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Psycholinguistics

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Introduction

Talking and listening appear to be easy and effortless. What could be simpler? However, the apparent simplicity of language is belied by hidden complexity. We speak on average sixteen thousand words a day, which is over nine hundred words an hour or fifteen words a minute. How are speakers able to achieve this linguistic gymnastics? Psycholinguists investigate the psychological processes that make it possible for humans to produce and comprehend language in real time. The emphasis on psychological processes distinguishes the study of psycholinguistics from that of linguistic anthropology (see the *Oxford Bibliographies* article on Linguistic Anthropology). Nevertheless, there are overlapping areas of interest because both subfields are concerned with the psychological, social, and biological underpinnings of language. This is evident in the research on the Human Uniqueness of Language and Language Universals and Linguistic Typology. Briefly, psycholinguists are concerned with how speakers and hearers map from thoughts to utterances. During Language Production, every word that a speaker utters has to be selected from the tens of thousands of words stored in the person's "mental dictionary." These words then have to be ordered according to the grammatical rules of the speaker's language and articulated via his or her mouth or hands. During Language Comprehension, the hearer has to be able to interpret these incoming utterances, decoding a word approximately every four seconds, while at the same time preparing a response to what the speaker is saying. The rate of information exchange is staggering. To understand these processes, multiple stages of formulation, execution, and decoding need to be elucidated. In addition, these processes need to be situated within the neural architecture that produces them and the social tectonics that maintain them. To this end, psycholinguists have developed a range of Methodologies to investigate these processes.

Historical Background

The history of psycholinguistics can be traced to the 18th and 19th centuries. Although strong interest has been shown in the origins of language and language universals—issues at the heart of anthropology, too—mainstream psycholinguistics has not always embraced cross-cultural investigation. This is due to the theoretical assumptions adopted during the Cognitive Revolution. This section covers some of the Early History, the Cognitive Revolution, and the Modularity of Mind. The end of this article discusses Current Trends and Future Directions.

Early History

Psycholinguistics has a venerable history tracing back centuries, described in detail by Levelt 2012. Of special interest in this context are the chapters detailing early thinking on the origins of language and linguistic variation. Contemporary psycholinguistics was undoubtedly propelled forward by an Interdisciplinary Summer Seminar in Psychology and Linguistics that took place at Cornell University in 1951, which led to a research report outlining how the two disciplines could contribute to studying the process of communication (Carroll 1951). A few years later, in 1953, a similar Summer Seminar in Psycholinguistics held at Indiana University led to another more substantial report (Osgood and Sebeok 1954), which provided a framework for how psycholinguistic approaches could be used to elucidate first- and second-language acquisition, as well as issues surrounding bilingualism. Substantial consideration was also given to the Sapir-Whorf hypothesis, the idea that the language you speak influences the way you think (which has seen a resurgence in recent

years; see the *Oxford Bibliographies* article on the Whorfian Hypothesis). The term "psycholinguistics" was introduced by Jacob Kantor in 1936, although the first major publication bearing that title did not appear until a decade later (Pronko 1946). Not until Osgood and Sebeok 1954 and, critically, Miller 1951 was psycholinguistics formulated in modern terms as the study of the encoding and decoding of language.

Carroll, John B. 1951. *Report and recommendations of the Interdisciplinary Summer Seminar in Psychology and Linguistics, Cornell University, 18 June–10 August.* **Ithaca, NY: Cornell Univ.**

A manifesto for psycholinguistics. While linguistics provides an analysis of the structure and content of language and psychology provides an analysis of the speaker's and listener's perceptions, attitudes, motivations, and behaviors, psycholinguistics seeks to uncover how the speaker encodes ideas (as influenced by perceptions, attitudes, etc.) into articulatory motor sequences and how the hearer, in turn, decodes acoustic signals into meanings.

Levelt, Willem J. M. 2012. *A history of psycholinguistics: The pre-Chomskyan era.* **Oxford: Oxford Univ. Press.**

This comprehensive book outlines the early history of psycholinguistics. It traces the four main lines that shape modern psycholinguistic work: brain and language, experimental approaches, linguistic diversity, and language acquisition.

Miller, George A. 1951. *Language and communication.* **New York: McGraw-Hill.**

This classic book provides an overview of the psychology of language and communication up to the 1950s. Miller uses notions from information theory to understand communication. Communication is to be understood as information transmitted between sender and receiver; information can be quantified for redundancy, transmission rate, noise, etc.

Osgood, Charles E., and Thomas A. Sebeok, eds. 1954. *Psycholinguistics: A survey of theory and research problems.* **Baltimore: Waverly.**

In this survey, the authors outline different approaches to studying language. Once again, linguistics plays a key role, especially in searching for linguistic universals across languages. A second strand is learning-theoretic, accounting for language use. A third line is information-theoretic, treating the language system as an information transmission system.

Pronko, Nicholas H. 1946. Language and psycholinguistics: A review. *Psychological Bulletin* **43:189–239.**

An early review of the nascent field of psycholinguistics. It describes the burgeoning experimental literature on everything related to the psychology of language and linguistics.

The Cognitive Revolution

The new psycholinguistics bloomed alongside the "cognitive revolution" sparked by Noam Chomsky's infamous review (Chomsky 1959) of B. F. Skinner's book (Skinner 1957). Skinner had attempted to explain language in entirely behaviorist terms, without reference to any mental representations, using notions from operant conditioning. MacCorquodale 1970 is useful to read alongside this classic piece by Chomsky. Chomsky 1959 stated that no amount of reinforcement or conditioning could account for the productivity and systematicity of language. Part of the critique became crystallized in the "poverty of stimulus" argument: that the child does not receive sufficient input to justify the generalizations that he or she comes to make about grammar. If the input is not sufficient to induct grammatical structures, then this must mean that the infant is born with an innate language acquisition device, and it must be universal. Chomsky 1959 also made the critical distinction between "competence" (the knowledge we have about a language) and "performance" (how we use that language). This appeared to divide neatly the province of linguists (who are to deliver a theory of competence) and psycholinguistics (who study performance). Indeed, psycholinguists in the 1960s spent considerable efforts testing the

psychological reality of syntactic processing. Over time, however, it appeared that many effects observed in the study of grammatical representations were being determined by semantic factors (Johnson-Laird 1974), which resulted in a shift in emphasis in subsequent research to other areas of language processing.

Chomsky, Noam. 1959. A review of B. F. Skinner's *Verbal Behavior*. *Language* 35.1: 26–58.

In this classic review article, Chomsky argues that behaviorism can never account for human language.

Johnson-Laird, P. N. 1974. Experimental psycholinguistics. *Annual Review of Psychology* 25.1: 135–160.

A review of experimental psycholinguistics, which concluded that many effects observed in the study of grammatical representations were actually being determined by semantic factors. Available online for purchase or by subscription.

MacCorquodale, Kenneth. 1970. On Chomsky's review of Skinner's Verbal Behavior. *Journal of the Experimental Analysis of Behavior* 13:83–99.

