Ramesh Kumar Mishra

Interaction Between Attention and Language Systems in Humans

A Cognitive Science Perspective

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To my father

Preface

Most first books originate from experience of teaching. The idea of this book probably originated when I started examining the interaction of language and vision few years ago at the Centre of Behavioural and Cognitive Sciences, University of Allahabad and later at the Centre for Neural and Cognitive Sciences, University of Hyderabad. I used eye tracking to link linguistic processing with visual and attentional processes as my main method. Soon it was clear to me that language and attention interaction was dynamic, way beyond what many Psycholinguistic textbooks had taught me. This led to further research and teaching in and around these topics and also very fruitful collaborations that have been instrumental in the conceptualization of this book. As a psycholinguist it was important for me to comprehend fully the enormously important framework of cognitive psychology. Ideas of various chapters came later with my own diversification as a researcher and also with the rapid explosion of research in the last decade. They all had to be summarized in some sense, at least for the beginning student and also for the expert as a point of view.

I have reviewed others' work as far as I was aware of them and I could connect to their relevance in each chapter. I have used figures and illustrations from several sources to enrich comprehension which I assume the interdisciplinary student will find helpful. I did not intend to write a textbook on psycholinguistics in the disguise of a monograph since many good textbooks already exist. My own findings appear sporadically at many places. In no sense this selection of literature is complete or can be complete. This is an exciting and dynamic area of research and every other day new findings are coming in. Every other day one finds papers published in each one of the areas that this book has covered. It is a field that is moving at a very rapid pace at the moment. I have tried to provide an overall sense of achievement and concern to the reader that I have felt myself for themes covered here without often sounding like a text book writer.

Many collaborators and colleagues have read chapters and have commented on drafts. I only hope that I could take advantage of their advice. Most remaining flaws are mine. I particularly wish to thank Raymond Klein, Daniel Burnston, Cristian

Olivers, Andriy Myachykov and Rick Dale. Their comments have helped me to sharpen my thought in a major way. I also thank Seema Prasad, my graduate student for her extensive help in preparation of the chapters. I thank Subha who helped in editing some chapters. And of course a big thanks you to Shinjini, the editor at Springer who has been very encouraging and whose sustained comments helped me achieve clarity in writing.

Most of my own research described in this book has been made possible by several grants from the Department of Science and Technology under their Cognitive Science Initiative and I am very thankful.

I have also benefited enormously through my many visits to the Max Planck Institute for Psycholinguistics, Nijmegen as a visitor. I gratefully acknowledge the friendly support of Falk Huettig and the MPI directors for these visits. These visits and interactions certainly have influenced my thinking about the psychological basis of language. Dalhousie University for which I am grateful to Ray Klein. This led to collaborative research described in this book. Much of my own work described in this book happened at the Center for Behavioral and Cognitive Science, University of Allahabad. The supportive atmosphere at the center and conversations with Narayanan Srinivasan in particular on attention and related topics must have influenced my thinking.

I must also thank the anonymous reviewer of the manuscript whose comments and observations led to a much improved manuscript in many ways.

Thanks to Bidisha, my wife and Ritwika, my daughter, for standing by me, when they were there and not there. Many of the chapters were written and revisions done amid the lakes and greens of Indian Institute of Technology, Guwahati where Bidisha teaches.

Contents

About the Author

Ramesh Kumar Mishra, Ph.D., is an associate professor of cognitive science at the Centre of Neural and Cognitive Sciences, University of Hyderabad. He has previously taught at the Centre for Behavioural and Cognitive Sciences, University of Allahabad. Dr. Mishra has published internationally and has edited/co-edited books in the areas of psycholinguistics, language-vision interaction and attention. His areas of interest include language–attention interaction, visual processing and action control. He has been a scientific visitor to the Max Planck Institute for Psycholinguistics, Dalhousie University and the Institute for Cognitive Science Studies, Tehran, among others. Dr. Mishra is on the editorial board of *PLOS One*, *Frontiers in Cognition*, and *Journal of Experimental and Theoretical Artificial Intelligence*. He is also a co-editor of the cognitive science journal *Brain, Cognition and Culture*. Dr. Mishra is a fellow of the Psychonomic Society, USA.

Chapter 1
Linking Language to Attention

The study of language and attention is on the rise in several disciplines such as cognitive psychology, psycholinguistics, cognitive science, language disorders as well as philosophy of mind. However, there is no coherent framework that helps make sense of the diverse results observed in these fields. While it is no longer fashionable to say language does not require attention, it is also not clear how attention and language influence one another during cognitive processing. It is not an easy thing to write about a field that is in fast motion. Language and attention influence one another during cognitive processing in many different ways. My attempt in this book is to look closely at psycholinguistics and cognitive psychology to see how concepts of attention have been used in the explanation of everyday language processing and how different levels of language affect attentional deployment during cognitive processing.

