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Professor, Center for Human Development,
University of California
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Co-Founder and Director, Scientific Learning
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Committee on Science, Space, and Technology
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Good morning Chairman Smith, Ranking Member Johnson, other Committee members, and members of the panel. Thank you for the opportunity to speak with you this morning about HR 3033, briefly share with you my work, identify the opportunities for translating research knowledge into practical applications and new technologies that will improve the outcomes for students with dyslexia and language based learning problems, and specific recommendations for HR 3033.

I want to commend the Committee for raising the visibility on such an important need. Significant research progress has been made in our understanding of the neurobiological and environmental factors that lead to reading failure, as well as the interventions most likely to lead to improved reading outcomes, as reflected in last year's hearing testimony. What is urgently still needed are actionable methods for using evidence based laboratory research to achieve demonstrated improvement in our students' literacy outcomes.

This legislation has the potential to construct a more effective, bi-directional highway to facilitate communication between research scientists and educators, with the express goal of developing and assessing the efficacy of novel, research informed educational tools, curricula and technologies for children with language-based learning problems. I specifically call your attention to my use of the more inclusive diagnostic classification, "language-based learning problem". This acknowledges that research has shown a direct link and considerable overlap between children diagnosed with oral and written language problems. The research emphasizes that dyslexia usually begins well before the child fails to learn to read and both oral and written language problems can be predicted by slow and inconsistent response to sounds much earlier in life.

Background

My name is Paula Tallal and I am a Professor, Research Scientist, Board-certified Clinical Psychologist, Inventor and a Co-Founder and Director of a neuroscience-based educational software business, Scientific Learning Corporation. I am the Co-Founder and was Co-Director of the Center for Molecular and Behavioral Neuroscience at Rutgers University, where I was a Board of Governor's Professor of Neuroscience for twenty-five years. I recently moved to San Diego where I currently hold academic appointments at both the University of California San Diego and the Salk Institute for Biological Studies, and am a Co-Director of The Temporal Dynamics of Learning Center, an NSF Science of Learning Center that is entering its tenth year and has received approximately $34,000,000 in funding. I received my Ph.D. from Cambridge University in 1974, where I first began my career-long research focus on the essential role of rapid auditory temporal processing in determining individual differences in language and literacy development and disorders.

Over the past 40 years, I have received continuous research funding from NIH, NSF and private foundations and had a leadership role in research programs amounting to over $50,000,000 to study the neurobiological and environmental factors underlying individual differences in language and literacy development and disorders, including dyslexia, as well as the temporal dynamics of learning. At the federal level, I have been invited to present a Decade of the Brain Lecture to members of the U.S. Congress and Senate, write a Congressional Report on Language Disorders, present a Congressional Briefing on Learning Disabilities to the Congressional Biomedical Research Caucus, and was chosen to be the sole Commentator for the entire field of Psychology by the Library of Congress for their Bicentennial Celebration on "Frontiers of the Mind in the Twenty-First Century". I was appointed to serve on the Task Force for *both* Language Disorders and Learning Disorders for the Diagnostic & Statistical Manual of Mental Disorders, 4th Edition (DSM-IV), the clinical manual that sets diagnostic descriptive criteria for cognitive, psychological and mental disorders, including language-based learning disorders. I am a Co-inventor on dozens of U.S. patents and won the Thomas Alvin Edison Patent Award for innovative research leading to the development of the Fast ForWord® series of neuro-educational training programs.

In addition to my academic credentials, I am one of the few scientists who have actively pursued the practical application and translation of the science of language based-learning disabilities out of the research laboratory and into classrooms and clinics on a broad scale. With this goal in mind, in 1996 I Co-Founded Scientific Learning Corporation, a publicly traded company that creates and markets neuroscience-based and efficacy tested language and reading educational software training programs to schools and clinics, under the trademarks Fast ForWord® and Reading Assistant®. To date, Scientific Learning Corporation's products have been provided to over 2.5 million children in 55 countries who are struggling with language (including English language learning) and/or reading development.

Given my diverse background and experience, I have a unique understanding of the intersection of three worlds: 1) the research scientist studying the neurobiological and environmental factors contributing to language based learning disorders; 2) the educators who are tasked with improving the literacy and other academic outcomes of a growing number of struggling students in the U.S; and, 3) the inventor/entrepreneur who has helped build a thriving education software business for developing, scaling up, distributing and assessing the efficacy of new tools and technologies for classrooms and clinical intervention.

