Introduction

Individuals with aphasia (IAs) with differing classification categories may have linguistic processing profiles which can be described, at least to some extent, by differential performance for different information types (phonological, semantic, and structural/syntactic). For example, individuals with Wernicke's aphasia or damage to posterior regions have been described as having relative impairments in semantic processing; individuals with Broca's aphasia with primarily anterior damage demonstrate disproportionately greater deficits in lexical activation and processing complex syntax as well as phonological information.

IAs often exhibit deficits in working memory (WM) (Caspari et al., 1998; Downey et al., 2003). In the context of aphasia, WM capacity has been conceptualized as a unitary process of a single "resource" pool for attentional, linguistic, and other executive processing. It has been suggested, however, that there may be separate "WM abilities" for different information types in individuals with and without neurological impairment (Caplan & Waters, 1999; Friedman & Gvion, 2003). We hypothesize that a relative deficit in WM capacity for any one type of information processing might differentially affect language processing at that level. To test this hypothesis, a measure of WM capacity tapping each of these information types separately is needed.

Developing an appropriate measure to assess WM ability in IAs has met with mixed success. Many WM tasks do not allow for assessment of separate aspects of on-line linguistic processing. Adaptations of Daneman and Carpenter's Reading Span (1980) have been administered to IAs in an effort to measure their WM capacity, but such tasks require listeners to process all three information types – phonological, semantic, and syntactic – simultaneously, while also remembering sentence-final words. Not surprisingly, many IAs perform poorly on such tasks. Due to the conflation of distinct linguistic information types involved in such a task, it is impossible to determine at what level breakdowns occur.

The current study is a first step in our research program investigating whether individuals with aphasia present with information-specific WM deficits that may account for their linguistic-specific deficits. This study employed a modified *n*-back task to measure information-type-specific WM abilities in IAs.

Methods

Participants

This report presents initial data on three adults with aphasia (3 males), ages 44-62 years (mean = 52.3 years). All participants were monolingual, at least 6 months post onset following single, left-hemisphere CVA (mean = 33 months), premorbidly right-handed, and passed a hearing screening (see Table 1). [note that we will have tested ten adults with aphasia in the next few months].

Tasks

The *n*-back task has been used to assess WM ability in neurologically intact individuals as well as numerous clinical populations (Jonides et al., 1997). The *n*-back requires participants to process a stream of incoming information and respond when the current stimulus is the same as the stimulus "*n* items ago". The *n*-back has several strengths. First, modality of presentation can be customized to the population of interest (i.e., auditory or visual). Second, response modality is via button press, making it manageable for IAs. Third, task difficulty can be parametrically increased by using a higher number of items "back". Finally, at the "easiest" levels (i.e., 1-back), the task is manageable for many clinical populations.

N-backs

We developed three categories of *n*-back, each testing separate information types: *PhonoBack* (phonological); *SemBack* (semantic); and *SynBack* (syntactic). PhonoBack stimuli consisted of 25 single words with the structure CVC, five ending in each of five frames: -at, -it, -in, -ill, or -ig. SemBack stimuli consisted of five words from each of five semantic categories (fruit, tools, furniture, animals, and clothing), controlled across category for length and frequency of occurrence. SynBack stimuli were five-word sentences with either active ("The doctor kissed the banker") or passive ("The banker was kissed by the doctor") structure. Ten nouns and ten verbs were used, controlled for length, frequency, and role (object/subject).

Each category consisted of two sub-categories: Identity and Depth. For Identity versions, targets were identical to prime items "*n* items back". Only Depth versions of the PhonoBack- and SemBack were administered; the SynBack-Depth was not administered because we predicted that it would be prohibitively challenging for IAs. In the PhonoBack-Depth, participants were instructed to respond to target items which rhymed with the prime (e.g., cat – rat). In the SemBack-Depth, targets were from the same semantic category as the prime (e.g., grapes – lime). For the SynBack-Depth, participants were told to respond when the current sentence had the same meaning as the sentence *n* items back, regardless of whether word order was different (e.g., "The doctor kissed the banker" has the same meaning as "The banker was kissed by the doctor", despite differing word orders).

Stimuli were digitally recorded by a native speaker of English. For all *n*-back tasks, stimulus onset asynchrony (SOA) was 4000ms.

SOAP

The "Subject-Relative, Object-Relative, Active, Passive Test" (SOAP) of Love & Oster (2003) was administered. The SOAP has proven useful for differentiating individuals with specific types of auditory comprehension deficits.

<u>Procedures</u>

Participants attended three 1-hour visits in a sound-insulated room. Auditory stimuli were played through computer speakers or headphones at a comfortable volume. Following two sets of 10-12 training items, each list contained 20 target items embedded among 60 and 76 total items for the 1- and 2-back, respectively. "Hits" were scored when participants pressed the button to "targets." Reaction times and "false positive" data (responses to non-targets) were obtained for all responses but not analyzed or presented at this time.

