Introduction:
In recent years research on diagnosis and treatment of dyslexia has accelerated with an increasing focus on identifying biological substrates and potential early precursors. This includes novel investigations of neural and genetic mechanisms that might contribute to patterns of disability in developmental language learning disorders (i.e. candidate genes and neurobehavioral markers) coupled with an emergent interest in gaining insight about complex difficulties in higher functions, such as reading, from examination of early neurodevelopment in populations at risk for language-learning impairments. These research aims have been facilitated by innovative intervention and remediation techniques that have been developed over the past decade. Finally, the field of dyslexia research has benefited greatly from new techniques and technologies – ranging from molecular genetics, to neuroimaging, to cognitive neuroscience.

Despite the explosion of research examining biological substrates and neurobiological correlates of dyslexia, few current discussions incorporate the idea that the study of dyslexia should and can be addressed in a multidisciplinary, convergent manner using the wealth of research emerging from molecular, genetic, physiological and cognitive laboratories. In particular, it has proved quite difficult to synthesize and integrate the wealth of knowledge now being gathered from research that examines the importance of early precursors, the role of genetics and gene-behavior associations, conditions often found to be co-morbid with dyslexia, and the developmental trajectories of populations at higher risk for language learning disorders. In part, this is a function of the fact that the vast expansion of research in these areas makes it difficult to keep abreast of the findings, much less understand and quantify their application to the complex landscape that is now the field of dyslexia.

However, a tighter focus on precursors, and on "pre-dyslexic" populations, would enable earlier identification of those children at highest risk for dyslexia and provide insight into the etiologies, common pathways, neurobiological correlates, and behavioral phenotypes. The recent, highly diverse findings in these domains are very promising but need to be
expanded to include a deeper focus and a more coherent integration of these interdisciplinary approaches. The knowledge gained through such a refocusing may well highlight the most promising early intervention techniques that could be applied within remediation and educational settings. Such an approach has enormous implications for a more through understanding of language disorders and of dyslexia in particular, and would also impact public policy regarding federal funding, parent awareness, and early infant and toddler programs.

**Fundamental Themes:**

One of the most important goals in dyslexia research is early identification, given that current remediation relies 100% on intervention therapies. Developmental neuroscience clearly shows that the earlier intervention is begun, the more "plastic" the brain, and the greater the possibility for improvement. Therefore, early identification is key. In this symposium we focus strongly on two themes.

I. Identifying those factors that contribute to the ability to identify the earliest predictors of later language learning disorders whether they be genetic, neurobiological or cognitive/behavioral. This aim speaks to insights that can be obtained from research examining putative neural mechanisms and their links with developmental language learning disorders, tracking early developmental trajectories in populations at risk for language learning disorders, identifying associations between candidate genes and behavioral phenotypes; and more specific concentration on comorbidity of related disorders that might provide insight on the etiology of dyslexia.

II. Explicating those factors that relate to understanding the core deficits in children who will present with a diagnosis of dyslexia. An integral and essential component of early identification relates to understanding the core deficits in young children – specifically those deficits that most effectively predict later language and reading problems in children who have not yet fully developed language or reading skills, but that are amenable to diagnostic measurement. Methodologies that might assist in this endeavor can be grouped thematically and include those noted above. In addition, recent advances in developmental imaging of young children now allows closer examination of the brain-behavior interface as well as the evaluation of the earliest effects of remediation and intervention.

Overall, the benefits of a focus on early childhood are two-fold: improved basic understanding of the role of gene-anatomy-behavior over time in emergent dyslexia (which benefits all affected populations), and earlier assessment and intervention (which benefits childhood populations specifically).

**Important points to keep in mind:**

- Genetic analyses must assess gene-behavioral associations not merely for the diagnostic hallmarks of dyslexia (reading impairment), but for the core underlying deficits as well, in order to implement a comprehensive application to early infant/toddler screening.
Earlier screening methods also open the door to earlier genetic assessments, which to date have been performed in largely adult (diagnosed) populations, as opposed to early childhood populations at higher risk for dyslexia.

Coupling of longitudinal behavioral, anatomic, and genetic analyses (in both human and animal models) could give rise to a much improved understanding of the etiology of dyslexia, as compared to current attempts to interpolate or reconstruct early neurobehavioral trajectories in diagnosed adults.

