Timed Oral Cognitive Tests Predict Brainstem Dysfunction Complaints

Jeffrey G. Portnoy[1], Marnina B. Stimmel[1], Roseann Archetti[1], and Frederick W. Foley[1,2]

[1]Ferkauf Graduate School of Psychology, Yeshiva University, Bronx, NY; [2]Holy Name Medical Center, MS Center, Teaneck, NJ

Abstract

Objectives: Examine the relationship between timed oral tests of cognition and complaints associated with brainstem dysfunction.

Methods: Patients who had undergone neuropsychological testing (N = 66) were examined via retrospective chart review. Patients completed orally administered neurocognitive measures as part of a neuropsychological battery. Kendall's τ correlations were computed to examine the relationship between the neurocognitive measures and Incapacity Status Scale (ISS) items on feeding and speech/hearing. Ordinal regressions examined predictive models of these disability items using three neurocognitive measures: the symbol digit modalities test (SDMT), Controlled Oral Word Association Test (COWAT), and the Stroop Color and Word Test.

Results: Significant correlations were noted between at least one brainstem disability item and six neuropsychological tests. Models using the SDMT, COWAT, and Stroop significantly predicted scores on both feeding and speech/hearing items.

Conclusions: A strong predictive relationship exists between timed oral cognitive tests and subjective complaints of brainstem dysfunction. In patients with impaired production of speech, such tests may be skewed measures of cognitive function; however, such tests could possess previously unseen value as objective measurements of disordered brainstem activity.

Background

Many neuropsychological tests have been validated for the assessment of cognitive function in multiple sclerosis (MS). While these tests are typically used to evaluate the underlying features of complex cognition, such as processing speed, attention, and language, they place additional demands on speeded brainstem activity,[1,2] which may give them additional clinical value as potential predictors of complaints related to brainstem dysfunction, such as dysarthria and dysphagia. Furthermore, these tests may be less appropriate neurocognitive measures for patients whose performance is rate-limited by difficulties with speech production.

Methods

- Charts of 66 MS patients were examined. All patients received a neuropsychological battery, including the SDMT, Brief Visuospatial Memory Test (BVMT), Stroop, COWAT (FAS and Animals), California Verbal Learning Test (CVLT), and Paced Auditory Serial Addition Test (PASAT).

	M	*SD*	Range
Age (years)	45.71	12.47	18 – 77
Duration of illness (years)	6.19	5.78	0 – 21
Gender	Female: *n* = 49 (74.2%)	Male: *n* = 17 (25.8%)	
Ethnicity	White or Caucasian: *n* = 49 (74.2%)	Black or African-American: *n* = 9 (13.6%)	Non-White Hispanic/Latino: *n* = 8 (12.1%)

- Kendall's τ correlations compared neuropsychological tests to two ISS items with hypothesized relationships to brainstem function: Feeding, and Speech/Hearing.
- Ordered logit regression models were used to assess the predictive strength of timed tests requiring oral responding on these two items. Tests spanned multiple cognitive domains (attention, processing speed, set shifting, and phonemic and semantic fluency).

Results

- Feeding correlated significantly with patients' scores on the SDMT (τ = –.228, p = .022), BVMT (τ = –.216, p = .027), Stroop (τ = –.266, p = .009), PASAT-3 (τ = –. 396, p < .001), and PASAT-2 (τ = –. 268, p = .018).
- Speech/hearing correlated significantly with patients' scores on the SDMT (τ = –.255, p = .012), FAS (τ = –.344, p < .001), Animals (τ = –.315, p = .002), and CVLT (τ = –.191, p = .049).
- Ordinal regression using SDMT, FAS, Animals, and Stroop as predictors explained significant amounts of variance in responses to Feeding (Nagelkerke R^2 = .438, p = .001) and Speech/Hearing (Nagelkerke R^2 = .335, p = .001).

Conclusions and Limitations

- While the ISS as a whole has been validated, the individual Feeding and Speech/Hearing items have not been validated as independently reliable measures of these functions.
- Brainstem dysfunction is a potential cause of impairment in feeding behaviors (as in dysphagia) and speech/hearing (as in brainstem-mediated dysarthria and hearing impairment). However, there is a complex system of motoric demands for these behaviors, and non-brainstem lesions or non-MS etiology were not ruled out in this study.
- Neurocognitive tests which are scored on the ability of the patient to rapidly produce oral responses are often chosen in MS for their ability to circumvent the need for patients to make fine upper-limb motor movements, which can often easily be observed as impaired. However, complaints such as dysarthria, hearing loss, and dysphagia are suggestive of difficulty perceiving auditory stimuli or producing quick oral responses to cognitive tasks. Just as motor dysfunction is treated as a confounding variable in written tasks, the presence of brainstem-related or other oral communicative difficulty must be considered in the interpretation of oral tests, which may not accurately represent functioning in the intended cognitive domain.
- Objective analysis of deficits in vocal communication or dysphagia is more challenging than in motor function, for which many reliable and valid tests exist. The development of such tests in the future might involve timed oral responding, but without the demands placed on the patient's functioning in particular cognitive domains.

References

1. Nygaard, G. O., Benavent, S. A., Harbo, H. F., Laeng, B., Sowa, P., Damangir, S., . . . Celius, E. G. (2015). Eye and hand motor interactions with the Symbol Digit Modalities Test in early multiple sclerosis. *Multiple Sclerosis and Related Disorders, 4*(6), 585-589.
2. Garrard, P., Bradshaw, D., Jager, H., Thompson, A., Losseff, N., & Playford, D. (2002). Cognitive dysfunction after isolated brain stem insult. An underdiagnosed cause of long term morbidity. *Journal of Neurology, Neurosurgery & Psychiatry, 73*(2), 191-194.