Language and Brain Lab Digest

Fall 2019

Models of Aphasia

By Gillian Foley and Xinming Zhou

The most common cause of aphasia is stroke in the left side of the brain. An estimated **20-40% of people that suffer a stroke develop some form of short-lasting aphasia.** However, if the stroke worsens, a more serious form of aphasia tends to develop. Research finds that many types of aphasia impairment follow a predictable pattern.

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What can the brain tell us about aphasia?

(continued)

One popular model, the **Wernicke-Lichtheim model**, enables scientists to classify aphasia and its effects on a person's everyday life. Even though it can be helpful to classify the broad types of aphasia, there is still massive variability within types. While Broca's and Wernicke's aphasias are two well-known aphasias that have broadly different symptoms, it also important to consider how one person's experience varies within each. Broca's aphasia is known as non-fluent aphasia, and although someone with Broca's aphasia might be able to read and comprehend writing, they have difficulty talking. Their speech can be clumsy and require a lot of effort to produce. For example, one person with Broca's aphasia may struggle get a single word out while others may be able to say a sentence out loud. On the other hand, a person diagnosed with Wernicke's aphasia often have no issues producing speech, but the content of that speech atypical. Their sentences tend to lack cohesion and content (Acharya & Wroten, 2019). For example, if you ask someone "what did you do yesterday?" one person may respond with words that don't fit the question—such as "hello"—and another may string together many unrelated words.

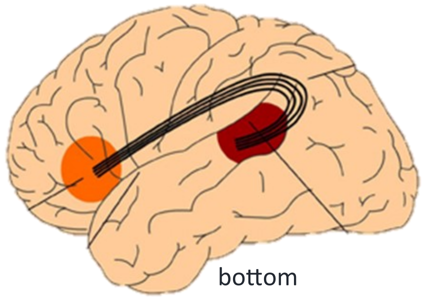
"Where did you put my shoes?" can become "Where put shoes?" in speech affected by Broca's aphasia[3]

To better describe variable experiences with aphasia, researchers gradually developed more specific models for aphasia that focus on where the brain was damaged. One famous model is Hickok and Poeppel's (2004) **dual-stream model**. This model describes two processing streams—the ventral stream supports speech comprehension and the dorsal stream is specialized for speech production. In the diagram provided above, the ventral stream corresponds to the brain regions highlighted in **purple**, while the dorsal stream is represented in **blue.**

The dual-stream model suggests that there are two functionally distinct

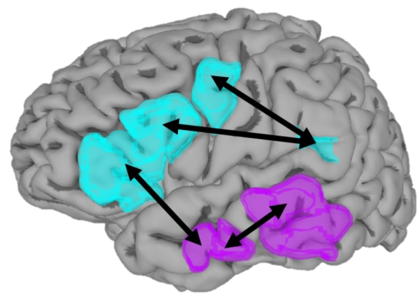
Wernicke-Lichtheim Model

The region highlighted in orange is Broca's Area and the area highlighted in red is Wernicke's area.



Dual-stream Model

The regions highlighted in blue are the Dorsal Stream and the regions highlighted in purple are the Ventral Stream.



pathways in our brain. The ventral stream interfaces with the semantic system, to attach meaning to incoming speech. The dorsal stream focuses on motor and articulatory systems. Essentially, this system prepares the muscle in our mouth and throat to

> "A table with… and… I don't know… and a… three-legged…and a… table, table."
>
> Speech affected by Wernicke's aphasia[2]

correctly produce the speech sounds in the words we want to say. By considering the dorsal and ventral streams of language processing, researchers can better understand how language is processed in people with specific damage. Tests like naming, speech repetition, or grammatical processing emphasizes the cause and effect of brain damage and disconnection over two major pathways.

Overall, the dual-stream model predicts that variable performance on specific speech or listening tasks may be linked to specific brain regions, and thus those abilities are impaired when the same regions are damaged. The hope is that by understanding the function of each of these brain regions, clinicians could more accurately predict symptoms and classify aphasias depending on where the stroke-damage occurred.

