

Stress assignment in aphasia: Word and non-word reading and non-word repetition

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Abstract

This paper investigates stress assignment in Dutch aphasic patients in non-word repetition, as well as in real-word and non-word reading. Performance on the non-word reading task was similar for the aphasic patients and the control group, as mainly regular stress was assigned to the targets. However, there were group differences on the real-word reading and non-word repetition tasks. Unlike the non-brain-damaged group, the patients showed a strong regularization tendency in their repetition of irregular patterns. The patients' stress error patterns suggest an impairment in retention or retrieval of targets with irregular stress patterns. Limited verbal short-term memory is proposed as a possible underlying cause for the stress difficulties.

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1. Introduction

This paper investigates word stress production in Dutch patients with aphasia. Over the years, evidence has accumulated that patients with aphasia may display difficulties in stress assignment (Cappa, Nespore, Ielasi, & Miozzo, 1997; Galante, Tralli, Zuffi, & Avanzi, 2000; Janssen, 2003; Laganaro, Vacheresse, & Frauenfelder, 2002; Miceli & Caramazza, 1993). The general pattern of findings for the patients under investigation is that regularization of stress occurs in their output. In other words, their stress production tends towards the most frequent patterns in the language. Regular stress patterns in Italian and German are based on the syllable structure of the words. In Italian, for example, underived words with a heavy penultimate syllable (*konténto* [glad]) generally take penultimate stress. Italian patients with aphasia have been found to alter stress assignment of words with exceptional or irregu-

lar stress (e.g. *mándorla* [almond]) to regular stress position (*mandórla*).

The stress difficulties have generally been attested in reading aloud words and non-words (Cappa et al., 1997; Galante et al., 2000; Janssen, 2003; Laganaro et al., 2002; Miceli & Caramazza, 1993), but also in picture naming and spontaneous speech (Cappa et al., 1997; Laganaro et al., 2002). It has been proposed that the stress errors in reading aloud reflect reliance on a non-lexical route in reading. The patients no longer have fast access to the lexical representation of the words, and instead rely on grapheme-to-phoneme conversion and syllable structure to assign stress. Similarly, for stress regularization in naming or spontaneous speech, it seems that lexical stress-specific information is partly unavailable or inaccessible, forcing the patient to rely on syllable structure, or on the generation of a default metrical structure, see Butterworth (1992).

However, one area of stress realization that has not been assessed in-depth in patients before, is stress production in non-word repetition. Such an investigation allows an analysis of the productivity of stress rules. Subjects have to repeat non-words with stress patterns differing in degree

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of regularity. By using non-words, we are able to test repetition performance of the same segmental string and syllabic structure in several stress conditions. This is a more controlled way of investigating whether patients rely on syllabic structure in stress assignment than choosing real words of different metrical patterns.

Such an approach also allows us to assess whether the data can be accounted for by neural network models, such as connectionist models. These models have been proposed to account for (typical acquisition of) Dutch word stress (Daelemans, Gillis, & Durieux, 1994; Gillis, Daelemans, & Durieux, 2000; Joanisse & Curtin, 1999). In a connectionist model, connections of input to output values each carry their own weight and activation threshold, based on probabilistic constraints. These connections determine patterns of activation in a network (Seidenberg, 1997). Strong connections are associated with patterns that occur often, i.e. regular stress patterns. As a consequence, frequent patterns will be produced faster than low frequent patterns with weak connections, or less frequent patterns are regularized in the output. Connectionist models are ideally suited for accommodating quasiregular behaviour as in Dutch word stress (see Section 2), which includes regular and (highly) irregular stress patterns.

Connectionist models have also been for reading (e.g. Plaut, McClelland, Seidenberg, & Patterson, 1996). The process of reading involves three connectionist networks, one that maps orthography to phonology, one that maps orthography to semantics, and one that maps semantics to phonology. When only the orthography to phonology route is available, low-frequency words are not recognized and are regularized. In cases of stress assignment, this will render regularization of stress during reading.

Network approaches have also been proposed to account for data of aphasic patients (e.g. Gupta & MacWhinney, 1997) and have been applied for modelling data of aphasic patients. Dell, Schwartz, Martin, Saffran, and Gagnon (1997), for example, modelled picture-naming errors of aphasic and non-aphasic speakers through a spreading-activation model. They first modelled normal error patterns in the mapping between the conceptual representation and the phonological form. Brain damage may reduce the integrity of representations at each level in the network and may reduce transmission of activation between levels. Lesioning the model can be accomplished by altering activation decay rate and/or connection weight.

The relation between verbal short-term memory and long-term phonological knowledge has been accounted for in (amongst others) Gathercole and Martin (1996), who stressed the impact of long-term phonological knowledge on immediate recall or non-word repetition. Gupta and MacWhinney (1997) also showed that non-word repetition and serial recall depend crucially on the strength of long-term phonological knowledge in the lexical system. This means that, for example, non-words with high neigh-

bourhood density and phonotactic probability are recalled more easily than those with lower neighbourhood density.

In connectionist terms then, low frequent patterns with weak connections are difficult to access in reading and are difficult to retain in nonword repetition. Particularly if the network has been lesioned, activation of the target pattern will often remain below threshold. Thus, by analogy, a tendency of stress regularization can be anticipated to occur. Patients do not have fast access to the lexical representations of words and have difficulty retaining non-word targets. Instead, they rely on grapheme-to-phoneme conversion and syllable structure to assign stress.

The present study aims to investigate stress assignment in Dutch patients with aphasia through repetition of non-words, as well as through reading aloud words and non-words. We appreciate, however, that not all patients may be able to perform all tasks. By tapping both reading and speech domains, we hope to gain a more complete picture of patients' stress abilities. Similar to a study by Nickels and Howard (1999), we anticipate that the reading task will be more problematic for the patients than a repetition task. The repetition task results will therefore be the focus of the study. We specifically aim to test the following hypotheses:

- The findings on the word reading task will replicate previous findings of German and Italian patients with aphasia. In other words, Dutch patients with aphasia will resort to stress changes in the word reading task. These changes will lead to more regular stress realizations (cf. Section 2 on Dutch word stress). The non-brain-damaged participants will not show regularization.
- In the non-word reading task, both the aphasic patient group and the controls will mainly assign regular stress to the non-words.
- The aphasic patients will have more difficulty with stress production in repetition of non-words with irregular stress patterns than a non-brain-damaged control group. The aphasic population's non-word repetition is expected to show a greater tendency towards regularization of irregular stress patterns than is expected for the control group.

This paper thus not only attempts to replicate findings of stress production of aphasic patients in Dutch, but also includes systematic analyses of word and non-word reading, as well as non-word repetition. Furthermore, we will look beyond the production of stress 'errors', but will also focus on the types of errors the patients make. We have included data of six patients, instead of only those of one or two patients, as previous research has done. This study also includes an age-matched control group, absent in (most of) the previous studies. Additionally, it will be assessed whether the findings of the aphasic participants can be accounted for by a connectionist network. Before

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