

# Subjective experience of inner speech in aphasia: Preliminary behavioral relationships and neural correlates



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## ABSTRACT

Many individuals with aphasia describe anomia with comments like “I know it but I can’t say it.” The exact meaning of such phrases is unclear. We hypothesize that at least two discrete experiences exist: the sense of (1) knowing a concept, but failing to find the right word, and (2) saying the correct word internally but not aloud (successful inner speech, sIS). We propose that sIS reflects successful lexical access; subsequent overt anomia indicates post-lexical output deficits. In this pilot study, we probed the subjective experience of anomia in 37 persons with aphasia. Self-reported sIS related to aphasia severity and phonological output deficits. In multivariate lesion-symptom mapping, sIS was associated with dorsal stream lesions, particularly in ventral sensorimotor cortex. These preliminary results suggest that people with aphasia can often provide meaningful insights about their experience of anomia and that reports of sIS relate to specific lesion locations and language deficits.

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## 1. Introduction

People with aphasia universally struggle with anomia, an acquired deficit of naming and word finding. These individuals often report that their internal knowledge of words exceeds what they demonstrate through aloud speech, saying, for example, “I know it but I can’t say it.” At times, these reports include the specific feeling that one can hear or say the correct word in one’s head, an experience that we label here as “successful inner speech,” or sIS. No prior studies have examined whether these subjective feelings of sIS provide useful information about the cognitive processes underlying anomia in a large group of individuals with aphasia. In this exploratory study, we gathered information from individuals with aphasia about sIS and related experiences, to test how these experiences map onto specific language deficits, preserved language abilities, and lesion locations.

### 1.1. Anomia and our model of naming

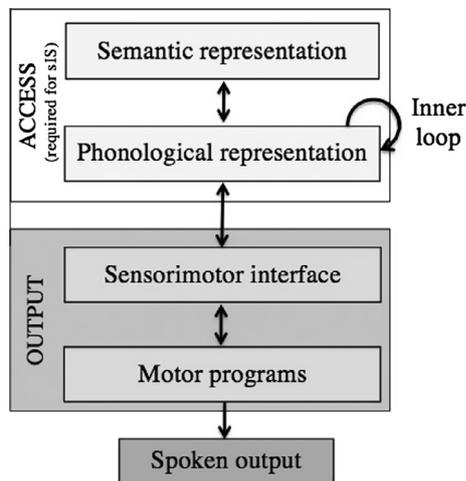
One-third of all stroke survivors are diagnosed with aphasia, a language disorder that often results in chronic communication deficits (Berthier, 2005; Engelter et al., 2006). The specific language impairments associated with aphasia can vary widely from person

to person, but a hallmark symptom of aphasia is anomia (Goodglass & Wingfield, 1997; Laine & Martin, 2006; Maher & Raymer, 2004). Anomia is easily observable: a person with aphasia is sometimes unable to produce certain words, either during spontaneous speech or during an attempt to name an object or picture (both labeled “overt anomia” here). The overt deficit is conspicuous, but the cognitive mechanisms underlying anomia are best understood in the context of a theoretical model showing the stages of successful naming. Fig. 1 presents a simplified model of the processing stages that have been suggested by existing naming models: access to a word’s semantic representation (encompassing both semantic knowledge for the concept and the corresponding abstract word-form), access to the phonological representation, and the post-lexical output processes that are necessary to turn that phonological form into a spoken word (Dell & O’Seaghdha, 1992; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Goldrick & Rapp, 2007; Levelt, 2001; Levelt, Roelofs, & Meyer, 1999; Walker & Hickok, 2015).

Correct naming requires success at each step of the naming process; consequently, overt anomia may result from a breakdown at any point, either within a stage or in the processing phase between stages (Dell et al., 1997; Laine & Martin, 2006). The locus of word-finding impairment within the access stages may be at the level of the semantic representation, at the level of the phonological representation, or in the mapping stage between the two. The process of word retrieval is typically understood to be complete once access

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**Fig. 1.** Simplified model of naming, demonstrating a distinction between access, which is necessary and sufficient for sIS, and output, which is then required for successful aloud naming.

to the phonological representation has been achieved (i.e., the end of the white *access* stages, Fig. 1). Next, there are additional *output* processes that are required to achieve successful spoken output (shown in gray, Fig. 1), i.e., the “word-production” components of naming (Kohn & Goodglass, 1985). A deficit at the level of the sensorimotor interface or motor programs, which may include phonological, phonetic and articulatory processes, can also result in spoken errors that can be difficult to distinguish from a word retrieval deficit (Feinberg, Rothi, & Heilman, 1986; Geva, Bennett, Warburton, & Patterson, 2011; Miceli, Amitrano, Capasso, & Caramazza, 1996).

