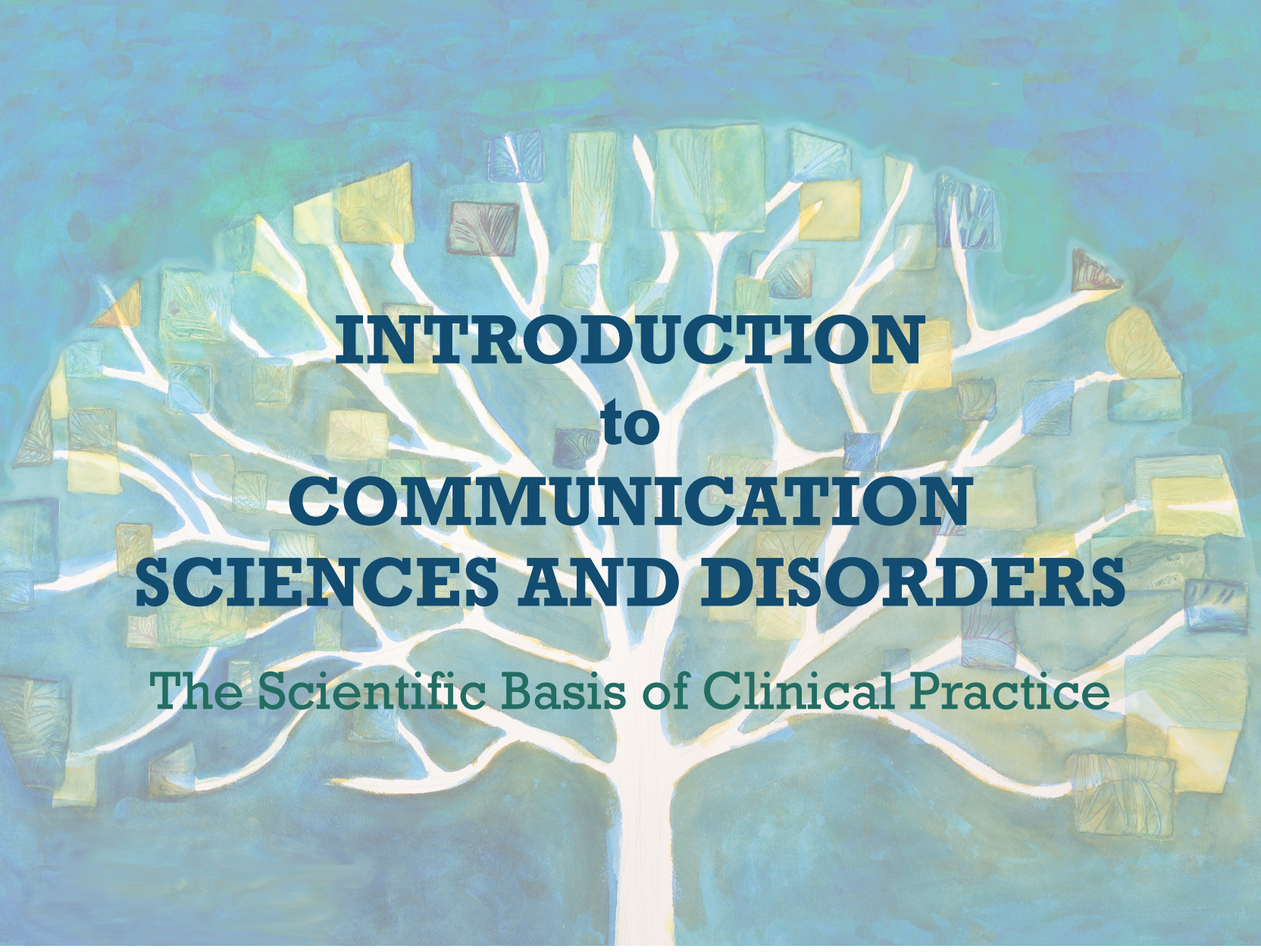

INTRODUCTION to COMMUNICATION SCIENCES AND DISORDERS

The Scientific Basis of Clinical Practice

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Preface

Introduction to Communication Sciences and Disorders: *The Scientific Basis of Clinical Practice* is a textbook designed and written for undergraduate students who enroll in a course that lays out the scientific foundations for the clinical disciplines of speech-language pathology and audiology. The great majority of departments in our field that offer an undergraduate major have a regularly taught introductory course among their course offerings. Introductory courses in any field, whether in psychology, anthropology, linguistics, or communication sciences and disorders (hereafter, CS&D), are survey courses in which nearly all aspects of a field are presented. For academic disciplines that have many aspects—and most do—breadth of coverage takes precedence over depth of coverage. Simplification of complicated material is inevitable, and long-standing, ongoing debates in a field cannot be described in detail. An introductory course in CS&D is subject to these characteristics, and these constraints. That being said, we have attempted to provide a carefully measured depth in each chapter, in the hope of conveying the sense of excitement in the continuing expansion of the scientific basis of clinical practice in CS&D.

This textbook is organized with a general plan of matching individual chapters to individual lectures, or perhaps to one-and-one-half lectures. The textbook is written to give the instructor the option of not including selected chapters in the classroom lectures, or not assigning them as required reading material, if that is desired. For example, there are two chapters that present information on pediatric language disorders, and two chapters that present information on pediatric speech sound disorders. For each pair of chapters, one chapter presents information on two or three disorders, and the other presents information on two or three *other* disorders. An instructor who decides to present examples of a particular pediatric language or speech sound disorder can surely choose one chapter for a lecture and assign (or not) the other chapter for reading. The same can be said of several other chapters in the textbook. In this sense, we believe the textbook is a flexible instructional companion for both instructors and students.

