Assessment of semantic processing of words in aphasia: A multi-measurement approach

Introduction

Comprehension and production of single words involves the processing of phonological and semantic representations. In aphasia, processing one or both aspects of a word's representation is invariably affected to varying degrees, and the extent of impairment determines the severity and character of the naming and comprehension deficit (e.g., Lambon Ralph, Moriarty & Sage, 2000). Therefore, accurate assessment of abilities in each of these domains has implications for both clinical and research endeavors.

Accurate assessment requires comparison against a reference group. Yet tests that are appropriate for persons with aphasia often produce ceiling or restricted-range performance in nonaphasic controls; we advocate that a large, unselected sample of persons with aphasia be used instead as the reference group. Accurate assessment further demands an effort to minimize irrelevant sources of variation by acquiring multiple measures of the processing domain in question (semantic or phonological).

This paper aims to facilitate accurate and comprehensive testing of the multiple operations involved in semantic processing of words and pictures. Data are presented on five measures of semantic processing that have been collected from large samples of individuals with diverse aphasia presentations. Measures of central tendency and performance ranges are presented, for readers to use in the calculation of standard scores (e.g., z-scores (1.1) and composite scores (1.2)).

1.1 $z = \frac{\text{score - mean}}{\text{Std. Dev}}$

1.2. composite score = Mn. of z-scores

Method

Participants. The measures of semantic processing detailed below were administered to individuals with aphasia participating in research programs at two sites[1] that have been collaborating over the past 20 years. The individual language profiles within this sample are representative of all classically defined aphasic categories (Wernicke's, Conduction, Anomic, Broca's, Transcortical sensory and motor). Within a psycholinguistic scheme of classification, the word processing deficits include profiles with primarily semantic impairment, primarily phonological impairment or combinations of both semantic and phonological impairments. Overall severity of aphasia also encompassed a full range across the subject pool as will be evident in the ranges of scores noted in Table 1.

Test measures. Four measures of lexical-semantic processing and one measure of conceptual semantics were administered to individuals who have participated in our research programs. Two are published tests (numbers 1 and 5). The remaining three were developed by our group and are available by request from the first author. The numbers of subjects tested on each measure varies (from 64 to 103) because measures were incorporated into our battery at different points in time, and some measures were used only at one site.

(1) *Peabody Picture Vocabulary Test* (*PPVT-Form L*, Dunn & Dunn, 1981). (n= 65 participants with aphasia). This is a standardized measure of word comprehension abilities that uses a spoken word-to-picture matching format with a target word and 3 distracters, some of which are similar in meaning to the target word. Target words are spoken by the examiner, and the participant is asked to point to the picture which matches the spoken word. Items on this test are presented in ascending order of difficulty. We established norms for the Raw Scores as well as the Standard Scores because some subjects scored well below the base Standard Score of 40, and we wanted to have a full range of severity represented in the group of scores.

(2) Lexical Comprehension (Within Category Set)[2] (n= 103 participants). Like the *PPVT*, this test uses a spoken word-to-picture matching format. There are four pictures, a target item and three categorically related distracters. Although the number of items in this test is small (n=16), it is sensitive to semantic deficits because distracter items are all semantically related to the target word. Normal subjects (n=5) averaged .992 correct (SD = .021).

(3) Noun-Verb Synonymy Judgments[3] (n= 87 participants). The task is to decide which two of three written (and spoken) words (three nouns or three verbs) are most similar in meaning. The task requires accessing semantic representations of the spoken (and written) words and comparing the similarity of their meanings. (n=30 test items). Normal subjects (n=5) averaged .969 correct (SD = .042).

(4) Concrete and Abstract Word Synonymy Judgments[4] (n= 64 participants). The task requirements for this task are identical to the noun-verb synonymy. Here we looked at the ability to evaluate meanings of concrete words and abstract words (n = 48 test items). Normal subjects (n=5) averaged .951 correct (SD = .052) on this measure.

(5) *Pyramids and Palm Trees Test* – picture version (Howard & Patterson, 1992). (n= 70 participants). This test is similar to the synonymy judgment task except that pictures are used rather than words. The participant is shown three pictures, one above the other two and is asked to match the top picture to one of the other two pictures with which it is most closely associated. No names of the pictures are mentioned, and the participant is asked not to name the objects. With the absence of overt verbal language, this task is considered a relatively pure measure of conceptual semantic processing.

Results

In Table 1, we provide the means and standard deviations for each of the five tests described above as well as the range of scores for each task. Although the participants on

average perform below normal, the ranges indicate some of our participants achieve levels near normal on some of these tasks.

Using the norms provided here (Table 1) and formula 1.1, a researcher or clinician would easily determine that a patient who scored 78 on the PPT had performed one and one-half standard deviations below the aphasic mean on that test ($z = -1.5$), suggesting impairment in conceptual semantic processing.

General Discussion

The measures reported here are intended to assess conceptual-semantic and lexical-semantic processing. In past studies, these measures have been used reliably to predict patterns of serial recall in verbal span tasks,[5] rates of semantic errors in picture naming,[6] learning in a verbal repetition span task,[7] and response to repetition priming treatment for naming.[8] We propose that this battery provides a useful model for clinicians and researchers to consider when evaluating individuals with acquired language impairment. The measures provide an objective means of determining the extent of semantic impairment, which will help clinicians to differentiate semantically- and phonologically-based word processing impairments and to determine appropriate treatment strategies.

Footnotes

Footnote 1. The names of the testing sites have been removed from the text to preserve author anonymity for reviewing purposes.

Footnotes 2-8. References have been removed from the text to preserve author anonymity for reviewing purposes.

References

Howard, D. and Patterson, K. (1992). *The Pyramids and Palm Trees Test.* Thames Valley Test Company.

M.A. Lambon-Ralph, L. Moriarty, K. Sage, & The York Speech Therapy Interest Group (2002). Anomia is simply a reflection of semantic and phonological impairments: Evidence from a case-series study. *Aphasiology*, 16, 56-82.

Table 1. Means and standard deviations for the semantic measurement battery.

Test	Number of Subjects	Mean	SD	Range
Lexical Comprehension Within category set. (n=16 items, % correct)	103	91.04	12.78	38-100
Peabody Picture Vocabulary Test (*PPVT-Form L*)				
Standard score	65	75.43	17.97	40-115
Raw score	65	127.54	30.55	25-168
Synonymy Judgments Noun and Verb Triplets (n=30 items, % correct)	87	76.44	16.69	37-100
Synonymy Judgments Concrete and Abstract Triplets (n=48, % correct)	64	75.09	13.92	44-94
The Pyramids and Palm Trees Test (n=52, % correct)	70	89.84	7.75	60-100