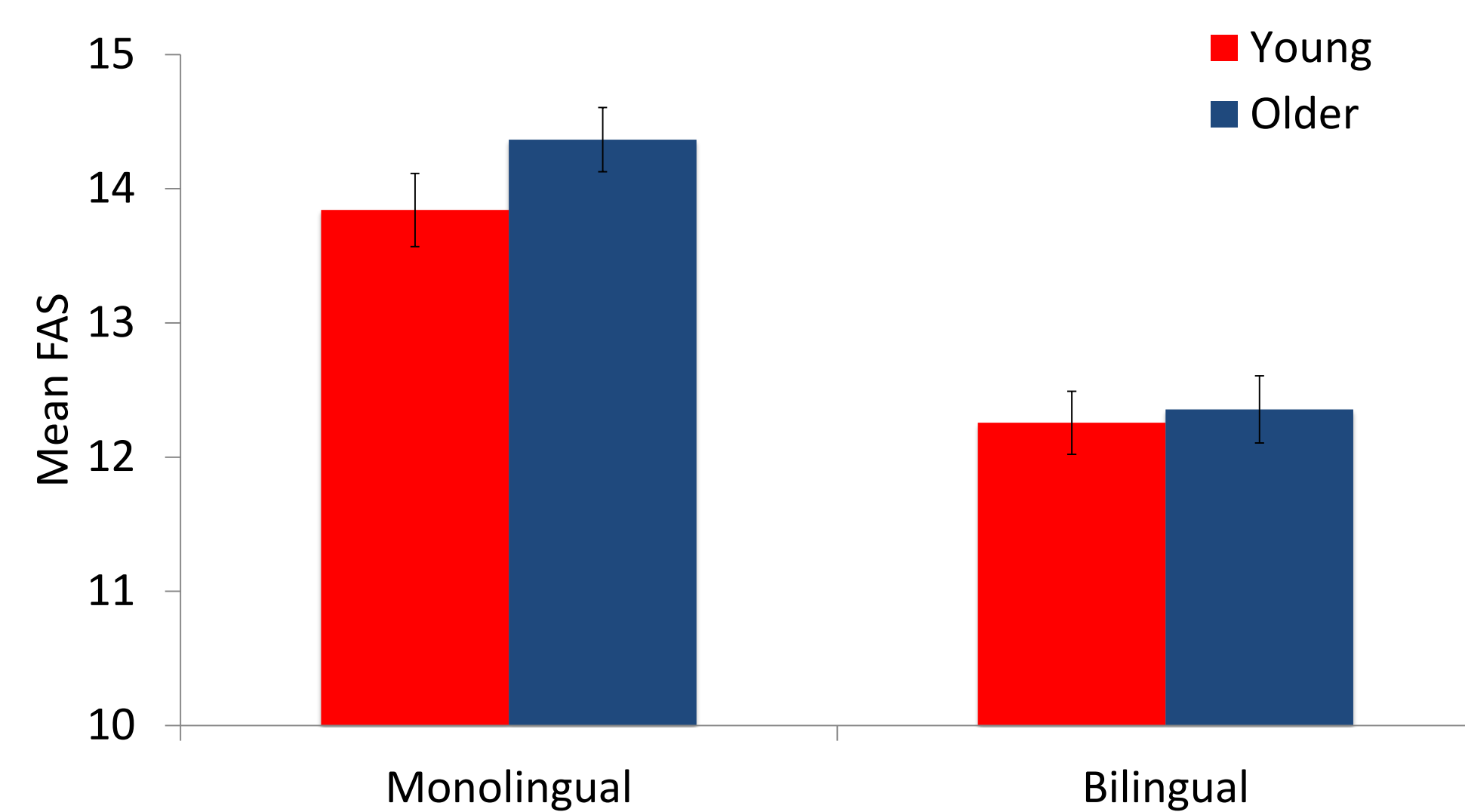


Figure 1. FAS fluency by language group and age

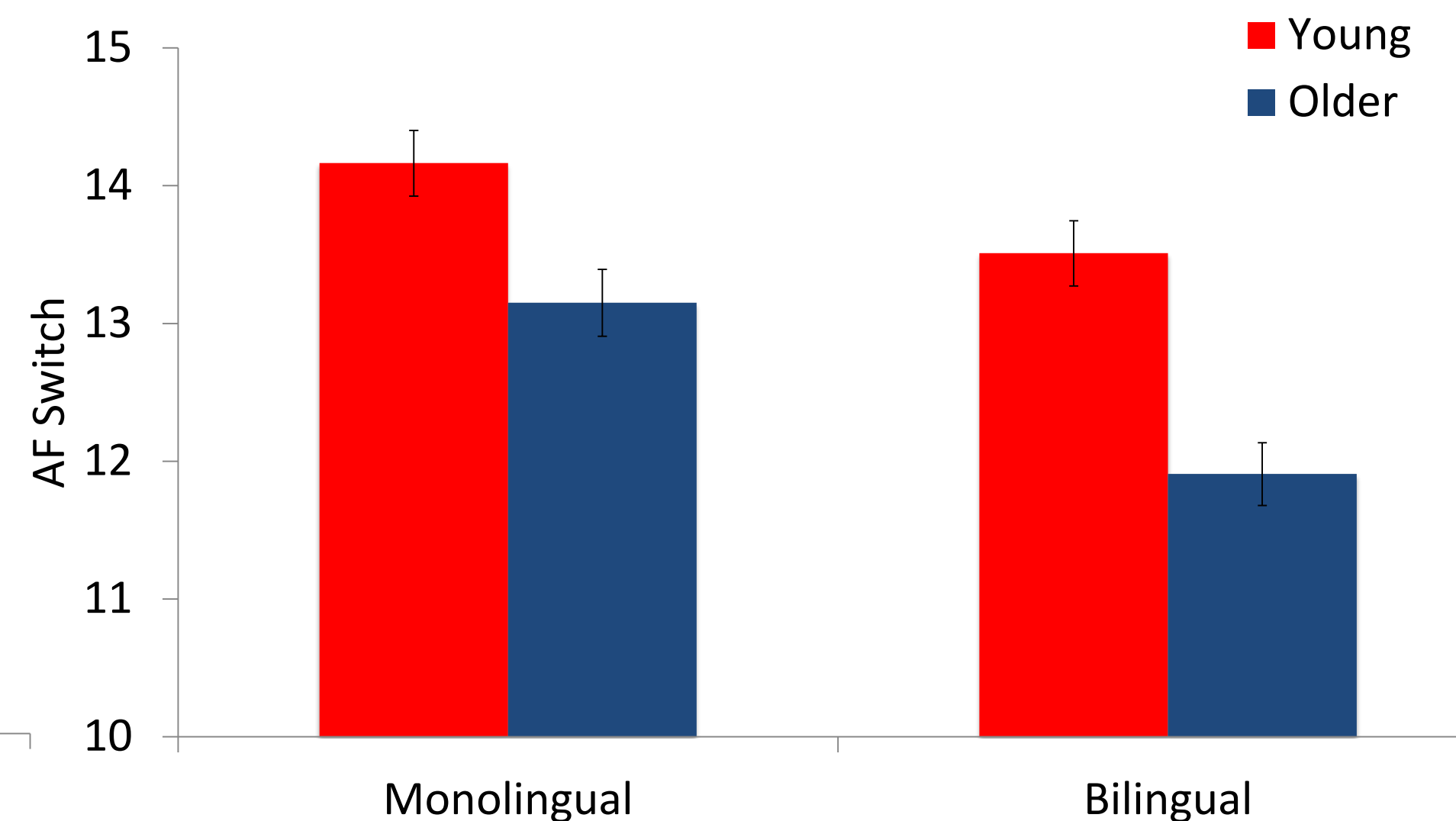


Figure 2. A-F switch fluency by language group and age

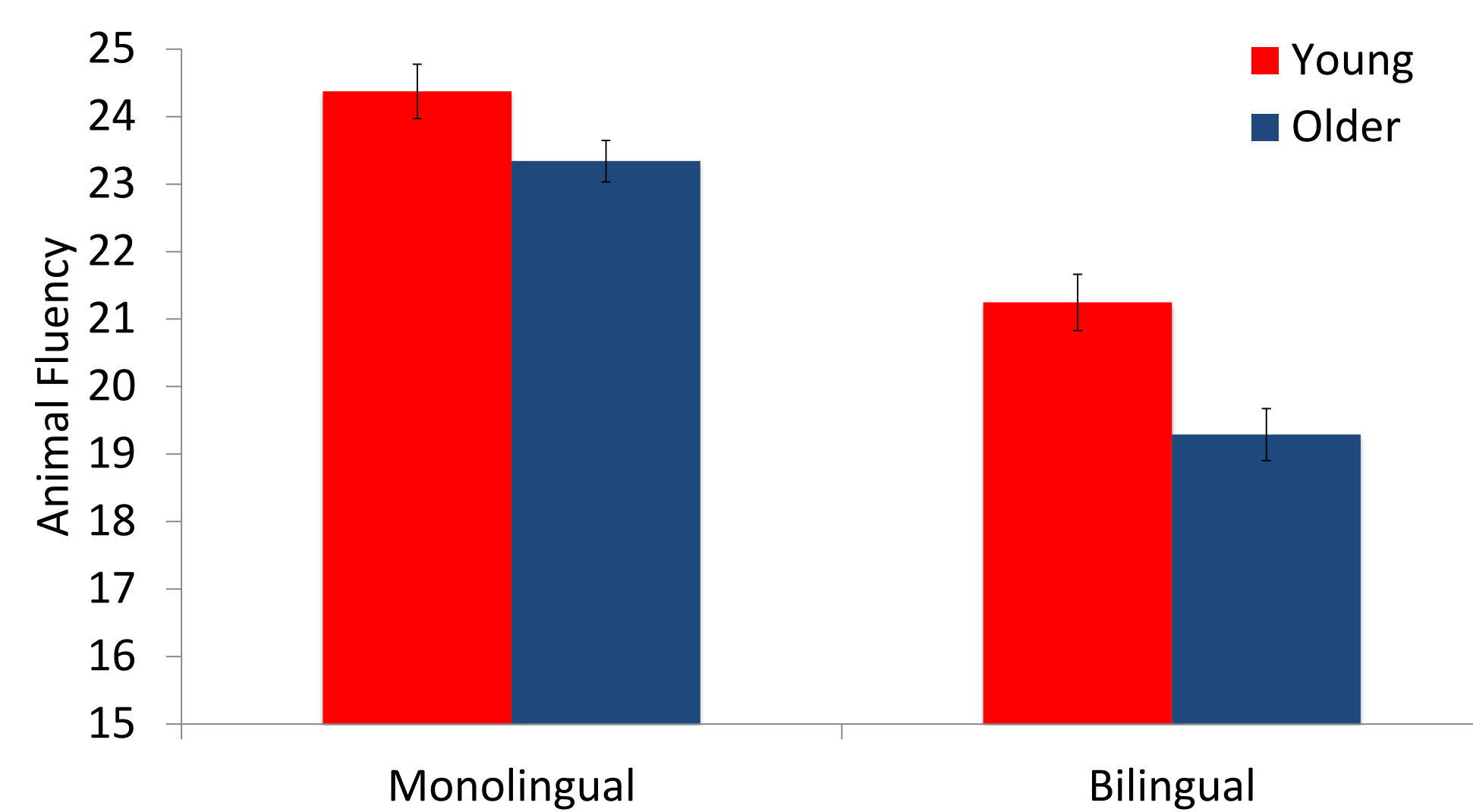


Figure 3. Animal fluency by language group and age

Error bars are standard error

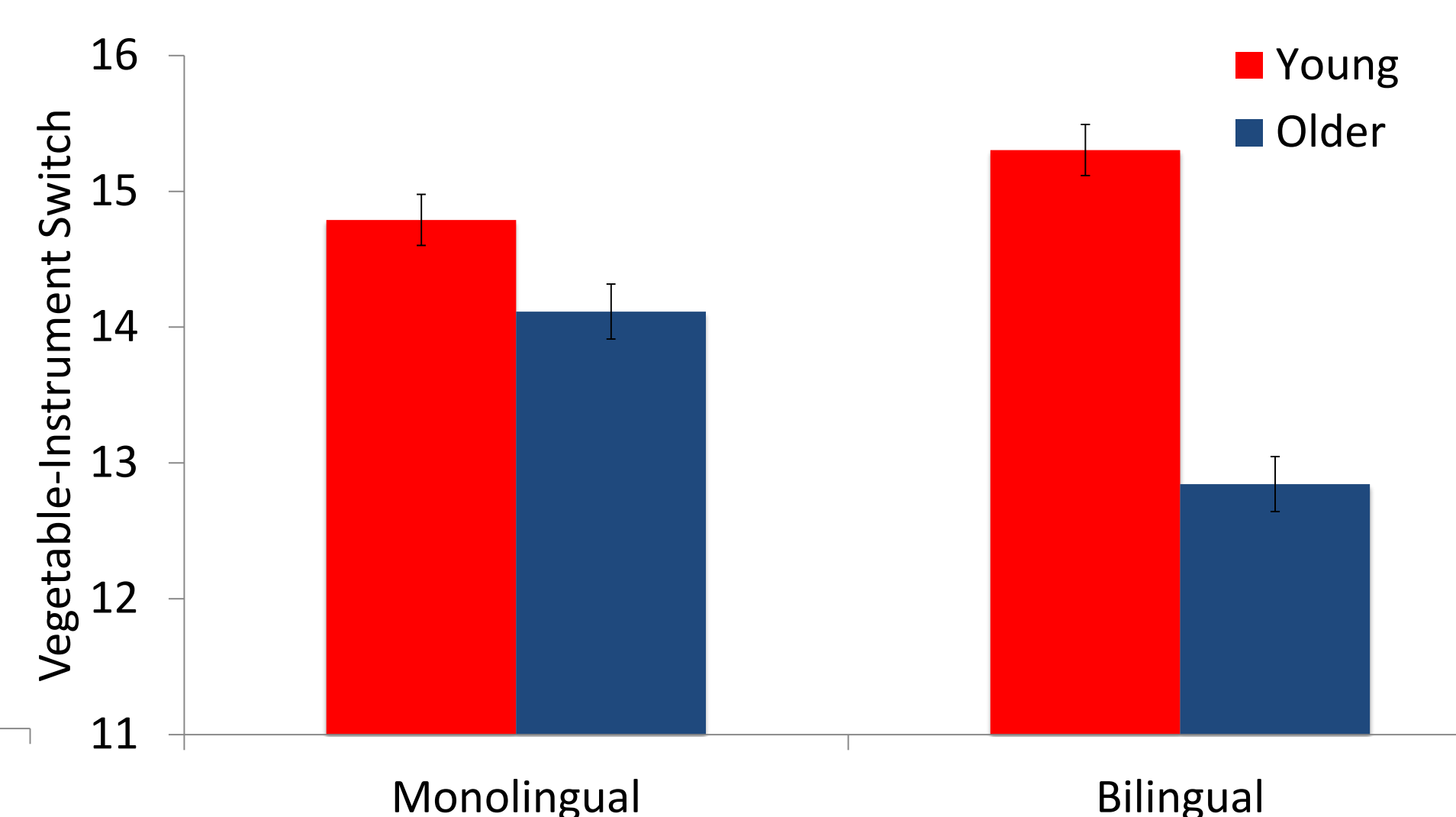


Figure 4. Vegetable-Instrument switch fluency by language group and age

- Monolinguals outperformed bilinguals on most tasks of lexical access (shown in blue).
  - BNT ( $F_{(1,220)} = 73.35, p < .001$ ), letter fluency ( $F_{(1,220)} = 12.78, p < .001$ ), and switching letter fluency ( $F_{(1,212)} = 3.94, p < .048$ ) showed a main effect of language group
  - Switching category fluency showed a significant interaction between age and language group ( $F_{(1,218)} = 4.96, p < .027$ ).
