Bilingualism and Cognition

Virginia Valian, Hunter College and CUNY Graduate Center

Appendix 1

Descriptions of and Links to Tasks Used in Executive Function Experiments

(For all demonstrations at millisecond.com, a download is required. To stop a demonstration in Windows before completing the task, access 'start task manager' with Control-Alt-Del, highlight 'Inquisit Runtime Window', and select 'end task'. Some tasks appear to continue *ad infinitum* unless they are manually halted.)

1. In *anti-saccade* tasks, the participant focuses on a center stimulus. Another stimulus is then presented in the periphery of the participant's vision. The natural and reflexive response is to look in the direction of that stimulus, to make a pro-saccade response. The participant must inhibit the pro-saccade response and instead look in the opposite direction, or make an anti-saccade. For one version of an anti-saccade task, see <https://www.youtube.com/watch?v=G6hMvZhJflM>; start at 3:27.
2. In verbal *Stroop* tasks, participants typically see color words that are written in ink that either matches or does not match the color word. The participant is asked to name the ink color rather than say the word. If a participant sees the word *red* printed in blue ink, for example, her task is to say "blue". For one version of a Stroop task, see <http://www.onlinestrooptest.com/stroop_effect_test.php>).

In numerical Stroop tasks, participants may see two numbers that differ in image size. The numeral itself can correspond or not with the size. For example, participants see a small 8 and a large 2. They must ignore the numeral and judge the 2 as larger than the 8.

1. In *stop-signal* tasks, the participant performs one of two actions, depending on the stimulus, but must occasionally suppress performance when given a cue. All three tasks have been used in experiments comparing mono- and bilinguals and all seem to involve (at least) inhibition of a prepotent response, whether that response is to look in the direction of the peripheral stimulus, to read a word rather than name the color the word is displayed in, or to continue responding when shown a stimulus. For one version of a stop-signal task, see <http://www.cambridgecognition.com/tests/stop-signal-task-sst>. Use the right and left arrows on the number pad.
2. In one version of the *letter memory task*, the participant must remember the last three letters that she has heard. As a new letter comes in, the oldest of the three letters must be dropped. The participant sees a stream of items and, for each item, clicks on it if that item was presented two items ago. *N-back* tasks are a more general term. For a version of the n-back task, see <http://cognitivefun.net/test/4>.
3. In the letter-shape task, participants must shift, when cued, from categorizing items as colors to categorizing them as shapes, and vice versa. In some versions, participants can be asked either to do a block of trials of one sort followed by a block of trials of another sort, or they can be asked to do one task or the other depending on a cue they see that informs them as to what dimension to attend to. In the latter condition, participants are frequently shifting their task-set representations, switching as required between responding to colors and responding to shapes. For a version of the color/shape task, see <http://www.millisecond.com/download/library/ColorShapeTask/>.

In another version, participants see either solid colored squares (red or green) or one of two figures (the outline of a circle or the outline of a triangle) for some blocks, and see figures superimposed on colored squares for other blocks. Other forms of task switching have other dimensions, such as judging numbers either on the basis of whether they are odd or even or on the basis of whether they are greater or smaller than 5. Although all versions of the task involve shifting, they also require updating and inhibition. Each task has its own specific requirements. For example, people might do well with color and shapes but badly with numbers.

1. In *Simon tasks*, the participant must inhibit the prepotent response of pressing a key that is spatially congruent with the stimulus. Switching is also involved: depending on the color of the rectangle, the participant may have to switch the finger that is being used. Perceptual switching is involved, because a stimulus can appear in at least two locations, and if a center presentation is included, three locations. Trials can switch from being congruent to incongruent. And several of those switches can occur simultaneously. Superior performance on this task involves a range of processes. The Simon task is one of the easier tasks that tap executive function. In many laboratories, reaction times for young adults (18-22 year-olds) average between 375 and 500 msec. Differences between congruent and incongruent trials range from around 15 to 40 msec. For a version of the Simon task, based on the original task by Simon and Wolf, 1963, and on Bialystok, Craik, Klein, & Viswanathan, 2004, see <http://www.millisecond.com/download/library/SimonTask/>
2. In a *flanker task*, the distinctive arrow (either the central arrow or a differently colored arrow) is flanked either by other arrows pointing in the same direction (congruent, or no-conflict, trials) or other arrows pointing in the opposite direction (incongruent, or conflict, trials). Although arrows are commonly used, they may take various forms; with children, fish seen from the side may be used instead of arrows. In versions that use a distinctive color, the placement of the arrow to be attended to may change from trial to trial, being sometimes in the center, sometimes just to the left of the central arrow, and sometimes just to the right of the central arrow. The participant's task is to press a key on the right side of the keyboard if the arrow is pointing right and a key on the left side of the keyboard if the arrow is pointing left. (There are also, however, versions in which the participant must press a key on the opposite side of the direction that the arrow is pointing in.)

