Phonemic Cued Performance on the Boston Naming Test: Correlates and Longitudinal Change in Alzheimer's disease

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Introduction

The Boston Naming Test (BNT) is a commonly administered neuropsychological measure that evaluates the ability of a patient to name a line drawing either spontaneously or under cued conditions (Goodglass & Kaplan, 2001). This task has been studied extensively in dementia populations. For example, in patients with Alzheimer's disease (AD), spontaneous performance is generally found to be impaired (Randolph et al, 1999). Furthermore, differential performance on naming in persons with and without the APOE-4 genotype in preclinical populations has been documented (Miller, Rogers, Sidarth & Small, 2005). What has not been characterized in the literature is the benefit AD patients derive from phonemic cueing on the BNT. The purpose of the current project is to 1) describe the nature of cueing improvement in individuals with AD, 2) investigate the relationship between cueing and other neuropsychological measures, and 3) evaluate the change in cueing over time and in individuals of differing genetic profiles.

Participants

Participants in this study (N=152) were selected from a larger data base of patients from the Baylor College of Medicine Alzheimer's Disease Center (see Doody et al, 2005 for further description). Inclusion criteria included meeting NINCDS-ADRDA criteria for probable AD (McKhann et al., 1984) and completion of a comprehensive neuropsychological evaluation including the BNT at baseline and at a 9 – 24 month follow-up. In order to avoid ceiling effects on the BNT phonemic cued improvement measure, only individuals whose baseline BNT scores were <= 50 were included. Dementia severity at baseline was mild- to moderate as established by the Mini Mental Status Exam (MMSE) (M= 21.9, SD=3.5) and follow-up. Patient demographics can be found in Table 1.

Method

All subjects were administered a comprehensive neuropsychological evaluation by a trained psychometrist supervised by a licensed clinical neuropsychologist. The following neuropsychological instruments were utilized in the current study: BNT, Letter fluency (FAS: Benton & Hamsher, 1978), Category Fluency (Animals: Newcombe, 1969), Verbal IQ from the Wechsler Adult Intelligence Scales- Revised (WAIS-R; Wechsler, 1981), Logical Memory I and II from the Wechsler Memory Scale- Revised (Wechsler, 1987), and Sequential Commands from the Western Aphasia Battery.

To determine the benefit subjects derived from phonemic cueing on the BNT, a Phonemic Cueing Improvement index (PCI) was derived as described in Table 2. Annual rates of change on all measures were also calculated by the formula described in Table 2.

Table 1: Participant Characteristics

Variable	M	SD
Age	75.61	6.05
Years of Education	13.47	3.17
Time Between Visits (yr.)	1.18	0.23
% Female	70.40%	
% Caucasian	90.80%	
AMNART	106.05	13.61
MMSE	21.85	3.52

Table 3: Naming and Other Neuropsychological Test Performances at Baseline and Follow-up

Variable	Baseline	Follow-up
BNT- No Phonemic Cues	35.83(10.12)	31.85(13.15)
Improvement with Cues	7.27(3.43)	6.38(3.87)
PCI	.36 (.19)	.32(.24)
Animal Fluency- Raw	7.89(3.90)	6.27(3.61)
FAS- Raw	21.32(10.74)	18.65(10.67)
WAIS-R VIQ	87.73(34.59)	85.56(15.47)
LM I	4.52(4.35)	4.36(5.27)
LM II	.84(1.78)	1.02(2.50)
WAB- Commands	67.82(19.84)	64.59(23.72)

Table 4: Correlations Between PCI and Other Neuropsychological Measures at Baseline

BNT Total	.87**
MMSE	.28**
Animal Fluency- Raw	.22**
FAS- Raw	.29**
WAIS-R VIQ	-.06
WAB- Commands	.04

Table 2: Formulas for Phonemic Cued Improvement and Annual Rate of Change

$$\text{Phonemic Cued Improvement (PCI)} = \frac{\text{\# Correct with Phonemic Cues - \# Correct Without Phonemic Cues}}{\text{60- \# Correct Without Phonemic Cues}}$$

$$\text{Annual Rate of Change} = \frac{\text{Score at Baseline - Score at Follow-up}}{\text{Time Interval}}$$