- Bilinguals outperformed monolinguals on two tasks of executive function and had more years of education (shown in yellow).
  - WCST ( $F_{(1,218)} = 4.43, p < .037$ ), WN – INC showed a significant interaction between age and language group ( $F_{(1,217)} = 5.03, p < .026$ ).
  - Education showed an interaction effect ( $F_{(1,220)} = 5.06, p < .025$ ).

- Bilinguals did not show superior performance on switching tasks compared to non-switching tasks, nor did they show improved performance on letter fluency tasks compared to semantic fluency tasks.
- Young adults performed as well as or better than older adults on all neuropsychological tasks.

## Discussion

- The results of the executive function tasks warrant further research to verify the presence of the bilingual advantage. The WCST suggest an advantage, but the results of the Stroop interference data are mixed.
- These data indicate that monolinguals show superior performance on all tasks of verbal fluency regardless of the level of cognitive control required, raising questions about the robustness and pervasiveness of the bilingual advantage.
- In previous studies socio-demographic variables give rise to multiple confounds. The current investigation controlled for immigration status, languages spoken, and cultural effects.
- Our older bilingual sample displayed no evidence of a greater executive advantage than young bilinguals.
- Due to the prevalence of verbal fluency tasks in neuropsychological assessment of Alzheimer's disease, new norms must be established for older bilingual populations. New performance standards will reduce the number of false positive diagnoses.

**References:** [1] Bialystok, E., Craik, F. I. M., & Luk, G. (2008). Cognitive control and lexical access in younger and older bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 34, 859-873. [2] Bialystok, E., Craik, F. I. M., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging and cognitive control: Evidence from the Simon task. *Psychology and Aging*, 19, 290-303. [3] Kousaie, S., Sheppard, C., Lemieux, M., Monetta, L., & Taler, V. (2014). Executive function and bilingualism in young and older adults. *Frontiers in Behavioural Neuroscience*, 8, 1-12. [4] Luo, L., Gigi, L., & Bialystok, E., (2010). Effect of language proficiency and executive control on verbal fluency performance in bilinguals. *Cognition*, 114, 29-41. [5] Bryan, J., Luszcz, M. A., & Crawford, J. R. (1997). Verbal Knowledge and speed of information processing as mediators of age differences in verbal fluency performance among older adults. *Psychology and Aging*, 12, 471-478.