The flanker task can be made more complicated by including a go/no-go component. When the arrow is flanked by forms of one shape, the participant's task is to press the key corresponding to the direction of the arrow. When the arrow is flanked by forms of a different shape, the participant's task is not to press any key. The go/no-go portion of the task involves inhibition of the tendency to respond, and minor switching depending on the direction of the arrow. The task can be made more complicated still by mixing go/no-go trials with "normal" trials; in that mixed condition, participants have to shift task representations. The flanker task, not surprisingly, is more difficult than the Simon task. Reaction times for young adults range from about 400 to 600 msec, and the cost of incongruency, depending on how it is measured, ranges from about 60-90 msec. For a version of the flanker task, using arrows, see <http://www.millisecond.com/download/library/FlankerTask/ArrowFlankerTest/>

1. In the *ANT*, the alerting cue, if present after display of the fixation cross, indicates that a trial is about to begin; the orienting cue, if present, indicates whether the items to be evaluated are above or below the fixation point. The items are flanker-type items – an item pointing in one direction flanked by congruent (no-conflict) or incongruent (conflict) items. For a version of the ANT, using arrows, see <http://www.millisecond.com/download/library/ANT/>
2. Other tasks include the Color Trails Test. In part 1, participants connect a series of ascending numbers, all of which are in a single color. In part 2, the numbers alternate colors. In the *Letter-Number Sequencing* subtest of the WAIS-III, participants connect a series of numbered and lettered dots displayed on a piece of paper with a pencil. Participants start with the number 1, go to the letter A, the number 2, the letter B, and so on. In one version of the *odd-man [sic]-out test*, participants see three lights and must choose the one that is further away from the others. There are many versions of this test. In the *Wisconsin Card Sorting Task*, participants sort cards, determining the relevant dimension by feedback; that dimension is then switched without warning; how long it takes participants to determine the new dimension is measured. The *Matrix Reasoning Test* can be a version of the Raven's Matrices Test. Many of these tasks were used by Siedlecki, Stern, Reuben, Sacco, Elkind, and Wright (2009). Another set of tasks has been used in studies with children, including one set used by Poulin-Dubois, Blaye, Coutya, and Bialystok (2011), and a different set used by Bialystok, Barac, Blaye, and Poulin-Dubois (2010).

Appendix 2

Details of Selected Experiments Cited in the Text

*Antón, Duñabeitia, Estévez, Hernández, Castillo, Fuentes, ..., and Carreiras 2014*. The study compared 360 children who were bilingual in Spanish and Basque or were monolingual in Spanish on the ANT. The bilingual children were recruited from schools in the Basque Country; the children were in the 2nd and 3rd grades (grouped together), 4th and 5th grades (grouped together), and 6th and 7th grades (grouped together). The bilingual children's Spanish was learned earlier than their Basque and, in their parents' judgment, was more fluent than their Basque. The bilingual children were enrolled in bilingual schools where Spanish and Basque were equally the language of instruction. The monolingual children were recruited from monolingual Spanish schools in monolingual Spanish areas. The children in the bi- and monolingual groups did not differ by age, reading and arithmetic skills, IQ, home income, parental education, or parental work status.

Children participated in a computer-assisted ANT task (with fish instead of arrows), one in which there was an added level of difficulty: an invalid cue was added to the other cue types. There were 10 different conditions, representing different cue types and incongruent vs congruent trials, and a total of 288 trials. Participants pressed a key on the keyboard for their response. The usual negative effect of the incongruent condition was observed, and it was strongest for the youngest children. There were no differences between mono- and bilinguals in the size of the orienting effect (how long it took children to orient to a cue), the size of the alerting effect, the size of the validity effect (whether the cue was valid), or – most important for present purposes – the size of the incongruency effect. All participants showed a cost of incongruency, but language group played no role (Antón et al, 2014).