The graduate training of speech-language pathologists (SLPs) and audiologists (AuDs) is a significant mission of CS&D departments. Communication Sciences and Disorders is, at its core, a clinical discipline. But if a clinical endeavor is to be disciplined, the core must include material that supports and motivates clinical practice with knowledge that has emerged from the research laboratory. This text is primarily concerned with the scientific basis of clinical practice, the former being a first step to qualify for the latter professional skill.

Clinical information is not ignored in the textbook. In fact, all chapters that present the nature of language, speech, and hearing disorders include some information on diagnosis and treatment of communication disorders. In some chapters, this information is integrated with the presentation of the main material, in others a brief section describes clinical issues relevant to the communication disorder(s) under discussion. A fixed formula is not used for the inclusion of clinical information in various chapters of the textbook; rather, in each chapter that presents information on communication disorders, the clinical information is placed in the location that seemed (in our opinion) to make the most sense.

Curricula in departments of CS&D are structured to include classes on typical and disordered language, on typical and disordered speech, and on typical and disordered hearing. This is to say that language, speech, and hearing occupy three different categories of coursework. The categories are organized more for the structure of a curriculum, rather than a belief that language, speech, and hearing processes are separate. They are not. The integrated nature of language, speech, and hearing processes, whether typical (normal) or disordered, is known by all clinicians and scientists concerned with communication sciences and disorders. For example, a child who is seen in the clinic for a delay in the mastery of speech sounds often has delays in language acquisition as well, and is at risk for reading delays. Similarly, an American child who is born deaf may have delays in oral language development but have typical language development in American Sign Language (ASL).

This textbook follows the approach of separating language, speech, and hearing chapters. But we ask students to keep in mind that this is a teaching decision (much like the organization of courses, as stated earlier), not a statement that the areas are separate. Language chapters are presented first, followed by speech chapters and then hearing chapters; this sequence is arbitrary. One of us (GW) taught the introductory course in the University of Wisconsin–Madison CS&D department for 20 years, changing the order of the language, speech, and hearing categories several times to see if one sequence was more effective than others; the order did not seem to make a difference.

The textbook covers a lot of information; this is a necessary feature of a text designed to be the primary reading material for a survey course in communication sciences and disorders. Some areas of the field may be mentioned only briefly, which does not mean we believe they do not merit careful discussion. Decisions were made to limit discussion of certain areas to a minimum to accommodate the goal of a compact textbook.

Two final comments are in order. First, the use of pronouns is an efficient and straightforward way to construct sentences in a textbook with frequent references to people. In cases (which constitutes most of the uses) we have chosen to limit pronouns to "he" and "she," and to alternate between the use of the two when the reference is to a person who is (for example), a clinician or person seeking services. Second, the pattern and extent of citations vary across chapters. Every effort has been made to provide interested students and instructors with up-to-date references, and with review papers that provide overviews of the current state of both the research and clinical aspects of a topic under study.

We hope the textbook and the course are effective in creating an enhanced understanding of the importance of successful communication, and of the need to understand the impact of a communication disorder on every aspect of an individual's life.

Happy learning!

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The people named are not responsible for any errors that may exist in the textbook; whatever errors exist are solely our responsibility.

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Introduction to Communication Sciences and Disorders

We would build a profession independent of medicine or psychology or speech, based in colleges and public schools.

—Van Riper, 1981

INTRODUCTION: COMMUNICATION SCIENCES AND DISORDERS AS A DISCIPLINE

This is how Charles Van Riper, one of the pioneers of the field of Communication Sciences and Disorders, remembered the early 20th-century beginnings of the discipline. From the time he began to speak as a child, Van Riper had a severe stuttering problem. In young adulthood, he continued to stutter and desperately sought a "scientific" explanation for his problem. He reasoned that if an explanation could be identified through a program of systematic discovery—a program of scientific research—treatment methods would follow from the explanations, perhaps leading to a cure for stuttering.

Van Riper interacted with a small group of individuals, several of whom were also people who stuttered; jointly they decided to break away from the domination of medical and Freudian perspectives on speech disorders. In 1925, approximately 25 individuals established an independent society called the *American Academy of Speech Correction*. This society was intended as a research organization. One of the charter members of this organization was Dr. Sara Mae Stinchfield, who was the first person in the United States to be awarded a PhD (from the University of Wisconsin) in the field of Speech Pathology. In 1929, the organization changed its name to the *American Society for the Study of Disorders of Speech*. The word "Study" in the organization's new name highlighted the scientific goals of the group. This contrasted with the more practical but (in the opinion of some of the founding members of that society) less lofty goal of *treating* Communication Sciences and Disorders. "Speech teachers," or people who attempted to help individuals with problems such as stuttering, articulation disorders, language delay, speech and language problems associated with neurological disease, or unintelligible speech resulting from absence or loss of hearing, were well known in society but certainly not professional mainstays in schools and hospitals.

The newly minted *American Society for the Study of Disorders of Speech* struggled a bit because of small membership and some disagreements among members. As recounted by Van Riper (1981), several of the

influential members wanted the group to focus on scientific investigation of stuttering, but others saw the world of Communication Sciences and Disorders more broadly. Pauline Camp, who was serving as the head of speech correction in the State of Wisconsin, proposed that the field could grow by establishing speech correction clinics in universities. These clinics would train future "speech correctionists" as well as scientists interested in the nature and cause of speech disorders. As trained clinicians found employment in public schools and demonstrated their ability to help children with speech problems, the need for additional trained professionals would increase, and the American Society for the Study of Disorders of Speech would grow.

