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Basis of intonation disturbance in aphasia: Perception

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Abstract

This study sought to determine whether abnormalities exhibited by patients with aphasia in intonation reception are attributable to deficit in processing (1) global (overall) pitch or fundamental frequency (F0) contours, or (2) components of F0 contours. Two experiments involving identification of matched statements and echo questions were conducted. The stimuli in Experiment 1 were full sentences (Global F0 condition), whereas those in Experiment 2 were sentences split into two parts (Partial F0 condition). Patients with fluent aphasia performed comparably with non-brain damaged control subjects on the identification of both stimulus types in both experiments. Patients with mild to moderate nonfluent aphasia performed similarly on the identification of statements, but they were impaired on the identification of questions. In Experiment 2, they performed comparably with control subjects on the identification of one part of the split question stimuli, but not the other part. Severely impaired nonfluent patients participated in Experiment 1 only, and they performed poorly on the identification of both stimulus types. Taken together, these findings suggest that intonation might be processed in units smaller than global F0 information, and that impaired ability to process those units might in part explain the nature of intonation disturbance in aphasia.

Keywords: Intonation; Aphasia; Autosegmental metrical theory; Perception

1. Introduction

Intonation refers to sentence/phrase level pitch. It is one of the elements of prosody, the nonsegmental components of spoken language (Couper-Kuhlen, 1986). Studies suggest

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variously that intonation disorder in aphasia may be due to underlying linguistic (Danly, Cooper, & Shapiro, 1983; Heilman, Bowers, Speedie, & Coslett, 1984; Pell & Baum, 1997; Perkins, Baran, & Gandour, 1996; Walker, Daigle, & Buzzard, 2002), phonetic-motoric (Cooper, Soares, Nicol, Michelow, & Goloskie, 1984; Danly & Shapiro, 1982; Graff-Radford, Cooper, Colsher, & Damasio, 1986; Ryalls, 1982, 1984; Seddoh, 2000) or temporal (Gandour, Petty, & Dardarananda, 1988; Gandour et al., 1992; see also Van Lancker & Sidtis, 1992) processing deficit. Studies that suggest primary linguistic involvement include those on perception (Heilman et al., 1984; Pell & Baum, 1997; Perkins et al., 1996; Walker et al., 2002) and production (Cooper et al., 1984; Danly & Shapiro, 1982; Danly et al., 1983). The possibility that aspects of intonation processing might be preserved following brain damage has also been reported for these patients (Baum & Pell, 1997; Berndt, Salasso, Mitchum, & Blumstein, 1988; Seddoh, 2000; Walker, Fongemie, & Daigle, 2001).

While the discrepant results may be attributable in part to methodological factors, a major obstacle for research on abnormal intonation is the fact that normal intonation is itself poorly understood. Most studies on brain damaged patients are based on the notion, termed contour interaction (CI) theory (Ladd, 1983), that intonation is a "continuous" prosodic phenomenon (Baum, Pell, Leonard, & Gordon, 1997; Pell, 1999) with pitch configurations that combine to form a single overall (pitch) line (Thorsen, 1980; Vaissiere, 1983). This pitch layer, which in acoustic terms is the global fundamental frequency (F0) contour, is considered to be the principal or the processing unit of intonation (e.g., Gandour, Dzemidzic et al., 2003), and it is considered to be either "linguistic" or "affective" when it occurs in nonemotional and emotional contexts, respectively.

A major problem with the CI theory has to do with the assumption of primacy and subsequent categorization of the global F0 contour into discrete "linguistic" and "affective" entities. Apart from its lack of strong empirical foundation (see Seddoh, 2002; Wong, 2002), this conceptualization implies that there exists two independent, contextually based intonation lexicons from which global patterns are extracted as part of sentence processing to match with meaning (see Cutler, 1977). Perhaps more importantly, hypotheses on the neural basis of intonation influenced by this theory are characterized by conflicting evidence, thus raising questions about their validity.

The most recent of these hypotheses (Gandour, Dzemidzic et al., 2003), for example, posits that prosodic elements are represented on the basis of their temporal spans, and that the notion of local versus global information processing (Ivry & Robertson, 1998) accounts for their lateralization. According to this hypothesis, entities such as tone and stress span over shorter temporal domains, so they undergo local processing in the left hemisphere. By comparison, intonation spans over longer temporal domains (i.e. whole sentences), so it undergoes global processing predominantly in the right hemisphere. While this view is consistent with a companion hypothesis that has attributed intonation disturbance in aphasia to underlying deficit in sentence timing ability (e.g., Gandour et al., 1988, 1992), studies suggest that there might be dissociation between intonation processing and speech timing (see Seddoh, 2004 and references therein). For example, aspects of intonation have been reported to be relatively normal for patients with aphasia and temporal control problems (e.g., Niemi, 1998; Seddoh, 2004). Abnormal intonation production in the presence of intact speech timing ability has also been reported for a patient with callosal damage (Klouda, Robin, Graff-Radford, & Cooper, 1988).