

# Tackling the Toll of Hearing Loss on Executive Function

**We need to think beyond the speech chain—and hearing aids—to fully address effects of hearing loss on older adults' cognitive health.**

BY M. KATHLEEN PICHORA-FULLER AND NATALIE PHILLIPS

Remember those graduate school lessons about the speech chain—in which a message travels between sender and receiver in stages, from one person's intention to another person's understanding?

For decades, we communication sciences and disorders professionals have used this model to consider how communication breakdowns relate to disorders of speech production or hearing. But it's important that we also think beyond this model when considering one person's difficulty understanding what another is saying.

Hearing can be challenging even when a talker's speech and a listener's audiogram are technically "normal." These challenges may come from poor room acoustics, incomprehensible messages, background noise or distorting technologies such as poor PA systems that thwart transmission of the speech signal. These factors interfere with hearing more as we get older, making us work harder to understand a message.

The speech-chain model is certainly useful, but most versions of it don't factor in whether message senders and receivers will expend extra effort trying to make it work—and if they must deliberately allocate mental resources to overcome communication obstacles (see sources). The reality is that most people will need to expend that extra effort as they get older; as hearing deteriorates (see "Lost in the Midst"), they'll need to concentrate harder when adverse conditions threaten to break the speech chain.

The inevitable result is a greater burden on people's cognitive resources and executive functioning. So, to effectively intervene with older patients, we need to look beyond hearing aids alone and train them on strategies to reduce the demands of listening on the brain.

## Passive hearing versus active listening

The brain controls the speech chain largely by cognitive executive functions: a collection of processes people use to guide behavior toward a goal (see sources). These processes promote self-initiated actions. They involve cognitive flexibility, planning, working memory, updating and shifting tasks or mental sets, goal maintenance, monitoring and regulation of performance, and inhibition or suppression of overlearned responses.

In brief, executive functions, often governed by brain networks including the prefrontal cortex, reflect *how* or *whether* a person goes about doing something. In the book "The Human Frontal Lobes: Functions and Disorders," Adam

Gazzaley and Mark D'Esposito argue that executive control influences sensory input (including audition and vision), internal states (including emotion and cognition), and motor and behavioral output (including speech and language production).

In effect, executive control is what differentiates passive hearing from active listening. Executive control functions may help to explain how and whether people listen effectively in a given situation, regardless of whether they have normal or impaired hearing.

## Age-related declines

Active listening requires "executive attention"—the ability to shut out distractions and focus on a main task or goal. Psychologists have found that executive attention rests on strong relationships between working memory and executive functioning. To a lesser extent, it also rests on processing speed, a general processing resource related to many aspects of higher-level cognition and known to decline with age (see sources).

Some of these executive-attention subcomponents decline more rapidly than others over the adult lifespan. For example, in adults older than 60, the ability to suppress habitual

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or dominant responses and the ability to divide attention efficiently appear to decline more quickly than abilities such as verbal fluency and reasoning. Now consider some older listeners' increasing difficulties with understanding speech: Their difficulties may stem from an interaction of age-related declines in peripheral and central auditory processing, working memory, and divided attention.

Certainly, age appears to be related to declines in performance on simple listening tasks—such as word recognition in quiet or noise—according to evidence we reviewed in a recent chapter (see sources). Giving older listeners more context can help improve performance. But age-related differences often persist when listening tasks are more cognitively demanding and involve memory or attention.

Thus, older adults draw heavily on auditory processing and executive functions when trying to understand what others are saying in many everyday situations. And the risk of developing clinically significant cognitive impairment appears to be greater for older adults with hearing loss than for peers with better hearing.

### Dementia and hearing

The everyday consequences of hearing impairment become significantly more serious when a person has one of the major neurodegenerative dementias. Auditory symptoms of these dementias include deficits in perception, auditory apperception, the semantic processing of sounds and emotions, and nonverbal auditory working memory and attention (see sources).

Within the last decade, researchers have linked dementia with central and peripheral hearing loss. For example, in the journal *Cognitive Behavioral Neurology*, George A. Gates and colleagues report evidence of an association between central presbycusis and executive dysfunction. They suggest both may result from similar neurodegenerative processes.

The real call to action here for geriatric health (in addition to screening hearing) is to identify older adults in the pre-clinical or asymptomatic phase of dementia—typically called mild cognitive impairment (MCI). It is at this stage that people could benefit the most from interventions. Consider that people with MCI are about five times more likely to develop dementia than their cognitively

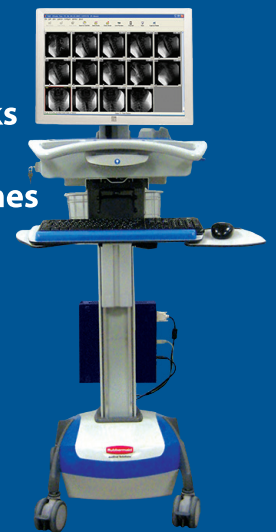
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healthy peers (5 to 10 percent versus 1 to 2 percent).

