

**Speech and language changes along the continuum of Alzheimer's Disease and Related Dementias: Diagnosis and management of communication abilities**

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UNIVERSITY OF WISCONSIN-MADISON

CCANDL  
COMMUNICATIVE CHANGE AND LEXIS IN AGING  
AND DEMENTIA: TRAINING AND RESEARCH

Wisconsin Registry for Alzheimer's Prevention  
UNIVERSITY OF WISCONSIN  
SCHOOL OF MEDICINE AND PUBLIC HEALTH

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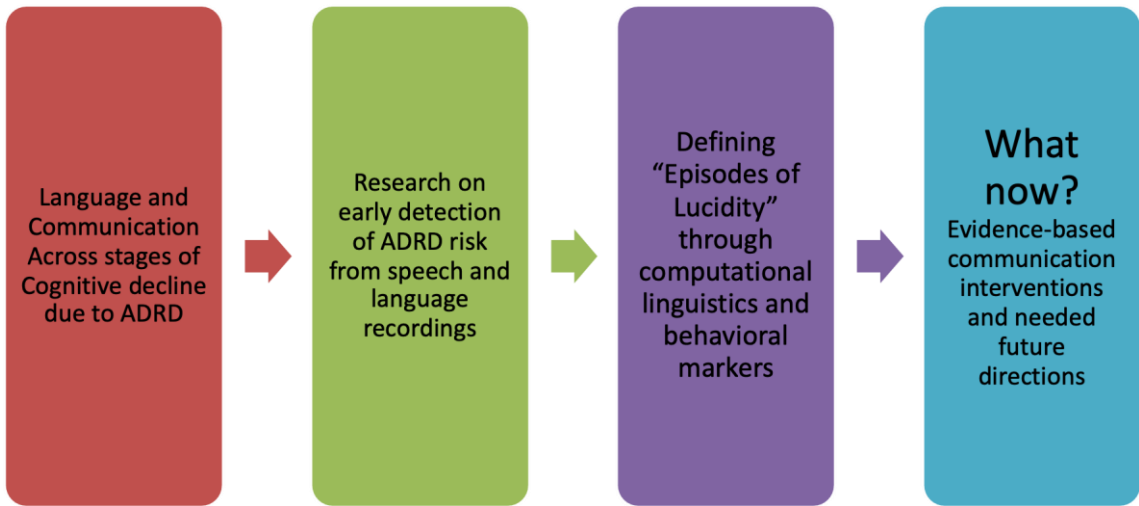
## Disclosures

- Funding from the following National Institutes of Health Grants:
  - R01 AG070940 (Mueller)
  - R01 AGO82052 (Mueller)
  - R21 AGO83928 (Souza)
  - R33 AG069827 (Gilmore-Bykovskiy)
  - R21 DC020257 (Maltman)
- **No other financial relationships to disclose**



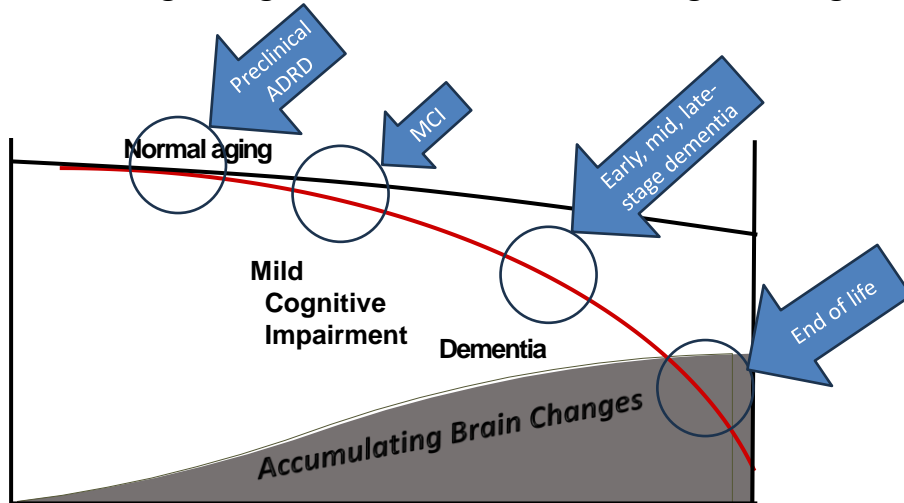
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# Outline