Coupling of early genetic assessments with early behavioral screening may also be particularly critical if it can be shown that "dyslexia" is polygenic, and that different genes influence different core deficits, since presumably, different core deficits would respond differentially to different interventions.

**Key Issues/Questions for participants to consider:**
The overall goal for the discussions across sessions and for the “Next Steps” discussion, that will take place in a moderated session on the last day, will be to reflect on what is already known about early precursors of dyslexia, consider the knowledge gained from this unique cross-disciplinary symposium, and address how we might integrate these (often divergent) lines of research and identify new directions that could illuminate dyslexia precursors, identification and remediation. In the final moderated session, we will attempt to put the research presented into a broader context, and will engage all the participants in generating a consensus plan on future critical research directions in dyslexia research.

We hope to address a number of broader issues over the course of this symposium that hopefully will foster synergies, as well as changes in research focus, that will move the field forward and produce a lasting and meaningful impact within the fields of dyslexia, cognitive science, neuroscience, genetics, and educational research. Specifically: (1) identify unexplored potential links between brain and behavior; (2) consider novel approaches including use of cutting-edge and emerging technologies; (3) identify strategies to facilitate identifying core deficits in the pre-reading domain; (4) strengthen links between research and practice; and (5) address policy and funding implications.

**Specific questions to keep in mind:**

- What early neural and genetic mechanisms might contribute to patterns of disability in language learning disorders? Will identifying biological substrates and potential early precursors allow earlier intervention? How might that be accomplished?
- If genes associated with dyslexia put children at risk for reading difficulties, how does genetic profile interact with environment (early language input, language development, instructional input, socio-economic status, native language and cultural influences, etc.) to influence the manifestation of reading ability/difficulty? Can that same genetic makeup also predict other aspects of
cognitive development, (e.g. such as attention, visual-spatial ability, cognitive organizational ability, mathematics, working memory) which have been shown to be impaired in dyslexic populations?

- What can animal models of candidate genes for dyslexia tell us? Animal models examining brain-behavior associations? As dyslexia is almost certainly a polygenic disorder, how might genotype/phenotype studies in humans assist in identifying reliable behavioral markers?

- What are the effects of gender on this disorder? Is there any support for the contention that when girls are affected they are more impaired than boys. What light do animal models shed on this area? Biological mechanisms?

- How early might one detect reliable predictors of later language learning disorders such as Dyslexia? Are there unique neurobiological and/or behavioral characteristics, which can be assessed in early childhood that could be important markers for later dyslexia?

- What are the patterns of comorbidity in dyslexia and what clues might that give us about the etiology? How might specific oral language disorders and dyslexia be related? Are they points on a continuum or do they have distinctly different precursors, etiologies and patterns of deficit?

- Do individual differences in anatomy or brain function predict to specific reading and/or oral language impairments in children? How might converging methodologies assist in addressing the conflicting findings in this area?

- As it is quite possible that dyslexia could arise from different etiologies, how might these differential etiologies relate to phenotype, the presence or absence of comorbid conditions, and the design and effectiveness of intervention approaches? Do differing etiologies imply different genes and/or different behavioral markers?

- How might emerging technology enhance early identification, diagnosis and remediation? What is the optimal role of innovative technology as a vehicle to fuel the development, study of, and delivery of instruction and intervention?

- It is now possible to use technology to simultaneously deliver an intervention, collect data on individual student performance, and facilitate data analyses to determine the effectiveness of the intervention. How might one use this model to also refine the intervention to enhance outcome and to tailor intervention to student profiles?

- What kinds of new collaborations (within or across a discipline) or public, private and institutional partnerships are needed to facilitate research into the issues discussed above? How might funding for studies of early precursors of language learning disorders and for the critical (and expensive) longitudinal behavioral, anatomic, and genetic analytic studies (human and animal) be secured?