MacCorquodale distills the core points of Chomsky's critique against Skinner and argues that these misrepresent or otherwise do not adequately address the crux of Skinner's approach. A useful paper to read alongside Chomsky 1959.

Skinner, Barrhus Fredric. 1957. *Verbal behaviour*. New York: Appleton-Century-Crofts.

Skinner provides a behaviorist account of language. The speaker's verbal responses were viewed as the product of environmental factors. For example, the infant imitates the adult, and these imitations are "reinforced" such that eventually the child produces a sound that is ever increasingly a better approximation of the adult's example.

Modularity of Mind

By the mid-1980s a new theoretical schism was to define much of the experimental research that psycholinguists would produce for the next decades. The crux of the matter was the type of architecture required for language processing. Fodor 1983 argued that cognition was best characterized as a set of discrete computations occurring in encapsulated modules. Fodor's book appeared during the heyday of artificial intelligence (AI), when researchers were trying to produce programs that would be able to understand and produce language; see Sharples, et al. 1989 for an overview of this approach. The models produced under the guise of AI meshed well with the proposed modular architectures of Fodor. Against this backdrop, another way of thinking about mind and language appeared. The new approach held that the units of computation were not symbolic but rather subsymbolic, as pioneered in McClelland, et al. 1986 and Rumelhart, et al. 1986. Connectionist models of language came to be hugely influential and highly controversial, as demonstrated by the exchange between Fodor and Pylyshyn 1988 and Smolensky 1988. The controversies continue today with fierce arguments over issues such as whether speakers operate with generally formulated rules (e.g., for plural nouns, add morpheme -s) with another mechanism to deal with exceptions (except for *sheep, deer, trout, salmon*, and so on). Or, do speakers instead deal with all cases using the same mechanism of generalization over statistical regularities, as connectionists would argue. Today increasingly powerful models of how statistical regularities are available that could provide the foundations for language use. This has led to a revisiting of some of the dogmas of the Chomskyan perspective, such as the poverty of stimulus argument discussed earlier (see, e.g., Perfors, et al. 2011). One major avenue being explored currently is exactly what kinds of statistical models best approximate human language behavior (cf. Chater and Manning 2006).

Chater, N., and C. D. Manning. 2006. Probabilistic models of language processing and acquisition. *Trends in Cognitive Sciences* 10.7: 335–344.

A review of probabilistic models of language. Such models are providing new impetus for empirically grounded accounts of language acquisition and language use. Available online for purchase or by subscription.

Fodor, Jerry A. 1983. *The modularity of mind.* **Cambridge, MA: MIT Press.**

Fodor argues cognition is best characterized as a set of discrete computations that are encapsulated. Encapsulated "modules" of computation receive certain input states and produce an output state but are blind to the workings of other modules.

Fodor, Jerry A., and Zenon W. Pylyshyn. 1988. Connectionism and cognitive architecture: A critical analysis. *Cognition* **28.1–2: 3–71.**

A critique of the connectionist approach to language and cognition. Available online for purchase or by subscription.

McClelland, James L., David E. Rumelhart, and the PDP Research Group. 1986. *Parallel distributed processing: Explorations in the microstructure of cognition.* **Vol. 2,** *Psychological and biological models.* **Cambridge, MA: MIT Press.**

This second volume presents specific connectionist models of memory, language, and thought.

Perfors, Amy, Joshua B. Tenenbaum, and Terry Regier. 2011. The learnability of abstract syntactic principles. *Cognition* **118.3: 306–338.**

Using a statistical-learning approach, the authors show that it is possible to induct the hierarchical phrase structure of a language and therefore this need not be an innate aspect of the language faculty (contra Chomsky). Available online for purchase or by subscription.

Rumelhart, David E., James L. McClelland, and the PDP Research Group. 1986. *Parallel distributed processing: Explorations in the microstructure of cognition.* **Vol. 1,** *Foundations.* **Cambridge, MA: MIT Press.**

According to connectionism, discrete units of language are not discretely stored. Instead, linguistic knowledge is represented across a network of neural-like units, and these units are manipulated by a spreading of activation. This first volume explains some of the basic ideas of the connectionist framework.

Sharples, Mike, David Hogg, Chris Hutchinson, Steve Torrance, and David Young. 1989. *Computers and thought: A practical introduction to artificial intelligence.* **Cambridge, MA: MIT Press.**

An introduction to artificial intelligence. The book covers a number of topics and demonstrates which aspects of human cognition are particularly difficult to instantiate in computer simulations, such as language processing and problem solving.

Smolensky, Paul. 1988. On the proper treatment of connectionism. *Behavioral and Brain Sciences* **11.1: 1–23.**

A full treatment of how a massively parallel subsymbolic system can nevertheless appear to be a sequential rule-following system, particularly important when trying to characterize language behavior. Available online for purchase or by subscription.

General Overviews

The key questions within psycholinguistics intersect with neighboring issues in psychology, linguistics, and anthropology. Core questions include: What are the representations and processes involved in transforming an idea into a set of articulatory motor movements of the mouth (or hands, in the case of sign languages)? Conversely, how does the hearer decode an acoustic signal into a meaningful interpretation? How do linguistic systems interact with other nonlinguistic representational structures, such as sensory and attentional systems? How do languages vary cross-linguistically? What does this variation tell us about the biological foundations of language, as well as the social and cultural processes at play during transmission? How do children acquire language? What prerequisites are in place for this learning to occur? In what ways is language learning different for the adult? Finally, in what way is human language special in comparison to communication systems in other species? For an overview of the issues, accessible introductions can be found in Altmann 1997 and Pinker 1994. More advanced issues are covered in Gleason and Ratner 1993 and Harley 2008. Gaskell 2007 and Cutler 2005 have state-of-the-art discussions on these questions, whereas Field 2004 is a handy dictionary of key concepts in psycholinguistics.

Altmann, Gerry T. M. 1997. *The ascent of Babel: An exploration of language, mind, and understanding.* **Oxford: Oxford Univ. Press.**

A brief, accessible, and engaging introduction to psycholinguists written by one of the key figures in the field. The book is written for the nonspecialist reader. The focus is different from that of Pinker 1994, with more emphasis given to issues of processing.

Cutler, Anne, ed. 2005. *Twenty-first century psycholinguistics.* **Mahwah, NJ: Lawrence Erlbaum.**

This collected volume presents a snapshot of contemporary psycholinguistics. The book explores the relationships between psychology and linguistics, biology and behavior, production and comprehension, as well as model and experiment.

Field, John. 2004. *Psycholinguistics: The key concepts.* **London: Routledge.**

An alphabetically organized introduction to the terminology and concepts of psycholinguistics.

Gaskell, M. Gareth, ed. 2007. *The Oxford handbook of psycholinguistics.* **Oxford: Oxford Univ. Press.**

This more advanced tome covers state-of-the-art approaches by psycholinguistic experts.