My expertise at the intersection between these worlds has particular relevance to H.R. 3033, the ''Research Excellence and Advancements for Dyslexia Act'' or the ''READ Act''. Specifically, my expertise as a *scientist* conducting longitudinal studies on language based learning disabilities has relevance for the requirement in H.R. 3033 for the "NSF to support multi-directorate, merit-reviewed, and competitively awarded research on the science of dyslexia, including the early identification of children and students with dyslexia." The opportunities I have had to present scientific research on the neurobiological and environmental factors leading to reading failure to thousands of educators and clinical professionals who serve children with language-based learning disabilities has relevance for " professional development for teachers and administrators of students with dyslexia." My business experience as a Co-Founder and Director of Scientific Learning Corporation, the first neuroscience-based education software company, founded by neuroscientists, has particular relevance for designing and assessing the efficacy of "curricula and educational tools needed for children with dyslexia." Most specifically, having over 40 years experience conducting NIH and NSF funded research, combined with 20 years of real-world experience translating this research to the classroom provides me with unique insight into the overall goal of conducting research that "has the goal of practical application."

This testimony will present three components for the Committee to consider in its deliberations on H.R. 3033, the READ Act:

1. Research
2. The "Translational to Education" Roadmap
3. Recommendations

<u>Research</u>

The really good news: Science is there for those who are dyslexic. As my colleague, Dr. Sally Shaywitz from Yale University stated last year in her testimony to this committee, "In dyslexia, science has moved forward at a rapid pace so that we now possess the data to reliably define dyslexia, to know its prevalence, its cognitive basis, its symptoms and remarkably, where it lives in the brain and evidence-based interventions which can turn a sad, struggling child into not only a good reader, but one who sees herself as a student with self-esteem and a fulfilling future."

The bad news: We do not have a knowledge gap, but an action gap. Again, from Dr. Shaywitz's testimony, "In dyslexia, remarkably in America, in the year 2014, we have not a knowledge gap but an action gap. We have the knowledge, but it is not being put into policy and practice and far too many children and adults, too, are suffering needlessly. There is an epidemic of reading failure that we have the scientific evidence to treat effectively and we are not acknowledging or implementing it. It is our hope that hearing the depth and extent of the scientific knowledge of dyslexia will alert policy makers to act and to act with a sense of urgency."

NEWSFLASH: Decades of scientific research show that reading success relies on a solid foundation of rapid and consistent auditory processing (listening) and oral language (particularly phonological) skills, and that weakness in these two areas predispose a child to subsequent reading failure. For a variety of neurobiological and environmental reasons, an increasing number of children are entering our education system with insufficiently developed speed of auditory processing, cognitive and oral language skills. Schools are in the business of teaching students how to read, not how to process faster or to speak. Traditional reading curricula, tools and approaches presuppose that a child has sufficient foundational auditory processing and linguistic skills to succeed. **Not providing educators with those tools and technologies that have already been shown to explicitly remediate the rapid auditory processing, cognitive, phonological and other oral language skills that are well known to be precursors to reading failure is equivalent to demanding that they construct the third floor of a school without having the tools to build a sufficiently strong foundational first and second floor, and then wondering why the school keeps collapsing.**

The Language to Literacy Continuum

There is ample prospective, longitudinal research that demonstrates the factors that ultimately cause reading failure begin well before a child enters formal education. Using both behavioral and electrophysiological techniques, my colleague Dr. April Benasich at Rutgers University demonstrated that infants as young as 7 months of age, who are destined to have language-based learning deficits later in life, already have differences in the speed at which they can process simple auditory tones that are presented rapidly in succession. Using an infant's temporal integration threshold at 7 months of age and gender, it was possible to predict 93% correctly those toddlers who at age 3 years scored in the "impaired" range on the Verbal Scale of the Stanford Binet Test of Intelligence. It is important to emphasize that children with slower auditory processing were *not intellectually impaired* on non-verbal components of intelligence nor did temporal integration thresholds predict non-verbal intelligence. This dissociation demonstrates the specificity of the relationship between auditory temporal integration thresholds and language-based learning.

