Sheila E. Blumstein

When Words Betray Us

Language, the Brain, and Aphasia

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ISBN 978-3-030-95847-3 ISBN 978-3-030-95848-0 (eBook)
https://doi.org/10.1007/978-3-030-95848-0

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To all those, here and gone, who made a difference in my life

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Prologue

My first introduction to aphasia was personal. At the time I did not know what aphasia was. When I was 19, my grandmother had a stroke. Within days of her stroke, I visited her in her home where she was lying in a hospital bed in her room. She could no longer speak. Although she tried, what came out were incomprehensible syllables. Over time, I could tell from my visits that she was improving. But the improvement was painfully slow. She could not walk on her own, she could say only a few words, and it was not clear how much she understood. Unfortunately, her story did not have a happy ending. She continued to have small strokes, and as a result, her language declined until she ultimately stopped all communication.

At the time, no one gave a name to her disorder. It was not until I was in graduate school that I made the connection when one of my professors, Roman Jakobson, talked about the breakdown of language in adults as a result of brain injury. I realized that my grandmother had had aphasia. It was then that I started reading and wrote my first paper in that course about aphasia. My grandmother may have lost her voice, but it has lived on as her legacy to me in my lifelong interest and commitment to understanding language, the brain, and aphasia.

Having been in the field since 1967 (starting in my second year as a graduate student), one has what I call the long view. Theories come and go, old theories are rediscovered, and new theories are developed. Progress seems infinitely slow – but with the long view, one can see that there is real and substantial change. And one also develops a personal perspective. And that is what this book represents. It is not intended to be a historical overview nor a critical analysis of the research of the field, although my worldview has been influenced by and owes much to those before me. It was written with the goal of making it accessible to the non-professional who may have personal experience with someone with aphasia or who is simply interested in learning about how language works, how it breaks down, and how the machinery of the brain makes it all happen.

There are many to thank for the support I have had throughout the years and who have helped bring this book to fruition. The list of people included here is not exhaustive, but it represents those who have deeply influenced and assisted me. First to my mentors of years ago, Roman Jakobson and Harold Goodglass. They provided guidance and support as I learned about aphasia and started my research career. In preparing this book, special thanks go to Carol Fowler and Donald Shankweiler who read drafts of all of the chapters and provided many helpful

comments and criticisms; to Ann Marie Clarkson, a talented artist, who drew many of the figures included in the book; and to my colleagues David Badre, Elena Festa, Bill Heindel, and Philip Lieberman and former students, now colleagues, Sara Guediche, Allard Jongman, Sahil Luthra, Emily Myers, Rachel Theodore, and Kathleen Kurowski for many helpful discussions and assistance. Thanks to the *Labites*, the undergraduate and graduate students and the postdocs, who were part of my lab at Brown University. Many thanks go to the team at Springer and especially to Sam Harrison, a great editor, who gave consistently helpful comments and advice. Finally, my gratitude goes to the many persons with aphasia with whom I worked and who were gracious participants in my research program and also to the National Institutes of Health and the National Institute on Deafness and Other Communication Disorders for supporting my research starting with a predoctoral fellowship in 1968 and continuing throughout my career.

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Introduction

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Think of the times when you are talking to someone and a word that you want to say escapes you, the perfect word that expresses your thought. Sometimes you never come up with the word, or other times the word just pops into your head, often hours later, unrelated to what you are doing, with neither conscious thought nor prompting. Even when you fail, you are sure you 'know' the word that you are searching for. You may be able to identify the first letter of the word, perhaps know how many syllables it has, or be able to name a word that is similar to it. Indeed, the word feels like it is right there *'on the tip of your tongue'*.

Or imagine your embarrassment, when you are at a party and a friend asks who that woman is standing next to your father, and instead of saying it is your aunt, you say it is your mother. Oops – how did that uninvited word, that '*slip of the tongue'* come out?

Words betray us all of the time – they can be frustratingly elusive; yet fortunately, for most of us, these misnomers occur relatively infrequently. Indeed, we just assume the normalcy of language, taking it for granted. It is always there for us, except for those few exceptional, interesting, and sometimes humorous lapses. But for some, such lapses are a constant feature of life. And difficulty in finding the right word may be only one problem or *symptom* that these individuals or persons must endure every day and often every moment. They may have a host of other problems in using language. Not just selecting words that form a sentence, but articulating them, stringing words together in a sentence, understanding what others are saying, and using the literary arts including reading and writing. Such individuals have aphasia.

How does this happen? Persons with aphasia have typically had a stroke or some brain injury as adults that have compromised their speaking and understanding of language. Prior to their neural episode, they were just like you and me – using language daily and never thinking about it. But that can change in an instant, and the consequence is that, on a daily basis, a person with aphasia is now fully cognizant that using language – saying whatever comes to mind, expressing feelings, ideas, understanding what others are saying – is compromised at best, impossible at worst.