Gleason, Jean Berko, and Nan Bernstein Ratner, eds. 1993. *Psycholinguistics.* **2d ed. Fort Worth, TX: Harcourt Brace.**

Although this book was published in the 1990s and therefore does not reflect some of the more recent findings of the field, it is nevertheless an excellent introductory textbook to the field.

Harley, Trevor A. 2008. *The psychology of language: From data to theory.* **3d ed. Hove, UK: Psychology Press.**

An up-to-date and comprehensive textbook on the field of psycholinguistics, written for undergraduate students.

Pinker, Steven. 1994. *The language instinct.* **New York: Morrow.**

This vastly popular introduction to language covers everything from the evolution of language to how children acquire it. The book takes a strong nativist stance, unlike Altmann's more balanced *The Ascent of Babel.*

Conferences and Societies

The following conferences and societies are a useful entry point to current research in psycholinguistics. The Annual Conference of the Cognitive Science Society is particularly supportive of multidisciplinary research, and anthropology features as one of its foundational fields. The other conferences included in this section are representative of the breadth of research found in this field. The Linguistic Society of America features traditional psycholinguistic topics, as well as those at the intersection between psycholinguistics and anthropology. The International Communication Association focuses on higher-level aspects of language processing, such as understanding narrative, rhetoric, and persuasion. There is also a significant amount of information is also available for of those interested in popular culture (see the *Oxford Bibliographies* article on Popular Culture). Architectures and Mechanisms for Language Processing and CUNY Conference on Human Sentence Processing focus on the traditional psycholinguistic topics of lexical and sentence processing. The International Symposium on Bilingualism is dedicated to the processing of multiple languages. The Society for the Neurobiology of Language and the Annual Neurobiology of Language Conference explores the biological foundations of language.

Annual Conference of the Cognitive Science Society.

A highly interdisciplinary conference in which cutting-edge psycholinguistic research is presented. The conference encourages research from a variety of perspectives and welcomes anthropological research. Proceedings from the conference are also available online.

Architectures and Mechanisms for Language Processing.

AMLaP is the premier dedicated conference for psycholinguistics, held in Europe. All aspects of language processing are considered, from lexical processing to discourse comprehension. The conference encourages integration of experimental studies with computational approaches.

CUNY Conference on Human Sentence Processing.

The American counterpart of AMLaP, this conference has historically had a more narrow focus (as the name suggests).

International Communication Association.

The ICA brings together scholars studying human communication. It has over four thousand members in over eighty countries. The association publishes a number of journals and has an annual conference.

International Symposium on Bilingualism.

This symposium is open to scholars working on any aspect of bilingualism.

Linguistic Society of America.

The LSA is the major association of linguists. It holds an annual conference and runs linguistic institutes for undergraduate and graduate students.

Society for the Neurobiology of Language and the Annual Neurobiology of Language Conference.

The SNL was established (in 2010) to support the study of the biological basis of language. Its main activity is organizing the annual Neurobiology of Language Conference (NLC).

Journals

Psycholinguistic research is published in general psychology, linguistics, and neuroscience journals. Cognition stands out as a major venue for papers exploring questions about the Human Uniqueness of Language and Language Universals and Linguistic Typology, among other topics. Other important venues include the Journal of Memory and Language, Language and Cognitive Processes, and Journal of Experimental Psychology: Learning, Memory, and Cognition. Frontiers in Cultural Psychology is a free online journal that features relevant research.

Cognition. 1972–.

This is one of the top-ranking journals publishing in the area of psycholinguistics, as well as other aspects of cognition. The journal is interdisciplinary and peer reviewed, presenting both empirical and theoretical cutting-edge developments.

Frontiers in Cultural Psychology.

A free online journal that offers cutting-edge research articles and reviews on cross-cultural psychology. Psycholinguistic research exploring cross-cultural issues is published here.

Journal of Experimental Psychology: Learning, Memory, and Cognition. 1975–.

This journal features experimental studies on the broader aspects of cognition and language processing.

Journal of Memory and Language. 1985–.

This is a critical publication in the field of psycholinguistics. The journal was launched in the 1960s, when it was known as the *Journal of Verbal Learning and Verbal Behavior*. In 1985 the new name Journal of Memory and Language was taken, eschewing the original behaviorist beginnings. Today the journal publishes broadly on all psycholinguistic topics.

Language and Cognitive Processes. 1985–.

A core publication in psycholinguistics. This journal publishes theoretical and experimental papers investigating the cognitive and neural processes underlying language comprehension and production.

Language Processing

Psycholinguists study the mental processes that underlie understanding and producing language. Until fairly recently, psycholinguistic research has been dominated by the study of the comprehension process instead of production, in particular, the comprehension of written language. This skew in focus was in large part due to the ease with which written materials could be presented and manipulated in experiments. Because of technological advancements and innovations in recent years, the study of speech has come to the fore. In particular, the study of language use in everyday conversation is becoming increasingly fertile ground for research.

Language Comprehension

Understanding language seems effortless, but psycholinguistic research has unraveled numerous distinct processes. What are the main components? The first step is to interpret speech sounds (speech perception) or decode orthography in the case of reading (word recognition) and then to retrieve the meaning associated with words (lexical access). The next step is to establish the relationships between words (sentence processing) and sentences (discourse processing). Each of these processes is a separate domain of inquiry, with more information about these found under the key words (in brackets). For an overview of these processes, see Harley 2008. More detail regarding speech comprehension can be found in Pisoni and Remez 2004, whereas Rayner, et al. 2011 provides details regarding the processes involved in reading.

Harley, Trevor A. 2008. *The psychology of language: From data to theory*. 3d ed. Hove, UK: Psychology Press.

Section C (pp. 165–284) covers the process of recognizing visual words and reading and provides references for further reading. This section also covers lexical access, sentence processing, and discourse processing.

Pisoni, David B., and Robert E. Remez, eds. 2004. *The handbook of speech perception*. Oxford: Blackwell.

A comprehensive overview of the field of speech perception.

Rayner, Keith, Alexander Pollatsek, Jane Ashby, and Charles Clifton. 2011. *The psychology of reading*. 2d ed. Hove, UK: Psychology Press.

This book provides a step-by-step guide to how readers comprehend written language. It includes information about various writing systems, how and why readers' eyes move as they extract information about words, inner speech, reading disorders, etc.

Language Production

When a speaker wants to convey a thought, what are the processes that enable the appropriate linguistic units to be activated and translated faithfully into articulatory motor commands of the mouth and tongue (or hands)? First, the message to be conveyed has to be generated. This, then, must be mapped onto the appropriate syntactic structure and the correct intonation contours (e.g., specifying which words are stressed). The specific words have to be activated, both their meaning and their sounds. Finally, this information must be fed to the motor system so that motor commands are sent to the vocal tract muscles. The classic text on speech production is Levelt 1989. Levelt, et al. 1999 provides a model of the language production process; the article is followed by peer commentary which is helpful for understanding the key points of dissension among researchers in this area.

Levelt, Willem J. M. 1989. *Speaking: From intention to articulation*. Cambridge, MA: MIT Press.