*Duñabeitia, Hernández, Antón, Macizo, Estévez, Fuentes, and Carreiras, 2014*. The study compared 504 monolingual Spanish and bilingual Spanish-Basque children in the 3rd to 8th grade on a verbal (Spanish) and a non-verbal Stroop task . As in Antón et al (2014), a large range of variables was controlled for. For both Stroop tasks, there was a cost associated with the incongruent stimuli, but there were no differences between monolingual and bilingual children on either, nor did the two tasks correlate. The distribution of reaction times was similar for mono- and bilingual children; overall reaction times and error rates were similar. Regression analyses showed no influence of language, teachers' judgments of children's reading, arithmetic, or attention skills, or IQ scores.

*Gathercole, Thomas, Kennedy, Prys, Young, Viñas Guasch, ..., and Jones, 2014*. The study recruited children, teenagers, young adults, and older adults from Wales and from England. The bilingual children came from Welsh homes where only Welsh was spoken, both Welsh and English were spoken, or only English was spoken. Individuals from homes where only Welsh or only English was spoken were effectively sequential bilinguals, not acquiring the other language until going to school, in contrast to those from homes where both languages were spoken. The monolingual English-speaking participants came from an area of England bordering on Wales. A total of 650 participants (divided into 28 age X language background groups) completed a card-sorting task where the dimension changed under instruction, and a total of a 557 completed a Simon task. Tasks were modified somewhat for the preschool aged children.

Overall, there were almost no differences as a function of language group in either accuracy scores or reaction times; there were also almost no differences favoring bilinguals within any age group, including older adults, and a few favoring monolinguals. Individuals who came from homes where both Welsh and English were spoken did not fare better than any other language group with respect to executive function.

*Poulin-Dubois, Blaye, Coutya, and Bialystok, 2011*. A total of 63 children, 33 of whom were bilingual, participated in five tasks measuring executive function. The first task was a switch task, where the experimenter first hid a treat in one location and, after the child had mastered the location, hid it in a different location, telling the child where it was. The second task was a version of the Stroop task, using small and large cutouts of fruits. A small fruit was placed on a different large fruit and the child was asked to point to the small fruit. The third task was a different type of switch task: children first placed large cubes in a large bucket and small cubes in a small bucket, and were then asked to reverse the placement and put the large cubes in the small bucket and the small cubes in the large bucket. The fourth task was a delay task in which the child was asked to wait until she heard a bell before eating a small cereal treat. The fifth task was another delay task in which children were shown an attractive gift bag and asked to wait (3 min) while the experimenter went to get a bow for the bag. Only on the shape Stroop task did bilinguals show better performance, with a higher proportion of correct trials compared to monolinguals (.50 vs .33).

*Bialystok, Barac, Blaye, and Poulin-Dubois, 2010*. A study with 162 children in two groups, one aged 3 and the other 4½ used a battery of four executive function tasks. The children were monolingual in either English (n=69) or French (n=37) or bilingual in English and another language (n=56) that was often but not always French. The tasks included a tapping task, in which the child had to tap twice if the experimenter tapped once, and tap once if the experimenter tapped twice; an opposite worlds task in which children first named cows and pigs and then had to reverse the naming (e.g., call a pig a cow); an ANT task, using fish instead of arrows; and a reverse categorization task similar to the buckets task, in which children had baby and mommy versions of animals rather than small and large cubes. Unfortunately, the Stroop was not included.

Bilingual children performed better than monolinguals on the tapping task, the opposite worlds task, and the reverse categorization task (scored in terms of number of children who failed or passed rather than in terms of proportion of correct choices), but not on the ANT. Bialystok et al (2010) interpret the tapping task as an inhibition task, and one that younger rather than older children are likely to show differences on. The task is not, however, as pure a test of inhibition as straight delay tasks, on which the younger mono- and bilinguals in the experiment reported by Poulin-Dubois et al (2011) did not differ. There are likely other task requirements of the tapping task and the other two tasks that showed a benefit for bilinguals that are at least as important as the requirement to inhibit a prepotent response. Bialystok et al (2010) report that the executive function tasks intercorrelated significantly, but they do not provide specific correlation values and warn against putting too much weight on the correlations.

