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The effect of syntax on reading in neglect dyslexia

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ABSTRACT

Individuals with text-based neglect dyslexia omit words on the neglected side of the sentence or text, usually on the left side. This study tested whether the syntactic structure of the target sentence affects reading in this type of neglect dyslexia. Because Hebrew is read from right to left, it enables testing whether the beginning of the sentence and its syntactic properties determine if the final, leftmost, constituent is omitted or not. The participants were 7 Hebrew-speaking individuals with acquired left text-based neglect dyslexia, without syntactic impairments. Each participant read 310 sentences, in which we compared 5 types of minimal pairs of sentences that differed in the obligatoriness of the final (left) constituent. Complements were compared with adjuncts, obligatory pronouns were compared with optional resumptive pronouns, and the object of a past tense verb was compared with the object of a present tense verb, which can also be taken to be an adjective, which does not require an object. Questions that require a verb were compared with questions that can appear without a verb, and clauses that serve as sentential complements of a verb were compared with coordinated clauses, which are not required by the verb. In addition, we compared the reading of noun sequences to the reading of meaningful sentences, and assessed the neglect point in reading 2 texts. The results clearly indicated that the syntactic knowledge of the readers with neglect dyslexia modulated their sentence reading. They tended to keep on reading as long as the syntactic and lexical-syntactic requirements of the sentence had not been met. In 4 of the conditions twice as many omissions occurred when the final constituent was optional than when it was obligatory. Text reading was also guided by a search for a "happy end" that does not violate syntactic or semantic requirements. Thus, the syntactic structure of the target sentence modulates reading and neglect errors in text-based neglect dyslexia, suggesting that the best stimuli to diagnose mild text-based neglect dyslexia are sentences in which the leftmost constituent is optional, and not required by syntax. Another finding of this study is dissociation between neglect dyslexia at the text and at the word levels. Two of the participants had neglect dyslexia at the text level, manifested in omissions of words on the left side of text, without neglect dyslexia at the word level (namely, without omissions, substitutions, or additions of letters on the left side of words).

1. Introduction

When individuals with text-based neglect dyslexia read, they neglect the words in the space contralateral to the lesioned hemisphere, which is usually on the left part of the sentence or text (Cubelli, Nichelli, Bonito, De Tanti, & Inzaghi, 1991; Ellis, Flude, & Young, 1987; Kinsbourne & Warrington, 1962; Schwartz, Ojemann, & Dodrill, 1997; Subbiah & Caramazza, 2000; Worthington, 1996; Young, Newcombe, & Ellis, 1991; see also Vallar, Burani, & Arduino, 2010 for a review). Because Hebrew, the language tested in this study, is read from right to left, text-based neglect dyslexia in Hebrew is usually manifested in the omission of the ends of sentences. This allows for the assessment of the effect of the syntactic structure of the beginning of the sentence on the rate of omissions of its end.

The aim of this study was to test whether preserved syntactic knowledge modulates reading in neglect dyslexia by impelling the participants to allocate attention to the neglected hemi-space until the syntactic requirements of the sentence are met. Our general hypothesis is that individuals with acquired text-level neglect dyslexia whose syntactic ability is preserved will tend to maintain the grammaticality of the sentences they read. Thus, they will try not to omit obligatory constituents, and will tend to stop reading the sentence only at points that create a grammatical sentence. We tested this hypothesis using various minimal pairs of sentences,

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comparing sentences in which the final constituent is obligatory to similar sentences in which the final constituent is optional.

Whereas we are not aware of previous research on the effect of syntax on reading in text-based neglect dyslexia, some evidence from two sources might be suggestive: studies of a possible effect of the meaning of the words read on reading in text-based neglect dyslexia, and lexical and morphological effects on reading in word-based neglect dyslexia.

As for evidence for the effect of the meaning of the words read on text-based neglect dyslexia, Schwartz et al. (1997) report on the reading of 64 English-speaking epileptic patients. Under the effect of sodium amobarbital injection to the right hemisphere, the epileptic patients substituted and deleted words on the left side of the sentences. Interestingly, words were deleted more frequently when the sentence still made sense without them, semantically and syntactically. These patients also made word substitutions on the left of the sentences, substituting the target word with a syntactically similar word, such as reading "a" instead of "the". The analysis of the sentences in which no substitutions occurred revealed that substitution of the left word would have created nonsensical sentences. Thus, there are indications that reading can be affected by the properties of the sentence (although it should be kept in mind that these patients did not have neglect dyslexia, and that they substituted whole words on the left side of the line, whereas individuals with text-based neglect dyslexia rarely substitute whole words on the left side of the text. Patients with text-based neglect dyslexia usually omit whole words, Young et al., 1991). Another relevant study was reported by Kartsounis and Warrington (1989). They describe a man with left text-based neglect dyslexia, whose reading was affected by properties of the sentence he read. When the sentences made sense, he read more sentences correctly and omitted fewer words on the left than when the target sentence was semantically implausible. Manipulating the semantic coherence of the sentences (by scrambling the words) affected his reading, with more word omissions in less coherent sentences. The same pattern was evinced in his performance in visuospatial tasks, which was significantly better when the stimuli were meaningful. Karnath and Huber (1992) also reported an effect of plausibility of the sentence on its reading. They tested a participant with text-based neglect dyslexia, and found that his reading accuracy and eye movements were affected by the acceptability of the sentence he read. The participant read written stories composed of 9 sentences each, in which sentences continued in the next line. The stories were manipulated according to whether an omission of the first (left) words on the second line would have created linguistically plausible continuation of the sentence or not. The findings were that the participant omitted the first words that still maintained the acceptability of the sentences in 80% of the sentence continuations that were acceptable with an omission, whereas only 14% omissions were made in the sentences in which omission was inacceptable. The patient's eye movements were also affected by the linguistic demands of the sentences, as although his return sweeps typically ended in the middle of the second line, they were followed by sequences of short saccades backwards toward the beginning of the second line, which tended to stop as soon as linguistically acceptable continuation of the text was found.