The first comprehensive book to tackle the process of language production, complete from conceptualization of the message all the way through to articulation of speech.

Levelt, Willem J. M., Ardi Roelofs, and Antje S. Meyer. 1999. A theory of lexical access in speech production. *Behavioral and Brain Sciences* 22.1: 1–75.

This article provides a model of the production process. It is followed by peer commentary so the reader can follow points of controversy and debate around issues in language production. Available online for purchase or by subscription.

Language and Cognition

How does the language system engage with nonlinguistic processes during online processing? When you are speaking or listening, your language system has to interact with numerous nonlinguistic systems such as attention, memory, and emotion. Psycholinguists such as Tanenhaus, et al. 1995 investigate how these processes unfold in real time. Another critical question under this topic is whether the language that you speak shapes the way in which you think (also known as the Whorfian hypothesis; see the *Oxford Bibliographies* article on the Whorfian Hypothesis). Gentner and Goldin-Meadow 2003 is a lively collection of articles exploring the question of whether language shapes the way in which you think. Malt and Wolff 2010 explores the flip side of the question, to what extent are constraints in perception and cognition reflected in language? Bowerman and Levinson 2001 offers a developmental perspective to these issues.

Bowerman, Melissa, and Stephen C. Levinson, eds. 2001. *Language acquisition and conceptual development*. Cambridge, UK: Cambridge Univ. Press.

Are concepts independent of language, such that the child merely has to attach labels to their thoughts? Or do children construct their concepts by learning the particularities of their parents' tongues? This collection of articles from leading researchers discusses how the language acquisition process interacts with conceptual development.

Gentner, Dedre, and Susan Goldin-Meadow, eds. 2003. *Language in mind: Advances in the study of language and thought*. Cambridge, MA: MIT Press.

Do differences in language have consequences for thinking? This collection of articles explore whether the language that you speak influences the way in which you think.

Malt, Barbara C., and Phillip M. Wolff, eds. 2010. *Words and the mind: How words capture human experience*. Oxford: Oxford Univ. Press.

How different are the meanings coded in different languages? Drawing on findings across a range of semantic domains and a variety of methods, this book explores variation in semantics and constraints in variation.

Tanenhaus, M. K., M. J. Spivey-Knowlton, K. M. Eberhard, and J. Sedivy. 1995. Integration of visual and linguistic information in spoken language comprehension. *Science* 268:1632–1634.

This paper investigates how visual and linguistic information come together during the online processing of language. Available online for purchase or by subscription.

Human Uniqueness of Language

Language as utilized by humans is undoubtedly special—no other animal communication system is quite on par. However, what precisely distinguishes human linguistic systems from others? To understand some of the unique features of human languages, Hockett 1960 is a useful introduction. The author sets out thirteen design features of language, such as arbitrariness (no direct connection between form and meaning), displacement (the ability to talk about things that are not present), and duality of patterning (a finite number of meaningless sounds combine to form an infinite number of meaningful signs). These features, he argues, are common to all human languages but do not appear together as a package in any other animal communication system. The design features have since been challenged on many fronts from both human and animal perspectives. For example, sign languages lack some of these "universal" features and yet have the communicative adequacy of any spoken language, as demonstrated in Sandler, et al. 2011. More recently, Hauser, et al. 2002 suggest that the only uniquely human feature of language is recursion; however, the description of the Pirahã language in Everett 2005 suggests that this is not true. Tomasello 2000 provides yet another influential perspective, arguing that the critical difference between humans and other animals is our ability to understand the minds of others and

that this serves as the bedrock of our uniquely human language capacity. Yet another perspective is offered in Deacon 1997, in which the author suggests that the capacity for symbolic reference distinguishes humans.

Deacon, Terrence W. 1997. *The symbolic species: The co-evolution of language and the brain.* **New York: Norton.**

Deacon focuses on the role of symbolic representation in language evolution. This book provides a useful review of the animal communication literature.

Everett, Daniel L. 2005. Cultural constraints on grammar and cognition in Pirahã. *Current Anthropology* **46.4: 621–646.**

Everett argues that recursion is not to be found in Pirahã, contrary to the claims made in Hauser, et al. 2002. The associated commentaries to this article provide further possible counterexamples to the Hauser, et al. claim.

Hauser, Marc D., Noam Chomsky, and W. Tecumseh Fitch. 2002. The faculty of language: What is it, who has it, and how did it evolve? *Science* **298.5598: 1569–1579.**

A highly influential and provocative statement regarding the uniquely human faculty of language. Hauser and colleagues argue that only recursion distinguishes human language from animal communication systems. Available online for purchase or by subscription.

Hockett, Charles F. 1960. The origin of speech. *Scientific American* **203:89–96.**

A classic, yet still contemporary, article on the evolution of language. Hockett outlines thirteen design features common to all human languages but absent in toto in other communication systems.

Sandler, Wendy, Mark Aronoff, Irit Meir, and Carol Padden. 2011. The gradual emergence of phonological form in a new language. *Natural Language & Linguistic Theory* **29.2: 503–543.**

Sign languages challenge some of the default assumptions made about the design of human languages. In this fascinating paper, Sandler and colleagues show that Al-Sayyid Bedouin Sign Language lacks phonological structure, thus providing a counterexample to the claim that all human languages feature duality of patterning. Available online for purchase or by subscription.

Tomasello, Michael. 2000. *The cultural origins of human cognition.* **Cambridge, MA: Harvard Univ. Press.**

In this elegantly written book, Tomasello makes the case that the human ability to understand another's intentions is the critical ingredient that distinguishes human communication systems from those of other animals.

Language Universals and Linguistic Typology

Psycholinguistics has been a critical contributor to the interdisciplinary search for language universals. Berlin and Kay 1969 is a landmark study in this vein. After studying the color systems from dozens of languages, the authors argued that there was a universal trajectory for developing a color lexicon. For example, if a language had three color terms, they would be *black, white,* and *red*; if a language had four terms, they would be *black, white, red,* and then either *green* or *yellow*; and so forth. Berlin and Kay grounded these universals in the physiology of the visual system, providing a psychological explanation for the cross-cultural findings. Their work has survived remarkably well over time, although it has had its detractors. Lucy 1997 and Wierzbicka 2005 provide important counterpoints. Regier and Kay 2009 summarizes the latest

on color language and cognition. The Berlin and Kay approach to studying universals has been applied to many other domains, including space (e.g., Levinson, et al. 2003) and events (e.g., Majid, et al. 2008). However, a lurking question remains: are the regularities being uncovered in these investigations truly "universal"? Evans and Levinson 2009 argues in the provocatively titled article, "The Myth of Language Universals," that there are no true universals of language (see Human Uniqueness of Language). The World Atlas of Language Structures is an online database providing information about the structural features of hundreds of languages and has been used in many recent investigations of language universals.

Berlin, Brent, and Paul Kay. 1969. *Basic color terms: Their universality and evolution*. Berkeley: Univ. of California Press.