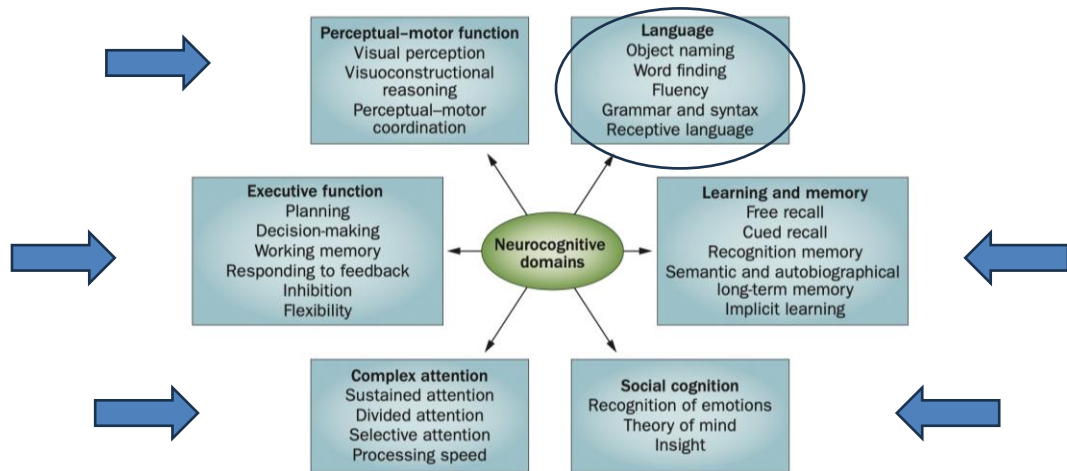


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# Characterizing changes to communication throughout stages of AD RD



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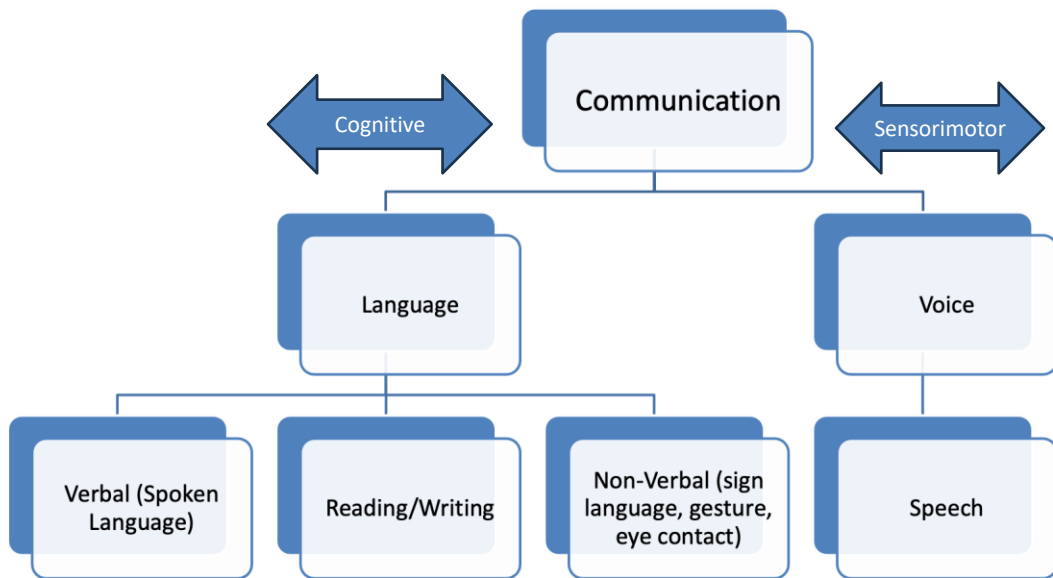
**Figure 2** | Neurocognitive domains. The DSM-5 defines six key domains of cognitive function, and each of these has subdomains. Identifying the domains and subdomains affected in a particular patient can help establish the aetiology and severity of the neurocognitive disorder. Objective assessments are essential, but the DSM-5 does not name any proprietary tests. Abbreviation: DSM-5, Diagnostic and Statistical Manual of Mental Disorders 5<sup>th</sup> edition.

