# Preface

Construction requires tools. Whether we are constructing a house, an educated citizen, or a scientific theory, we will be stymied if we do not have the right tools. However rich our raw materials are, they are mere bits and scraps of unrealized potential if we lack the means of assembling them into the products we envision. Imagine a carpenter arriving at Home Depot, her truck already full of lumber, and finding an empty tool counter. Her house will go unbuilt.

The building that we are seeking to construct is a strong foundation of knowledge regarding the cognitive underpinnings of how deaf individuals learn, especially how they acquire literacy. Our truck is indeed full of raw materials: reading researchers have, in recent years, made great strides in describing how literacy is acquired in hearing individuals; neuroscientists have made considerable progress in identifying the neural networks involved in reading and cognition; cognitive scientists have greatly increased our understanding of the underlying mechanisms of memory, executive functioning, visuospatial reasoning, and other processes.

Yet, we strongly suspect that the applicability of this burgeoning knowledge to the very unique population of deaf individuals has limitations. When an individual's primary source of information about the world is through vision, the processes through which he navigates the world, learns to read, and acquires knowledge are quite different from those of individuals who hear as well as see their world. How do we understand those differences? How do we come to understand how visual knowledge, in the absence (or near absence) of auditory knowledge, affects the development of cognitive functions and the acquisition of language? How do visual languages contribute to literacy?

These questions are important, not only for improving the lives of deaf individuals but for enriching our understanding of learning for all individuals. But, of course, we need the right tools to answer these questions. Unfortunately, the myriad of assessments that have contributed remarkably to the growing knowledge base for understanding cognitive development for hearing individuals cannot simply be administered to deaf individuals (either in research, clinical, or educational settings) with confidence in the validity of the scores. The uniqueness of deaf individuals' perceptual experiences, their linguistic histories, and their social and cultural backgrounds

mandates an intensive effort to reengineer many commonly utilized assessment practices so that they will yield information that can be accepted and interpreted without hesitation. Additionally, a battery of new assessments will also be necessary to measure visual language skills, since these skills play a critical role in the lives of many deaf individuals.

The Toolkit project described and presented in this book represents a step in pursuit of effective and valid cognitive, linguistic, and achievement assessments for deaf individuals. This project was undertaken at the Science of Learning Center in Visual Language and Visual Learning (VL2) at Gallaudet University. VL2 is one of six national centers funded by the National Science Foundation to address questions that are of critical concern for the Science of Learning. VL2 was funded (in 2006) to pursue answers to the questions posed above; i.e., to contribute to our knowledge of how visual languages and the unique sensory and perceptual experiences of deaf individuals contribute to their brain development, their cognitive capacities, their language development, and their acquisition of literacy.

From the beginning days of VL2, it was evident that we would need to devote our energies to the development of tools for our scientific work. We also knew that there were critical needs for better assessments among practitioners in fields of deaf education and clinical practice. As well, we understood that there was considerable overlap between the needs for assessments that would serve the needs of researchers and those that would serve the needs of practitioners. Center scientists representing different disciplines met to discuss the different assessment needs of the Center and to suggest existing instruments, discuss tests that could be modified or adapted for use for this population, and outline needs for new visual language assessments.

The result of these discussions was the VL2 Toolkit Project. In this project, we assembled a variety of assessments into a comprehensive battery and designed a project wherein we would administer the entire battery to the same group of project participants. This design would allow us to evaluate the underlying systems of correlations among measures of general cognitive functioning, including executive functioning, visuospatial abilities, short-term and working memory, reading comprehension, math and writing fluency and general academic knowledge, and expressive and receptive language skill. The data would allow us to speak to the issues of reliability and both concurrent and construct validity, and also give us an opportunity to examine the underlying covariance structure of a broad set of measures.

This book presents the findings from the VL2 Toolkit project. In these chapters, each Toolkit measure is described, and a statistical analysis is presented that speaks to the psychometric properties of the measure. Thus, the descriptions should be useful both for readers interested in a compendium of measures that have been used and studied successfully with this population, and for readers interested in understanding some of the technical properties of these tools when administered to this population. Chapters 1 and 2 present a more detailed discussion of the rationale for the project, describe the procedures used in conducting the project, and display the background characteristics of the individuals who participated in the project. Chapter 3 presents the findings for Toolkit measures of general cognitive functioning. Chapter 4 discusses the measures selected for assessing visuospatial ability.

Chapter 5 offers the analyses and descriptions for measures of short-term memory, working memory, and signed verbal learning. Chapter 6 discusses the findings for four separate measures of reading. Chapter 7 presents the results of other areas of academic achievement, including writing and math fluency and general academic knowledge. Chapter 8 discusses measures of expressive language, while Chapter 9 discusses measures of receptive language. Chapters 10–12 delve more deeply into a variety of issues having to do with visual languages and visual representations of English: Chapter 10 discusses fingerspelling and presents some descriptive data based on an analysis of the error patterns of Toolkit participants on the fingerspelling test. Chapter 11 presents a discussion of considerations in the development of tests of American Sign Language and provides short descriptions of existing measures that are currently in use and under development. Chapter 12 describes an innovative strategy for using the written responses of participants to the speechreading test as a window on deaf students' writing strategies. In Chapter 13, we present the results of a factor analysis of the toolkit measures in an effort to identify underlying cognitive structures for this population, and we use the resulting factor scores combined with data from the project background questionnaire to explore the interrelationships among selected background characteristics and performance on the derived neurocognitive factors.

We acknowledge the support and participation of many in both conducting the Toolkit Project and in producing this manuscript. We especially thank the National Science Foundation for their significant support in establishing the VL2 Center (under Cooperative Agreement SBE -0541953). We are indebted to the scientists from the Center who contributed to the selection of instruments and the design and execution of the project, especially Dr. Peter Hauser and Dr. Diane Clark. VL2's data assistant Selina Agyen expertly organized all project recruitment and scheduling. We bow deeply to the hard working group who helped prepare the testing materials, particularly former student, Dr. Christen Szymanski, and the team of student and postdoc assessors, which included Assessment Coordinator Leah Murphy, Postdoctoral Fellow Dr. Shilpa Hanumantha, Predoctoral Fellow Wyatte Hall, and graduate assistants Yunjae Hwang, Millicent Musyoka, and Greg Witkin. Finally, we are deeply grateful to the 90 Gallaudet student participants, many of whom endured over 9 h of testing spread out over 3 days. Their contributions to this project are in evidence on every page of this book.

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