In conclusion, it is important to remember that aphasia can affect anyone, and affected individuals and their loved ones are not alone. Understanding of aphasia continues to develop and hopefully access to resources and continued support will continue to increase.

Additional resources can be found at:

https://www.aphasia.org/helpful-materials/

https://aphasia-rehab.slhs.uconn.edu/uconn-aphasia-group/

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[1]Acharya, A. B., & Wroten, M. (2019). Broca Aphasia. In StatPearls. Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK436010/

[2]Ellis, A. W., Miller, D., & Sin, G. (1983). Wernicke's aphasia and normal language processing: A case study in cognitive neuropsychology. *Cognition, 15*(1), 111–144.

[3]Fridriksson, J., den Ouden, D.-B., Hillis, A. E., Hickok, G., Rorden, C., Basilakos, A., ... Bonilha, L. (2018). Anatomy of aphasia revisited. *Brain, 141*(3), 848–862.

[4]Gleason, J. B., Goodglass, H., Green, E., Ackerman, N., & Hyde, M. R. (1975). The retrieval of syntax in Broca's aphasia. *Brain and Language, 2*, 451–471.

[5]Hickok, G., & Poeppel, D. (2004). Dorsal and Ventral Streams: A Framework for understanding aspects of the functional anatomy of language. *Cognition, 92*(1–2), 67–99.

Inside Speech RESEARCHERS

By Triana Feliconio

Dr. Carl Coelho
Professor, SLHS

I have been studying communication disorders resulting from traumatic brain injury (TBI) for several years. Although some individuals with TBI have aphasia, most do not, yet they still struggle formulating complete meaningful messages. These difficulties are referred to as cognitive-communication deficits. My research in this area has involved looking at discourse in young adults with brain injuries. Recently, while on sabbatical at the Walter Reed National Military Medical Center, I had the opportunity to study service members, men and women, wounded while deployed in Iraq and Afghanistan. Most have mild brain injuries and many have cognitive-communication disorders. Our lab has identified discourse measures that identify the mildly impaired and we are also **examining the impact of post-traumatic stress disorder on discourse production**.

I always knew I wanted to be a professor and that I wanted to study something related to sound. However, it took me some time to zero in on the field of auditory neuroscience, which is the study of how the brain processes sound. Broadly speaking, my lab studies how auditory brain function changes as we age and how different experiences with sound rewire the brain. **In the lab, we examine how noisy and loud environments negatively affect sound processing in the brain and how music and language learning positively affect sound processing in the brain**. Our research finds relationships between low-level sound processing in the brain and higher-level functions like language.

Dr. Erika Skoe,
Associate Professor, SLHS

Sahil Luthra
Graduate student, Psychology

I'm really fascinated by the fact that everyone produces their speech sounds differently and as listeners we have to do this adjustment process every time we encounter a new talker. Most of the time we're not aware of that we have to do this recalibration every time we talk to someone. I'm really interested in how that happens and how the brain helps us do that. It's all very fun!

Pamela Fuhrmeister
PhD candidate, SLHS

I'm interested in why it's so hard for adults to learn to understand and pronounce speech sounds in a second language. Even with years or decades of practice, learning the sounds of a second language is still really difficult for a lot of people. My research tries to understand why that is and what makes some people good at it and what causes others to struggle.

Ashley Parker,
Graduate student, SLHS

I love helping students discover what they're interested in. I love working one and one helping students work on what they're excited about. With teaching lectures, I love talking about the content and expressing that to others. With research I get to work with an incredible advisor and lab mates who teach me everyday. I love coming here everyday!

Can a **night's sleep** help you understand someone with a foreign accent?

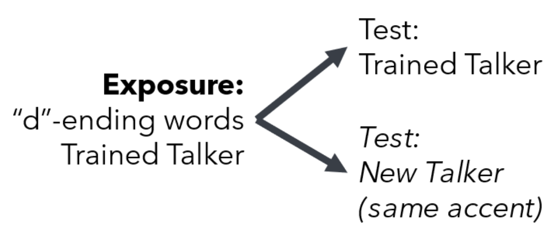
Science suggests... Yes!