This book deals with those important cognitive processes that make language processing seemingly effortless. Attention is one of them. In his celebrated *Aspects of Theory of Syntax*, Chomsky (1965) wrote, 'ideal speaker-listener in a completely homogeneous speech-community, who knows its language perfectly and is unaffected by such grammatically irrelevant conditions as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of this language in actual performance' (p. 3). This book shows that these conjectures about the linguistic capacity of the ideal native user of language may not be true. Experimental evidence from myriad disciplines such as psycholinguistics, cognitive psychology and cognitive neurosciences in the last several decades has shown that human language performance is constrained by cognitive processes. Effortless actual linguistic performance is only possible if there is harmony among important cognitive processes such as memory, attention and motivation. It is now well accepted that any holistic theoretical understanding of human language capacity must include a thorough investigation of those cognitive processes that make linguistic performance a success. This book explores the locus of language and attention interaction in different psycholinguistic processes.

The issue of how language and attention interact is of enormous importance to anyone who wants to know how the mind works. This is because if language helps express thoughts, attention selects the most relevant ones to work on. Wundt had

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investigated how executive control processes and attention influence sentence processing (see Blumenthal 1975). Similarly, one can find related concerns in the writings of Wittgenstein (see Stern 1995). Further, recent evidence from a range of linguistic and cognitive phenomena suggest that attention mechanisms affect how humans process language (see Kurland (2011) for a review and also Mishra (2014)). Attentional deficits often lead to delay in language development (Ebert and Kohnert 2011). Language structure itself seems to reflect aspects of human attentional mechanisms (Ibbotson et al. 2013). That is, what is attended most often becomes the grammatical subject of the sentence that is expressed (Wallace 1982).

Since attention is an important modulator of cognition, its interface with language is logical. While the exact nature of attentional involvement in different language processes remains specific to that process, there seems to be a broad consensus that attention influences much of linguistic processing in general (Gong and Shuai 2012; see Shtyrov et al. 2012 for a different view). Many assume that 'attention' is omnipresent in any and every cognitive process. Therefore, there is no need to propose a separate theory on the interaction of attention with other cognitive processes. The truth is that, there have been long-held views in psycholinguistics and cognitive sciences that see linguistic processing as unaffected by other processing and as encapsulated modules (Fodor 1983; see also Peretz 2012). This has led to a tacit assumption that some core syntactic processing of language can happen without attentional control and are like reflexes (Pulvermüller et al. 2008). However, in other domains of language processing such as picture naming (Roelofs 2007) or sentence generation (Myachykov et al. 2011) attentional involvement has been observed. It is the aim of this book to examine 'what' type of attentional involvement is more prominent in some linguistic processes and not in others. The study of the interaction between language and attention is also one way to examine critically the encapsulation argument for modules or even the concept of domain specificity. One important aim of this book is to examine these different observations and arrive at some consensus. Either attention and language interact more fully at some levels or they do not.

The book's chapters explicitly discuss different linguistic domains, including the influences of individual differences and culture where attentional mechanisms with regard to language processing have been investigated. This is not a psycholinguistics textbook in the conventional sense, but it is for researchers who work broadly in the fields of psycholinguistics and cognitive psychology as well as in the neuroscience of language, and who particularly look at language and attention in their research. The book is structured in a way so as to offer a comprehensive treatment of topics that have received serious research attention related to attention and language. I have only considered topics where substantial progress has been made both in theory and empirical research on the question of language and attention. Many a time researchers have not directly examined if attention affects the linguistic process but have used attention as an explanation of the data. The book examines how attention–language interface manifests in listening, speaking and reading as well as how individual differences such as bilingualism and literacy level influence such processing.

The book should also be helpful to students who wish to know the state of the art in research in the area of language and attention. Topics covered discuss research coming from multiple methodologies and a diverse range of participants to show how complex attention and language can be. Theoretically, this book motivates an anti-modular but interactionist position on cognitive operations relevant for language and attention. The book also shows that not a single theory or proposal can account for the multiple ways in which attention and language influence one another. Different human linguistic activities like reading, speaking and listening call for different involvement of attention and executive processes (see Mishra 2013 for a review). Different researchers have used different facets or conceptualization of attention, i.e. filtering process versus focusing device, to account for different linguistic processes, as indicated earlier. Others have examined attention and language together invoking concepts like 'automaticity' of cognitive operations. The book examines how these conceptualizations have been used to account for psycholinguistic processes in theory and model building.

