

Appendix: Evidence for a bilingual advantage in other inhibitory control and cognitive flexibility tasks in childhood

<u>Study</u>	<u>Participants*</u>	<u>Relevant tasks</u>	<u>Dependent variables</u>	<u>Bilingual advantage?</u>
Bialystok (1999)	60 (30 bilingual) 3- to 6-year-olds	Moving word ¹	Mean score for inconsistent trials	YES <i>Indicates accuracy advantage on conflict trials</i>
Bialystok (2010)	Study 1 51 (26 bilingual) 6-year-olds	Study 1 A. Trail making ² B. Global-local ³	Study 1 A. Time required to complete Trail A; Time required to complete Trail B B. Error rate for neutral, congruent and incongruent trials; RT for neutral, congruent and incongruent trials	Study 1 A. YES, YES B. YES, YES, YES (for global trials only); YES, YES, YES (for both global and local trials)
	Study 2 50 (25 bilingual) 5.8-year-olds	Study 2 A. Trail making B. Global-local (fewer trials, and control classification condition where only one dimension)	Study 2 A. Time required to complete Trail A; Time required to complete Trail B B. Error rate for control condition, RT for control condition; Error rate for neutral, congruent and incongruent trials; RT for neutral, congruent and incongruent trials	Study 2 A. YES, YES B. NO, NO; NO, NO, NO (for both global and local trials), YES, YES, YES (for both global and local trials) <i>Indicates overall advantage in the time taken to complete trail making and global local tasks</i>
Bialystok (2011a)	63 (31 bilingual) 8-year-olds	Complex classification ⁴	Accuracy for single modality trials, RT for single modality trials; Accuracy for matched and mismatched dual modality trials, RT for matched and mismatched dual modality trials;	NO, NO (for both visual and auditory trials); YES, YES (stronger for visual trials) NO, NO (for both visual and auditory trials);

			Passing the dual modality task (60% performance threshold)	YES (for visual trials only) <i>Indicates overall accuracy advantage in more difficult dual modality trials of complex classification task</i>
Bialystok et al (2010)	162 (56 bilingual) 2- to 5-year-olds	A. Luria hand-tapping task ⁵ B. Opposite worlds task ⁶ C. Reverse categorisation ⁷	A. Number of correct responses B. Errors in same-world and opposite world; Increase in errors for opposite world (i.e. Conflict error) C. Pass/fail based on mean post-switch score	A. YES B. YES, YES; YES C. YES <i>Indicates switching accuracy advantage in Reverse categorisation and opposite worlds tasks, accuracy advantage in Luria-hand tap</i>
Bialystok & Martin (2004)	Study 1 67 (31 bilingual) 5-year-olds	Study 1 Reverse categorisation	Study 1 Mean post-switch scores (of 10 cards), pass/fail post switch	Study 1 NO, NO <i>Indicates no advantage in switching accuracy</i>
Bialystok & Shapero (2005)	Study 1 48 (24 bilingual) 6-year-olds Study 2 53 (26 bilingual) 5 ½ -year-olds	Study 1 A. Embedded figures ⁸ B. Ambiguous figures ⁹ Study 2 A. Embedded figures B. Opposite worlds C. Ambiguous figures	Study 1 A. Number of figures identified B. Score based on number of hints needed to switch percept Study 2 A. Number of figures identified B. Conflict error, Conflict RT C. Score based on number of hints needed to switch percept	Study 1 A. NO B. YES Study 2 A. NO B. NO, YES C. YES <i>Indicates no advantage for embedded figures, advantage for switching RT in opposite worlds task and ease in ambiguous figures task</i>
Bonifacci et al (2011)	36 (18 bilingual) 6- to 12-year-olds	Go / no-go ¹⁰	Errors and omissions for Go and No-Go trials; RT for Go and No-go trials	NO, NO; NO, NO

