Improving language performance through memory training
Preliminary study shows improvements on tasks with only 10 hours of training

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Executive Summary

PURPOSE

All listeners and readers must construct meaning and interpret language in real time, frequently through misheard or garbled speech or text. Foreign language professionals (FLPs) face extreme examples of these kinds of problems, regularly working with degraded source materials that make interpretation a challenge.

Processing language as it is heard or read is a multi-faceted, complex process, and recent research by the University of Maryland Center for Advanced Study of Language (CASL) has found that more successful language professionals are more likely to possess a better working memory.¹

Following up on that research, CASL investigated the effectiveness of working memory training in improving performance on various language and cognitive tasks in foreign language practitioners.

CONCLUSIONS

CASL researchers tested participants on a variety of cognitive tasks before the memory training and after. Results of these tests revealed the following conclusions:

1. Participants responded more quickly on all tasks that measured reaction time.
2. Participants were more accurate on a listening task and in their interpretations of and responses to questions about ambiguous sentences.
3. Participants completed more timed reading comprehension tasks.
4. Participants reported positive experiences with the training, improvement on the training tasks, and perceived increases in their work performance and efficiency.

RELEVANCE

The working memory training used in this study correlates with improved performance on numerous cognitive and language tasks, and participants found the training useful and enjoyable. This approach may be used in follow-up research or training initiatives aimed at improving job performance for FLPs.

TTO 3501 E.3.3 | CDRL A017 | DID DI-MISC 80508B | Contract No. H98230-07-D-0175

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Funding/Support: This material is based upon work supported, in whole or in part, with funding from the United States Government. Any opinions, findings and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the University of Maryland, College Park and/or any agency or entity of the United States Government. Nothing in this report is intended to be and shall not be treated or construed as an endorsement or recommendation by the University of Maryland, United States Government, or the authors of the product, process, or service that is the subject of this report. No one may use any information contained or based on this report in advertisements or promotional materials related to any company product, process, or service or in support of other commercial purposes. The Contracting Officer's Representative for this project is David Cox, Government Technical Director at CASL, (301) 226-8970, dcox@casl.umd.edu.
Executive Report

PURPOSE

The job performance of foreign language professionals (FLPs) often depends on their successful interpretation of ambiguous, corrupt, or incomplete texts. FLPs work with both real-time and static texts that are often degraded in quality. They must assemble interpretations that are both accurate and coherent.

Interpreting degraded and ambiguous texts is an extreme example of the kind of interpretation that all listeners have to perform every day. Because listeners receive and process language incrementally (one syllable, one word, one phrase at a time), they must constantly evaluate and reevaluate possible interpretations for sentences that they are encountering in real time, and often reach conclusions about the most likely directions of a sentence well before a speaker has finished uttering it. Resolving these kinds of indeterminacies has been hypothesized to involve both language-specific components—such as vocabulary knowledge and the proper application of syntactic frameworks—and more general cognitive components—like working memory. (See sidebar for more information about working memory.)

Previous work at the University of Maryland Center for Advanced Study of Language (CASL) determined that FLPs who are more successful with ambiguous tasks frequently have, among other things, larger working memory capacities.

Following that work, CASL undertook a small pilot study to examine the effectiveness of working memory training in the FLP population. In addition to examining the effectiveness of briefer periods of training, CASL also wanted to gauge interest in this kind of training among the FLP population to ascertain whether it would be feasible to implement the training on a larger scale.

Approach

Ten USG employees participated in a 14-hour study to test the effectiveness of working memory training and also to pilot this kind of training within this population. The study began and ended with participants performing tasks that (a) accurately test both working memory and linguistic performance and (b) mirror as accurately as possible the tasks performed by FLPs. Participants spent 10 hours on working memory training, exercises that were selected by CASL to maximize benefits to foreign language professionals. Training was self-paced and self-directed; participants were encouraged to complete an hour a day and instructed to finish the entirety of the training within 3 work weeks (15 working days).