All participants received all 11 information-type conditions. Order of conditions was counterbalanced such that the PhonoBack- and SemBack-Identity versions were completed in the first session and the PhonoBack- and SemBack-Depth versions in the second, or vice versa. The SynBack-Identity and SOAP were presented during the third session.

<u>Results</u>

Currently, only 3 participants' data are available; therefore, no statistical analyses are presented at this time. Several features of the data, however, are noteworthy.

Within information-type conditions, all participants scored more hits on the 1-back than on the corresponding 2-back (see Figures 1 and 4), except for NBH01, who scored equally poorly on the PhonoBack-Depth 1- and 2-back. NBH02 and NBH03 were more accurate on the SemBack-Identity 1-back compared to the PhonoBack- and SynBack-Identity 1-back, but still performed well on these tasks (see Figure 2). This pattern mirrored the pattern we found in a pilot study using neurologically intact college students. Participant NBH01, however, performed relatively poorly on the PhonoBack- and SynBack-Identity 1-back. This participant also performed considerably worse than the other two participants on all conditions for the Identity 2-back (see Figure 3).

Conclusions & Clinical Implications

Despite the small sample size, our WM tasks appear to be able to differentiate information-type specific WM deficits in individuals with aphasia. Having such a measure to differentially assess level-specific WM abilities in IA would greatly enhance our understanding of the underlying architecture of cognition and language. Not only would the information gained from such a measure improve and elaborate clients' clinical profiles, but it may lead to future modifications on current classification categories to yield a more accurate and precise description of aphasic performance and potential.

Thorough analyses of these and additional participants currently being tested will be presented and discussed in the context of improving clinical awareness of the strengths and weaknesses of each individual client, informing therapeutic interventions accordingly.

Table 1: Participant Information

	Age at testing (years)	Months Post-Onset	Sex	Handed-ness	Native English?	Years of Educ	WAB-AQ
NBH01	51	51	Male	Right	Yes	16	58
NBH02	62	31	Male	Right	Yes	>20	81.7
NBH03	44	17	Male	Right	Yes	17	68.1