				<i>Indicates no advantage in Go/no-go task (although a cognitive anticipation task showed bilingual advantage)</i>
Carlson & Meltzoff (2008)	50 (12 bilingual, 21 immersion) 5- to 7-year-olds	A. Simon Says ¹¹ B. KRISP ¹² C. Delay of gratification ¹³ D. Statue ¹⁴ E. Gift delay ¹⁵	A. Score for the level of inhibition achieved on no-go trials. B. Accuracy C. Latency of delay D. Number of movements E. Score according to level of restraint shown F. Composite executive function score combining inhibition scores with two working memory tasks	A. NO B. NO C. NO D. NO E. NO F. YES (relative to both immersion and monolingual)
				<i>Indicates no advantage inhibition tasks (though advantage in two working memory tasks and overall executive function score is reported)</i>
de Abreu et al (2012)	80 (40 bilingual) 8-year-olds	Sky search ¹⁶	Score derived from speed and accuracy	YES
				<i>Indicates advantage in Sky search task which involves need to ignore distracters</i>
Duñabeitia et al (2014)	504 (252 bilingual) 8- to 13-year-olds	Colour word stroop ¹⁷ Numerical stroop ¹⁸	Error rates in congruent, incongruent and neutral trials; RT in congruent, incongruent and neutral trials	NO, NO, NO; NO, NO, NO
				<i>Indicates no advantage for either colour word or numerical Stroop tasks</i>
Iluz-Cohen & Armon-Lotem (2013)	43 (14 balanced, 11 L1, 8 L2 dominant bilinguals and 10 low language proficiency bilinguals) 4- to 6-year-olds	Embedded figures	Number of embedded figures identified	YES (for high proficiency bilinguals relative to low proficiency bilinguals)
				<i>Indicates advantage in embedded figures task</i>
Martin-Rhee & Bialystok (2008)	Study 2 41 (21 bilingual) 4-year-olds	Study 2 Day/night stroop ¹⁹	Study 2 Accuracy score	Study 2 NO

	Study 3 32 (13 bilingual) 8-year-olds	Study 3 Univalent and bivalent arrows task ²⁰	Study 3 Overall Error and RT; Conflict RT	Study 3 NO, YES; NO <i>Indicates overall RT advantage arrows task (similar to Simon task)</i>
Nicolay & Poncelet (2013)	106 (53 immersion) 8-year-olds	A. Mental flexibility ²¹ B. Go/no-go	A. Errors and RT B. Errors and RT	A. NO, YES B. NO, NO <i>Indicates no advantage go/no-go task, advantage in the mental flexibility RT</i>
Poulin-Dubois et al (2011)	63 (33 bilingual) 2-year-olds	A. Multilocation ²² B. Shape Stroop ²³ C. Snack Delay ²⁴ D. Reverse Categorization E. Gift Delay	A. Number of trials needed to look in correct location first post-switch B. Accuracy C. Number of trials snack successfully delayed, Average latency D. Score out of 6 for pre- and post- switch trials E. Latency	A. NO B. YES C. NO, NO D. NO E. NO <i>Indicates accuracy advantage in shape Stroop only</i>
Wimmer & Marx (2014)	141 (70 bilingual) 3- to 5-year-olds	Ambiguous figures	Score based on ability to identify alternative features	YES

* Numbers are given for dual language groups; remaining numbers are monolingual

1 Moving word: Children are asked what a word card says when paired with a picture of the object (consistent trial) and a picture of a different object (inconsistent trial).

2 Trail making: Numbers/letters are distributed across a page. In Trail A, children need to draw a line to connect the numbers 1-25 in order. In Trail B children need to alternate between letters and numbers connecting 1-12 and A-L in order (1-A-2-B-3-C etc.).

3 Global local: Children are asked to respond to stimuli that have global and local dimensions (for example, a large circle (global dimension) formed by several small squares (local dimension)). The dimension to respond to (global or local) is identified at the start of a block. Blocks have a mix of trial types. In congruent trials global and local dimensions of stimuli match (e.g. a large circle formed by several smaller circles), in incongruent trials they mismatch (e.g. a large circle formed by several smaller squares), in neutral trials the non target dimension is irrelevant to the response set (e.g. in a global block, a large circle formed by several letter Xs).