Camp's proposed strategy for growing the profession was right on target. University programs were developed, with the training of "service providers" (clinicians) and scientists conducted in the same environment. The guiding principle of this training concept was the presence of clinicians and scientists in a common environment, teaching each other and enhancing their respective knowledge and performance. Scientists formulated more specific and worthy research questions by obtaining information about the clinical details of communication problems in actual patients, and clinicians sharpened their diagnostic procedures and practice techniques by learning from the research. This training model has persisted until the present day, and has been successful.

In 1934, the young speech organization, much larger than it was in 1930, was reconstituted under a third name: the *American Speech Correction Association*. This name stuck until 1947, when the association was renamed the *American Speech and Hearing Association*, or *ASHA*. In 1978, the group was renamed the *American Speech-Language-Hearing Association*, to recognize the equivalent importance of language function (as compared to the act of producing speech, or the ability to hear) in the understanding of normal and disordered communication function. The association has retained this name to this day but is still referred to as "ASHA."

As of 2018, ASHA reported a membership (including student members) of 203,945 individuals (https://www.asha.org/uploadedFiles/2018-Member-Counts.pdf).

Among the members of ASHA are 12,480 who have their primary training in Audiology and practice as Clinical Audiologists. Many of these professionals are also members of the American Academy of Audiology (AAA), an organization whose mission is to define the training and practice guidelines for professionals who work as clinical audiologists (https://www.audiology.org/about-us/academy-information). AAA was founded in 1988, in recognition of the need for an organization whose primary purpose would be serving the profession of Clinical Audiology. Many of the 12,000+ Audiologists who are members of ASHA are also members of the American Academy of Audiology.

There is a difference between the perspectives of ASHA and AAA on the right to practice Clinical Audiology. ASHA currently argues that a Clinical Audiologist must have a Certificate of Clinical Competence in Audiology (CCC-A), issued by ASHA, as the proper credential for the practice of audiology. AAA's position is that the CCC-A is not necessary for the practice of audiology; what is required is that students-in-training in audiology have a sequence of courses that is recognized as the foundation for training professional audiologists, and that a year of professional work (much like an internship) follows the completion of the coursework training. In the view of AAA, this training prepares the student for state licensure as a Clinical Audiologist, which when obtained provides the "legal" right to practice clinical audiology. The different perspectives on the credentials needed by trainees to practice clinical audiology are complicated; readers are encouraged to visit https://www.audiology.org/publications-resources/document-library/audiology-licensure-vs-certification. There is a concerted effort among several different associations, including ASHA and AAA, to resolve these different perspectives (https://www.asha.org/uploadedFiles/Aligned-Sense-of-Purpose-for-the-Audiology-Profession.pdf).

COMMUNICATION SCIENCES AND DISORDERS: THE WHOLE IS GREATER THAN THE SUM OF ITS PARTS

When Van Riper remembered the early vision of a discipline "independent of medicine or psychology or speech," he was not thinking of abandoning the *content* of these other fields of study. Rather, he imagined an academic and clinical field with a separate identity, forged from the concepts and facts of medicine, psychology, and other disciplines, but clearly something different and new—a field with its own identity, able to stand on its own merits. It is comically ironic (to this author, at least) that over the past 10 to 15 years, two buzzwords on college campuses have been "interdisciplinary research" and "translational research." The field of Communication Sciences and Disorders embraced these two activities—in fact, defined itself by an interdisciplinary and translation mentality—long before they became fashionable and fundable claims in university settings.

An Interdisciplinary Field

Communication Sciences and Disorders is a field practiced and studied by individuals with expertise in a variety of academic and clinical disciplines. It is truly interdisciplinary, the product (but not merely the sum) of many different areas of knowledge. Speech is produced by moving structures of the respiratory system, larynx, and vocal tract (the latter sometimes referred to as the "upper articulators," including the tongue, lips, and jaw). Scientists and clinicians who are interested in communication disorders must understand the anatomy (structure) and physiology (function) of these body parts. When a person speaks, air pressures and flows are generated throughout the speech mechanism, and an acoustic signal (what you hear when someone talks) is emitted from the lips and/or nose. An understanding of these aerodynamic and acoustic phenomena of speech requires at least a foundation of knowledge of basic physics.

When the acoustic signal emerges from the talker's mouth (or nose), it is metaphorically "aimed" at another person who receives it through his or her auditory mechanism. This makes it clear that the anatomy and physiology of the auditory system must be mastered by the person specializing in Communication Sciences and Disorders. As with the process of speech production, hearing and comprehending acoustic signals involve complex mechanisms understood properly only with a decent amount of knowledge in the areas of anatomy, physiology, and physics (and other areas as well).

Of course, when talkers produce speech, they want to communicate a message. The nature and structure of the message—what is being communicated, and the form it takes when it is spoken—is determined by linguistic-cognitive processes. For example, linguistic-cognitive processes are set into motion by the simple act of asking someone to have coffee. An idea must be developed and structured in linguistic terms according to the intent and wishes of the person doing the asking. The idea is something like, "I want to spend time with this person and suggesting we have coffee at a comfortable café seems like a good approach," but the manner in which this "want" is structured as a message can vary wildly, depending on many factors. "Would you like to have coffee?" "Hey, how 'bout we grab some coffee?" "I'm really sleepy, let's stop at *Completely Wired* and get some coffee." "I'd really like to talk to you over coffee." "Let's have a no-obligation date over coffee." "Coffee?" These different ways to convey the same message reflect variation in underlying cognitive processes and linguistic structure, both of which are critical to language usage. The clinician and scientist in Communication Sciences and Disorders deal with disorders of language structure and usage, and must therefore have expertise in the broad areas of hearing, cognition, and linguistics.