*Poarch and van Hell, 2012*. For children, ranging in age from 5 to 8, there are benefits of trilingualism on the Simon task and benefits of both bi- and trilingualism on the ANT. Serving as participants were German-speaking monolinguals, German speakers who were learning English as a second language in school (second language learners), bilingual German-English-speaking children, and trilinguals for whom either German or English was a native language along with a different language, and who were learning German or English or both in school. On the Simon task, trilinguals were advantaged compared to monolinguals and there was a strong trend for a benefit for bilinguals compared to monolinguals. Bi- and trilinguals did not differ, nor did any other pairs.

The same children, minus the monolinguals, participated in the ANT six to eight months after the Simon task (Poarch & van Hell, 2012). The bi- and trilinguals did not differ from each other and each showed a smaller cost of incongruency than did the second language learners. Some effects on the alerting and orienting components of the ANT were also found, and those effects differed from some prior results with adults. In both the Simon and the ANT, children's language status did not affect their overall reaction times, even though some experiments have shown overall faster responding by bilinguals. In both the Simon and the ANT, the bi- and trilinguals did not differ, suggesting that whatever benefit accrues to children in being bilingual is not intensified by being trilingual.

*Calvo and Bialystok, 2014*. Children from eight public schools were divided into groups based on questionnaire data on SES and on language status. All children spoke English at school; bilinguals also spoke another language at home. Children were placed into one of four groups: working-class monolingual (n=20) or bilingual (n=44), and middle-class monolingual (n=46) or bilingual (n=65). Children performed a number of tasks, including a test of working memory and a flanker task. On the test of working memory, there were independent benefits of being bilingual or being middle-class.

Children performed three conditions of the flanker task (Calvo & Bialystok, 2014). In the control condition there was a single red chevron. In the search condition the red chevron was placed either in the center of the screen or to the left or the right of the center and flanked by black diamonds. In the conflict condition the flankers were black chevrons that pointed in the same direction or the opposite direction. Children saw two control blocks, two search blocks, and one conflict block. The conflict block was the middle of the five blocks. Data for a conflict effect (incongruent minus congruent scores) are not reported for the conflict block.

Bilingual children were significantly more accurate than monolinguals on all conditions of the flanker task; middle-class children showed a strong tendency to be more accurate than working-class children. Since bilinguals were more accurate than monolinguals on all three conditions, that might suggest that their superior performance overall on the conflict condition reflects greater accuracy in general, rather than better executive function. There were no benefits for reaction time of bilingualism or higher socioeconomic status. Although the results suggest independence between language status and socioeconomic status, they are somewhat equivocal with respect to the benefits of either for performance on the flanker task.

*Bialystok, Craik, and Luk, 2008*. Young adults averaging age 20 and older adults averaging age 67 participated on three tasks. The first task was a modification of the Simon task, in which rectangles with replaced with arrows. In the first condition, the arrows were presented in the center of the screen and participants had to press a key in the same direction that the arrow pointed. In the second condition, the arrow again appeared in the center of the screen, but now participants had to press a key in the reverse direction that the arrow pointed. The requirement to reverse responses from the first block to the second is similar to other shifting tasks where a change of task representation is required. It also involves inhibition of a prepotent response. As expected, reaction times were longer in the reverse condition than in the control condition. But mono- and bilinguals were equivalent, though there was a tendency for the old bilinguals to show an advantage.

In the third condition of the Simon task, arrows appeared on the left or right side of the screen and participants had to press a key corresponding to the direction that the arrow was pointing, regardless of which side of the screen the arrow appeared on. This condition was thus similar to the classic Simon task and allowed a comparison in performance between congruent and incongruent trials. Here, too, both inhibition and shifting are required, but the mix is different from the preceding contrast. The old bilinguals were advantaged compared to their age peers – in fact, oddly, showed no incongruency effect at all – but the young bilinguals were not. If anything, young bilinguals showed a larger incongruency effect (22 ms) than young monolinguals did (8 ms). Altogether, then, young bilinguals were identical to monolinguals across the board on the Simon, whether in the control condition, the reverse condition, or the classic condition that included both congruent and incongruent trials; older bilinguals were significantly advantaged compared to older monolinguals only in the classic condition.