Sachdev et al., 2014



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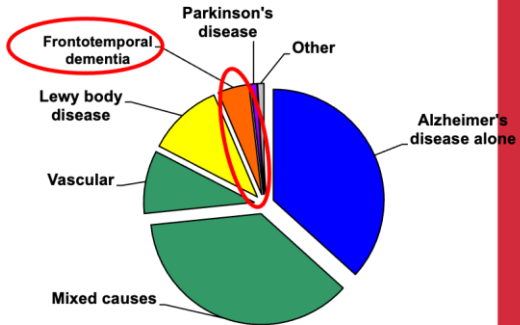
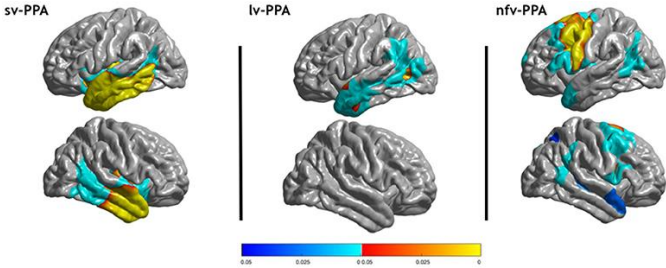
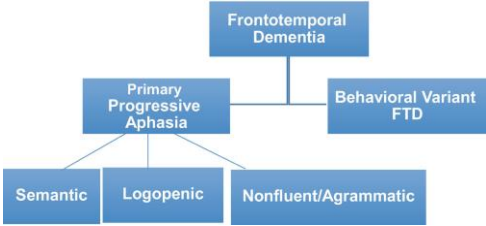
## “Cognitive-Communication”



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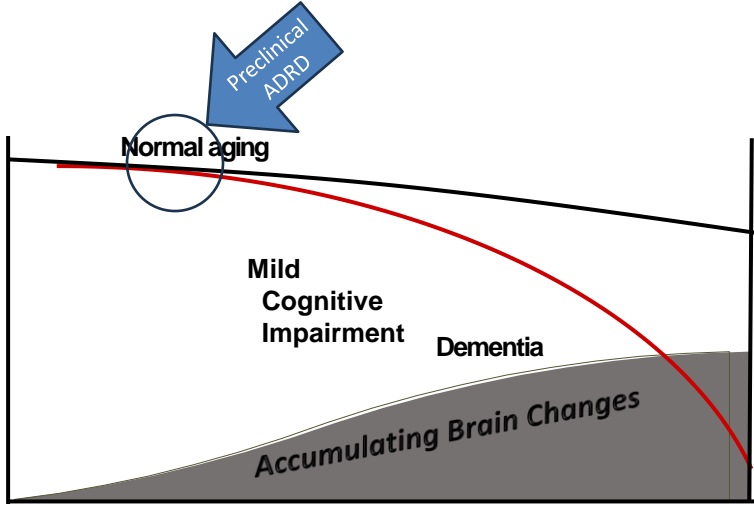


# Dementia causes



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# Characterizing changes to communication throughout stages of ADRD



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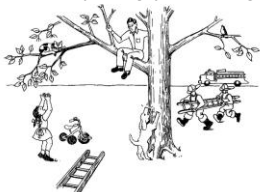
Garrard et al., 2005; Snowden et al., 2001; Berisha et al., 2015

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## Example of Connected Speech Vs. Traditional Language Tasks

### Connected Speech

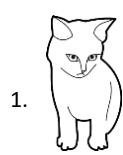
"Tell me everything you see going on."



"Well, I see a man stuck up in a... a tree (laughs) while a daughter, um I mean a girl, is reaching..."

### Naming

"Tell me the name of what you see."



"Cat."



"Ladder."

Picture description task from: **A System for Quantifying the Informativeness and Efficiency of the Connected Speech of Adults With Aphasia** J Speech Hear Res. 1993;36(2):338-350. doi:10.1044/jshr.3602.338

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# Wisconsin Registry for Alzheimer's Prevention (WRAP), PI Sterling Johnson

Late middle-aged adults who:

1. Are cognitively normal at baseline
2. Have a parent who had Alzheimer's disease OR
3. Have no family history of Alzheimer's disease