The term "cognitive-linguistic" refers to psychological processes applied to the use of language forms. "Cognition" refers to several psychological processes, including memory; executive function (e.g., planning behavior, connecting current behavior with future consequences); the development, refinement, and stabilization of mental representations; brain computation speeds; and transfer of information from one type of memory (e.g., short-term memory) to another (e.g., long-term memory). These various aspects of cognition are listed here as separate processes but in fact may overlap and in some cases be different reflections of a single psychological process. "Linguistic" refers to any aspect of language form—sounds, words, sentences, tone of voice, and so forth. The term "cognitive-linguistic" is used here to indicate that the psychological processes previously listed (among others) are applied to language forms and therefore to communication. The same cognitive processes are applied to other forms of knowledge, as well (such as spatial reasoning or mathematics).

We are not done. Because speech and language develop throughout infancy and childhood and may change throughout the lifetime and especially in old age, expertise in Communication Sciences and Disorders requires a solid knowledge of child development and aging. Most obvious, perhaps, is the need to have a broad and deep expertise concerning the many diseases and conditions associated with speech, hearing, and language disorders. Extensive medical knowledge is absolutely necessary to function as an effective specialist in Communication Sciences and Disorders. This knowledge ranges from how surgeries on structures of (for example) the brain, tongue, and ear affect speech, hearing, and language function, to how pharmaceutical interventions (such as drugs for Parkinson's disease, or schizophrenia, or even chronic arthritis) may change a patient's ability to communicate.

Finally, legal and technical issues are relevant to the profession of Communication Sciences and Disorders.

These issues concern a person's right to receive the proper services when he or she has a speech, hearing, or language disorder, as well as the requirements for professional accreditation as someone who can provide services or train people to provide services, or the requirement of extensive training in research to mentor students who intend to devote their careers to research. Our field has been fortunate to have professional leaders who can lay claim to both clinical and research expertise.

Table 1–1 provides a partial summary of the areas of knowledge and, in many cases, expertise, required of the professional in Communication Sciences and Disorders. This list includes the areas previously mentioned and adds a few more for good measure. There are (at least) two ways to react to this list. One is to feel intimidated by the need to know so much about so many areas. The other is to look at the combination of these different types of knowledge as something special, as an opportunity to be informed about many different areas of study and, most importantly, to employ an integrated and synthesized fund of this information in an understanding of the most human of behaviors, communication. Of course, a single individual is not likely to be an accomplished expert in each of these areas, but a commitment to learn the basic principles of each of the disciplines listed in Table 1–1, to use this knowledge when providing clinical services to a person with a communication disorder, to function as an effective member of a clinical or research team, or to develop an answer to a research question, is genuinely exciting. Communication Sciences and Disorders is the original, lifelong learning discipline.[1]

TABLE 1–1. Some Areas of Knowledge Required for People to be Effective Professionals in the Field of Communication Sciences and Disorders

Neuroscience
Brain anatomy (structure)
Brain physiology (function)
Neuropharmacology (chemicals and their role in brain function)
Motor control (how brain controls movement)
Sensory function (how brain processes sensation)
Anatomy and Physiology of the Speech Mechanism (muscles, ligaments, membranes, cartilages, etc., associated with the respiratory, laryngeal, and upper airway system, which collectively are called the "speech mechanism")
Anatomy and Physiology of the Hearing Mechanism (bones, membranes, ligaments, special structures of the ear)
Child Development
Aging
Diseases of the Head, Neck, Respiratory System, Auditory System, and Brain
Syndromes
Physics
Aerodynamics
Acoustics
Movement
Cognition
Memory and Processing
Planning
Manipulation and Use of Symbols
Linguistics
Phonetics and Phonology
Morphology
Syntax
Semantics
Pragmatics

Translational Research

Researchers and clinicians are often trained in the same department and yet do not interact professionally to a significant degree. This has been a concern in various branches of medicine, as well as in departments such as Psychology, and Communication Sciences and Disorders. Many scientists in these professions are trained to do something they understand as "basic science." In basic science, research questions are asked for the sake of improving the knowledge base in a field, or to address purely theoretical questions. An assumption of this approach to research has been that basic science, if done well, will eventually have an effect on clinical practice. In this way of thinking, "basic science" does not need to be motivated or prompted by immediate clinical concerns; any improvement in knowledge of the world must have implications for the betterment of humankind.

[1]As a university professor in Communication Sciences and Disorders, I more than once told students that it was hard to believe someone was willing to pay me to come to my office every day, learn new things in many different areas, and use this information in my research, in the classroom, and in mentoring teaching (one-on-one instruction, as with graduate students training to be researchers).

Let's consider an example of a possible link between basic science and clinical application. A fair number of scientists have investigated birdsong and its relationship to the evolution of human language (reviews can be found in Fitch, 2000, 2006, and Deacon, 1998). Much of this work has been funded by a federal agency, the National Institutes of Health (NIH), whose primary mission is to sponsor research that ultimately improves health care in the United States. The research on birdsong (and vocalizations produced by other, nonhuman species) has been "sold" to the federal agency by claiming potential links between, on the one hand, an understanding of why and how birds sing, and on the other hand, a better understanding of speech and language capabilities in humans. The link between birdsong and human communication is evolutionary, in which birdsong is a "step" along the evolutionary path to human vocalization for purposes of communication. The reasoning is extended by arguing that a better understanding of the basic "mechanisms" of vocal communication, which can be studied in birds using techniques that cannot be used in humans,[2] should *eventually* lead to a better understanding of the partial or complete failure of similar mechanisms in humans. A better understanding of disease-related problems in human vocalization should, this reasoning concludes, result in better ways to diagnose and treat human vocalization disorders.

