Patterns of Decline on Language Testing in Primary Progressive Aphasia

Abstract

The aim of this study was to investigate patterns of decline on language testing in subtypes of primary progressive aphasia (PPA) and to examine the effects of other variables on rate of decline. Forty-six patients with PPA (mean age = 66.9 $\pm$ 6.6; 27 female; mean education = 16.4 $\pm$ 2.8) completed language testing. PPA subtypes were not distinguishable by rapidity of decline; however, there were different patterns of performance on language testing. Age and education did not affect rate of decline on any test. These results have implications for patient/family education regarding language deterioration and future planning.

Introduction

Primary progressive aphasia (PPA) is a language disorder characterized by insidious onset and gradual deterioration of language manifested by deficits in word finding, word usage, word comprehension, or sentence construction associated with atrophy of the frontal and temporal regions of the left hemisphere (Mesulam, 2001; 2013). PPA is comprised of three main variants, each with specific clinical features and pathophysiology. Nonfluent agrammatic PPA (nfaPPA) is characterized by core features of agrammatic language production and/or apraxia of speech. Imaging abnormalities are present in left posterior frontal and insular regions. The semantic variant (svPPA) is defined by anomia and single-word comprehension deficits associated with atrophy in ventrolateral anterior temporal lobes bilaterally, usually greater on the left. Speech fluency, syntax, and word repetition are preserved. The logopenic variant (lvPPA) is defined by word retrieval and sentence repetition deficits. Single word comprehension is

relatively preserved. Imaging abnormalities are seen in the left temporoparietal junction (Gorno-Tempini, Hillis, Weintraub et al., 2011).

While these variants have been well described cross-sectionally, they tend to become more alike over time. Moreover, within variants, there is wide variation in the rate of decline. Individuals with PPA and their families most want to know what to expect, and when. The aim of this study was to investigate patterns of decline on language testing in each of these clinical subtypes and to examine the effects of other variables (i.e., age, education, handedness, gender, antidepressant medications, language rehabilitation) on rate of decline. We hypothesized that higher education would be associated with slower decline, and older age with faster decline.

Methods

Participants

Forty-six patients with PPA (mean age = 66.89 $\pm$ 6.621; 27 female; mean education = 16.39 $\pm$ 2.777) were enrolled. PPA subtype was identified when possible on the basis of history, comprehensive neurological examination, imaging, and a battery of language tests. Patients were classified using consensus criteria for each variant (Gorno-Tempini et al., 2011). Participants who did not meet the criteria for any subtype were judged to be unclassifiable (unC). See Table 1 for distribution across the variants.

Materials

Participants underwent language assessment (see Table 2) on at least two occasions. Here we focus on decline on three tests: Boston Naming Test, short form (BNT, Kaplan, Goodglass, & Weintraub, 2001; Mack, Freed, Williams, & Henderson, 1992); Hopkins Assessment of Naming Actions (HANA, Lala, Race, Tsapkini, & Hillis, 2012), and the Pyramids and Palm Trees Test, short form (PPT; Howard & Patterson, 1992; Lala et al., 2012).

Data Analysis

We defined decline on each test as: % correct at the final test session minus % correct at the initial test session. We defined rate of decline as: decline divided by number of months between initial and final test sessions. We defined rapid decliners on a given test as those in the lowest quartile for rate of decline (most negative change per month). We defined slow decliners as those who were in the highest quartile for rate of decline (least negative change per month). We used linear regression to test the association between rate of decline on each test and continuous measures (age, education). We used logistic regression and chi square to identify associations between dichotomous variables and quartiles of decline. We tested differences in mean rate of decline between PPA variants using ANOVA.

Results

There were no differences between PPA variants in the mean rate of decline on any test, perhaps because of low power and bimodal distribution of scores on each test. Nevertheless, the mean rate of decline on the HANA was highest in the nfaPPA group; the mean rate of decline on the short form of the PPT was highest in the svPPA group; and the mean rate of decline on the BNT was highest in the lvPPA group (Table 3; Figure 1). There were rapid decliners and slow decliners among all three variants and among unclassifiable PPA participants in all three tests (Tables 4a-c). The distribution among variants across quartiles did not differ significantly by chi square; but there was a trend for more rapid decliners (the most rapid quartile of change) on the PPT among those with svPPA (chi square=3.4; p=0.058). The highest percentage of rapid decliners on the HANA was in the nfaPPA group; the highest percentages of rapid decliners on the BNT were in the lvPPA and svPPA groups; and the highest percentage of rapid decliners on the PPT was in the svPPA group.

There was no tendency for an effect of age or education on rate of decline on any test. There was no difference between average rate of decline or percentage of rapid and slow decliners for right or left handers, men versus women, or participants who were versus were not taking antidepressants, memantine, or cholinesterase inhibitors. There were few rapid decliners among participants taking cholinesterase inhibitors on the short form of the PPT, but this observation can entirely be accounted for by the fact that generally only participants with lvPPA are prescribed cholinesterase inhibitors (because they typically have Alzheimer's disease pathology), and they rarely showed rapid decline on the PPT. There was a tendency for those involved in language rehabilitation to show slower rate of decline on the BNT compared to individuals receiving no rehabilitation (-0.59% vs. -1.96% per month; ns).