In this classic book, Berlin and Kay investigate the color terminologies across diverse languages. This book transformed the study of language universals. Many key distinctions were introduced, and it has continued to be the benchmark for cross-cultural studies of semantics.

Evans, Nicholas, and Stephen C. Levinson. 2009. The myth of language universals: Language diversity and its importance for cognitive science. *Behavioral and Brain Sciences* 32.5: 429–448.

A remarkable summary of the quest for language universals. Evans and Levinson argue that no linguistic feature is universally present in all languages. The commentaries following the article illustrate the resulting controversy that it sparked. Available online for purchase or by subscription.

Levinson, Stephen, Sérgio Meira, and The Language and Cognition Group. 2003. "Natural concepts" in the spatial topological domain-adpositional meanings in crosslinguistic perspective: An exercise in semantic typology. *Language* 79.3: 485–516.

Examines whether there are universal spatial concepts expressed in nine unrelated languages using a standardized elicitation kit, akin to the procedure used by Berlin and Kay 1969. Available online for purchase or by subscription.

Lucy, John A. 1997. The linguistics of "color." In *Color categories in thought and language*. Edited by C. L. Hardin and Luisa Maffi, 320–346. Cambridge, UK: Cambridge Univ. Press.

A thought-provoking critique of Berlin and Kay 1969. Lucy points out some of the methodological limitations of predefining a referential space in order to explore cross-cultural semantics.

Majid, Asifa, James S. Boster, and Melissa Bowerman. 2008. The cross-linguistic categorization of everyday events: A study of cutting and breaking. *Cognition* 109.2: 235–250.

Examines the cross-cultural categorization of event categories in twenty-eight typologically, genetically, and geographically diverse languages. Majid and colleagues show considerable regularity in linguistic categories and argue that variation in meaning is constrained. Available online for purchase or by subscription.

Regier, Terry, and Paul Kay. 2009. Language, thought, and color: Whorf was half right. *Trends in Cognitive Science* 13.10: 439–446.

A recent synopsis of research on color language and cognition. Regier and Kay argue that there are universal tendencies in color naming. However, languages that differ in their color naming also have concomitant differences in color cognition, consistent with the Whorfian hypothesis (see the *Oxford Bibliographies* article on the Whorfian Hypothesis). Available online for purchase or by subscription.

Wierzbicka, Anna. 2005. There are no "color universals" but there are universals of visual semantics. *Anthropological Linguistics* **47.2: 217–244.**

Wierzbicka provides new evidence from Australian languages that questions whether color is a coherent conceptual domain in all languages. She also provides an alternative framework for studying semantics cross-culturally using semantic primitives. Available online for purchase or by subscription.

The World Atlas of Language Structures.

An online database featuring dozens of linguistic features and their distribution worldwide. Readers can read contained chapters and explore interactive maps of linguistic features across the globe.

Methodologies

Psycholinguistics is characterized by the use of multiple methods, with the aim of garnering converging evidence. The discipline has a strong emphasis on experimental methods, although observational and corpus-based approaches also figure prominently.

Experimental Approaches

In an experiment, the researcher manipulates an independent variable and measures how that affects a dependent variable. Say, for example, you want to test whether it is easier to name objects that are familiar than those that are unfamiliar. Here, the independent variable is the familiarity of the object. A psycholinguist would construct one set of materials that is high in familiarity and another that is low in familiarity. "Ease" could be measured in a number of different ways, but one simple way is to measure the amount of time between when a picture of an object appears to when the person produces the word. Because a number of factors can influence reaction times for producing words—such as word frequency, length, age of acquisition—the familiar and unfamiliar materials would have to be matched on all of these extraneous variables. The final data would be analyzed statistically. Cozby 2008 introduces experimental methods, whereas Meltzoff 1998 provides a tutorial for critically evaluating experimental methods and results.

Cozby, Paul C. 2008. *Methods in behavioral research.* **10th ed. New York: McGraw-Hill Higher Education.**

A basic introduction to experimental and quasi-experimental research methods and statistical inference. Supplementary materials accompanying this book are available online.

Meltzoff, Julian. 1998. *Critical thinking about research: Psychology and related fields.* **Washington, DC: American Psychological Association.**

An introduction on how to interpret and critique experimental research, with practical examples.

Off-Line and On-Line Measures

Within psycholinguistic experiments, a contrast is usually made between off-line and on-line measures. In an off-line experiment, the dependent variable taps into the outcome of language processing. For example, a participant might be given sentences, such as "John fears Mary" and "John frightens Mary," and asked, "Why?" The dependent variable is which protagonist is taken to have caused the event of fearing or frightening. It turns out that John is taken to be the cause in "John frightens Mary," but it is Mary who is considered to be the cause in "John fears Mary" (Brown and Fish 1983). Off-line experiments are useful for measuring global linguistic knowledge but can be limited when trying to establish the

psychological mechanisms involved. On-line experiments tap into language processing as it happens (Carreiras and Clifton 2004). They do not require an explicit judgement on the part of the participant and provide information about the time course of mental processes. For instance, participants' reaction times to sentences can be measured. A participant can be given a sentence, such as "John fears Mary because she is easily hurt" or "John fears Mary because he is easily hurt." If participants take longer to read the second sentence than the first it suggests that, in the latter, the fact that John is easily hurt is not as good a reason for his fear than the fact that Mary is easily hurt.

Brown, Roger, and Deborah Fish. 1983. The psychological causality implicit in language. *Cognition* **14.3: 237–273.**

A classic paper utilizing off-line methods, in this case in order to investigate verb semantics. Available online for purchase or by subscription.

Carreiras, Manuel, and Charles Clifton Jr., eds. 2004. *The on-line study of sentence comprehension: Eyetracking, ERPs, and beyond.* **New York: Psychology Press.**

A compendium of online methods for investigating the moment-to-moment comprehension of language.

Types of Subjective Judgements

Participants are asked explicitly to make a judgement about the acceptability or grammaticality of a sentence. Plausibility judgements are another method of ascertaining language norms. Subjective methods of these kinds are often found in the sentence and discourse processing fields. They are sensitive to syntactic well-formedness, discourse coherence, lexical-level knowledge, etc. Recently these methods have come under some critique; see, e.g., Gibson and Fedorenko 2013 and Dąbrowska 2010.

Dąbrowska, Ewa. 2010. Naive v. expert intuitions: An empirical study of acceptability judgements. *Linguistic Review* **27.1: 1–23.**

Linguists and nonlinguists can have systematic differences in acceptability judgements. This paper examines the possible consequences of these differential judgements. Available online for purchase or by subscription.

Gibson, Edward, and Evelina Fedorenko. 2013. The need for quantitative methods in syntax and semantics research. *Language and Cognitive Processes* **28.1–2: 88–124.**

A critique of the use of subjective measurements in linguistic and psycholinguistic research. Available online for purchase or by subscription.