Research by many groups of scientists has shown that infants' and young children's ability to discriminate between speech sounds (phonemes) that are distinguished solely by rapid acoustic changes (less than 100 milliseconds), such as consonant-vowel

syllables, also predicts reading abilities later in life. Today, there is a significant body of evidence that has substantiated that individual differences in the speed and consistency of auditory processing is a good predictor of individual differences in language-based learning abilities. The research also confirms that slow auditory processing of both speech and non-speech acoustic cues characterize children who struggle with language and literacy development. **To use an analogy, when it comes to processing (listening to) auditory information, children with language-based learning problems are operating on "dial-up" speed while those with good language skills are operating on "high speed internet".**

Auditory Processing Can Be Assessed and Addressed at Any Age

Using a straightforward electrophysiological test, Dr. Nina Kraus and colleagues from Northwestern University recently demonstrated that future language difficulties could be predicted from the brain's response to speech in noise at age 3; the biological response to sound predicted the same children's language skills a year later. Moreover, the same model of neural sound processing tracked with children's actual reading abilities in school-age children. This research demonstrates that a simple test, that measures how a young brain responds to sound, predicts who is likely to have language and reading difficulties long before they begin to read. In children already experiencing reading failure, it is now possible to objectively determine which specific aspects of sound processing may be the bottleneck underlying a child's reading difficulties. **The good news is that research has shown that addressing this bottleneck with classroom listening interventions can improve a child's reading ability and fundamentally rewire the brain for healthier learning and communication skills.**

Why is the precision and speed of auditory processing important for learning language?

Listening to and processing ongoing speech is the *fastest* thing the human brain has to do. Our brain does not know what language we are going to have to learn to speak. In order to learn to talk, we first have to *learn to listen* to and chunk information into meaningful segments in the rapidly changing, complex acoustic sounds around us. The most pervasive and consistent sound patterns we hear as infants and young children are the sounds of our native language. Our brains use these repetitive sound patterns to establish the statistical probability that certain chunks of sounds will repeat, that certain sound patterns follow others to form phonemes, syllables and words in our language, and eventually, that certain words follow others to form the grammatical rules of our language. These essential processes must be *learned* and are highly dependent on repetitive environmental exposure. The more opportunities a young brain has to hear phonemes, syllables, words and sentences presented in a clear and predictable manner, the faster its auditory neurons will be able to establish distinct, neural firing patterns (representations) of the individual speech sounds (phonemes) that form the building blocks for both spoken and written language**. In other words, frequently talking with and reading to infants and young children will increase the likelihood of future reading success.**

Why is the precision and speed of auditory processing important for learning how to read?

In order to learn to read a child must become aware that words are made up of individual sounds, and it is these *sounds* that the letters represent. This process is called "phonological awareness". **Decades of reading research, specifically research on dyslexia, has demonstrated that failure to become phonologically aware is at the heart of reading failure.**

What are the risk factors leading to deficits in phonological awareness?

There have been decades of research showing that there are a number of genetic, neurobiological as well as environmental factors predisposing a child to have deficits in phonological awareness and subsequent reading failure.

Key factors include:

1) Family History of Language Impairment. One well established risk factor is being born into a family that already has one or more individuals with a history of language-learning impairments (LLI). Dr. April Benasich has done comprehensive psychological and electrophysiological evaluations comparing infants that do or do not have a family history of LLI. Her large data set shows that the single most important variable that differentiates between these babies is their **speed of auditory processing**. Babies with a positive family history of LLI are significantly slower in processing simple auditory tone sequences than babies with a negative family history, and 50% of these family history positive babies are at increased risk of developing a language-based learning disability.

2) Low Socio-Economic-Status. Another risk factor is *linguistic impoverishment*, which has been shown to accompany socio-economic poverty. In their landmark studies published in "Meaningful Differences in the Everyday Experiences of Young American Children", Professors Betty Hart and Todd Risley, University of Kansas, demonstrated that by the age of 4 years, children born into low socio-economic families are exposed to 30 million fewer words than those born into high socio-economic families. This has become known as the "30 million word deficit". This linguistic impoverishment deprives a child of receiving the essential auditory neural stimulation required to establish distinct phoneme representations, build vocabulary, and develop age appropriate oral language skills. Furthermore, longitudinal research has shown that even when children are equated in reading ability at age 5, by age 13 **children who had low oral language development when they entered school are more than five years behind in reading compared to their peers with high oral language skills.**

3) English Language Learners. Children for whom English is not their native language are also at great risk of becoming struggling learners. Not only does oral language comprise upwards of 80% of the school curriculum, many of these children have not had sufficient language stimulation *in English* to set up the distinct phonological representations for

English phonemes that are required for phonological awareness in learning to read English.

These risk factors are not mutually exclusive. Unfortunately, many of our struggling readers have more than one of these risk factors that further compound their struggle to learn to read and become proficient readers.

The Challenge for our Schools

For a variety of social, cultural and economic reasons there are increasing numbers of children with one or more neurobiological and/or environmental risk factors that predispose them to have weak English language skills when they enter school, fail to learn to read, and hence fall further and further behind as they move through our education system. Despite increased funding through Title 1 and IDEA, according to the latest National Assessment of Educational Progress (NAEP) scores, more than 60 percent of fourth and eighth graders struggle with reading and require targeted instructional support. Almost half of students of color, from low-income families and/or from urban areas enter fifth grade with reading skills *below the basic level*. These outcomes mean that **millions of young people lack rudimentary reading skills essential for academic or occupational success**.