The drive to identify people at-risk for and in the early stages of dementia has sparked clinical interest in subjective cognitive impairment (SCI), in which people who perform normally on cognitive tests experience a subjective decline in cognition. Studies indicate that people with SCI are at higher risk for transitioning to MCI and dementia; one study found almost a quarter of people with SCI developed MCI over four years (see sources). What's more, hearing impairment emerged as one of the strongest predictors of SCI, along with depressive symptoms and poor psychological well-being, in a study of a population-based sample by Julian Benito-Leon and colleagues (published in the *Journal of Alzheimer's Disease*). Our hope is that future studies further probe relationships among hearing loss, executive functions and cognitive impairment in older adults.

### The speech chain and the brain

Growing awareness of the connection between auditory and cognitive aging has inspired new research and raised questions about the implications of cognitive decline for audiology practice. Optimistically, many older adults can enjoy better audibility due to advances in hearing technologies. We can hope that better hearing will result in better cognitive health and quality of life.

However, many older adults delay seeking help for hearing problems for decades. And those who do purchase hearing aids may struggle to adjust to them without professional support. This, in turn, can affect cognitive functioning: For example, epidemiological research led by Paul Mick (published in the journal *Ear and Hearing*) found that older adults with unacknowledged or unaddressed hearing loss

## Active listening requires “executive attention” —the ability to shut out distractions and focus on a main task or goal.

performed more poorly on cognitive tests and showed a greater risk of social isolation compared with peers with normal hearing.

Can hearing aids counteract cognitive decline and dementia? Although the evidence is still sparse, it's unlikely that amplification alone will be sufficient. But this doesn't mean older adults with hearing loss are doomed to social isolation and dementia. Viewed through the lens of the speech-chain model, hearing aids would seem a viable solution to the problem of compromised auditory input. If an older adult wears an appropriately fit hearing aid or assistive technology and receives appropriate support services, then the speech chain should be improved.

However, if the person experiences a decline in cognitive executive-control functions, the speech chain may malfunction when demanding listening tasks drain diminished cognitive resources. In such everyday situations, it is very likely that listeners will quit listening, especially when the effort of listening exceeds the perceived value of achieving their listening goals. As quitting becomes a more frequent coping strategy, the person may increasingly withdraw from social interactions—which may exacerbate declines in cognition or other aspects of health.

This downward spiral in health has implications for how we address hearing loss in older adults: We advise going beyond the traditional focus on hearing aids to include a focus on executive attention and active listening. A useful guideline here is the Framework for Understanding Effortful Listening (FUEL), the consensus paper of the Eriksholm Workshop on “Hearing

Impairment and Cognitive Energy.” For example, FUEL proposes that we train patients on strategies to improve the allocation of cognitive resources. For example, patients can select quieter spaces or learn to use context to reduce listening demands. Other areas of training could include breaking complex tasks into smaller ones and using conversational strategies and multimodal cues to increase focus of attention, improve self-efficacy, and optimize support from conversational partners.

Many of these behavioral interventions are already familiar to rehabilitative audiologists, but they take on a new meaning when we rethink the speech chain to link to the brain—and shift the emphasis from passive hearing to active listening. 🎧