*Prior and MacWhinney, 2010*. On a color-shape task, bilinguals are advantaged when the condition requires shifting between the two. If trial sets were blocked – only color or shape had to be responded to – monolinguals and bilinguals responded with equivalent reaction times (about 450 msec). In the mixed condition, when both color and shape were included, both monolinguals and bilinguals had longer reaction times than in the blocked condition, and responded equivalently (about 670 msec) on trials that did not require a shift from color to shape (or the reverse; Prior & MacWhinney, 2010), and both were even slower on trials that required switching. Thus, both monolinguals and bilinguals were slowed when they moved from a condition that blocked cues to one that mixed cues. But on trials in mixed-cue blocks that required a shift from color to shapes (or the reverse), monolinguals were slower than bilinguals (876 msec vs 814 msec).

*Craik, Bialystok, and Freedman, 2010*. This analysis of records in Toronto, Canada, found that bilingualism protected against dementia even when controlling for immigration status. The authors examined 211 consecutive records from a two-year period at a memory clinic in Toronto of individuals who were diagnosed as probably having Alzheimers disease. The average age at which families reported initial symptoms was 72.6 for monolinguals and 77.7 for bilinguals. The average age at first appointment was 76.5 for monolinguals and 80.8 for bilinguals. Both differences were significant, and were maintained after controls for covariates were introduced.

The individuals were about evenly divided between mono- (n=109) and bilinguals (n=102). That rate of bilingualism suggests that about 50% of the population of Toronto is bilingual. Craik et al (2010) consider but reject the possibility that bilinguals have a higher threshold of reporting signs of cognitive decline on the grounds that the difference between age of first reported symptom and age of diagnosis is slightly shorter for bilinguals.

*Chertkow, Whitehead, Phillips, Wolfson, Atherton, and Bergman, 2010*. This analysis of records in Montreal, Canada, found that *bi*lingualism is protective only for immigrants. Indeed, nonimmigrant monolinguals showed later decline than nonimmigrant bilinguals. One puzzling finding concerned native language differences: among nonimmigrant monolinguals, those whose native language was English were diagnosed 5.4 years later than those whose native language was French. Benefits of *tetra*lingualism – knowing four or more languages – were found for nonimmigrants.

Among immigrants, the pattern was different. First, being an immigrant resulted in an overall earlier onset of cognitive impairment compared to nonimmigrants who were either monolingual English speakers or multilingual with English as their native language, for all language groups except those with four or more languages. Among the immigrant population, monolinguals showed significantly earlier cognitive decline than bilinguals, trilinguals, or multilinguals. Thus, in this sample, being an immigrant was costly in terms of age of cognitive impairment, compared to nonimmigrants, but that cost was offset for individuals who spoke four or more languages. Because of the large number of variables in this study, and the difference in findings among nonimmigrants and immigrants, it is difficult to arrive at an overall interpretation.

*Bialystok, Craik, Binns, Ossher, and Freedman, 2014*. A study comparing mono- and bilinguals in Toronto, Canada, with respect to both mild cognitive impairment and dementia, confirmed earlier findings that bilinguals presented with dementia at a later age than did monolinguals (in this study, about 7 years later), and also demonstrated a later onset of cognitive decline than monolinguals (about 4 years later). The individuals were tested on nine tasks. Monolinguals and bilinguals performed similarly, both among those with mild cognitive impairment and among those diagnosed with dementia. That equivalence would be expected if indeed the two language groups were at the same cognitive stage when they were being assessed as impaired or demented, even though the bilinguals were older than the monolinguals. Monolinguals performed at a numerically higher level on eight of the tasks, including a number-letter switching task, while performing numerically worse on the Stroop. The number-letter switching task was the only task that showed a significant difference between monolinguals and bilinguals, in this case favoring monolinguals. In contrast, among the demented individuals, monolinguals performed numerically worse than bilinguals on six of the nine tasks, though only the Stroop showed a significant difference.

Curiously, mild cognitive impairment did not necessarily worsen more quickly in monolinguals than bilinguals. Three follow-up tests for individuals with cognitive impairment at 6 mo intervals showed no differences in rate of decline among monolinguals and bilinguals. One might have expected that the enhanced cognitive functioning that gave bilinguals more than 4 years before symptoms arose would continue to show a benefit. How else would they have a 7 year later onset of dementia? Follow-up tests for those demented individuals who were able to perform the tasks also showed no differences in rate of decline between monolinguals and bilinguals. The results overall were clear, however, in showing a benefit of bilingualism, even when controlling for immigration status and other factors.