Results

Mean scores for neuropsychological measures are reported in Table 3. Patients in the present study showed an average improvement of approximately 7 points with phonemic cueing, which is slightly higher than previously published accounts (i.e. 5 point improvement noted in Randolph et al, 1999). Correlational analysis of baseline performances among measures is reported in Table 4. PCI correlated strongly with measures of fluency and memory, as well as with overall dementia severity. Next, annual rates of change for included measures were evaluated (Table 5). Again, deterioration on semantic and phonemic fluency measures was strongly associated with less benefit derived from phonemic cues as measured by the PCI over time. Baseline PCI did not correlate significantly with the annual rates of change on other measures.

As previous research has indicated that the presence of the APOE-4 allele may be related to verbal difficulties in preclinical AD populations (Miller et al, 2005), it was hypothesized that the presence of this genotype may be differentially related to changes in PCI over time. To evaluate this hypothesis, a 2 x 2 repeated measures MANOVA was performed with genotype (+ APOE-4 (N=78), -APOE-4 (N=47)) serving as the between subject factor and time (baseline and follow-up) serving as the within subject factors. The MMSE, PCI, Animal fluency, FAS, and uncued BNT performance served as dependent measures. A significant main effect was found for time ($F(5, 119) = 11.1$, $p < .001$) and genotype ($F(4, 120) = 2.8$, $p = .057$) trended toward significance. Between subject effects (Table 6) revealed that APOE + individuals benefited more from cueing and produced more words on phonemic fluency despite being at the same level of dementia severity as individuals without the APOE-4 allele. Differences in uncued BNT performance and animal fluency were not statistically significant. As this was an unexpected finding given previous research, T-tests were conducted on other baseline neuropsychological measures. Interestingly, the APOE-4+ > APOE-4- finding was not established for other measures, and scores on tasks such as logical memory I and II were generally higher in the APOE-4 – group although not to a statistically significant degree. No demographic differences were found between the genotype groups.

Table 6: Average Performance on Measures Over Time in APOE-4 Genotypes

	APOE- Mean(SD)	APOE+ Mean(SD)	F(1)	p
MMSE	20.39(.54)	20.27(.42)	0.03	ns
BNT Uncued	31.52(1.65)	34.99(1.28)	2.78	ns
PCI	0.30(.03)	0.37(.02)	4.30	p<.05
Animals	6.33(.47)	7.39(.36)	3.12	ns
FAS	18.3(1.4)	22(1.1)	4.23	p<.05

Table 5: Correlations Between PCI (Baseline and ARC) and ARC of Neuropsychological Measures

Variable	Correlation (r) with Baseline PCI	Correlation (r) with PCI ARC
BNT Total	-.06	.53**
MMSE	.04	.14
Animal Fluency- Raw	.13	.26**
FAS- Raw	.11	.22**
LM I	.08	.05
LM II	-.13	-.06
WAIS-R VIQ	.11	.15
WAB- Commands	.08	.15

* p <=.05 ** p<=.01

ARC= Annual Rate of Change

Conclusions

The improvement derived from phonemic cueing on the BNT is strongly associated not just with its parent measure (BNT) but also with verbal fluency measures. This suggests that all of these measures assess the integrity of semantic memory stores. Supporting this fact is the rate of change on these measures is strongly associated, and is not associated with changes in overall dementia severity.

Previous research has documented slower progression on dementia and daily living measures in AD patients who are positive for APOE-4. In the current study semantic memory measures were generally better in the APOE-4+ group than the negative group across time. In addition, these individuals also benefited significantly more from cueing on the BNT. This finding, if replicated, suggests that individuals with the APOE-4 allele may be experiencing a significantly greater retrieval problem than a semantic memory deficit at this stage of the disease process. Thus, on measures were a phonemic "cue" is given in the form of a letter on fluency measures or a phoneme on the BNT, performance is actually improved. On free recall measures, this advantage does not materialize. Alternatively, this finding could be the result of sample selection. Because of the possibility of ceiling effects, individuals with BNT scores greater than 50 were omitted. This may have led to selection of APOE-4 negative patients with relatively intact retrieval networks being omitted from the sample.