These data thus suggest that sentence meaning and structure may affect reading in text-based neglect dyslexia. Additional suggestive evidence for a possible linguistic effect on reading in neglect dyslexia comes from lexical effects on word-based neglect dyslexia. In word-based neglect, which can occur independently of visuospatial neglect or text-based neglect dyslexia, the readers neglect (omit, substitute, or add) letters in one side of the word, typically the left side. Several studies found that the lexical properties of the target word such as lexicality, frequency, morphological structure, orthographic neighborhood, and regularity, as well as the lexicality of the response affect the reading errors of some individuals with word-based neglect dyslexia (Arduino, Burani, & Vallar, 2002; Arduino, Burani, & Vallar, 2003; Arguin & Bub, 1997; Behrmann, Moscovitch, Black, & Mozer, 1990; Caramazza & Hillis, 1990; Cubelli et al., 1991; Ellis et al., 1987; Ellis, Young, & Flude, 1993; Kinsbourne & Warrington, 1962; Patterson & Wilson, 1990; Reznick & Friedmann, 2009; Riddoch, Humphreys, Cleton, & Fery, 1990; Stenneken, van Eimeren, Keller, Jacobs, & Kerkhoff, 2008; see Vallar et al., 2010 for a review), indicating that preserved lexical knowledge as well as morphological considerations modulate these patients' reading. The findings regarding lexical and morphological effects on word reading in word-based neglect dyslexia suggest that, similarly, syntactic knowledge may affect the reading of sentences and text in text-based neglect dyslexia.

In the following sections we first assess the syntactic abilities of the participants, and then test in 8 experiments the effect of the syntactic structure of the sentences they read on the rate of their neglect dyslexia errors.

2. Participants: background, syntactic abilities, and single word reading

Seven Hebrew-speaking individuals with acquired text-based left neglect dyslexia following right-hemisphere damage participated in the study. They were 24–81 years-old (mean age = 59), 6 of them had neglect following right hemisphere CVA and one sustained a vast right hemisphere damage with skull fractures and shards from a bomb. All participants had pre-morbidly full control of spoken and written Hebrew – six of them had Hebrew as their native language, and one participant, OM, spoke Hebrew for 48 years prior to his stroke. The BIT (Behavioral Inattention Test, Wilson, Cockburn, & Halligan, 1987) indicated visuospatial neglect for all participants, and all of them had a score below the cutoff in the conventional subtests of space-based neglect (see Table 1). Individuals with severe impairment of reading at the single word level were excluded from the study on the basis of a single word reading test and the number of errors they had at the word level in reading sentences. None of the participants had aphasia or developmental language or reading disorders. All of them had normal or corrected-to-normal vision. According to their medical files, none of them had hemianopia.[1] See Table 1 for background information about the participants, and Appendix A for CT scans of four of the participants.

2.1. Assessment of syntactic abilities

2.1.1. Syntactic tests

Before asking whether syntax affects reading in neglect dyslexia, we needed to assure that the syntax of the participants with neglect dyslexia was unimpaired. For this aim we assessed the syntactic abilities of the participants with neglect dyslexia, using 4 syntactic tests from BAFLA test battery (Friedmann, 1998): relative clause production, tense and agreement completion, embedded and coordinated sentence repetition, and preposition completion. We chose these tests because they assess the structures that are

[1] The assessment of the participants' visual fields has been done before we tested them, by the neurologists in the rehabilitation centers. This assessment typically involves a clinical confrontation test or a computerized perimetry test or both, in which the patient provides a verbal report upon stimulus presentation to determine whether he/she detected the presence of the stimulus or not; these assessments usually include a confrontation test with maximal rightward shift of the head on the trunk and then maximal rightward shift of the gaze. These assessments indicated that none of the participants had hemianopia, but one should bear in mind the difficulty in determining whether or not a patient with visuospatial neglect has hemianopia.