The training regimen was abbreviated from Posit Science’s Brain Fitness Classic program and consisted of combinations of five different kinds of 15-minute training exercises. The tasks are designed to keep trainees on the threshold of their best performance: as they improve on the following tasks, the computer dynamically adjusts to their level and makes the tasks harder (e.g., asks trainees to remember more or pay closer attention):

- **High or Low**—Listeners are presented with a series of different tones and are asked to designate the pitch of the tones.
- **Tell Us Apart**—Pairs and triples of phonemes are presented in a series and listeners must recreate the series. This task, along with High or Low, focuses on the smallest blocks of linguistic auditory memory.
- **Sound Replay**—This task requires the listener to sequence a set of syllables.
- **Listen and Do**—Listeners must carry out a series of instructions by manipulating a graphic interface.
- **Story Teller**—This exercise presents a listener with an audio narrative and then asks the listener to answer questions about it. Along with Listen and Do, this exercise is a higher level audio memory task, much more likely to obviously approximate the tasks performed by FLPs.

A CLOSER LOOK

What is working memory?

Remembering a phone number until you can find a pen; storing the next three steps of a recipe in your head while you walk to the refrigerator and back; comparing the memory of a painting hung in several places in a room and deciding which you like best—all of these tasks rely on working memory.

**Working memory is the small amount of memory that can be used to store information for immediate and delayed retrieval.**

It’s the “buffer” that we work from to store and manipulate information that will allow us to perform cognitively complex tasks.

Much about the nature and operation of working memory is still not understood; however, a number of competing conceptual models attempt to explain how it works.

Researchers know that working memory performance peaks in early adulthood and declines with age, and as the population ages there is increasing interest in research that explores how it can be trained and enhanced through practice.

Posit Science, the company whose software was adapted for the training regimen of this study, is one of a number of business ventures that are developing products designed to do just that.
CONCLUSIONS

The findings from the empirical study show general trends in improvement of performance after working memory training.

1 Participants responded more quickly on all tasks that measured reaction time.

Across tasks, working memory training had the greatest impact on reaction time. Participants were generally quicker to respond after their working memory training, suggesting that their training had left them better able to rapidly retrieve information from their working memory and implement their responses.

The Air Force Officer Qualifying Test (AFOQT)\(^1\) is a reading comprehension task, and the Wechsler Abbreviated Scale of Intelligence (WASI)\(^2\) measures fluid intelligence. Both saw marked reaction time improvements, with 9.88 percent and 32.9 percent decreases, respectively.

Garden path sentences are classic psycholinguistic examples of ambiguity resolution—that is, when listeners or readers must make sense of potentially ambiguous speech or text. This type of processing is improved by improved working memory. (See sidebar for more information about garden path sentences.) In this study, the garden path task saw a decrease in reaction time for the unambiguous sentences, while the reaction time for the ambiguous sentences stayed about the same (see Figure 1).

2 Participants were more accurate on a listening task and in their interpretations of and responses to questions about ambiguous sentences.

The Listening Span task requires participants to listen to sentences while also remembering a series of symbols and is a widely used test for working memory.\(^3\) Participants demonstrated an increase in overall score and a decrease in accuracy-based errors after working memory training (see Figure 2). In addition, there were small increases in accuracy on both kinds of stimuli in the garden path task.

3 Participants completed more timed reading comprehension tasks.

The results of the AFOQT, which is a timed test, show a small increase in completion rates (see Figure 3). This small increase suggests that participants are on average better able to complete more of the test after working memory training than before.

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A CLOSER LOOK

What are garden path sentences?

Garden path sentences are sentences that, when read, often lead you along a path—usually to a wrong interpretation of meaning. They are illustrations of the syllable-by-syllable, word-by-word language processing that listeners and readers perform and the erroneous conclusions and subsequent repairs they make.

Research demonstrates that listeners’ and readers’ repair strategies tax working memory—as one must remember what came in the first part of the sentence to incorporate it into a new structure.

In a recent study, participants encountered stimuli that encouraged these difficulties and forced them to employ repair strategies. Consider the following sentence:

As the student prepared the salad that was healthy and fresh remained in the refrigerator.

During the study, participants read this sentence and answered questions like, “Did the student prepare herself?” Upon first encountering this ambiguous garden path sentence, readers tend to (erroneously) treat the salad as the object of prepared.