Basic science such as work on birdsong has been criticized for occupying federal funds that might be used to fund "applied" research. "Applied science" is research with more immediate clinical consequences, research with less distance between the results of a study and its potential use in clinical settings. For example, funding could be provided for a research program in which participants with healthy voices are enrolled in a vocal exercise regime (like the kind of warm-up exercises used by many professional singers) and compared to a group of participants who do not engage in this exercise (a "control group"). The *applied* research question is, do nonspeech vocal exercises generalize, or translate, to the use of the voice in everyday speech? Perhaps the effect of the vocal exercise could be evaluated by having listeners judge the quality of participants' voices, with the critical comparison being the "goodness" (pleasing quality?) of voices pre- versus postexercise. This is basic, nonclinical research—nonclinical because the participants do not have voice disorders—but a positive result, where exercise produces a more pleasing voice, points more directly to a specific clinical application in patients with voice problems.

The relatively new buzzword for applied science is "translational research," or research in which the results of basic science can be translated relatively quickly to clinical application. The hypothetical vocal exercise study is one example of translational research; many others have been proposed (see Ludlow et al., 2008; Raymer et al., 2008). The National Institutes of Health (NIH), the federal agency having the mission of funding and setting priorities for health-care-related research activities in the United States, published in 2008 the following text on its website concerning translational research:

> To improve human health, scientific discoveries must be translated into practical applications. Such discoveries typically begin at "the bench" with basic research—in which scientists study disease at a molecular or cellular level—then progress to the clinical level, or the patient's "bedside."

Scientists are increasingly aware that this bench-to-bedside approach to translational research is a two-way street. Basic scientists provide clinicians with new tools for use in patients and for assessment of their impact, and clinical researchers make novel observations about the nature and progression of disease that often stimulate basic science. See https://nexus.od.nih.gov/all/2016/03/25/nihs-commitment-to-basic-science/ for a summary of the benefits of funding both kinds of research.

The National Institute on Deafness and Other Communication Disorders (NIDCD), the NIH institute that is the primary funder of research in Communication Sciences and Disorders, has a specific funding program for translational research (as of 2017). This funding mechanism is called the *Research Grants for Translating Basic Research into Clinical Tools.* The stated objective and requirements of these grants are as follows:

> [T]o provide support for research studies that translate basic research findings into better clinical tools for human health. The application should seek to translate basic behavioral or biological research findings, which are known to be directly connected to a human clinical condition, to a practical clinical impact. Tools or technologies advanced through this FOA [Funding Opportunity Announcement] must overcome existing obstacles and should provide improvements in the diagnosis, treatment or prevention of a disease process. For the purposes of this FOA, the basic science advance-

[2]Such as creating a small area of brain damage to see how it affects the development of birdsong, or depriving a newborn bird of exposure to his or her species' song to determine if, as the baby bird matures, the song develops in the same way as in birds who are exposed to their song from birth.

ment must have previously demonstrated potential for clinical impact and the connection to a human clinical condition must be clearly established. The research must be focused on a disease/disorder within one or more of the NIDCD scientific mission areas: hearing, balance, smell, taste, voice, speech, or language.

Research conducted under this FOA is expected to include human subjects. Preclinical studies in animal models are allowed only for a candidate therapeutic that has previously demonstrated potential for the treatment of communication disorders. The scope of this FOA allows for a range of activities encouraging the translation of basic research findings to practical impact on the diagnosis, treatment, and prevention of deafness and other communication disorders. [https://grants.nih.gov/grants/guide/pa-files/PAR-17-184.html]

The first statement presents the issue of "translational research" with molecular or cellular work as the basic science, but basic science exists at the behavioral level of analysis, as well. This is why the NIDCD description mentions a "range of activities" in its mission to fund translational research in Communication Sciences and Disorders.

Both of these NIH statements imply that it is the basic scientist's *obligation* to show how laboratory results can be "translated" to clinical settings. This is in contrast to earlier models of the basic science/applied science dichotomy, in which the basic scientist might have said, "I'll do the bench work (very basic science) and down the road, perhaps way down the road, clinicians can figure out how to use my findings when they diagnose and treat patients." In this view, the clinician, not the scientist, has the primary responsibility for translating the basic science to clinical application. The second paragraph of the statement sounds remarkably similar to the concept, described previously, of training "speech correctionists" in university settings where clinical practice informs the direction of research programs, and research findings enhance clinical practice. Pauline Camp suggested this concept in 1934, and our discipline has been guided by the "two-way street" philosophy since that time. As a field, we have understood the potential value of "translational research" for a long time.

Does the Basic Science Work? Does the Clinic Work?

It is all well and good to claim that people in the field of Communication Sciences and Disorders understood the value of interdisciplinary work, and practiced translational research well before the concept was so christened and attained the status of an official movement on 21st-century university campuses and in government funding agencies. It is quite another thing to claim scientific success as the result of interdisciplinary efforts, or to show that basic science has indeed been translated to clinical application. A major goal of this text is to present introductory information on normal and disordered communication processes in a way that highlights previous, and the latest, scientific findings that have emerged from interdisciplinary thinking. For the time being, the reader is asked to trust the claim that the growth of the scientific basis of normal communication processes, and Communication Sciences and Disorders, has been nothing short of spectacular over the last 50 years. None of this would have been possible if speech, language, and hearing scientists had not been open to the influences and thinking of scientists in areas such as linguistics, physiology, neuroscience, and psychology (among others). Most importantly, the openness of these scientists to the experience and knowledge of clinical speech-language pathologists and audiologists has made a huge difference to the growth of the scientific knowledge base in normal and disordered communication.