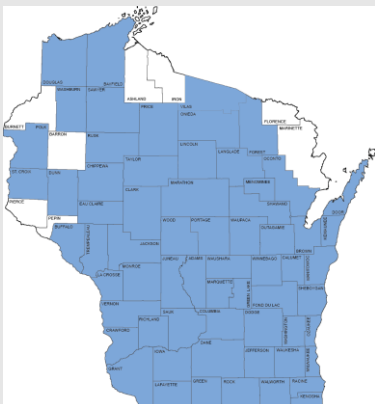


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## WRAP Participants



64 Counties



32 States



N=>1665

Mean age at baseline is 54, mean age at most recent visit = 67

Average years of follow-up is >12 years (min=0, max=22)

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## WRAP visits occur every two years

- Cognitive testing, including samples of recorded speech
- Medical Exam
- Health, lifestyle, and daily functioning questionnaires
- Blood draws (genotyping, health analysis, plasma banking)
  - Many participants also provide:
    - MRI
    - Amyloid and Tau PET scans
    - Cerebrospinal fluid

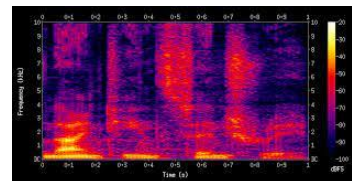


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Tell me everything you see going on in this picture.



It => PRON => PRP  
 took => VERB => VBD  
 me => PRON => PRP  
 more => ADJ => JJR  
 than => CONJ => IN  
 two => NUM => CD  
 hours => NOUN => NNS  
 to => PART => TO  
 translate => VERB => VB  
 a => DET => DT  
 few => ADJ => JJ  
 pages => NOUN => NNS  
 of => ADP => IN  
 English => PROPN => NNP  
 . => PUNCT => .



~1 minute of speech yields over 20 different linguistic metrics



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# Declines in metrics from 1 minute speech samples are associated with sub-clinical declines in neuropsychological tests

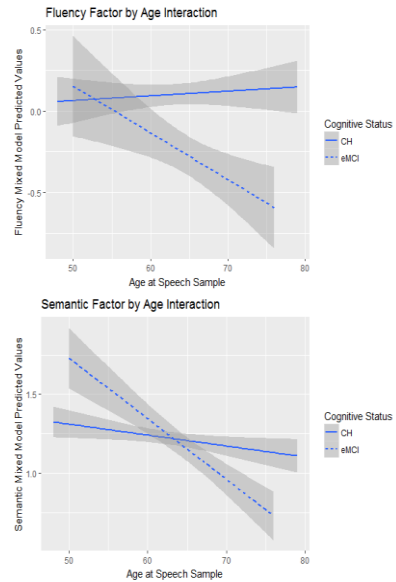
frontiers | Frontiers in Aging Neuroscience | Sections | Articles | Research Topics | Editorial

ORIGINAL RESEARCH article  
 Front. Aging Neurosci., 09 January 2018  
 Sec. Neurocognitive Aging and Behavior  
 Volume 9 - 2017 | <https://doi.org/10.3389/fnagi.2017.00437>

Declines in Connected Language Are Associated with Very Early Mild Cognitive Impairment: Results from the Wisconsin Registry for Alzheimer's Prevention

Kimberly D. Mueller<sup>1\*</sup> | Rebecca L. Kosick<sup>2</sup> | Bruce P. Hermann<sup>3</sup>  
 Sterling C. Johnson<sup>1,4</sup> | Lyn S. Turkstra<sup>5</sup>

- N=264 WRAP participants, 200 cognitively unimpaired stable, 64 with sub-clinical cognitive decline



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# Declines in metrics from one minute speech samples are associated with amyloid positivity from PET scans in cognitively unimpaired WRAP participants

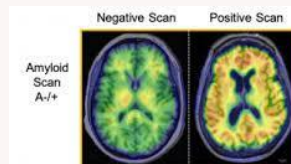
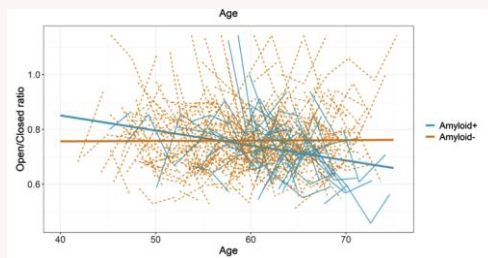
Received: 16 December 2020 | Reviewed: 2 April 2021 | Accepted: 3 May 2021 | Published online: 24 May 2021  
 DOI: 10.3389/fnagi.2021.522039

