

The Relationship Between Verbal Fluency and Connected Language in Probable Alzheimer's Disease

Stacy A. Kenney

Advisor: Amy E. Ramage
Communication Sciences and Disorders

Background

- Alzheimer's disease (AD) results in devastating deterioration of multiple cognitive processes that are evident in language abilities very early in the disease progression.
- Verbal fluency is one such measure that is often impaired in those with AD because it relies on frequently compromised cognitive skills such as memory for semantic storage of words, and executive functioning for search and retrieval strategies, thus relying heavily on working memory [1].
- Connected language also relies on executive functions necessary for not only accessing semantic storage of words but also for generating a message, function assignment, constituent assembly and verb inflection, as well as phonological encoding for expression [1].

Specific Aims

- To do an in-depth examination of the relationship between verbal fluency and connected language in probable AD.
- To determine whether and how well verbal fluency and connected language scores predict mild cognitive impairment and probable AD group membership.

Methods

- Auditory recordings of connected language (Cookie Theft Picture Description task [2]) and verbal fluency samples (Animal Naming) were acquired from the DementiaBank Pittsburgh Corpus [3] for use in this study.
- Repository included test results for the Mini-Mental Status Exam (MMSE), Blessed Dementia Scale, and Hamilton Depression Scale to discriminate participants. Groupings for AD participants were based on the MMSE: 30-24 Mild, 23-18 Moderate, 17-0 Severe [6,7].
- The Animal Naming fluency task was scored for total number of animals named, repetitions, and paraphasias [4]. Reliability across two trained raters was excellent ($ICC_{1,K} = 0.991$).
- Picture description samples were transcribed by researchers contributing to the TalkBank repository using Computer Language Analysis (CLAN) software [5]. MOR was used to characterize morpho-syntactic language metrics for each transcript [5].
- Pearson correlations were computed between verbal fluency score and the MOR output variables for each group.
- Ordinal linear regression determined which variables best predicted group membership: MCI, mild MMSE, moderate MMSE, or severe MMSE subgroups.

Participants

	MCI	MMSE Groups		
		Mild	Moderate	Severe
n	17	16	50	30
Age ^a	67	74	70	73
Gender (M:F) ^a	9:8	7:9	15:35	11:19
MMSE	27	25	20	13
Years of Education ^b	15	12	12	11
Blessed ^b	1.24	5	7	8
Hamilton Depression Scale ^a	3.75	5	6	6

Table 1. ^aNo group differences for age, gender, or Hamilton Depression Scale [8]
^bMCI differed significantly from all other groups ($ps < .0001$).