It is *not* a goal of this text to present detailed information on therapy (management) techniques for persons with speech, language, and/or hearing disorders. Readers will learn a great deal *about* speech, language, and hearing disorders, but a full treatment of clinical processes and procedures is a topic for a more advanced course of study, typically in graduate programs (see later in the chapter).

An aspect of the clinical process that is discussed throughout this text is the *diagnosis* of speech, language, and/or hearing disorders. Technically, diagnosis involves the identification and determination of the nature and cause of a disorder. Notice the inclusion of "nature" in this definition. Proper techniques must be employed to describe a disorder and to document the characteristics of a communication disorder that make it different from other communication disorders. A good part of this text is therefore devoted to descriptions of how we know a specific speech, language, and/or hearing disorder is "x" and not "y."

This text does not shy away from controversies in our field about the nature and causes of certain communication disorders. As in any health-care-related field, many diagnoses remain unclear and are the subject of ongoing debate. In the best of all worlds (sorry,Voltaire), we would welcome absolute certainty concerning the diagnosis of human diseases and conditions. The world-as-is, however, does not allow such certainty, but let's not regard the gray areas as defeats; they are opportunities. Uncertainty and controversy have always been the engines of scientific advancement. Not knowing, or disagreement about what we

do know, pushes science forward. Diagnosis, then, is a critical part of the scientific underpinnings of a health-care-related discipline such as Communication Sciences and Disorders. In many cases, questions concerning clinical diagnosis and the basic science foundation of our field are completely intertwined.

The second part of the heading for this section asks, "Does the Clinic Work?" Do speech-language pathologists and audiologists make a difference in the lives of people with communication disorders? Although this text does not present detailed information about treatment of communication disorders, there is widespread evidence for treatment success.

It is important for the reader to know that many of the services offered by clinicians in our field have been documented as being effective. In the absence of such documentation, the entire enterprise of training clinicians to treat communication disorders could be questioned. Fortunately, our interdisciplinary and translational approach to understanding communication disorders has produced diagnosis and management techniques that are effective for many patients. A selective sampling of publications in which this clinical success is reviewed includes results for voice therapy (Angadi, Croke, & Stemple, 2017; Desjardins, Halstead, Cooke, & Bonilha, 2017; Ramig &Verdolini, 1998; Ruotsalainen, Sellman, Lehto, Jauhiainen, & Verbeek, 2007), hearing disorders (Ferguson, Kitterick, Chong, Edmonson-Jones, Barker, & Hoare, 2017; Kaldo-Sandström, Larsen, & Andersson, 2004; Mendel 2007), stuttering (Baxter et al., 2015; R. Ingham, J.C. Ingham, Bothe, Wang, & Kilgo, 2015; Tasko, McClean, & Runyan, 2007), childhood articulatory disorders (Gierut, 1998; Wren, Harding, Goldbart, & Roulstone, 2018), and childhood language disorders (Law, Garrett, & Nye, 2008; Tyler, Lewis, Haskill, & Tolbert (2003). Students who obtain undergraduate and graduate degrees in our field learn the scientific basis and technical details of these successful clinical strategies. This is not to say that we have conquered all, or even many, of the communication disorders affecting people around the world. Indeed, there is a substantial amount of disagreement concerning precisely what constitutes therapy "success" for people with communication disorders, and a specific therapy technique may work for some patients but not others. But the articles listed previously show a pattern of success for many communication disorders; continuing research will add to this list.

Evidence-Based Practice

Although this text does not present detailed information on management (treatment) of communication disorders, the concept of evidence-based practice (EBP) and its role in speech, language, and/or hearing therapy is integral to an understanding of how knowledge of typical and disordered communication is related to treatment of communication disorders.

EBP, a movement with roots in the medical world, takes as its central concept that any treatment approach should be supported by scientifically based evidence of the treatment's effectiveness (the term "efficacy" is often used to refer to effectiveness of a therapy procedure, but the technical sense of "efficacy" is an experimental demonstration that a particular clinical technique shows promise as an effective management tool; it is like a first step in the determination of a treatment's real-world effectiveness). The need to formalize such a notion may at first glance seem surprising, for should a treatment *not* be administered in the absence of solid evidence that it works? Again, in the best of all worlds this would be so, but in much of medicine and behavioral sciences, including Communication Sciences and Disorders, the effectiveness of treatments is often unknown or only partially supported by research data.

EBP must be based on proper outcome measures. Evidence for the success of a therapeutic approach requires the measurement of one or more variables after (or sometimes during) the treatment. Outcome measures should have the best possible *face validity*, meaning that the measures provide good indices of the phenomena they are supposed to represent. An example from basketball helps to understand face validity of outcome measures. If an outcome measure is desired for a player's in-game shooting accuracy following several months of intense practice of nongame, unguarded shooting, the percentage of shots made over 100 attempts has good face validity if the measure is taken during games. The measure has much poorer face validity if the measure is taken over 100 shots attempted during multiple games of HORSE. Shooting percentage during games is a much better outcome measure for "real-world" shooting as compared to shooting percentage during games of HORSE.