Discussion

As expected, there was decline in performance on all language tests in all subtypes of PPA. PPA subtypes were not distinguishable by rapidity of decline; however, there were different patterns of performance on language testing. Rate of decline and percentage of rapid decliners were highest on the HANA in nfaPPA, on the PPT in svPPA and on the BNT in lvPPA. Percentage of rapid decliners was also high on the BNT in svPPA. These results were consistent with previous reports indicating that individuals with nfaPPA decline more rapidly in action than object naming while those with svPPA show the opposite pattern (Grossman, 2002; Hillis, Oh, & Ken, 2004; Thompson, Lukic, King, Mesulam, & Weintraub, 2012) and those with svPPA show most notable decline in object semantics (Corbett, Jefferies, Ehsan, & Lambon Ralph, 2009).

Surprisingly, age, education, and handedness were not important prognostically for individuals in this study. These variables are typically considered in estimating recovery from stroke. There were slow and rapid decliners within each variant of PPA, but we were not able to

identify the critical variables that distinguished them. Further study of prognostically relevant variables is indicated in this population. It is possible that imaging variables or genetics may prove to be useful in predicting those who will show rapid or slow decline. The ability to predict decline in function, and thus advise family members and caregivers regarding future planning, would be invaluable clinically.

Finally, there was a tendency for those who received speech-language pathology intervention to have a slower rate of decline on the BNT. Word retrieval is an easily identifiable therapy target, especially for those with svPPA and lvPPA. However, other language functions may be more appropriate for intervention based upon the differing patterns of test performance among PPA subtypes. This finding also supports referral for speech-language pathology intervention for those with PPA, a practice which may not be routine in the setting of neurodegenerative disease.

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Table 1: Age and education in years for PPA subtypes and for participants overall

PPA Variant	**Age** Mean (SD)	**Education** Mean (SD)
NFA PPA N = 6	66.33 (5.428)	17.17 (2.401)
SV PPA N = 13	65.31 (6.613)	15.00 (2.708)
LV PPA N = 13	68.85 (6.296)	17.38 (2.219)
UnC N= 14	66.79 (7.547)	16.43 (3.155)
Total N = 46	66.89 (6.621)	16.39 (2.777)

Table 2: Tests on the Primary Progressive Aphasia Battery

Benson Figure Copy
Verbal Fluency: Phonemic Test
Word Reading Test
Benson Complex Figure Delay
Benson Figure Recognition
Semantic Word-Picture Matching Test
Semantic Associates Test
JHU Sentence Anagram Task
Sentence Repetition Test
Pyramids and Palm Trees-short
Kissing and Dancing
Sentence Reading Test
Spelling to Dictation
Boston Naming Test-short
Hopkins Assessment of Naming Actions
Berndt
Cinderella Story
Cookie Theft Picture Description (BDAE)
Apraxia Battery for Adults
Social Norms Questionnaire (SNQ22)

Table 3: Mean rate of decline on language test scores for PPA subtypes and participants overall

PPA Variant	**BNT** Mean (SD)	**HANA** Mean (SD)	**PPT** Mean (SD)
NFA PPA	-0.1741 (0.44568)	-2.6490 (3.47544)	-0.3130 (0.48941
SV PPA	-0.9137 (1.11482)	-1.6003 (3.22219)	-2.0296 (4.13074)
LV PPA	-1.7226 (3.32275)	-0.9708 (0.95102)	-0.7472 (1.03876)
UnC	-2.6864 (4.81760)	-1.1586 (1.44045)	-0.2877 (0.65767)
Total	-1.5942 (3.26851)	-1.5220 (2.27606)	-1.0078 (2.55306)

Tables 4a-c:

BNTdeclineQuart * PPAvariant Crosstabulation

Count

		PPAvariant				
		nfa	sv	lv	unc	Total
BNTdecline Quartile	1	0	2	2	2	6
	2	0	2	2	3	7
	3	2	1	0	2	5
	4	2	1	4	1	8
	Total	4	6	8	8	26

HANAdeclineQuartile * PPAvariant Crosstabulation

Count

		PPAvariant				
		nfa	sv	lv	unc	Total
HANAdecline Quartile	1	2	1	1	2	6
	2	1	0	2	3	6
	3	1	2	1	3	7
	4	1	2	1	1	5
	Total	5	5	5	9	24

PPTdeclineQuartile * PPAvariant Crosstabulation

Count

		PPAvariant				
		nfa	sv	lv	unc	Total
PPTdecline Quartile	1	0	5	2	1	8
	2	1	4	2	3	10
	3	1	0	2	0	3
	4	3	4	4	6	17
	Total	5	13	10	10	38

Figure 1: Mean rates of decline on language test scores for PPA subtypes and participants overall