S. E. Blumstein, *When Words Betray Us*,
https://doi.org/10.1007/978-3-030-95848-0_1

Think about the devastation that would cause. Language is the window into who and what we are. Language perhaps more than any other cognitive function defines us as human beings. It provides our lives with richness and defines not only our culture but also who we are as individuals. It serves as the primary vehicle for interacting with others. Language is the connection between our inner self and the world around us, and it provides the vehicle for us to be social and productive human beings and to navigate the world.

The goal of this book is to tell the story of aphasia – the what, the how, and the why. What is the nature of the deficits that aphasics have, how does the brain put together the pieces of language into a unitary whole, and why do particular areas of the brain underlie language and its many components? As with all good stories, there are multiple threads that comprise it. There is the story itself; besides witnessing the human toll of this disorder, the story of aphasia gives us a window into language and brain function. It allows for a rich picture that elucidates a tapestry of spared and impaired language abilities, and the complexity of the mapping of these abilities on to our neural machinery.

Elucidating the relation between language and the brain has its origins in neuropsychology – a field whose goal is to understand the neural bases of cognitive functions by studying the behavior of individuals who display different impairments pursuant to brain injury. Neuropsychology has a long and rich history, and the study of persons with aphasia has been a major part of it. In the early years, from the late nineteenth century to the mid-twentieth century, there were rich descriptions of persons with aphasia made by neurologists, psychologists, and neuropsychologists such as Henry Head, Kurt Goldstein, Hughlings Jackson, and Alexander Luria, to name a few. It was shown that although the two (left and right) hemispheres of the brain are structurally symmetrical, they are not functionally symmetrical. Behavioral tests of patients with injury to either their left or right hemisphere indicated that the two hemispheres do different things. The critical role of the left hemisphere in language was established – left hemisphere brain injury resulted in aphasia for most adults, whereas damage to the right hemisphere did not.

The complexity of the organization of language in the left hemisphere was also established. Based on observations and descriptions of individuals who sustained brain injury and on analyses of post-mortem autopsies, it was shown that damage to different areas of the left hemisphere resulted in different patterns of impairment – with a complex interaction of both largely spared and severely impaired language abilities. For example, as we will describe in detail in Chap. 2, Broca's aphasics with damage affecting frontal structures of the left hemisphere understand language well and yet show impairments in expressing language, whereas Wernicke's aphasics with damage to temporal lobe structures of the left hemisphere have difficulty understanding language and yet produce language easily and fluently. These constellations of spared and impaired abilities or *symptom-complexes* provided the basis for hypotheses about the function of lesioned areas of the brain.

Hypotheses based on descriptions are just the start of scientific investigations. Testing of these hypotheses is the next step and requires application of rigorous experimental methods. The history of aphasia is no different. Starting in the

mid-1960s, this psycholinguistic or neurolinguistic approach was the dominant means of studying language and the brain. Here, a range of experimental paradigms, largely drawn from psychology, were used to increase the understanding of aphasics' language behavior in order to try to explain the basis of the deficit coupled with an explanation of the function of the damaged neural tissue. For example, consider what your mind/brain has to do to understand a word such as 'cat'. You have to perceive the sounds of the word, 'c', 'a', 't'. The sounds have to match a particular word from among all of the words in English that you know (it's 'cat' not 'bat', 'cut' or 'cap'). You have to select that word, 'cat', and map its sounds to its meaning. So if an aphasic does not understand a word, the question is why? Does a failure to understand the meaning of 'cat' reflect a problem in processing sounds, matching sounds to words, mapping words to meanings, or unpacking the meanings of words themselves? A series of experiments would need to be designed and run, and then related to where the brain injury is. Do persons with damage in this area typically show problems with understanding words? And if so, do they display similar results across experiments that use different methods? Indeed, the bedrock of our knowledge of the neural bases of language comes from these experimental studies of aphasia. In the chapters that follow, we will explore not just the effects of brain injury on language behavior through the lens of aphasia but also examine what these findings tell us about how language is processed in the brain as we speak, understand, and communicate with others.

The importance of this endeavor is multifold. It provides a window into the history of an exciting and ever evolving science. Indeed, it reflects the incrementalism of science; while there are changes and often seemingly entirely new insights and discoveries, most have deep historical roots. We will see how the basic elements remain, but we will also see how technological advances provided by brain imaging and computer-based modeling have helped shape our current knowledge of language and the brain. These methods allow for a precise mapping of the injured brain that was difficult, if not impossible, in earlier times. Their application to persons with brain injury as well as to the uninjured brain allows us to compare language in the brain when it is damaged to when it is spared from injury. Do lesions in aphasia predict the areas that give rise to language in the uninjured brain?

We will also see how computational modeling has shaped how we look at language and its neural basis. Is the brain like a computer? And what type of computer? We will see how current computational models have properties that mirror those of neurons, thus providing a biologically-driven theoretical framework as we examine how the brain processes information about the components of language and integrates these pieces into a unitary whole as we speak and understand. Is language broken up in the brain into neural regions that are specialized for particular linguistic functions or modules such as speech, words, syntax, and semantics, or is language represented in a broadly distributed network of connections (similar to networks of neurons) where each linguistic function recruits multiple neural areas that have different but complementary functions?

And what happens to our computational model when a part of it is damaged? What happens to the real brain under these circumstances? What happens to