Genes, Environment, and Dyslexia
The 2005 Norman Geschwind Memorial Lecture

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This article presents an overview of some methods and results from our continuing studies of genetic and environmental influences on dyslexia, and on individual differences across the normal range that have been conducted over the past 25 years in the Colorado Learning Disabilities Research Center (CLDRC) and in related projects. CLDRC investigators compare the similarities of identical twin pairs who share all their genes and fraternal twins who share half their segregating genes to assess the balance of genetic, shared family environment, and nonshared environment influences on dyslexia and on individual differences across the normal range. We have learned that among the children we have studied in Colorado, group deficits in reading (dyslexia) and individual differences in reading across the normal range are primarily due to genetic influences, and these genetic influences are often shared with some of the same genetic influences on deficits and individual differences in language and ADHD. We have also learned from our molecular-genetic linkage studies that there are regions on several chromosomes likely to contain genes that influence dyslexia. Several specific genes within these regions have been tentatively identified through molecular-genetic association analyses, but much more research is needed to understand the pathways among specific genes, regions of noncoding DNA that regulate the activity of those genes, the brain, and dyslexia. I conclude with a discussion of our research on individual differences in early reading development, on the role of early learning constraints in dyslexia, and on how genetic influences are expressed through their interaction and correlation with the environment.

Key Words: Behavioral genetics, development, dyslexia, environment, genes, reading disability, twins

INTRODUCTION

I was most grateful and honored to be invited by the IDA to give the Norman Geschwind Memorial Lecture. Dr. Geschwind was a giant in the field of language disorders and he recognized the important role
that genetic influences may play in their etiology. When I first met Dr. Geschwind in the early 1980s and proclaimed my excitement about our new behavior genetic studies of dyslexia, his response was something like "... well, genes of course, but how do they influence the brain?" Later in the paper, I will give an update of what I think we have learned over the past years in answer to that question.

For more than 25 years, I have enjoyed the combination of basic science and applied interests of the IDA membership and the many IDA conference presentations that I have attended on the problem of dyslexia and its related disorders. I have also enjoyed presenting occasional lectures to much smaller groups at previous IDA conferences. When I contemplated speaking to a much larger audience of IDA members for the Geschwind Memorial Lecture, I decided to depart somewhat from my usual focus on the details of specific studies and present a broader historical perspective on the work we have been doing in the Colorado Learning Disabilities Research Center and in our earlier Colorado Reading Project over the past 27 years. That is also the general goal of this paper.

In outline, my specific goals in the paper are to: 1) begin with a brief historical overview of the CLDRC and the Colorado Reading Project while introducing my wonderful coinvestigators and some of the main themes of our research; 2) describe the CLDRC twin sample, how we define dyslexia, and some of the behavior-genetic methods that allow us to estimate the average influences of genes, shared family environment, and nonshared environment on dyslexia; 3) present some recent results from our behavior genetic analyses from the different projects; 4) discuss the results of our recent molecular genetic analyses with a cautionary note about their interpretation and application; and 5) conclude with some results from our International Longitudinal Twin Study of individual differences in prereading and early reading development.

SECTION I: HISTORY OF THE CLDRC

Our “Center” status began in 1990 when the National Institutes of Child Health and Human Development (NICHD) began funding four different research centers for the study of learning disabilities. Prior to our designation as a Center, we had been funded since 1979 by NICHD as a Program Project that we called the “Colorado Reading Project.” This project, directed by John DeFries at the University of Colorado Institute for Behavioral Genetics, was initially focused from 1979 to 1982 on the development and validation of measures for reading and related skills. Beginning in 1983, these measures were administered in our behavior genetic studies of identical and fraternal twin pairs with at least one member having a school history of reading disability, and in control twin pairs with no school history of reading problems. Our sample of twins has been growing since that time, with new measures and methods of analysis being introduced across the