Recent theorizations on attention and multi-modal processing look at how different cognitive systems interact dynamically during processing that includes language, vision and attention (Spivey 2007). Such interaction of cognitive processes represents a non-modular cognitive architecture (Dehaene et al. 1998). Both linguistic as well as non-linguistic information influence one another during processing (Mishra 2009). Therefore, the discussion of attention–language interaction has to include the discussion of modularity of cognitive systems as well as several other variables such as individual differences and task effects. Attention has been shown to be a core causal process whose deficits can explain a linguistic deficit in different cognitive disorders (Kurland 2011). Contemporary research shows language, attention, vision, memory and perception influence one another to produce cognition (Spivey 2007; Jackendoff 2012). For example, listening to spoken words can lead to changes in attentional states, driving eye movements towards objects that are only very remotely similar to what the spoken word refers to (Mishra 2013). Therefore, language processing in the visual world depends on attentional mechanism. This book discusses how attentional mechanisms are involved in language processing and how language in turn affects attentional strategies.

A main reason behind writing this book was to explore if there is any pattern and similarity among the different ways in which attention has been implicated in different linguistic processing. These could be attention as a process, as a focusing device, as something that leads to conscious perception and as a mechanism which filters undesirable stimuli. Researchers who have used eye tracking as a methodology explicitly link attention with oculomotor movement, which in turn presumably reflects some aspects of language processing (Henderson and Ferreira 2013; Mishra 2009). Reading researchers have linked attentional shifts during reading with lexical access and oculomotor control (Rayner 1998). Specifically, while some have viewed a serial allocation of attention during reading (Reichle et al. 2003), others have conceived of a parallel mode of deployment of attention on several words at a time (Engbert et al. 2005). Research in language production has linked

attention with focusing on the object, which leads to phonological access (Griffin and Bock 2000). Researchers in the domain of sentence processing have looked at 'automaticity' with regard to syntactic versus semantic processing (Pulvermüller et al. 2008). In the domain of second language acquisition, attention has been linked with consciousness and motivation to learn (Tomlin and Villa 1994). Finally, infant language researchers have looked at joint attention and its links with early language development (Tomasello and Farrar 1986). Apart from this, attention has been also used as a device in the examination of discourse processes (Brennan 1995). Therefore, attention has been linked to particular tasks and domains of processing. One major rationale of this book is to seek some general explanation which can be used as a framework while discussing the language–attention interface for different linguistic processes.

The multifarious use of the concept 'attention' is partly due to the confusion that exists in cognitive psychology on the nature of attention. Currently, there are different theories on the nature of attention. Some have looked at attention as a process which leads to formation of perceivable objects from features (Treisman 1998), while others have looked at attention more as a manner of biasing focus towards one entity compared to another which leads to recognition of targets (Desimone and Duncan 1995). Yet others have further fractionated attention into internal and external formats that sub-serve different cognitive operations (Chun et al. 2011). Attention has also been looked at in terms of space and time as well as modes of deployment, i.e. exogenous and endogenous (Theeuwes 1991). There are also recently offered views that totally negate the very concept of attention (Anderson 2011). Philosophers of mind with interests in the link between consciousness and the role of attention in it have considered attention as a mechanism which transforms a phenomenal awareness into a more objective perception (Block 2007). Very recently, it has been proposed that attention should always be viewed as related to a task, i.e. what attention does for a task (Koralus 2014). These diverse views thus entail different theorizations on the nature of attention and language interaction. For our purpose, I will consider some views and aspects of attention that are more widely accepted and that have been used in the explanation of empirical phenomena in the domain of language processing. The attempt will not be to redefine what attention is, but to examine which view of attention is best used in the explanation of particular linguistic processing.

Substantial progress in disability research shows a clear link between attention and language/cognitive development. For example, dyslexic researchers now view reading deficits arising from a visual and attention incapacity to process information (Pavlidis 1981). Attentional and executive function deficits have been implicated in specific language impairment (Finneran et al. 2009). Auditory attention has been implicated in the comprehension of complex sentences (Montgomery et al. 2009). Aphasia is considered to be a higher language disorder that also seems to be linked with attention deficit (Tseng et al. 1993). This evidence suggests that attention is a critical factor in language development and its deficits could lead to language and cognitive disorders. Nevertheless, it is important to point out that there is no