4 Complex classification: Children are asked to classify visual and auditory stimuli into one of two categories (for example, animal or musical instrument), in single modality blocks only visual or auditory stimuli is presented. In dual modality blocks visual and auditory stimuli are presented simultaneously and the child instructed to respond to one modality only; individual items within this block may be matched (auditory and visual stimuli from same category) or mismatched (auditory and visual stimuli from different categories).

5 Luria hand-tapping: A reverse imitation game where children are asked to perform the 'opposite' action to the experimenter (e.g. If I tap once, you tap twice and vice versa)

- 6 Opposite worlds: In the same-world condition, children are asked to follow a path in a picture, naming each animal they encounter. In the opposite-world condition, an event then makes that world 'topsy turvy'. Children are encouraged to embrace this and call the animals by the wrong name (e.g. a sheep might become a pig).
- 7 Reverse categorisation task: Children sort objects according to one rule (e.g. put small blocks in a small bucket and large blocks in a large bucket) then are asked to switch the rule (e.g. put large blocks in small bucket and vice versa)
- 8 Embedded figure: Children are asked to find an embedded figure (e.g. mouse) in several scenes which increase in difficulty according to the level of distracting information included
- 9 Ambiguous figures: Children are shown ambiguous figures with two possible interpretations (e.g. rabbit/duck) and asked to indicate when their perception switches
- 10 Go/no go: Children learn a response rule (e.g. press the H key for hand pictures and the F key for foot pictures). On Go/No go trials they are instructed not to respond on trials with certain characteristics (e.g. images presented with a sound)
- 11 Simon Says: Following a traditional childhood game, children are told to imitate the actions of the experimenter only when introduced with the words 'Simon says'
- 12 KRISP: Children are required to identify which of an array of pictures matches a model picture, since the differences are very slight, inhibition is required to take time in making the response
- 13 Delay of gratification: Children indicate their preference for a large reward over a small reward, delivery of their preference (the large reward) depends on a delay. Children can signal if they want to end the delay, but in that case will only receive the smaller reward.
- 14 Statue: Children are asked to stay still (like a statue) with eyes closed holding a flag. The experimenter makes a series of distracting movements and vocalisations, and the child's movements are recorded.
- 15 Gift delay: The child is told that they will be given a gift, but are asked not to peek at it and/or unwrap it until the experimenter returns.
- 16 Sky search: Children are asked to identify as quickly as possible a number of stimuli which match the model from a large array of distracters
- 17 Colour word stroop: Children were asked to read differently coloured words aloud, some were colour words printed in a congruent colour, some colour words printed in an incongruent colour, and some non-colour words
- 18 Numerical stroop: Children were asked to indicate by computer press which of two numbers was in the largest font, in congruent trials the number in the largest font was also the highest number shown, in incongruent trials the number in the largest font was the lowest number, in neutral trials the same number was presented in different sizes
- 19 Day/night stroop: Children are asked to switch prepotent responses, saying 'day' to a card depicting a moon and stars, and 'night' to a card depicting the sun
- 20 Univalent and bivalent arrows task: Like Simon task but replaces coloured squares with arrows, children respond to the direction of the arrow and ignore location
- 21 Mental flexibility: Children are asked to alternate between two response rules (e.g. respond to display by touching button below green dragon or by touching button below blue dragon, green and blue dragon might appear at either side of screen)
- 22 Multilocation: A child repeatedly finds a reward at one location, the hiding location is then changed and the child invited to search after a delay
- 23 Shape Stroop: Children are asked to identify a target item (e.g. a small apple) embedded in a larger picture of the same category (e.g. a large banana), in the context of distracter items including a large version of the target in which a smaller picture of the same category is embedded (e.g. a small orange embedded in a large apple).
- 24 Snack Delay: Children were asked to delay eating a snack until a bell rang