An example from health care, closer to the concerns of this textbook, is one of drug treatment for epilepsy for which there may be the potential for multiple outcome measures with face validities that are only subtly different. The question is, after 6 months of drug treatment, are there fewer seizures as reported by the patient (one potential outcome measure)? As reported by the patient, are there *no* seizures over the same time period (a second potential outcome variable)? After 6 months of drug treatment, can a seizure be induced in the clinical setting by very bright flashing lights (a third potential outcome variable)? Or, after 6 months, are the blood levels of the drug in the "correct" range based on values reported in the scientific literature (a fourth

potential outcome variable)? At first glance, the first two outcome measures have the best face validity—the best evidence for reduction of seizures is a report from a patient that seizure episodes have been reduced or eliminated. Some clinicians and scientists, however, may think that patient-reported data are unreliable because they are subject to the notorious uncertainties of memory or even a patient's misrepresentation of seizure history. Measures such as inducement of a seizure by flashing lights or drug blood levels are regarded as more objective (and have a clearly quantitative basis) and therefore may seem more reliable than the patient reports of seizure history. Yet, from the perspective of the patient, inducement of a seizure in a controlled clinical setting or "good" drug blood levels mean very little when he or she is losing consciousness two or three times a week or even having many episodes of preseizure activity.

The choice of a proper outcome measure (or measures) is not straightforward and is often the subject of considerable debate. The debate is lively and even heated when the behaviors of speech, language, and hearing disorders are evaluated for their response to therapy. Readers may want to keep this in mind when considering the concept of EBP.

The concept of EBP has taken on a life of its own as an academic discipline, and there is no end to the debate about precisely what serves as "good" scientific evidence for the efficacy of a treatment. Table 1–2 presents a six-level EBP model of "goodness" of evidence, with the "best" evidence at the top (Level I) and the worst at the bottom (Level VI). This simplified model of EBP serves the purposes of this discussion well and has been presented several times in the Communication Sciences and Disorders literature (Dodd, 2007; Dollaghan, 2004; Moodie, Kothari, Bagatto, Seewald, Miller, & Scollie, 2011).

TABLE 1–2. Levels of Evidence Applied to Evidence-Based Practice: A Simplified Model

Level I	Systematic reviews and meta-analyses of randomized controlled trials (RCTs)
Level II	A single RCT
Level III	Nonrandomized, controlled (well-designed) treatment studies
Level IV	Nonexperimental studies
Level V	Case reports and/or narrative literature reviews
Level VI	Expert/authority opinion

Levels of Evidence

Level I and II evidence are usually based on large numbers of participants to generate the most reliable statistical results. In Table 1–2, Level I evidence is summarized as "systematic reviews" or "meta-analyses" of RCTs. An RCT is an experiment in which each individual from an initial, large pool of participants is randomly assigned to one of two (or more) treatments. Ideally, neither the experimenters nor the participants have knowledge about which treatment has been assigned to any participant in the study. The participants (and in many cases, the experimenters) are "blind" to which participants have been assigned to which treatments, and the participants are "blind" to the status of their treatment condition (real treatment group, or placebo group). This is an example of a "double-blind" experiment.

In Table 1–2, Level I evidence is summarized as "systematic reviews" or "meta-analyses" of RCTs. A systematic review is the organization and evaluation of data from many different, individual RCTs, and a "meta-analysis" is a quantitative (statistical) analysis of the data from many such studies. A meta-analysis of the results of many different studies can only be done when the data from each study are sufficiently comparable—as when the same pretreatment and outcome measures were used in the different studies (such as number of seizures per week), the same blinding conditions, the same dosage levels, and so forth.

Level II evidence is the result from a *single* RCT. Level II evidence is high-level scientific evidence but is not as trustworthy as having many different demonstrations, from different laboratories and different scientists, of the same outcome. In other words, when Level II evidence is replicated several times, Level I evidence has been produced.

Level I and II Evidence in Communication Sciences and Disorders. In Communication Sciences and Disorders, it is relatively difficult to obtain Level I and II evidence. How easy is it to find, for example, 100 people who have a similar stuttering problem, or 100 people who have had a stroke and who have very similar problems with expressing or comprehending speech? How easy is it to find 100 children with autism, who all have the same communication challenges and similar characteristics in noncommunication domains? In each of these cases, the answer is: Not easy at all. In addition, it is unusual for different laboratories that study communication disorders, and even a single communication disorder such as stuttering (as one example), to use the same measure of stuttering fre-

quency (perhaps number of stuttered words per 100 words produced). For these reasons and others, RCTs are unusual in our field.

Many RCTs in medical fields contrast an experimental group that receives a trial drug for a condition or disease, and a control group that receives a placebo. Both groups take pills on a schedule, but do not know if they are taking the experimental medication or sugar pills. Such experiments in Communication Sciences and Disorders raise an ethical question: how do you withhold treatment from a group of individuals with a communication disorder?

RCTs are unusual in our field. They are difficult to execute because of many factors, not the least of which is assembling an initial participant pool, with the same kind and degree of speech/language/hearing challenges, from which random assignment to different treatment types is possible. Perhaps this explains why some introductory texts in Communication Sciences and Disorders (e.g., Justice & Redle, 2014) choose to talk broadly about EBP from sources external to scientific pursuits. These sources include patient values and preferences, and clinician expertise (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). These factors are considered jointly with scientific data as contributions to EBP in the life of a speech-language pathologist or audiologist. The absence of solid Level I and II "high-level" evidence in our field places greater weight on the other factors (patient preference, clinical experience) in treatment decisions made by speech-language pathologists and audiologists.

Level III Evidence. The description of Level III evidence in Table 1–2 is "non-randomized, controlled (well-designed) treatment studies." As in the case of RCTs, two groups are typically studied and compared, one receiving Treatment X, the other Treatment Y (or no treatment). Level III evidence does not involve randomization from a pool of eligible subjects but must be well controlled in other ways.

Studies that produce Level III evidence are relatively common in the communication sciences and disorders literature. Level III evidence often comes from studies with a relatively small number (e.g., 10 to 20) of participants in each group, certainly smaller than the group numbers in (for example) drug trials. In addition to the absence of randomization of participants to treatment conditions, the relatively small number of participants in Level III studies renders them less powerful statistically and, therefore, less "valued" than RCTs.