Methods of Determining Similarity

Similarity judgements can elucidate how the relationship between linguistic units is mentally represented. Explicit similarity judgements can be gleaned by asking people to consider two objects and asking them to make a same/different judgement, or in a triad test, the participant is given a target object and must decide which of two foils is the best match for the target. These tasks are most useful when the number of items to be considered is small. However, as the item set grows, a sorting task can be more efficient. Participants in a sorting task are presented with a set of materials and asked to group items based on how similar they deem them to be. In a successive sorting task, after making an initial grouping, participants continue to divide and join groups, and thus generate richer similarity data. See Weller and Romney 1988 for more on these methods. Similarity data can also be implicitly generated. For example, when English speakers are asked to free-list all the animals they know, they typically begin with domestic pets (dog, cat), then move to farm animals (cow, sheep, chicken), and then to wild animals (tiger, lion, giraffe). The closer two words are produced, the more similar that pair

(Henley 1969). Note, the order in which animals are listed reveals underlying similarity relations. In this example, participants do not usually list animals by size, color, or tastiness (even though those could be reasonable principles). Instead, it appears that animals are similar to the extent that they share function or familiarity. Free-association tasks (Galton 1879) invite participants to generate a single exemplar to a target (e.g., I say "bread," you say "_____"?). Again, implicit similarity data is revealed.

Galton, Francis. 1879. Psychometric experiments. *Brain* **2.2: 149–162.**

In this classic paper from the 19th century, Francis Galton (cousin of Charles Darwin) introduces free-association as an objective method to investigate the processes of the mind. Available online for purchase or by subscription.

Henley, Nancy M. 1969. A psychological study of the semantics of animal terms. *Journal of Verbal Learning and Verbal Behavior* **8.2: 176–184.**

An early investigation of the semantic field of animal terms in English using five different experimental techniques. This study illustrates that the different techniques give comparable outcomes and thus all are tapping into the same underlying representations. Available online for purchase or by subscription.

Weller, Susan C., and A. Kimball Romney. 1988. *Systematic data collection.* **Newbury Park, CA: SAGE.**

A concise introduction to collecting similarity data, including free-listing, pile sorting, triadic comparisons, etc. The book also includes a helpful discussion on ascertaining reliability, validity, and sample size.

Measuring Reaction Times

All psychological processes take time to execute. By carefully manipulating one variable while keeping others constant, one can infer properties relating to the underlying psychological processes. For example, in a naming task the experimenter can measure how long it takes participants to produce a word in response to a printed word, picture, or any other external stimulus (Cattell 1886). The fact that low-frequency words take longer to produce than high-frequency words, as demonstrated by Oldfield and Wingfield 1965, suggests that lexical activation may be different for low-frequency words (see Jescheniak and Levelt 1994). The time taken to name pictures can also be used to study syntactic- and discourse-level phenomena. Of course, by speaking a word and then asking a participant to match the word to pictures or other materials, the experimenter is also able to study the time course of the comprehension process. In another paradigm, the lexical decision task developed by Meyer and Schvaneveldt 1971, participants are presented with a string of letters and have to indicate, usually by pressing a button, whether the string is a word or nonword. The length of time taken to decide whether it is a word can shed light on aspects of lexical access and the mental lexicon. For instance, people are faster at deciding whether something is a word when they have been previously presented with a semantically related word; see Lucas 2000 for a recent overview. When two things are similar and involved together in processing, they can help or hinder each other, as in the previous example. This is known as "priming." Lexical decision tasks are not the only place we see priming. Priming effects are seen in naming, when making semantic judgements, etc. Priming can be facilitative (i.e., faster responses to a stimulus, or related stimuli, on subsequent presentation) or inhibitory (i.e., slower responses). The priming paradigm has been used to investigate all aspects of language from phonology to syntax. Another common paradigm in which reaction times serve a critical function is self-paced reading. Participants are given a word or sentence to read. When they have finished reading the presented fragment, they press a button to receive the next bit of the text. The time taken to read each fragment is measured and provides an indication of where the reader finds something difficult or unusual. In reading experiments, researchers can manipulate texts so that they minimally differ, and thus reading times can be used to measure processing ease/difficulty.

Cattell, James McKeen. 1886. The time it takes to see and name objects. *Mind* **11.41: 63–65.**

Using reaction-time experiments, Cattell studied word and picture naming and showed that it takes longer for people to name pictures than words, presumably because of the extra steps involved in retrieving the name of the picture. Available online for purchase or by subscription.

Jescheniak, Jörg D., and Willem J. M. Levelt. 1994. Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 20.4: 824–843.

In this classic article, Jescheniak and Levelt explore the locus of the word-frequency effect in speech production and conclude that it is a result of differential activation thresholds for high- versus low-frequency words. Available online for purchase or by subscription.

Lucas, Margery. 2000. Semantic priming without association: A meta-analytic review. *Psychonomic Bulletin & Review* 7.4: 618–630.

A recent review of the literature on semantic priming that spells out the consequences of this research for learning about the nature of the mental lexicon, i.e. how words are represented in the mind.

Meyer, David E., and Roger W. Schvaneveldt. 1971. Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology* 90.2: 227–234.

In this citation classic, Meyer and Schvaneveldt showed that identification of a word is easier when it is preceded by a word with a related meaning. For example, people are faster at saying that *doctor* is a word when it is immediately preceded by *nurse* than when it is preceded by an unrelated word, e.g., *butter*. Available online for purchase or by subscription.

Oldfield, R. C., and A. Wingfield. 1965. Response latencies in naming objects. *Quarterly Journal of Experimental Psychology* 17.4: 273–281.

This paper was the first to report the word-frequency effect in speech production. The authors found that naming pictures with low-frequency names took longer than pictures with high-frequency names. Available online for purchase or by subscription.

Eye-Tracking

Eye movements, like self-paced reading, also reveal information about the time course of mental processes, but at a finer level of granularity; see Rayner 1978 and Rayner 1998 for reviews. A reader's eye makes a series of jerky "saccadic" movements, separated by moments when it lands on a spot and fixates. Researchers use these movements as a way of tapping into different sorts of cognitive processes. For example, by measuring eye movements during sentence comprehension, researchers can distinguish whether a reader has a problem when first reading a critical word or later when integrating that word into the sentence context. This is possible because separate measures of initial fixation and regression (going back to the critical word after moving away from it) can be distinguished in a manner not so easily achieved using self-paced reading. Aside from reading, eye movements have been a highly profitable way to study spoken word comprehension and production, using the visual world paradigm. The eye movements of a person looking at a picture while listening to speech are tightly coupled to the unfolding speech, as demonstrated in Tanenhaus, et al. 1995. Similarly, in production, the time spent looking at a picture depends on how long it takes to retrieve the phonological form of an object name (Meyer, et al. 1998). Innovations in technology mean that eye-trackers are now smaller and more inconspicuous than ever, making the use of eye-tracking during conversational interactions an exciting avenue of research in the future (see Crosby, et al. 2008 and Richardson, et al. 2007).