Language Performance

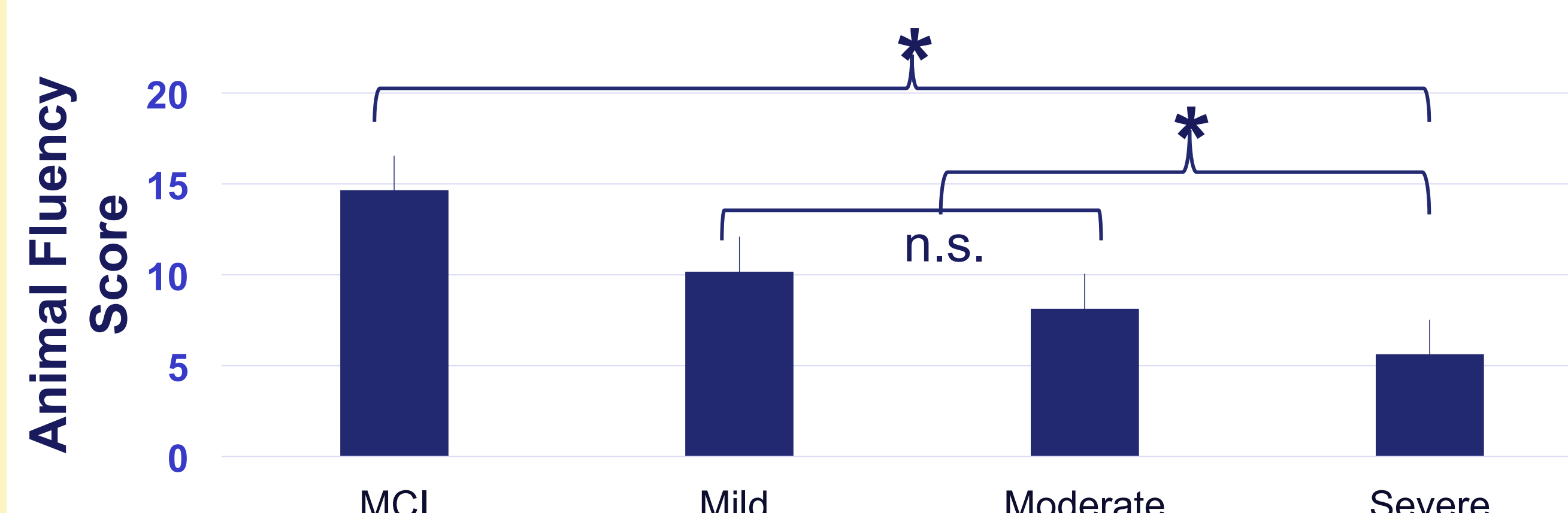


Figure 1. The relationship between verbal fluency and classification of subgroups.

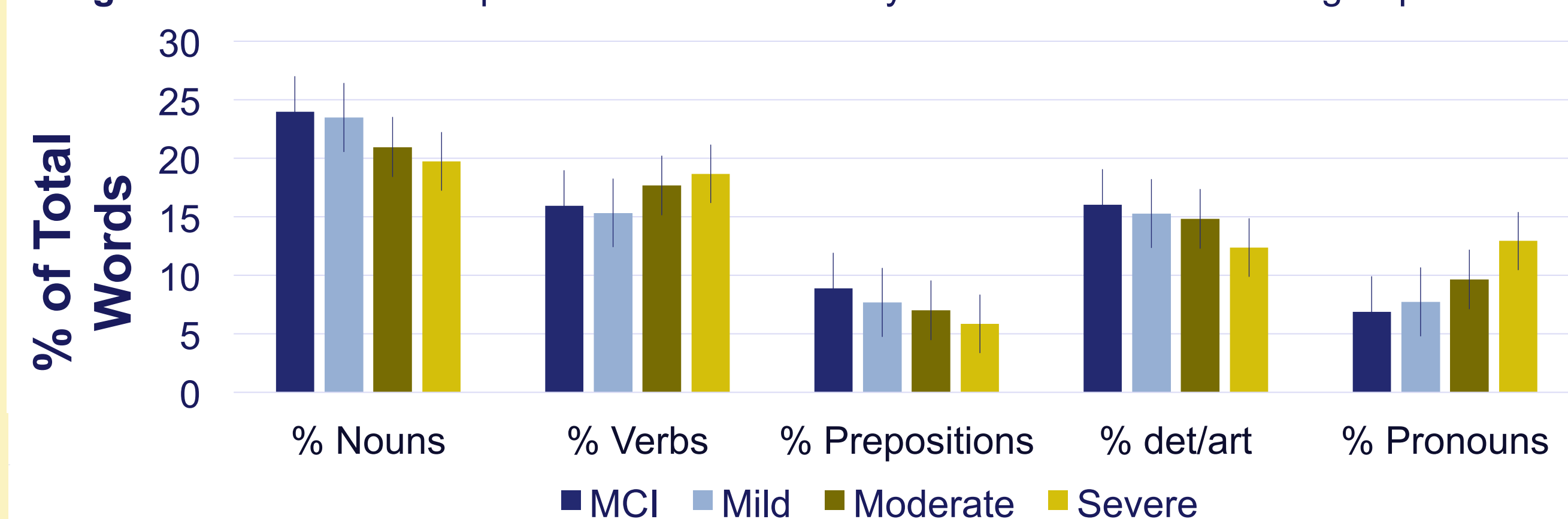
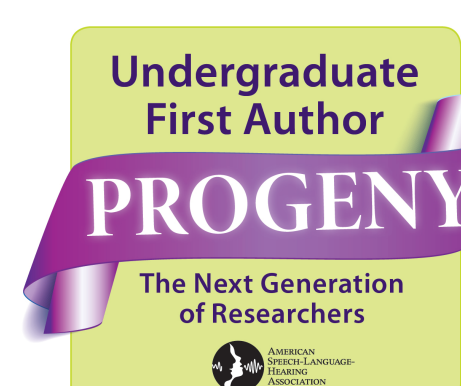


Figure 2. Verbal fluency and morpho-syntactic differences by subgroup.
Nouns: MCI = Mild > Severe
Verbs: MCI and Mild < Severe; Mild < Moderate
Prepositions: MCI and Mild > Severe; MCI > Moderate; Determiners/Articles: MCI = Mild = Moderate > Severe
Pronouns: MCI < Moderate & Severe, Mild < Severe
 * The groups did not differ for any of the mean length of utterance, frequency of word type/token, duration, speed or error measures (all $ps > .05$).