RESEARCH ARTICLE

**Amyloid beta associations with connected speech in cognitively unimpaired adults**

Kimberly D. Mueller<sup>1,2,3,4</sup> | Carol A. Van Hulle<sup>2,4</sup> | Rebecca L. Kosick<sup>2</sup> | Erin Jonaitis<sup>3</sup> |  
 Cassandra C. Peters<sup>1</sup> | Tobey J. Betthauser<sup>2,4</sup> | Bradley Christian<sup>5,6</sup> |  
 Nathaniel Chin<sup>2,3,4</sup> | Bruce P. Hermann<sup>3,7</sup> | Sterling Johnson<sup>2,3,4,8</sup>

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<sup>5</sup> Waisman Laboratory for Brain Imaging and Behavior, University of Wisconsin–Madison, Madison, Wisconsin, USA  
<sup>6</sup> Department of Medical Physics, University of Wisconsin–Madison, Madison, Wisconsin, USA



Amyloid PET - Image from Betthauser et al., 2020

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# Machine learning and automatic speech recognition validated against human transcription and coding


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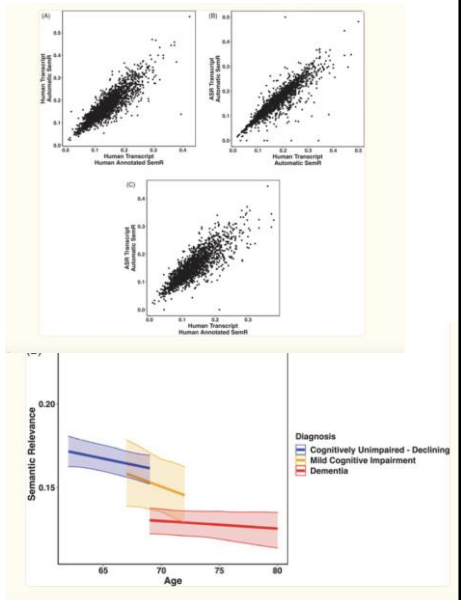


**Alzheimer's & Dementia**  
 Diagnosis, Assessment & Disease Monitoring

[Alzheimers Dement \(Amst\)](#), 2022; 14(1): e12294. PMID: PMC8865737  
 Published online 2022 Feb 23. doi: [10.1002/dad2.12294](#) PMID: [35229018](#)

**Automated semantic relevance as an indicator of cognitive decline: Out-of-sample validation on a large-scale longitudinal dataset**

[Gabriela Stegmann](#)<sup>1,2</sup>, [Shira Hahn](#)<sup>1,2</sup>, [Samarth Bhandari](#)<sup>2</sup>, [Kan Kawabata](#)<sup>2</sup>, [Jeremy Shefner](#)<sup>3</sup>, [Cayla Jessica Duncan](#)<sup>3</sup>, [Julie Liss](#)<sup>1,2</sup>, [Visar Berisha](#)<sup>1,2</sup> and [Kimberly Mueller](#)<sup>4,5,6</sup>



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## Potential cross-cultural functionality of speech analysis Evans, Coley, Gooding, Norris, Ramsey, Green-Harris & Mueller (2022)

- 48 Black/African American and 30 Non-Hispanic White WRAP participants residing in Milwaukee, Wisconsin
- Declines in connected language were associated with accelerated declines in cognition
- No differences in sensitive linguistic metrics between the two groups

> [Aphasiology](#). 2022;36(8):982-1005. doi: [10.1080/02687038.2021.1931801](#). Epub 2021 Jun 18.

**Preliminary assessment of connected speech and language as marker for cognitive change in late middle-aged Black/African American adults at risk for Alzheimer's disease**

[Elizabeth Evans](#)<sup>1</sup>, [Sheryl L Coley](#)<sup>2</sup>, [Diane C Gooding](#)<sup>3</sup>, [Nia Norris](#)<sup>2</sup>, [Celena M Ramsey](#)<sup>2</sup>, [Gina Green-Harris](#)<sup>2</sup>, [Kimberly D Mueller](#)<sup>4</sup>

Affiliations + expand  
 PMID: [36016839](#) PMID: [PMC9398189](#) DOI: [10.1080/02687038.2021.1931801](#)  
[Free PMC article](#)

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## What does it mean that subtle changes to speech are occurring in preclinical AD and potentially other dementias?