Researchers expect participants to perform better on ambiguous sentences after working memory training, because they might be better able to recover from their erroneous interpretations.
Participants reported positive experiences with the training, improvement on the training tasks, and perceived increases in the work performance and efficiency.

After the study, CASL surveyed the participants to determine what worked for them in the training—and what did not. One participant was unable to complete the training at all; she had been retasked soon after enrolling in the study and had never found time for the training in her new position. Most participants reported trouble finding time, citing the highly variable demands of their work.

Those who were most successful followed a more rigorous schedule, treating the training almost like a course. All participants reported that they felt they had improved over the course of their training, but a few were unsure how that would translate to their job. A few others continued to express interest in a longer working memory training course.

From their perspective:
- “I think that the training was very useful, because I have to do a lot of memorization for language work, and it was helpful to me for that.”
- “I may have improved a little, but not much because I didn’t follow the ‘every day’ instruction—which I feel would make a HUGE difference.”
- “It was intriguing, especially the task exercises, but I don’t think they seemed particularly relevant or useful for what I do.”
- “I would still like to have a chance to complete the entire program sometime in the future.”

**RELEVANCE**

Following working memory training, participants in this study showed improvement in reaction time, accuracy, and completion time measures. Each of these measures evaluates cognitive readiness and performance, and their improvement implies improvements in the quality of FLPs’ work. These findings suggest that training FLPs’ working memory could potentially yield gains in efficiency and accuracy in the workforce.

**CONSIDERATIONS**

Although the current study yielded interesting findings, there are some considerations to keep in mind when reviewing the data.

**Number of participants and the need for a control group**

This study lacks some explanatory and predictive power because of the small number of participants. CASL originally sought to recruit 20 participants for this study, but repeated attempts to enroll more than 10 were fruitless; potential participants reported difficulty finding time for the training during their work days. A larger group is predicted to yield more robust and reliable results.

Similarly, with no control group to compare the training group with, we cannot conclude whether people improve simply with the passage of time or as a result of a placebo effect.

**Length of training period**

The Posit Science training regimen is designed for 40 hours of training; participants in this study, in deference to their work schedules, completed only 10. As with any other kind of training, it takes time for changes to manifest, and it is difficult to predict what kinds of outcomes might be possible after such a short training period. This group saw small improvements in their accuracy and reaction time, but CASL predicts that more thorough training would produce larger benefits.

**FLP schedules**

Although users were instructed to finish the training within 21 days, the mean for the completed study was 29 days, a full week longer than requested. This is problematic because the training is designed to be completed in a more concentrated period of time. The volume of the training is important, but the density of training across a period of time is also important.

Part of this difficulty may have been due to simple logistical issues; two users were required to share each laptop and although no participants reported difficulty with this arrangement, it is possible that sharing laptops made timely completion more complicated. At least one participant did state, in follow-up questioning, that it would have been easier to do the training if it had been available online. (For more feedback from the participants, see Conclusion 4.)

More commonly, though, users reported having trouble making the study fit their schedules. The program was designed for maximum flexibility, allowing participants to complete 15 minutes at a time according to their own schedules, because CASL is well aware of the variable nature of FLPs workflows.
This flexibility appears to be something of a double-edged sword, though, as a lack of scheduling may make it more difficult to finish the training; those who were most successful at completing the training quickly built schedules for themselves that they followed more rigorously. This finding suggests that working memory training may be more successfully completed in the format of a regularly scheduled course.

ENDNOTES


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Funding/Support: This material is based upon work supported, in whole or in part, with funding from the United States Government. Any opinions, findings and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the University of Maryland, College Park and/or any agency or entity of the United States Government. Nothing in this report is intended to be and shall not be treated or construed as an endorsement or recommendation by the University of Maryland, United States Government, or the authors of the product, process, or service that is the subject of this report. No one may use any information contained or based on this report in advertisements or promotional materials related to any company product, process, or service or in support of other commercial purposes. The Contracting Officer’s Representative for this project is David Cox, Government Technical Director at CASL, (301) 226-8970, dcox@casl.umd.edu.

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