Crosby, Jennifer R., Benoît Monin, and Daniel Richardson. 2008. Where do we look during potentially offensive behavior? *Psychological Science* **19.3: 226–228.**

Participants in this study listened to a white discussant criticizing affirmative action in the presence of three other participants, two white and one black. Eye-movement analysis revealed that the black participant attracted gaze during potentially offensive comments regarding affirmative action. Thus, people simultaneously integrate what is said with a participant's social identity (see the *Oxford Bibliographies* article on Linguistic Anthropology). Available online for purchase or by subscription.

Meyer, Antje S., Astrid M. Sleiderink, and Willem J. M. Levelt. 1998. Viewing and naming objects: Eye movements during noun phrase production. *Cognition* **66.2: B25–B33.**

Meyer and colleagues demonstrate that eye movements are tightly coordinated with the linguistic processes of speech planning. Available online for purchase or by subscription.

Rayner, Keith. 1978. Eye movements in reading and information processing. *Psychological Bulletin* **85:618–660.**

A comprehensive overview of the earlier research on eye movements and what it can tell us about language processing, particularly reading. Available online for purchase or by subscription.

Rayner, Keith. 1998. Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin* **124.3: 372–422.**

A more recent review of the literature on eye movements and language. Available online for purchase or by subscription.

Richardson, D. C., R. Dale, and N. Z. Kirkham. 2007. The art of conversation is coordination. *Psychological Science* **18.5: 407–413.**

Using two eye-trackers simultaneously, this paper investigated the coordination of gaze during conversation between two participants. Eye movements were coupled (i.e., both participants looked at the same object) more often than chance, suggesting conversation licenses coordinated joint attention. Available online for purchase or by subscription.

Tanenhaus, M. K., M. J. Spivey-Knowlton, K. M. Eberhard, and J. Sedivy. 1995. Integration of visual and linguistic information in spoken language comprehension. *Science* **268:1632–1634.**

This paper shows how eye movements are tightly coupled to speech in a dynamic way. Available online for purchase or by subscription.

Neuropsychological and Neuroimaging Approaches

The brain basis of language has played a crucial role in psycholinguistic theory development since its nascent days (see Levelt 2012). Aphasia, the loss of language abilities due to brain damage, led researchers to suggest one method of examining the role of the brain in language processing; namely, the use of case studies of patients with brain lesions. By closely observing language behavior and later conducting postmortem examination of patients' brains, researchers discovered sites critically involved in the production and comprehension of language (Broca's and Wernicke's areas, respectively). These neuropsychological studies from the 19th century were foundational in theorizing about the biological bases of language. Today neuropsychological case studies are a source of evidence and inspiration (witness Mahon and Caramazza 2009 and Shallice 1988), but they are perhaps less prominent than they have been in the past. Gernsbacher 1994 (the first *Handbook of Psycholinguistics*) featured a number of chapters on neuropsychology, whereas a decade later

in Gaskell 2007, the most recent handbook, neuropsychology occupies a more modest presence. This shift is related to the now widespread use of noninvasive techniques to measure the brain's activity in language processing. Witness the shift in emphasis to neuroimaging techniques in the above-mentioned handbooks by Gernsbacher and Gaskell. Neuroimaging research has focused predominantly on two sorts of questions. First, are different aspects of language processed in distinct cortical regions? Second, are the regions engaged in language processing exclusive to language? Meta-analyses to date suggest that language is supported by a widely distributed network of brain regions, which are shared with other nonlinguistic processes.

Gaskell, M. Gareth, ed. 2007. *The Oxford handbook of psycholinguistics.* **Oxford: Oxford Univ. Press.**

For the latest developments featuring neuropsychology, see the more recent compendium of articles by psycholinguist scholars.

Gernsbacher, Morton Ann., ed. 1994. *Handbook of psycholinguistics.* **San Diego, CA: Academic Press.**

The first handbook covering the discipline of psycholinguistics. In this compendium of articles by leading scholars in the field of psycholinguistics, a number of chapters with clinical case studies are featured.

Levelt, Willem J. M. 2012. *A history of psycholinguistics: The pre-Chomskyan era.* **Oxford: Oxford Univ. Press.**

This comprehensive book traces the early history of neuropsychological approaches to language including, among others, the classic work of Paul Broca and Carl Wernicke.

Mahon, Bradford Z., and Alfonso Caramazza. 2009. Concepts and categories: A cognitive neuropsychological perspective. *Annual Review of Psychology* **60:27–51.**

A recent synopsis of cognitive neuropsychological studies of brain-damaged patients and what they tell us about how conceptual knowledge is represented. Available online for purchase or by subscription.

Shallice, Tim. 1988. *From neuropsychology to mental structure.* **Cambridge, UK: Cambridge Univ. Press.**

A wonderful treatise, arguing for the importance of neuropsychology in understanding everyday cognition. The book lays out the foundations of neuropsychology, including common clinical disorders as well as the rationale and methodology of the field.

Functional Neuroimaging Techniques

Functional neuroimaging techniques measure blood flow in the brain. The rationale for measuring blood flow is that when neural activity increases, accompanying blood flow to that area will also increase. Positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) both measure blood flow. Researchers correlate changes across experimental conditions to neural activity in order to discern which brain regions are most active in the processing of such materials (Gernsbacher and Kaschak 2003). The advantage of both of these techniques is that they are able to localize spatially with great precision; however, because increase in blood flow is delayed by a few seconds from when neural activity actually begins to increase, the temporal resolution for these techniques is poor.

Gernsbacher, Morton Ann, and Michael P. Kaschak. 2003. Neuroimaging studies of language production and comprehension. *Annual Review of Psychology* **54:91–114.**

An accessible introduction to neuroimaging techniques, which covers PET, fMRI, as well as EEG methods. Available online

for purchase or by subscription.

Electroencephalography

Temporal resolution is extremely precise in electroencephalography (EEG) and magnetoencephalography (MEG). EEG measures the electrical activity of the brain through means of electrodes on the scalp surface; MEG measures magnetic fields generated by neuronal activity. In event-related potentials (ERPs), voltage changes on the scalp are measured in relation to the presentation onset of a stimulus. ERP peaks are labeled according to latency (time in milliseconds) and polarity (positive or negative). Common components found in psycholinguistic research are the N400 (negative peak at 400 msec) which occurs after a semantically anomalous word, as demonstrated by Kutas and Hillyard 1980 and Kutas and Hillyard 1984, and the P600 which is associated with syntactic violations (Osterhout and Holcomb 1992). More recently, analyses of event-related changes of induced band power are also being incorporated in psycholinguistic investigations (e.g., Bastiaansen, et al. 2002).

Bastiaansen, Marcel C. M., Jos J. A. van Berkum, and Peter Hagoort. 2002. Event-related theta power increases in the human EEG during online sentence processing. *Neuroscience Letters* 323.1: 13–16.

Recent EEG studies of language processing are unpacking novel aspects of the neural signal, in addition to ERPs. This paper presents one such innovative technique. Available online for purchase or by subscription.

Kutas, M., and S. A. Hillyard. 1980. Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science* 207.4427: 203–205.

