The "bilingual advantage"

Does learning a second language improve working memory?

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This is an interim report on an ongoing study that investigates whether having a high degree of proficiency in two languages impacts individuals' cognitive abilities, in ways that are relevant to Language and Intelligence Analysts. The study compares Language Analysts with varying degrees of second-language proficiency to native, "balanced" bilinguals - those who use both languages on a regular basis - on measures of working memory, cognitive control, and linguistic ambiguity resolution.

RESEARCH GOALS AND RELEVANCE

This study is designed to achieve the following goals: 1) replicate and extend previous results showing that native bilinguals have superior working memory abilities compared to monolinguals; (2) determine whether this so-called "bilingual advantage" extends to Analyst-relevant tasks involving linguistic ambiguity resolution; 3) determine whether the bilingual advantage extends to Language Analysts who started learning a second language (L2) in adulthood; and 4) determine whether a high degree of second-language proficiency is necessary to produce the advantage, or whether even beginning second-language learners may show some benefit.

Ultimately, the results of this study will help us understand the interplay between the ability to speak two languages with high proficiency and its effect on working memory, which together will help us develop valuable cognitive intervention programs to improve analysts' working memory and job performance. Moreover, if high-proficiency L2 speakers' performance is akin to (or approaches that of) balanced bilinguals' on cognitive, ambiguity resolution, and working memory tasks, then one may begin to infer particulars about the L2 group from the current native-bilingual literature, which shows that speaking two languages fluently bestows a cognitive benefit on a range of everyday measures. Ultimately, the results of this research could argue for wanting a bilingual workforce in the USG and promoting one through various forms of intensive training, and might further place a high value on a bilingual staff (perhaps even a subset of which is a native-bilingual staff) of the future. The results may eventually inform job-selection criteria and training of current government employees (see Discussion).
BACKGROUND AND TERMINOLOGY

What is working memory? Working memory is a cognitive system dedicated to the temporary processing, maintenance, and integration of information during the performance of everyday cognitive tasks such as problem solving, planning, drawing inferences, taking in new information, and understanding language. People naturally vary in their working memory capacity, and it is well-known that limitations in working memory capacity are related to language processing difficulty and misinterpretation in both first and second languages.

What is the bilingual advantage? Previous research has shown that balanced bilinguals—namely, native speakers of two languages who use both languages on a regular basis—are better than monolinguals at certain working memory tasks that require participants to filter out distracting information. However, it is unknown whether late learners of a second language, such as Language Analysts, show a similar advantage. Furthermore, even if so-called “late bilinguals” show an advantage relative to monolinguals, it remains unclear what degree of proficiency in a second language might be required to produce this advantage: would it only manifest in highly advanced learners, or would Language Analysts at lower levels of proficiency also show benefits?

How can working memory be improved? Previous CASL research has shown that repeated practice with computer-based working memory tasks improves participants’ ability to filter out distraction and comprehend complex and ambiguous linguistic input of a kind that Language Analysts often encounter. However, it is possible that learning a second language may itself be a kind of cognitive “training” that results in a working memory advantage, which might extend to a range of common cognitive tasks.

STUDY DESIGN

This study is designed to compare four groups of participants: "high proficiency" L2 Spanish speakers (e.g., Spanish Language Analysts with scores of 3 or higher on the ILR), "low proficiency" Spanish speakers (e.g., Spanish Language Analysts with scores of 2 or lower on the ILR), balanced Spanish-Catalan bilinguals, and monolingual Spanish speakers. Participants complete the following tasks over the course of approximately one hour: a pretest sentence processing task involving complex and ambiguous language materials; a non-linguistic working memory task that engages the same processes involved in language processing difficulty and recovery from misanalysis, and finally, a posttest version of the initial sentence processing task. All tasks are in Spanish.

Predictions

We expect to replicate previous research that has found a bilingual advantage in non-linguistic working memory tasks. We also expect a novel finding: that the bilingual advantage extends to linguistic tasks that rely on shared working memory abilities. Specifically, bilinguals are predicted to show superior performance in the non-linguistic working memory task, but also to be superior to monolinguals in their ability to comprehend ambiguous sentences in the pretest and posttest sentence processing tasks. Finally, their performance on the non-linguistic working memory task is predicted to correlate with their performance on the sentence processing tasks, while this is not predicted for the monolinguals.

STATUS, PRELIMINARY RESULTS, AND NEXT STEPS

We have already gathered and analyzed data for the Spanish monolinguals (51 participants) and the native, balanced Spanish/Catalan bilinguals (59 participants), in collaboration with researchers at the University of Barcelona in Spain (an additional 11 monolinguals and 14 bilinguals were tested but dropped from analyses because they did not meet study requirements or failed to complete the tasks with sufficient accuracy). These data replicate findings that bilinguals exhibit a significant advantage in working memory relative to monolinguals, and newly suggest that this advantage extends to reading comprehension as well. Moreover, we found that short-term practice with a particular version of the working memory task predicted how well
bilinguals, but not monolinguals, were able to recover from comprehension difficulty on the posttest reading task.1

Having established these effects, the next step is to gather data from high- and low-proficiency L2 Spanish speakers (e.g., Language Analysts). Currently, we are searching for the ideal population of high- and low-proficiency L2 Spanish speakers, and we plan to collect and analyze these groups’ data over the course of the coming year. The Spanish monolinguals and balanced bilinguals will be used as "baselines" against which to compare the L2 Spanish groups.

