

Drawing: Its contribution to naming in aphasia

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Abstract

Drawing in aphasia therapy has been used predominately as a substitution for speech or to augment communication when other modalities are non-functional. The value of drawing as a route for facilitating verbal expression has not been a focus of prior research. We compared the usefulness of drawing and writing as compensatory strategies for improving naming in individuals with aphasia. Activation patterns of writing and drawing in healthy adults were examined using fMRI. Clinical results suggest that drawing facilitated naming whereas writing diminished accurate naming responses, and that drawing quality is not relevant to this facilitatory effect. Functional MRI findings revealed strong bi-hemispheric activation of semantic and phonological networks while drawing that may support our clinical findings.

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1. Introduction

One of the most devastating impacts of stroke can be its effect on language. Many individuals with aphasia struggle to communicate even their basic needs. In an effort to help the individual with aphasia a variety of compensatory strategies for improving communication are taught for use both in and outside the therapeutic setting. These strategies are usually multi-modal and may include writing (Beeson, Rising, & Volk, 2003; Hillis, 1989; Robson, Marshall, Chiat, & Pring, 2001), gesturing (Hanlon, Brown, & Gerstman, 1990; Hoodin & Thompson, 1983; Pashek, 1997; Raymer & Thompson, 1991) and drawing (Beeson & Ramage, 2000; Lyon & Helm-Estabrooks, 1987; Rao, 1995; Sacchett, Byng, Marshall, & Pound, 1999). Drawing has been used predominately as a means of substitution for speech or to augment communication when other modalities are non-

functional. The literature on drawing as a communication aid is well summarized by Lyon (1995) in his review article.

Drawing, because it is intrinsically non-linguistic, can be a useful means of communication even for individuals with severe aphasia. The primary focus of drawing in the literature has been on its utility as a means of non-verbal communication of information, not on improving speech production (Beeson & Ramage, 2000; Lyon & Helm-Estabrooks, 1987; Rao, 1995; Sacchett et al., 1999). However, drawing, combined with residual forms of language, has the potential to enhance verbal communication in aphasia. The value of drawing as a means of driving speech production in individuals with aphasia has not been a focus of previous research.

The aim of the present study was to determine the relationship of drawing to that of speech production in individuals with aphasia. There have been numerous investigations of drawing and these findings indicate that individuals with left hemisphere (LH) lesions tend to produce simplified drawings with an absence of detail

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(Bay, 1962, 1964; Duensing, 1953; Gainotti & Tiacci, 1970; Swindell, Holland, Fromm, & Greenhouse, 1988; Warrington, James, & Kinsbourne, 1966), reduced in size (Gainotti & Tiacci, 1970; Swindell et al., 1988) and contain mixed perspectives (Hatfield & Zangwill, 1974; Lyon, 1989). Further, the quality of drawings made by individuals with aphasia has been reported to reflect the integrity of the semantic system (Gainotti, Silveri, Villa, & Caltagirone, 1983) suggesting that drawing and language are conceptually linked (Gainotti et al., 1983; Kirk & Kertesz, 1989; Swindell et al., 1988). Although these studies discuss the relationship of drawing abilities to a fundamental conceptual disorder in individuals with aphasia, the link to verbal output has not been thoroughly investigated.

We propose that drawing may improve speech production by offering an alternative route to accessing the semantic system. The semantic system is thought to have access to object knowledge from various representations of meaning including structural, perceptual and associative (Humphreys, Price, & Riddoch, 1999). To name an object a number of processing stages occur. Early visual processes encode the structural aspects of the object, such as shape and size, and the perceptual details of the object, such as color. This in turn accesses the functional and associative properties of the object, such as category. This information is matched to the stored knowledge of the object and ultimately activates the phonological representations for its name.

Drawing may facilitate a deeper level of semantic processing through increased attention to the structural and perceptual aspects of the object. If each level of processing depends upon excitatory and inhibitory connections for accurate target word selection, then the strength of activation of the target must exceed its semantic competitors to successfully progress to phonological encoding. Drawing an object may aid in this refining process through ongoing attention to structural and perceptual details of the object, thereby eliminating competitors which do not contain the appropriate attributes. Drawing therefore may be considered a semantic-based intervention that could improve verbal output in individuals with aphasia. Semantic-based treatment is known to improve phonological output in aphasic individuals (Coelho, McHugh, & Boyle, 2000; Drew & Thompson, 1999; Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985; Howard, Shaw, & Heisey, 1986; Nickels & Best, 1996).

An additional reason why drawing may be beneficial for improving access to the semantic network is that drawing involves spatial analysis and imagery, both processes known to activate the right hemisphere (RH) which is intact in most individuals with aphasia. Unlike drawing, other modalities used in aphasia therapy such as writing, rely heavily on linguistic symbols and have been shown to activate primarily LH regions (Nakam-

ura et al., 2000; Tokunaga et al., 1999). Drawing has been shown to activate RH regions including the inferior frontal lobe, Brodmann 44, (Imamura et al., 1996) and the posterior inferior temporal region, Brodmann 37, (Makuuchi, Kaminaga, & Sugishita, 2003). Makuuchi et al. (2003) have suggested that RH semantic knowledge of the object such as its parts and shape subserves drawing. Drawing, therefore, may be considered a non-linguistic intervention that potentially accesses semantic knowledge in the RH.

In this investigation we sought to answer the following questions: (1) if drawing and language are conceptually linked, will drawing facilitate lexical access and phonological output in individuals with aphasia, (2) if lexical access and phonological output are improved, will the quality of drawing be associated with this improvement, and (3) if drawing does in fact promote naming in individuals with left-hemispheric damage will evidence from fMRI support our hypothesis that drawing activation is primarily in the right hemisphere compared to writing and will this activation be associated with known “language areas” of the right hemisphere. Specifically, will patterns of activation in the right hemisphere be stronger under the drawing condition than writing in both Brodmann areas 44 and 37.

We designed an experiment to investigate each question. In experiment 1, we test the hypothesis that drawing compared to writing improves naming in individuals with aphasia. Writing was used as a control because it is a common strategy for facilitating communication in aphasia therapy, and like drawing it requires a graphic output. Additionally, writing activates primarily left hemispheric regions, whereas we expect drawing to activate predominately right hemispheric regions.

We also analyzed drawing quality with the assumption that the quality of drawings would correlate with improved naming. We hypothesized that detailed object drawings, with higher ratings for quality, would reflect stronger access to the semantic representation of the object and therefore would have a better chance of facilitating naming. This hypothesis is based, in part, upon the results of Gainotti et al. (1983) who reported that individuals with a disruption at the semantic-lexical level of language integration were impaired when attempting to draw the form and details of an object.

In experiment 2, we test the hypothesis that drawing, unlike writing, activates right hemispheric regions that may be spared in individuals with aphasia. Such evidence would support the idea that drawing helps recruit intact right-hemisphere-based semantic networks that can be used to facilitate word retrieval. We therefore expect drawing to improve naming more than writing and to show increased right hemisphere activation during drawing tasks as measured by fMRI. We use mentally simulated drawing and writing for this experiment. Some studies have utilized the mental simulation of

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