In comparison to semantically expected words (e.g., *work* in "It was his first day at work"), semantically unexpected words (e.g., *socks* in "He spread the warm bread with socks") elicit a large negative-going deflection, beginning around 250 msec and peaking at 400 msec. The N400 ERP component was first reported in this paper; Kutas and Hillyard took it to be a reflection of semantic processing. Available online for purchase or by subscription.

Kutas, M., and S. A. Hillyard. 1984. Brain potentials during reading reflect word expectancy and semantic association. *Nature* 307.5947: 161–163.

In this paper, Kutas and Hillyard further specified the nature of the N400. They showed that the less probable a word in that context, the larger the N400; or conversely, the more expected a word in a context, the smaller the N400. They suggest the N400 reflects the degree of semantic priming. Available online for purchase or by subscription.

Osterhout, Lee, and Phillip J. Holcomb. 1992. Event-related brain potentials elicited by syntactic anomaly. *Journal of Memory and Language* 31.6: 785–806.

In this paper, Osterhout and Holcomb demonstrated that there was a distinct neural signal to syntactic anomalies, which was distinct from that found for semantic anomalies. A larger positive-going deflection peaking at 600 msec was seen for "dispreferred" sentence structures, such as "The woman persuaded to answer the door," in comparison to preferred sentence structures, such as "The woman struggled to prepare the meal." Available online for purchase or by subscription.

Transcranial Magnetic Stimulation

The brain-imaging techniques outlined in Functional Neuroimaging Techniques and Electroencephalography tell the researcher that there is a correlation between a particular brain region (e.g., left prefrontal cortex) and a specific linguistic behavior (e.g., grammatical processing). However, these techniques do not show that the brain region is causally responsible for that behavior. In order to test for causation, psycholinguists can turn to transcranial magnetic stimulation

(TMS). TMS produces a localized and temporary disruption in neural processing when placed against the scalp. The effects can last from fractions of a second to almost an hour, depending on the type of stimulation used. Therefore, researchers can temporarily "knockout" a brain region, producing a "virtual lesion," and investigate what role that region plays in language production and comprehension (see Devlin and Watkins 2007 for a review).

Devlin, Joseph T., and Kate E. Watkins. 2007. Stimulating language: Insights from TMS. *Brain* 130:610–622.

This review paper showcases how TMS is used noninvasively to disrupt brain processes temporarily. As well as demonstrating the causal role of various brain regions in language processing, it highlights how this method can be used to enhance recovery in patients with aphasia.

Corpus-Based Approaches

In conjunction with experimental approaches in which language behavior is manipulated under controlled conditions, psycholinguists study everyday language usage by examining corpora. These corpora, along with experimental methods, play an important role in developing computational models of psycholinguistics. Gries 2012 presents the relationship(s) between corpus linguistics and psycholinguistics. Chater and Christiansen 2008 explores the relationship between corpus methods and computational approaches.

Chater, Nick, and Morten H. Christiansen. 2008. Computational models of psycholinguistics. In *The Cambridge handbook of computational psychology*. Edited by Ron Sun, 477–504. Cambridge, UK: Cambridge Univ. Press.

This chapter sketches different frameworks used by psycholinguists to model the representations and procedures underlying language acquisition and language processing.

Gries, Stefan T. 2012. Corpus linguistics, theoretical linguistics, and cognitive/psycholinguistics: Towards more and more fruitful exchanges. In *Corpus linguistics and variation in English: Theory and description*. Edited by Joybrato Mukherjee and Magnus Huber, 41–63. Amsterdam: Rodopi.

An introduction to corpus linguistics, covering a variety of perspectives. The chapter is helpful in sketching out possible relationships between psycholinguistics and corpus linguistics.

Text and Speech Corpora

Researchers often want to establish the frequency or representativeness of specific aspects of language. The Brown Corpus was one of the earliest psycholinguistic corpora and has been one of the most influential (cf. Kučera and Francis 1967 and their estimates of word frequency). Constructed in the early 1960s, the Brown Corpus features over a million words of American English across a range of genres. Today, with the advances in electronic storage and distribution, many language corpora are available. Some corpora also feature annotations for parts of speech and other structural information.

Kučera, Henry, and W. Nelson Francis. 1967. *Computational analysis of present-day American English*. Providence, RI: Brown Univ. Press.

A classic work. Using a corpus of around a million words from a variety of sources, Kučera and Francis calculated basic statistics of American English, e.g., lists of most frequent words. This compendium served as a reference for experimental psycholinguistics for decades.

Current Trends and Future Directions

The new way of thinking about language coincides with other synergistic developments in the field. Psycholinguists are becoming increasingly cross-linguistic in their efforts. After decades of reliance on English, psycholinguists today are eagerly embracing how language-specific processing principles can be incorporated into psycholinguistic theories, as discussed in Bates, et al. 2001. Perhaps the most fascinating findings in this vein have been uncovered in relation to the psycholinguistics of sign languages, as reviewed by Emmorey 2002. The acknowledgment of cross-linguistic variation also comes with a renewed interest in bilingualism and multilingualism, as illustrated in Kroll and de Groot 2009. Neuroscience is also becoming increasingly critical to theory development, although there are still challenges for the coming years, especially when it comes to incorporating cross-cultural variation. Psycholinguists, as discussed in Christiansen and Kirby 2003, are also investigating the origins of language (see Human Uniqueness of Language), a topic that for a long time was taboo for any serious-minded language scientist. The new wave of evolutionary psycholinguistics is seriously engaging with the different trajectories that languages can take, as exemplified by Levinson and Gray 2012. Finally, psycholinguists in the early 21st century seek to embed their theories of language processing into the wider cognitive, social, and cultural contexts, causing psycholinguistics to become more multidisciplinary than ever before.

Bates, Elizabeth, Antonella Devescovi, and Beverly Wulfeck. 2001. Psycholinguistics: A cross-language perspective. *Annual Review of Psychology* 52:369–396.

A review of cross-linguistic research investigating language development, language use, and language disorders. Available online for purchase or by subscription.

Christiansen, Morten H., and Simon Kirby. 2003. Language evolution: Consensus and controversies. *Trends in Cognitive Sciences* 7.7: 300–307.

A short review on current thinking on language evolution in the cognitive sciences. Available online for purchase or by subscription.

Emmorey, Karen. 2002. *Language, cognition, and the brain: Insights from sign language research.* **Mahwah, NJ: Lawrence Erlbaum.**

This fascinating book explores core psycholinguistic questions by exploring what sign languages can reveal about human language and language processing.

Kroll, Judith F., and Annette M. B. de Groot, eds. 2009. *Handbook of bilingualism: Psycholinguistic approaches.* **Oxford: Oxford Univ. Press.**

A valuable collection of articles that introduce psycholinguistic approaches to bilingualism.

Levinson, Stephen C., and Russell D. Gray. 2012. Tools from evolutionary biology shed new light on the diversification of languages. *Trends in Cognitive Sciences* 16.3: 167–173.

An introduction to evolutionary biology and models from this field that can apply to the study of languages. Available online for purchase or by subscription.

back to top