Level IV Evidence. Level IV evidence is produced when a study is performed in the absence of proper experimental controls. The lack of a control group whose performance can be compared to an experimental group is a common problem in experiments that align with Level IV evidence.

Level IV-type evidence is found in in the speech, language, and hearing literature. Treatments are applied to a group of individuals with communication disorders, in the absence of proper controls. People with communication disorders improve following the treatment, and a conclusion is reached that the specific treatment is to be valued for its positive effect on the communication impairment. In the absence of controls, however, any form of treatment, not the specific treatment employed, may have improved the communication skills of a group of persons with a communication impairment.

Levels V and VI Evidence. Levels V and VI are types of evidence considered to be poor support for a treatment approach in any field. Case reports, which consider the outcome of a specific treatment applied to a single patient, or to a series of patients with similar characteristics, lack controls and cannot be generalized to a larger group of patients. The absence of experimental controls and the study of only a single or few individuals contribute heavily to the evaluation of this kind of evidence as "poor quality." Even so, case reports are common in the health care literature, including the treatment literature in Communication Sciences and Disorders.

An argument can be made that case reports gain value when they are organized and synthesized in a single publication, with conclusions drawn from the careful analysis of results across reports. The problem with this line of thinking is that the primary problem of lack of experimental controls in each case report is not solved by accumulating many case studies. The shared flaw of most case studies, of no experimental controls, means that a summary of many cases for the purpose of providing evidence to support a treatment approach is a summary of many flawed experiments.

Another type of Level V evidence is the narrative literature review. Narrative literature reviews are publications in which a large number of research papers, most often those that provide Level III evidence, are organized and evaluated for the purpose of drawing qualitative conclusions about a focused issue. Narrative reviews are popular in Communication Sciences and Disorders and are published in leading journals. Narrative reviews have poor evidence quality for the purpose of supporting a treatment approach, because ultimately they are position papers, like editorials, with a primary

aim of persuading readers that their conclusion(s) is (are) preferable to alternate conclusions.[3]

The narrative review and its aim to persuade by summaries of existing research findings and theoretical issues, is a more scholarly version of the lowest evidence level, that of expert/authority opinion. Anyone can have an opinion that is stated as the likely truth. When "anyone" turns out to be an authority in a discipline, and asks that his or her position be accepted not on the basis of published data but on his or her authority, the evidence has little or no value.

The concept of EBP is firmly grounded in the interaction and co-dependency of laboratory experiments and clinical practice. Scientists construct experiments to generate results in support of proper diagnosis and effective clinical management, and clinicians apply the findings to their patients and evaluate their real-world results. On the basis of those clinical results, scientists may adjust their experiments to provide additional and improved data for EBP.

A Typical Undergraduate Curriculum

Table 1–3 shows the undergraduate, major curriculum in Communication Sciences and Disorders at the University of Wisconsin–Madison. This sequence of courses is more or less representative of curricula in any department in the United States that offers an undergraduate degree in our field (some variation will occur from department to department). The course for which this text was written is shown in parentheses because it is not a requirement in the UW–Madison department for an undergraduate major in the field. Rather, this course is taken each semester by a large number of students to satisfy a breadth requirement in the College of Letters and Science. Many students who choose to major in Communication Sciences and Disorders at UW–Madison do take the introductory course, and in many cases, the exposure to the field provided by the class is the reason they choose Communication Sciences and Disorders as their major.

A group of courses in the curriculum (Speech Science; Hearing Science; Neural Bases of Speech, Hearing, and Language; Speech Acoustics and Perception; Language Development in Children and Adolescents; the Phonetic Transcription module of Phonological Development and Disorders) establishes a solid scientific foundation for normal (typical) processes of communication. Other courses (the second part of Phonological Development and Disorders; Voice, Craniofacial, and Fluency Disorders; parts of Neural Bases of Speech, Language, and Hearing Disorders; Auditory Rehabilitation; Child Language Disorders: Assessment and Intervention) provide basic information on the classification, causes, and nature of the many diseases and conditions associated with communication disorders. Some curricula may have a course called "Preclinical Observation," in which students are introduced to the clinical process by observing clinical sessions, rather than being directly involved in diagnosing or treating communication disorders.

WHO ARE THE PROFESSIONALS IN COMMUNICATION SCIENCES AND DISORDERS?

Students obtain undergraduate and graduate degrees in preparation for a job. In the field of Communication Sciences and Disorders, this preparation is for employment as a speech-language pathologist or audiologist in an educational or health care setting. Or, a student may prepare for a career as a professor in a college or university setting. At the undergraduate level, training is not differentiated across these different career paths. Nearly everyone who intends to be a professional in Communication Sciences and Disorders learns a common scientific foundation for the field, as summarized in Table 1–3.

Preparation for, and the Profession of, Speech-Language Pathology

The requirements to practice as a speech-language pathologist (SLP) include coursework that furnishes a knowledge base specified by ASHA, completion of a master's degree, a clinical fellowship, and successful performance on a national exam. The information presented here is based on ASHA's published certification standards as of 2014, as well as some revisions and amendments to these standards published in 2016. ASHA documents are available at https://www.asha.org

Students finishing an undergraduate major in Communication Sciences and Disorders apply to master's degree training programs in the fall semester of their senior year (or later, if they decide to take a year or two off before beginning graduate school). There are currently over 200 such training programs in the

[3]The author feels free to point to the evidentiary weakness of narrative reviews because he has published several of them. Conversely, narrative reviews may organize the literature in a way that is useful for clinicians and scientists as they pursue their professional goals.