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## Sources

- Albers, M. W., Gilmore, G. C., Kaye, J., Murphy, C., Wingfield, A., Bennett, D. A.,...Zhang, L. I. (2015). At the interface of sensory and motor dysfunctions and Alzheimer's disease. *Alzheimer's and Dementia*, 11(1), 70–98. <https://doi.org/10.1016/j.jalz.2014.04.514>
- Albert, M. S., DeKosky, S. T., Dickson, D., Dubois, B., Feldman, H. H., Fox, N. C.,... Phelps, C. H. (2011). The diagnosis of mild cognitive impairment due to Alzheimer's disease: recommendations from the National Institute on Aging–Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's and Dementia*, 7, 270–279. <https://doi.org/10.1016/j.jalz.2011.03.008>
- Amieva, H., Ouvrard, C., Giulioi, C., Meillon, C., Rullier, L., & Dartigues, J. F. (2015). Self-reported hearing loss, hearing aids & cognitive decline in the elderly: A 25-year study. *Journal of the American Geriatrics Society*, 63(10), 2099–104. <https://doi.org/10.1111/jgs.13649>
- Banich, M. T. (2009). Executive function: The search for an integrated account. *Current Directions in Psychological Science*, 18, 89–94. <https://doi.org/10.1111/j.1467-8721.2009.01615.x>
- Benito-Leon, J., Mitchell, A. J., Vega, S., & Bermejo-Pareja, F. (2010). A population-based study of cognitive function in older people with subjective memory complaints. *Journal of Alzheimer's Disease*, 22, 159–170. <https://doi.org/10.3233/JAD-2010-100972>
- Gates, G. A., Gibbons, L. E., McCurry, S. M., Crane, P. K., Feeney, M. P., & Larson, E. B. (2010). Executive dysfunction and presbycusis in older persons with and without memory loss and dementia. *Cognitive and Behavioral Neurology: Official Journal of the Society for Behavioral and Cognitive Neurology*, 23(4), 218–223. <https://doi.org/10.1097/WNN.0b013e3181d748d7>
- Gazzaley, A., & D'Esposito, M. (2007). Unifying prefrontal cortex function: Executive control, neural networks, and top-down modulation. In B. L. Miller & J. L. Cummings (Eds.), *The Human Frontal Lobes: Functions and Disorders* (2nd ed. 187–206). New York: Guilford Press.
- Gorno-Tempini, M. L., Hillis, A. E., Weintraub, S., Kertesz, A., Mendez, M., Cappa, S. F.,... Grossman, M. (2011). Classification of primary progressive aphasia and its variants. *Neurology*, 76, 1006–1014. <https://doi.org/10.1212/WNL.0b013e31821103e6>
- Hardy, C. J., Marshall, C. R., Golden, H. L., Clark, C. N., Mummery, C. J., Griffiths, T. D.,... Warren, J. D. (2016). Hearing and dementia. *Journal of Neurology*, 263, 2339–2354. <https://doi.org/10.1007/s00415-016-8208-y>
- Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological Assessment*. (4th ed.) Oxford: Oxford University Press.
- McCabe, D. P., Roediger, H. L., McDaniel, M. A., Balota, D. A., & Hambrick, D. Z. (2010). The relationship between working memory capacity and executive functioning: Evidence for a common executive attention construct. *Neuropsychology*, 24, 222–243. <https://doi.org/10.1037/a0017619>
- McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack Jr, C. R., Kawas, C. H.,... Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging–Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, 7, 263–269. <https://doi.org/10.1016/j.jalz.2011.03.005>
- Mick, P. T., & Pichora-Fuller, M. K. (2016). Is hearing loss associated with poorer health in older adults who might benefit from hearing screening? *Ear and Hearing*, 37(3), e194–e201. <https://doi.org/10.1097/AUD.0000000000000267>
- Mitchell, A. J., Beaumont, H., Ferguson, D., Yadegarfar, M., & Stubbs, B. (2014). Risk of dementia and mild cognitive impairment in older people with subjective memory complaints: Meta-analysis. *Acta Psychiatrica Scandinavica*, 130, 439–451. <https://doi.org/10.1111/acps.12336>
- Petersen, R. C. (2011). Clinical practice: Mild cognitive impairment. *New England Journal of Medicine*, 364, 2227–2234. <https://doi.org/10.1056/NEJMc0910237>
- Petersen, R. C., Caracciolo, B., Brayne, C., Gauthier, S., Jelic, V., & Fratiglioni, L. (2014). Mild cognitive impairment: A concept in evolution. *Journal of Internal Medicine*, 275, 214–228. <https://doi.org/10.1111/joim.12190>
- Pichora-Fuller, M. K., Alain, C., & Schneider, B. (2017). Older adults at the cocktail party (pp.). In J. Middlebrooks, J. Simon, A. Popper, & R. R. Fay (Eds.), *The Auditory System at the Cocktail Party* (227–259), Springer Handbook of Auditory Research. Springer: Berlin. [https://doi.org/10.1007/978-3-319-51662-2\\_9](https://doi.org/10.1007/978-3-319-51662-2_9)
- Pichora-Fuller, M. K., Kramer, S. E., Eckert, M., Edwards, B., Hornsby, B., Humes, L.,... Wingfield, A. (2016). Hearing impairment and cognitive energy: The framework for understanding effortful listening (FUEL). *Ear and Hearing*, 37 Supp., S5–S27. <https://doi.org/10.1097/aud.0000000000000312>
- Royall, D. R., Lauterbach, E. C., Cummings, J. L., Reeve, A., Rummans, T. A., Kaufer, D.,... Coffey, C. E. (2002). Executive control function: A review of its promise and challenges for clinical research. *Journal of Neuropsychiatry and Clinical*

*Neurosciences* 14(4), 377–405.  
<https://doi.org/10.1176/jnp.14.4.377>

**Weintraub, S., Wicklund, A. H., & Salmon, D. P.** (2012). The neuropsychological profile of Alzheimer disease. *Cold Spring Harbor Perspectives in Medicine*, 2, a006171. <https://doi.org/10.1101/cshperspect.a006171>

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