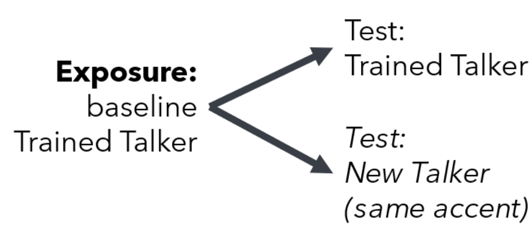
By Ashley Lombardi and Matt Phillips

During listening, the incoming speech signal is almost instantly mapped onto the correct sound representation in the brain. However, the speech sounds produced in everyday conversational speech are not the "cleanest" version of any given speech sound due to a lack of precision by the talker. For example, imagine you are listening to someone who is in a hurry and is slurring their words compared to someone who is speaking carefully. This variation in speech sounds is exacerbated by different talkers, accents, environmental noise, etc. This study investigated how people are flexible enough to adapt to a foreign accent of different speakers, and specifically, how sleep facilitates this process.

Experiment 1

Experiment 1 of this study serves to determine whether or not exposure to a specific talker of a foreign accent ("Trained Talker") could be generalized to a different talker of the same accent ("Generalized Talker"). All participants were English speakers who listened to a native speaker of Mandarin Chinese speak a collection of words in English. Half of the participants (the "d"-exposure group) were exposed to words with multiple syllables ending in the sound "d" (i.e., un-de-fine**d**) while the other half (baseline group) were not. Both groups were further divided: half were tested with the same talker and the other half was tested with a new talker of the same accent. During the test phase, all participants listened to spoken words and were asked to identify

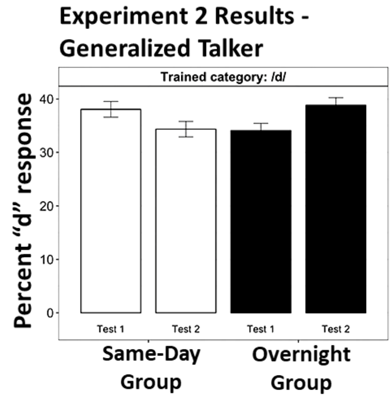




whether the last consonant was either "d" or "t". The results of Experiment 1 show that while the participants did adapt to the differences of a foreign accent, adaptation did not generalize to another speaker with the same foreign accent.

Experiment 2

The second experiment specifically investigated the role of sleep in adaptation to the speech of different talkers by providing a 12-hour delay between people listening to one Mandarin-accented speaker ("Trained Talker") and the exposure to a new speaker with the same accent ("Generalized Talker"). There were two subgroups in this experiment - the Overnight group and the Same-Day group. Like the first experiment, the participants were required to categorize the specific sounds ("did you hear a "d" or a "t"?") they heard from the accented speaker. As a control, participants in the Same-Day group were first exposed to the accented talker in the morning and returned for the next session after 12 hours of normal daytime activity. Participants in the Overnight group were exposed to the first talker in the evening and had a 12-hour overnight gap before returning for the second session to listen to the new talker. Assuming that the 12-hour gap contained sleep, the Overnight group isolates the effect of sleep on understanding new talkers with the same accent that the participant was trained on.



Graph depicting the results for the "Generalized Talker." Note the improvement from Test 1 to Test 2 in the Overnight Group (black bars).

Conclusion

Both the Overnight Group and Same-Day group both showed an improvement in understanding the new accented talker, which shows that taking time between listening sessions is beneficial in adapting to new accents. However, the results confirm that participants who slept between listening sessions were even better at understanding the new speaker with the same Mandarin accent. This indicates that sleep is a useful tool in adapting to people with unfamiliar accents. If you are planning on traveling to a different country, or are frequently exposed to a new accent of your native language, try taking naps or sleeping between long periods of exposure to this accent- you may notice an improvement in your ability to understand the people around you!

Xie, X., Earle, F. S., & Myers, E. B. (2018). Sleep facilitates generalisation of accent adaptation to a new talker. Language, Cognition and Neuroscience, 33(2), 196–210.

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