References

- Mueller K. D., Kosick RL, Hermann BP, Johnson SC and Turkstra LS (2018) Declines in Connected Language Are Associated with Very Early Mild Cognitive Impairment: Results from the Wisconsin Registry for Alzheimer's Prevention. *Front. Aging Neurosci.* 9:437. doi: 10.3389/fnagi.2017.00437
- Goodglass, H., & Kaplan, E. (1983). Boston Diagnostic Aphasia Examination (BDAE). *Psychological Assessment Resources*.
- Becker, J. T., Bolter, F., Lopez, O. L., Saxton, J., & McGonigle, K. L. (1994). The natural history of Alzheimer's disease: description of study cohort and accuracy of diagnosis. *Archives of Neurology*, 51(6), 585-594.
- Morris, J. C., Heyman, A., Mohs, R. C., Hughes, J. P., van Belle, G., Fillenbaum, G., ... Clark, C. (1989). The consortium to establish a registry for Alzheimer's disease (CERAD): I. Clinical and neuropsychological assessment of Alzheimer's disease. *Neurology*, 39, 1159-1165.
- MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.
- Folstein, M., Folstein, S., & McHugh, P. (1975). "Mini-mental state": A practical method for grading the clinician. *Journal of Psychiatric Research*, 12(3). doi: 10.1016/0022-3956(75)90028-6
- Tombaugh, T. N., & McIntyre, N. J. (1992). The Mini-Mental State Examination: A Comprehensive Review. *Journal of the American Geriatrics Society*, 40(9), 922-935. doi:10.1111/j.1532-5415.1992.tb01992.x
- Hamilton, M. (1960). A rating scale for depression. *J Neurol Neurosurg Psychiatry*.
- Meng, X., & O'Aray, C. (2010). Education and Dementia in the Context of the Cognitive Reserve Hypothesis: A Systematic Review with Meta-Analyses and Qualitative Analyses. *PLoS ONE*, 7(6). doi:10.1371/journal.pone.0038268
- Venneri, A., Miltole M, De Marco M. Paradigm shift: semantic memory decline as a biomarker of preclinical Alzheimer's disease. *Biomark Med.* 2016; 10:5-8.



Effect	Point Estimate	95% Confidence Limits		Parameter Estimates	Sig.
		Lower	Upper		
Age	0.996	0.953	1.041	0.001	.967
Sex (F vs. M)	0.738	0.312	1.746	0.268	.562
Education	0.767	0.661	0.889	-0.248	.001
% Pronouns	1.183	1.052	1.330	0.147	.049
% Nouns	1.067	0.958	1.187	0.109	.095
Verbal Fluency	0.768	0.694	0.850	-0.263	.000

Table 2. Variables that predicted group membership from ordinal linear regression.

↑ Years of Education	↓ Likelihood Severe
↑ Verbal Fluency Score	↓ Likelihood Severe
↑ Percent Pronouns	↑ Likelihood Severe
↑ Percent Nouns	↑ Likelihood Severe
↑ Age	↑ Likelihood Severe

Table 3. A representation of how variables predicted group membership.

Conclusion

- Verbal fluency correlated with connected language metric differently in each group, specifically in the mild AD group in whom verbal fluency correlated with the percentage of nouns, prepositions, pronouns, and adverbs to total words produced.
- Age, years of education, percent pronouns and nouns, and verbal fluency score were most predictive of group membership.
- Education is thought to increase *cognitive reserve*, which appears to slow the deterioration of cognitive processes [9].
- Verbal Fluency relies on executive functioning such as word storage and retrieval that declines in disease progression [1].
- Use of a higher percentage of pronouns to total words is predictive of severe AD group membership. The use of the less descriptive pronoun (e.g., "she") for a more descriptive noun ("the woman") may be indicative of impaired lexical retrieval/access with diminished semantic memory. This is likely a reflection of the deterioration of transentorhinal, medial temporal cortex with advanced AD pathology [10].