- Language is a cognitive domain that is affected early in AD, and most likely related dementias
- Language is necessarily dependent upon memory, executive function, social cognition
- Speaking is a functional activity of daily living, it is easy to do
- Can be collected at home, unsupervised
- Can speech diagnose AD or dementia? **NO**, but could be a screening tool or a disease monitoring outcome measure for clinical trials
- New NIA grant will determine feasibility and usability of remote speech collection from a subset of WRAP participants



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## Defining Episodes of Lucidity in Older Adults with Dementia through audiovisual recording, behavioral and linguistic analyses (PI Gilmore-Bykovskiy)

- “Lucid” episodes have been described in the literature through caregiver accounts. These episodes almost always include an aspect of **return of communication abilities** that were presumably lost.
- The NIA is interested in gathering objective data to define these moments, and ultimately study the neurobiology underlying these events
- Equally important, capturing and characterizing lucidity in individuals with dementia may result in improved treatment, by recognizing the **personhood that exists in people living with dementia** throughout their life course
- Gilmore-Bykovskiy lab at UW Madison is one of 5 NIA funded studies designed to study lucidity

> [Alzheimers Dement.](#) 2023 Jan;19(1):343-352. doi: 10.1002/alz.12709. Epub 2022 Jun 27.

### Toward harmonization of strategies for investigating lucidity in AD/ADRD: A preliminary research framework

[Andrea Gilmore-Bykovskiy](#)<sup>1 2</sup>, [Joan M Griffin](#)<sup>3 4</sup>, [Kimberly D Mueller](#)<sup>5 6</sup>, [Sam Parnia](#)<sup>7</sup>, [Ann Kolanowski](#)<sup>8</sup>

Affiliations + expand

PMID: 35757902 PMID: PMC9792622 DOI: 10.1002/alz.12709

[Free PMC article](#)

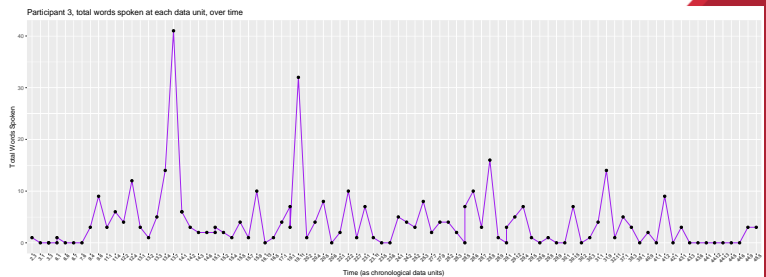
Abstract



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## Potential episode of lucidity, example

- Enrolled in early 2022
- 89-year old female living in hospice, retired CAN
- History of left cerebellar lacunar infarct
- ASHA-FACS questionnaire indicated that the participant "never" initiates verbal requests, uses names of familiar people, or follows simple verbal directions
- Over 96 different audiovisual data units, time series analysis



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## Diagnosis, intervention, and clinical practice implementation



<https://asha.org>



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## First line of defense: hearing

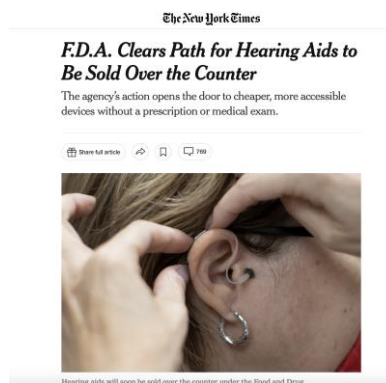
- 25% of 65-74 year olds have disabling hearing loss (NIDCD.nih.gov); 50% of those over 75 have disabling hearing loss
- Hearing health is one of the top 10 modifiable risk factors for dementia
- “You can’t remember stuff if you don’t hear it in the first place.” Nathaniel Chin, MD.
- Find an audiologist:  
<https://www.asha.org/profind/>



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## Over-the-counter hearing aids: improving access

- Available without a hearing test/prescription
- More affordable
- BUT, have not been tested in people living with cognitive impairment
- New R21 at UW Madison, in partnership with Mayo Clinic at LaCrosse and Northwestern University; will be enrolling people with MCI and mild dementia to test communication benefit with OTC hearing aids



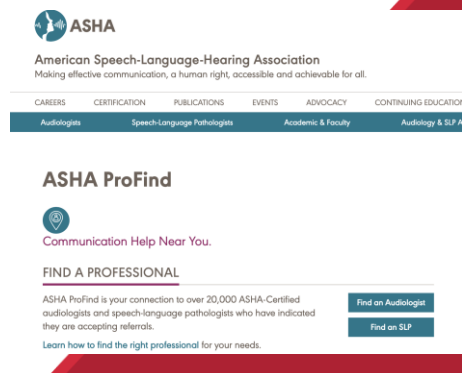
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## What about communication?