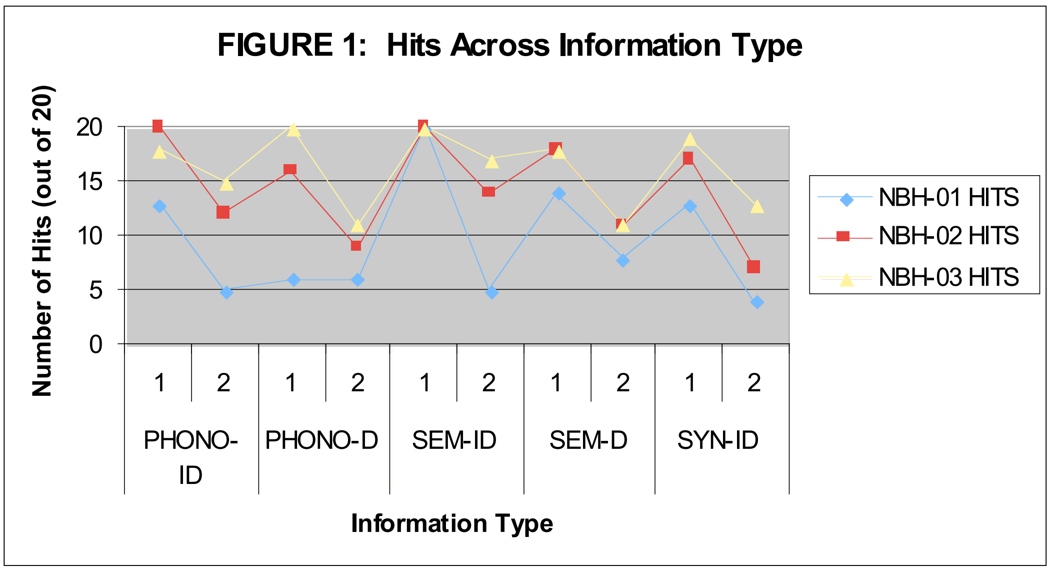


FIGURE 2: Hit rates for Identity 1-back

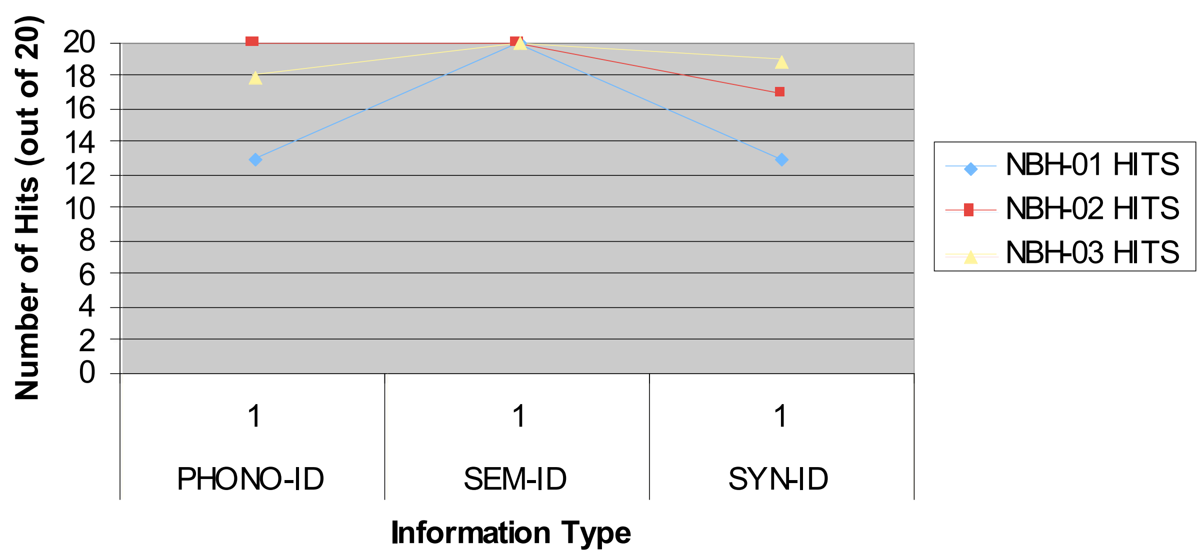
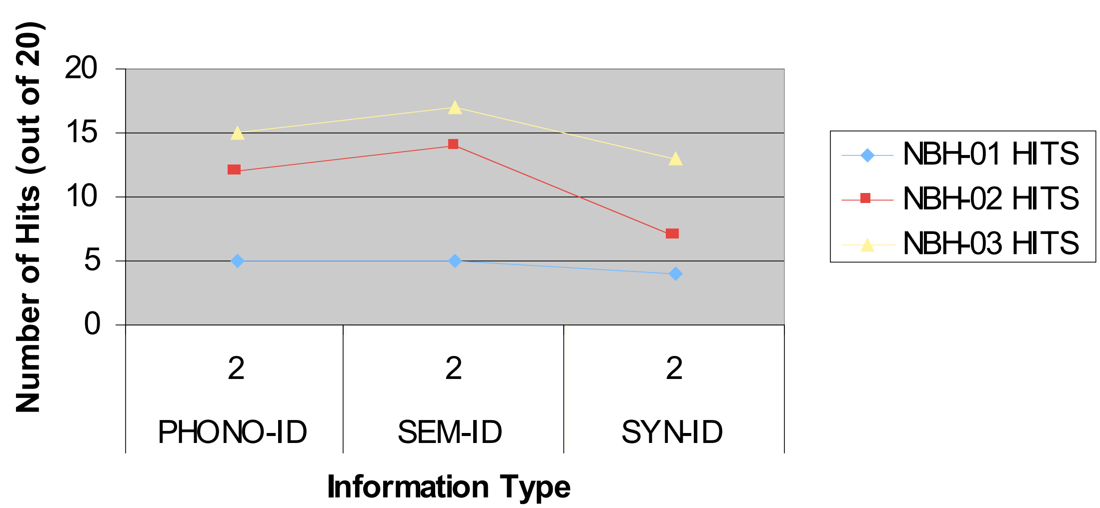


FIGURE 3: Hit rates for Identity 2-back



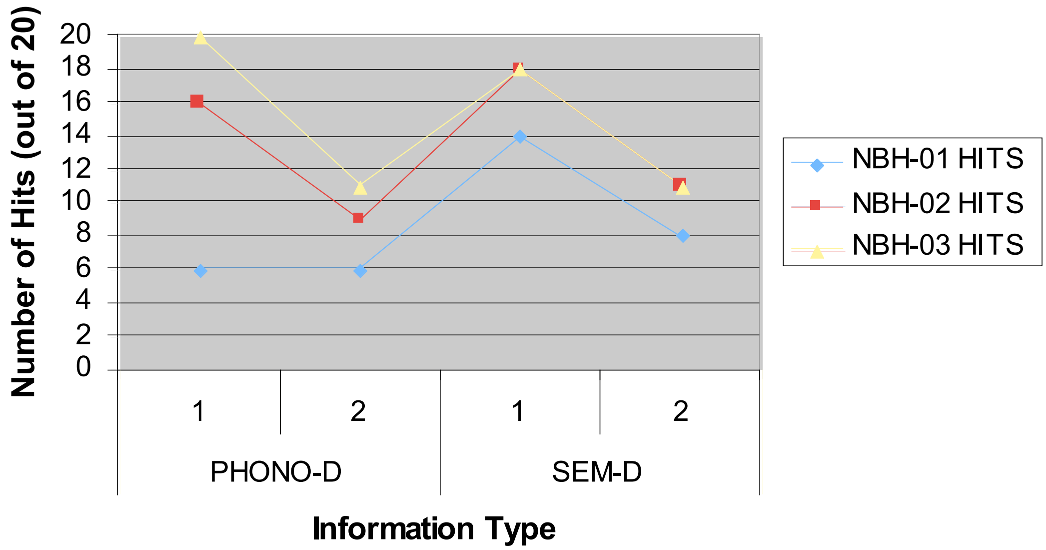


FIGURE 4: Hit rates for Depth 1- and 2-back

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