### 1.2. The subjective experience of anomia

Anecdotally, many persons with aphasia endorse the idea that their out loud naming abilities do not match their inner speech (IS), stating, “I know it but I can’t say it” (Blanken, Dittmann, Haas, & Wallech, 1987; Martin & Dell, 2007) or more specifically, “I can say it in my head” or “I can hear it in my head.” These statements are often accompanied by a sense of frustration, but their exact meaning is unclear and, to date, they have not been systematically explored. We hypothesize that many individuals with anomia are aware of the level at which their inability to find a word arises, and that these statements relate to underlying word retrieval and production processes.

More precisely, we hypothesize that there are at least two discrete internal experiences of anomia, both of which result in a person being unable to produce a word correctly out loud:

- A. Wanting to communicate a concept or idea but failing to find the right word in one’s head (idea without word, **IwW**)
- B. Finding the right word in one’s head but failing to turn that lexical form into a spoken word (**sIS**)

Note that throughout this manuscript we use the terms IwW and sIS to refer to the *subjective experience* of anomia. Therefore, the term sIS does not imply that the IS is necessarily correct, only that the individual reporting the experience of sIS feels that it is; the accuracy of these reports may vary across individuals.

The difference between these two subjective experiences can be understood in terms of the possible loci of impairment in the naming model above (Section 1.1): we suggest that IwW relates to a deficit at an early stage of processing involving access to either the semantic or phonological representation, whereas sIS reflects

successful access to the word but a deficit in the post-lexical *output* processes (Fig. 1). We hypothesize that the sense of successful sIS arises after successful retrieval of both the semantic representation and the phonological form. In the model, self monitoring occurs via an inner loop that utilizes speech perception areas in the superior temporal gyrus (Indefrey, 2011), but the precise mechanism of monitoring is not critical for the current study (for further discussion of self-monitoring in IS, see Discussion Section 4.4). IwW as described above is heterogeneous: an individual may feel that he/she cannot retrieve any word at all, or has retrieved a related word, or has retrieved a word that is close but not exactly right. Stated plainly, IwW encompasses all experiences of anomia that do not meet the criteria for sIS. In contrast, sIS is discrete: an individual reporting he/she feels able to say or hear the right word internally, despite being unable to say it out loud. We can make targeted predictions about who should experience sIS, both with respect to language processing abilities and to lesion location (see Section 1.5).

### 1.3. Relationship between sIS, IwW and other failures of word retrieval

To further clarify our operational definitions of sIS and IwW, it is useful to distinguish them from two related concepts, the tip-of-the-tongue (ToT) phenomenon and “feeling-of-knowing” (FoK). The ToT experience is well known to all language users and has been well characterized in the psychology literature since the early work of Brown and McNeill (1966). The ToT state is “a failure to recall a word of which one has knowledge” (Brown & McNeill, 1966), where an individual is unable to access a word, but has a feeling of being very close to recalling it. Here, we endorse the view that ToT arises from successful lexical-semantic access and incomplete (but partial) phonological access (Burke, MacKay, Worthley, & Wade, 1991; Dell et al., 1997; Harley & MacAndrew, 2014; James & Burke, 2000; Levelt et al., 1999; Meyer & Bock, 1992).

By definition, individuals experiencing ToT do *not* have full access to the phonological form of the target word at the time of attempted production, so ToT is distinct from our definition of sIS. Furthermore, most language users have experienced the ToT sensation, but individuals without neurological speech impairments should rarely experience a feeling of sIS without successful spoken output. ToT is also distinct from IwW, although healthy language users may experience both types of word-finding failure. It is possible for IwW to reflect a feeling of partial phonological access, in which case it would be very closely related to ToT; however, as described in Section 1.2, IwW also encompasses retrieval of a related word or an inability to retrieve any word at all. These word-finding failures do not necessarily include the ToT state’s sense of closeness to retrieving the target word, which likely results from the achievement of partial phonological access (Brown, 1991; Jersakova, Souchay, & Allen, *in press*). Thus, we hypothesize that the ToT experience does not precisely map onto the anomic experiences we describe here, but lies in between IwW and sIS at the level of partial phonological access.

Similarly to ToT, a FoK experience is a metacognitive state in which a person can identify that a word is stored in memory, believes that he/she may be able to recall it at a later time, and would be able to recognize the target word when it is presented to him/her (Hart, 1965). Importantly, FoK does not necessarily include the sense of closeness that accompanies a ToT state (Hanley, 2014). FoK is easily distinguishable from our definition of sIS, as it does not include access to the phonological form. In contrast, FoK and IwW share many characteristics and may be indistinguishable in some cases. Specifically, in the context of naming, both FoK and IwW involve a sense of recognition of a certain object or person presented, without the ability to retrieve the name. FoK likely surpasses the level of knowledge included in

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