- Speech-language pathologists are trained to provide cognitive-communication interventions
  - For those with MCI, a neuropsychological approach (taking advantage of intact brain networks and training on memory and word retrieval)
  - Supportive interventions
    - Caregiver communication training
    - Calendar systems, assistive and adaptive communication systems, environmental supports and cues
    - Memory books and wallets
    - Spaced retrieval training of specific targets

Find an SLP:

<https://www.asha.org/profind/>



The screenshot shows the ASHA ProFind website. At the top, it says "ASHA American Speech-Language-Hearing Association Making effective communication, a human right, accessible and achievable for all." Below this is a navigation menu with categories: CAREERS, CERTIFICATION, PUBLICATIONS, EVENTS, ADVOCACY, and CONTINUING EDUCATION. Underneath, there are sub-categories: Audiologists, Speech-Language Pathologists, Academic & Faculty, and Audiology & SLP A. The main heading is "ASHA ProFind" with the tagline "Communication Help Near You." Below that, it says "FIND A PROFESSIONAL" and "ASHA ProFind is your connection to over 20,000 ASHA-Certified audiologists and speech-language pathologists who have indicated they are accepting referrals." There are two buttons: "Find an Audiologist" and "Find an SLP". At the bottom right, there is a small circular logo with a red 'W' on a white background.

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## Ensure that language testing is included in neuropsychological test battery, and listen to subjective language complaints

- If language scores are disproportionately low as compared to other cognitive domains, consider referral to SLP (may be PPA, particularly logopenic variant)
- If not, consider referral to SLP
- Provide communication care handouts

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## Consider person-centered recommendations for external communication aids (Hickey & Douglas, 2021)

I wear hearing aids to help me communicate.



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## Consider providing a culturally responsive, ethnographic approach to recommendations

### Mes feelings

Acadian		English
J'su content	😊	Happy
J'su excite	😄	Excited
J'su surpris	😮	Surprised
J'su disappointé	😞	Disappointed
J'su ménnuie	😓	Lonely
J'su sad	😞	Sad
J'su worrié	😟	Worried

### Nepali translations for my care

Nepali phrases written so you can sound them out.	
Hello/Goodbye	Na-mas-te
My name is (name)	Mero nam (name) ho
How are you doing?	Kasto cha
Excuse me	Su-nus-ta
Thank you	Dhanya-bad
Beautiful	Ram-ro-cha
Help	Ma-dat-cha-heen-cha
Tea	Chiya
Do you have pain?	Gaha du-khay-ko-cha
Do you want more?	Khana-ar-cha-heen-cha



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## Summary

- Language and communication are likely affected throughout the Alzheimer's disease continuum
- Speech sample analysis may be a sensitive screening or disease monitoring tool for clinical trials
- Communication analysis may lead to better understanding of lucid episodes in people living with dementia
- Cognitive-communication therapy or approaches are appropriate throughout the disease continuum



William Schatner is a spokesperson for hearing health due to his own struggles with tinnitus (<https://local21news.com>)



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## Acknowledgements

- Wisconsin Registry for Alzheimer's Prevention Study Participants
- Wisconsin Alzheimer's Institute
- Wisconsin Alzheimer's Disease Research Center
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- Dr. Rebecca Langhough
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  - Erin Bruehlman
  - Claire Terp
  - Camryn Streid
  - Olivia Goulette
  - Alayna Miller
  - Douglas Cowman
  - Caitlyn Miller
  - Caroline Downey
  - Lauren Collins
  - Elizabeth Evans



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## Questions



<https://www.theaustralian.com.au>

<https://www.irisseniorliving.com/senior-living/tx/rowlett/miller-rd/blog/?article=intergenerational-programs-in-memory-care-part-one>

<https://montessoridementia.org/blog/using-montessori-techniques-caring-elderly>