*Alladi, Bak, Duggirala, Surampudi, Shailaja, Shukla, ..., and Kaul, 2013*. This retrospective study in Hyderabad, India, compared multi- and monolinguals. In Hyderabad, immigration was not an issue, because all individuals had grown up in India, but bilinguals had more years of education than monolinguals. The Indian patients overall tended to receive a diagnosis at an earlier age than the Canadian patients – at age 61.1 for monolinguals and age 65.6 for bilinguals. For the Canadian patients, the ages for diagnosis of dementia ranged from 70.9 to 78.2 (Bialystok et al., 2014). Protective factors such as higher education may account for the Westerners' later age of onset. Methodological differences among the studies may also be responsible: the Indian participants' age of onset was determined by family report. As was the case for most of the previous studies, bilingualism was protective, even when covariates like education were controlled for.

*Crane, Gruhl, Erosheva, Gibbons, McCurry, Rhoads, Nguyen, Arani, Masaki, and White, 2010*. This study examined second generation Japanese-American men in Honolulu. The men were born between 1900 and 1919 and were part of a larger health study. In 1991-1993 the men were assessed via the Cognitive Abilities Screening Instrument (CASI); only the 2520 who were non-demented were part of the study. There were three subsequent assessments. Participants were divided into three analytic groups, based on whether they spoke, read, and wrote Japanese in addition to English. (There were two different ways of performing that classification; both showed similar results). Group 1 (the monolingual group) said they spoke or read no or very little Japanese; Group 2 – 59% of the sample – said they spoke but did not read or write Japanese; Group 3 (the bilingual group) said they both spoke and read Japanese. Group 2 was used as the reference group in a mixed-effects model examining decline over a 10-year period. Neither Group 1 nor Group 3 differed from the reference group in their rate of cognitive decline.

*Zahodne, Schofield, Farrell, Stern, and Manly, 2014*. A community-based prospective study of 1067 Hispanics in New York City found no difference in cognitive decline between Spanish-English bilinguals and Spanish monolinguals ranging in age from 64 to 95. All the participants had been born outside the US. In addition to using self-reports from participants about how well they spoke English, experimenters also assessed English proficiency via an objective test in a subset of 235 participants. Participants were assessed periodically over a period of up to 22 years, averaging 6.5 years. Before covariates were entered, language status predicted onset of dementia, but once covariates were included, language status was not associated with dementia. Age at enrollment in the study, education, and sex of participant were associated: a higher age at enrollment, less education, and being male did predict dementia. For the subset of participants for whom objective English assessment scores were available, proficiency in English in this sample of Spanish-speaking immigrants was also not associated with cognitive decline, although it was associated with better executive function.

*Kavé, Eyal, Shorek, and Cohen-Mansfield, 2008*. This prospective study of a random national sample of Israelis found a dose-related response: the more languages the better. The researchers tested the participants three times over a 12-year period. The 1369 individuals were bi-, tri-, or at least tetralingual and had an average age of 83 in the first wave. Roughly half the sample had been born in Israel, and half were immigrants. All participants spoke at least Hebrew; because of the nature of the Israeli population, all individuals who spoke Hebrew also spoke another language. There were 684 individuals in the second wave and 164 in the third.

Regression analyses conducted at each wave showed that the number of languages individuals spoke were independent predictors of scores on a cognitive screening test at all three waves, and accounted for a significant increase in *R2* after age, gender, country of origin, education, and age of immigration to Israel had been entered as independent variables. The best scores were obtained by individuals speaking four or more languages (similar to Chertkow et al's 2013 findings). Educational level was a strong predictor, but even among individuals with more than 12 years of education, having four or more languages was associated with better cognitive scores than was having three languages, and having three was associated with better cognitive scores than was having two. Thus, education and language status had independent effects.

Kavé et al (2008) note that cognitive factors might have antecedently distinguished those with more languages from those with fewer; life differences could also have forced some individuals to speak multiple languages, and those life experiences, for those who survived them, may have led to increased cognitive capacity. Unfortunately, Kavé et al do not address attrition. The individuals who died between waves might have differed in relevant ways from those who survived. The change in *R2* due to language status increased from wave to wave. (A comparison of Gollan et al (2011) and Kavé et al (2008) might suggest conflicting roles of education, but Gollan et al examined *degree* of bilingualism, while Kavé et al examined number of languages.)

References (see main text)