

Phoneme-based rehabilitation of anomia in aphasia

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Abstract

This study investigated the effects of phonologic treatment for anomia in aphasia. We proposed that if treatment were directed at the level of the phonologic processor, opportunities for naming via a phonological route, as opposed to a strictly whole word route, would be enhanced, thereby improving naming. The participants, ten people with anomia and aphasia due to left hemisphere stroke, received 96 h of phoneme based treatment in 12 weeks. To learn if treatment improved naming, a single-subject, repeated probe design with replication was employed. The primary outcome measure was confrontation naming. Secondary outcome measures included phonologic production, nonword repetition and discourse production. Results suggest a positive treatment effect (confrontation naming), improvements in phonologic production and nonword repetition, and generalization to discourse production. When tested 3 months after the completion of treatment the effects appeared to be maintained.

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1. Introduction

One of the most common and debilitating features of aphasia is an impairment in ability to retrieve words, whether it involves naming seen objects, or producing nouns, verbs and other words conveying meaning in spontaneous propositional speech (Goodglass, 1993). The traditional treatment approach to this problem is to explicitly

train individuals with aphasia in whole word naming (see Nickels, 2002 for extensive review). Controlled studies have shown that this approach may improve naming performance but generalization is typically very limited, that is, the knowledge gained by the patient tends to be limited to the words actually trained, and there is at best very modest improvement in naming performance with untrained words. This generalization may be limited mainly to words that are semantically related to those in the training corpus (Kiran & Thompson, 2003; McNeil, 1997). The mechanisms underlying generalization are not well understood. Because generalization can be limited with “naming

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therapies”, there currently exists no viable means of training patients on the full corpus of words (perhaps several thousand) they are likely to need in daily life, except in the most determined and capable of subjects (Basso, 2003). Two approaches might be taken to solving this problem: (1) Develop cost effective means for providing training on several thousand words; and (2) develop alternative training methods. In this paper, we describe an alternative training method, training of phonemes and phonological sequence knowledge, that has the potential for broad generalization because knowledge of the full repertoire of phonemes and phonological sequence knowledge could potentially support production of all words. The mechanisms by which a purely phonological treatment could benefit anomia are implicit in a connectionist model of language function, discussed below.

1.1. Connectionist model of phonological function

The Wernicke–Lichtheim (W–L) information processing model of language function has played a dominant role in understanding aphasic syndromes (Lichtheim, 1885) and has stood the test of time in defining the topographical relationship between the modular domains (acoustic representations, articulatory-motor representations, and concept representations) underlying spoken language function. Unfortunately, the W–L information processing model does not specify the characteristics of the representations within these domains and how they might be stored in the brain. It also does not address the means by which these domains might interact. We have proposed a parallel distributed processing (PDP) model that uses the same

general topography as the W–L model (Nadeau, 2001; Roth, Nadeau, & Heilman, 2006), but also specifies how representations are generated in the modular domains and how knowledge is represented in the links between these domains (Fig. 1). Though not tested through simulations, this model is neurally plausible and provides a cogent explanation for a broad range of psycholinguistic phenomena. More generally, connectionist concepts are now deeply embedded in and receive enormous support from mainstream neuroscientific research (e.g., Rolls & Deco, 2002; Rolls & Treves, 1998).

The PDP modification of the W–L model posits that the acoustic representations (akin to Wernicke’s area) are based upon large numbers of units located in auditory association cortices that represent acoustic features of phonemes. The articulatory motor representations (analogous to Broca’s area) are based upon units located predominantly in dominant frontal operculum that represent discrete articulatory features of speech (as opposed to continuously variable motor programs). The semantic or conceptual representations are based upon an array of units distributed throughout unimodal, polymodal, and supramodal association cortices that represent semantic features of concepts. Each unit within a given domain is connected to many, if not most, of the other units in that same domain (symbolized by the small looping arrow appended to each domain in Fig. 1). Knowledge within each domain is represented as connection strengths between the units. Thus, semantic knowledge is represented as the pattern of connection strengths throughout the association cortices supporting this knowledge. Within any domain, a representation corresponds to a specific pattern

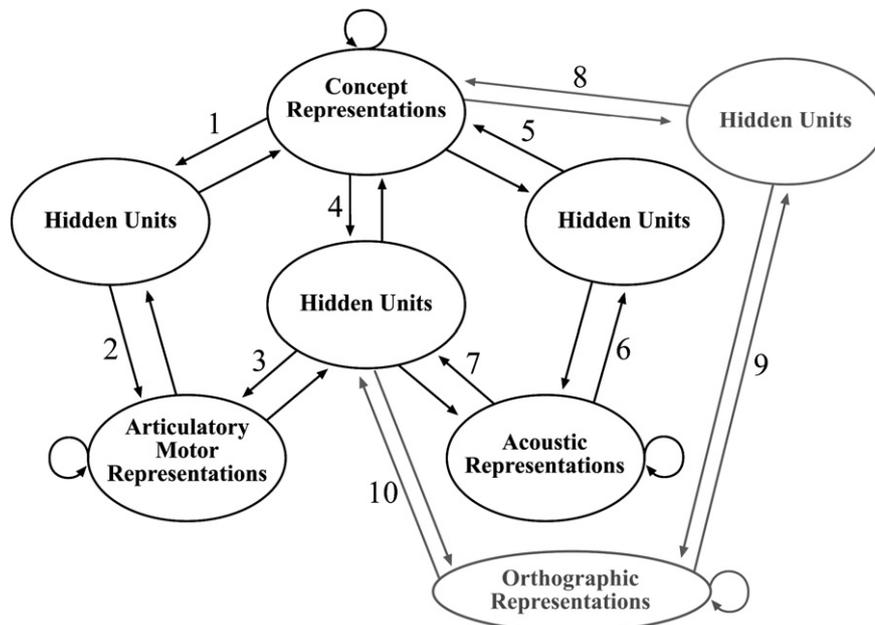


Fig. 1. Connectionist model of phonological processing. The core model, developed in Nadeau (2001) and Roth et al. (2006) and reviewed in the Introduction, is depicted in black. An elaboration of the model that includes networks supporting reading, depicted in gray, suggests a means by which letter and orthographic sequence knowledge introduced during the phonological rehabilitation process might contribute to the development of phonological awareness (conceptualization of discrete phonemes) and to phonological sequence knowledge, and vice versa.

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