DISCUSSION

Balanced bilinguals have a reliably large working memory advantage relative to monolinguals. High- and low-proficiency L2 learners are predicted to fall somewhere along this spectrum. Where they fall will provide information that will help us design effective cognitive training regimens to improve Language Analyst performance, and may also help inform Language Analyst training and selection. For instance, if the low-proficiency group shows no working memory advantage while the high-proficiency group does, it will underscore the importance of training Language Analysts to a high proficiency level, since working memory abilities impact not only their foreign language abilities but may also improve overall job performance. It will also increase the importance of selecting Language Analysts with a high language learning aptitude, since these Language Analysts may ultimately end up with stronger working memory abilities. If high-proficiency Language Analysts show a working memory advantage that is similar in magnitude to that of balanced bilinguals, it may suggest that they have less to gain from cognitive training. Conversely, if low-proficiency Language Analysts show little or no bilingual advantage, it will suggest that they stand to benefit greatly from cognitive training, and that this training may even aid the language learning process to some extent. If neither group shows a bilingual advantage, it will suggest that learning a language in adulthood does not enhance working memory abilities, and that cognitive training could be beneficial to Language Analysts across the entire range of proficiency levels.

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1 For a slightly more detailed description of the tasks and current findings, please see the scientific abstract in the Appendix, which will be presented as an oral (paper) presentation at this year’s conference on Architectures and Mechanisms for Language Processing (AMLaP), in Paris, France (September, 2011).
Mounting research findings demonstrate that balanced bilinguals enjoy certain cognitive advantages relative to monolinguals. On tasks requiring cognitive control (CC) – the ability to regulate behavior and resolve interference among competing representations – bilinguals frequently outperform monolinguals selectively on trials inducing conflict [1]. Other evidence reflects broader patterns: bilinguals are better at conflict monitoring during goal-directed tasks, performing faster generally under high, but not low, conflict-monitoring conditions [2]. Considering psycholinguistic research emphasizing that domain-general CC enables recovery from temporary misinterpretation [3], we show that bilinguals’ putative CC advantage impacts their syntactic-ambiguity resolution abilities: brief practice on an N-back memory task with high (but not low) conflict-monitoring demands differentially affects garden-path recovery in bilinguals versus monolinguals.

Balanced Spanish-Catalan bilinguals (N=59) and Spanish monolinguals (N=51) completed three tasks in this order: a (Spanish) self-paced, moving-window reading task involving sentences that were temporarily ambiguous between a preferred subject-first or dispreferred object-first cleft interpretation; a 20-minute high- or low-interference version of an N-back task (interference condition was randomly assigned); and a posttest form of the self-paced reading task. In the reading task, comprehension probes measured lingering effects of misanalysis in object-first sentences [based on 4; see examples below]. During N-back, subjects viewed single words sequentially and indicated whether an item appeared 3 trials previously. Only the high-interference version contained “lures”—words that appeared 2, 4, or 5 items before, compelling subjects to override a familiarity bias to correctly indicate that the item was not a 3-back target.

On N-back, bilinguals were significantly more accurate than monolinguals in the high-interference (p<.01), but not the low-interference version (p>.37). However, in the high-interference version, language-group did not interact with trial type, suggesting that the benefit is not restricted to stimuli engaging conflict resolution (lures), but rather reflects a general conflict-monitoring advantage in high conflict-monitoring conditions, consistent with [2].

In the reading task, participants spent longer in disambiguating regions of, and were less accurate on, object-first versus subject-first items (p’s<.01)—the expected garden-path effect; but there was no interaction with group. Bilinguals were more accurate than monolinguals generally across all item types (object-first, subject-first, and filler probes; p<.05), demonstrating that bilinguals’ comprehension advantage was not specific to garden-path recovery.

Interestingly however, bilinguals’ accuracy improvement throughout the N-back task on lure trials alone selectively predicted their improvement from pre- to posttest on object-first comprehension probes (r=.39, p<.05), which forced syntactic reanalysis and CC. Monolinguals showed no such pattern (r=.15, p=.45), suggesting only bilinguals transfer the benefit of brief interference-resolution practice to the ability to revise parsing misanalyses.

Together these results suggest that balanced bilingualism bestows a general cognitive benefit in high, but not low conflict-monitoring situations – namely, when there is repeated switching between conflict (lures) and non-conflict (target, non-lure) trials – non-specific to conflict trials independently. Regarding sentence-parsing, only bilinguals’ short-term practice with interference resolution confers an improved ability to revise early misinterpretations. We discuss findings in terms of bilinguals’ advantage in conflict-monitoring, which enables them to detect situations requiring frequent CC and flexibly increase domain-general conflict-resolution mechanisms that are shared with syntactic ambiguity resolution processes.

Examples:

• Object-first Cleft Sentence (probe in parentheses): Este es el cajero que cuestionaba el gerente sobre el inventario. (El cajero cuestionaba al gerente.)
English translation: This is the cashier who the manager questioned about the inventory. (The cashier questioned the manager.)

- Subject-first Cleft Sentence (probe in parentheses): Este es el cajero que cuestionaba al gerente sobre el inventario. (El gerente cuestionaba al cajero.)

English translation: This is the cashier who questioned the manager about the inventory. (The manager questioned the cashier.)

REFERENCES


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