Participants should hold these priorities and questions in mind throughout the various sessions and discussions, both formal and informal, and come to the last morning with notes of the key research issues, directions, and your best ideas, prepared to contribute to this important session.
AGENDA

Sunday, June 27, 2010

Informal Reception at Ashford Castle

7:00 PM  NAME OF ROOM  (to be announced)

Receive Symposium booklets and information
Monday, June 28, 2010

Introduction

8:30 William Baker  Introductory Remarks
8:45 April Benasich and Holly Fitch  Welcome to Ireland, Meeting Goals

Brain Development, Genes and Behavioral Phenotypes
Moderator: Maryanne Wolf

9:00 Richard Nowakowski  Overview of early brain development; Linking genetics to brain structure
9:40 Q/A
10:00 BREAK
10:30 Elena Grigorenko  What genetics can teach us about neurodevelopmental disabilities: Deciphering the genetics of speech and language
11:10 Q/A
11:30 John Stein  Genetic bases for impaired development of magnocellular neuronal systems throughout the brain in dyslexia.
12:10 Q/A
12:30 LUNCH

Genes and Behavioral Phenotypes, (continued)
Moderator: Maryanne Wolf

2:00 Cecilia Marino  Investigation of candidate genes in families with dyslexia.
2:40 Q/A
3:00 BREAK

3:30 Fumiko Hoeft  Prediction of children's reading skills: Understanding the interplay among environment, brain, and behavior
Tuesday, June 29, 2010
Potential Early Precursors/Neural Mechanisms of SLI and Dyslexia
Moderator: Paula Tallal

9:00 Joe LoTurco  *Disruptions in neuronal migration and synaptic plasticity in an animal model of dyslexia*

9:40 Q/A

10:00 Glenn Rosen  *Disruption of neuronal migration by RNAi of Dyx1c1 results in neocortical and hippocampal malformations.*

10:40 Q/A

11:00 BREAK

11:30 R. Holly Fitch  *From genes and cortical anomalies, to behavior and plasticity: Animal models of cortical development.*

12:10 Q/A

12:30 LUNCH

Afternoon - Open for now

Lake Boat Cruise (optional)
Wednesday, June 30, 2010

Potential Early Precursors of SLI and Dyslexia
(Language Learning Disorders)

Moderator: Naseem Choudhury

9:00  Nina Kraus  Sensory-Cognitive Interplay in the Auditory Brainstem: Implications for Dyslexia

9:40  Q/A

10:00  BREAK

10:30  April Benasich  Timing, information processing and prediction: Longitudinal converging measures from infancy to childhood.

11:10  Q/A

11:30  LUNCH

1:00  Ben Maassen  Overview and early results of the prospective longitudinal studies of the Dutch Dyslexia Programme

1:40  Q/A

2:00  BREAK

Wednesday, June 30, 2010 (continued)

Co-Morbidity of SLI, Dyslexia, Autism

Moderator: Naseem Choudhury

2:30  Martha Herbert  Structural brain abnormalities and asymmetries: Comorbidity in developmental language disorders and Autism

3:10  Q/A
3:30  Elise deBree  *Cognitive processes in children at higher risk for Dyslexia and in children with SLI.*

4:10  Q/A

4:30  ADJOURN

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Thursday, July 1, 2010

Developmental Neuroimaging: Identification, Intervention and Remediation
Moderator: Peggy McCadle

8:30  P. Ellen Grant  *Evolution of pediatric imaging and application of cutting-edge MR techniques in pediatric patients*

9:10  Q/A

9:30  Christiana Leonard  *Anatomical risk factors for language and reading disorders.*

10:10  Q/A

10:30  BREAK

11:00  Elena Plante  *Neuroanatomical correlates of language, attention and memory in Language-learning disabilities.*

11:40  Q/A

12:00  LUNCH
1:30  **Nadine Gaab**  *Neural correlates of plasticity examined with fMRI after language/reading remediation*

2:10  Q/A

2:30  BREAK

3:00  **Ken Pugh**  *Examining reading development and reading disability: Potential contributions from functional neuroimaging*

3:10  Q/A

4:30  **Bruce McCandliss**  *Using fMRI, DTI and EEG to identify changes in cognitive function and neural structure for attention, reading and language: School-based Training and Intervention studies.*

5:10  Q/A

5:30  ADJOURN

7:00  Gala Dinner at Ashford Castle
Friday, July 2, 2010

Summary and Future Directions

9:00   **Breakfast, Overview and Directed Discussion:**
       Summary of critical research directions and priorities (Next Steps) and
       Methodological developments necessary to move forward

**Moderators and Discussants:** April A. Benasich, Naseem Choudhury, R. Holly
Fitch, Peggy McCardle, Paula Tallal, Maryanne Wolf

**FORMAL CLOSING REMARKS**

April Benasich and Holly Fitch
William Baker

11:00   ADJOURN AND CHECK OUT OF HOTEL

12:00   Board bus for return to Shannon Airport