Why Have Schools Failed to Focus on Improving Students' Fundamental Auditory Processing and Linguistic Capacities?

Given the substantial body of research that has consistently shown that learning to read requires:

- a solid foundation of fundamental auditory processing (listening) skills;
- oral language skills (specifically phonological awareness)

and substantial resources have been directed to improving reading outcomes of U.S. students, why have schools failed to focus on improving the auditory processing and oral language skills of struggling readers?

Schools traditionally have been in the business of teaching children how to read, not how to listen or speak. A wide variety of curricula are available for teachers that are designed to teach reading. However, the vast majority of this presupposes that the student already has established sufficient spoken English language skills as well as the distinct neural firing patterns for phoneme representations that are required for the child to become phonologically aware and, hence, benefit from traditional reading instruction (phonics and/or whole language). Even when teachers recognize that many of their struggling students do not have the foundational perceptual, cognitive or linguistic skills essential for them to be able to achieve with traditional reading instruction, they do not believe there is anything they can do about this other than try their best to "teach around" these deficits. It is commonly believed that children enter school with differing genetically and/or environmentally endowed brain capacities and that teachers must just make-do with these individual differences in neural capacity.

However, significant breakthroughs in the neuroscience of learning have demonstrated that this view is fundamentally wrong! **For children who have not acquired sufficient foundational perceptual, cognitive or linguistic skills essential to achieve with traditional reading instruction, they require *explicit "catch-up" interventions* in these areas before traditional reading instruction can be effective.**

Neuroplasticity: The Brain that Changes Itself

One of the basic tenets of modern neuroscience is that, "Neurons that fire together nearly simultaneously in time, wire together", and the more often a pattern of neurons fire together, the more likely a clear representation of important patterns in the external world will be established. Being able to predict what is about to happen next is highly reinforcing to the brain and repeated exposure allows the brain to process faster, more consistently and more automatically. **Throughout life, but especially early in life, the brain is literally shaped anatomically and physiologically by *experience*. This repeated scenario of stimulus, neural firing, and reward, leads to experience-driven organization of the brain. This is called "neuroplasticity".**

Decades of neuroscience studies have explicitly identified what variables are needed to most efficiently and effectively drive neuroplasticity of the perceptual and cognitive systems shown to predispose a child to become a struggling reader. The needed variables include: 1) frequent, intense input (repetition, repetition, repetition), 2) adaptive training (moving from easier to harder items, based on individual performance), 3) sustained attention and 4) timely reward (timed to trigger neurochemical signals in the brain that indicate, "that was a good one, save it!"). **Understanding neuroplasticity, and the variables that drive it, has the potential to revolutionize interventions for children with auditory perceptual, cognitive, phonological awareness, language and reading problems**.

Fast ForWord®: A model system for translating neuroplasticity-based training research into educational programs

Research shows that for the vast majority of dyslexics, before they begin to fail to learn to read in the early school years they already have failed to establish a strong oral language system as toddlers and preschoolers. Even before they begin to struggle with oral language development, they already are showing signs of aberrant auditory processing (listening) skills, particularly the speed and consistency of the brain's response to rapidly successive sounds. This cascade from auditory perceptual weakness, to oral language weakness, to reading failure, which I have called the **Language to Literacy Continuum**, follows the child from infancy into adult life, if not corrected.

When a child shows signs of reading failure, the traditional interventions focus on providing more one-on-one instruction or specialized therapy, coupled with more time devoted to reading instruction in the classroom. While this may help some children, the

numbers of children not responding to this traditional intervention approach speak for themselves. **How long is it going to take for educators to realize that the traditional tools for teaching reading, regardless of how expertly and how often they are applied, do not work for most struggling readers until more foundational perceptual, cognitive and linguistic skills are remediated?**

In 1994, my lab joined forces with the University of California San Francisco (UCSF) lab of Dr. Michael Merzenich, a recognized leader in physiological neuroplasticity research. Our goal was to create neuroplasticity-based neural training exercises for children with language-based learning impairments that would 1) speed up auditory processing, attention and memory, and 2) provide highly intense, individually adaptive, linguistic training, ranging from phonology to grammatical comprehension. **My earlier studies had shown that we could significantly improve speech perception in children with language disorders by using computers to *enhance* the acoustic structure of speech by *slowing down* the fast changing components within syllables and words.**

We capitalized on this knowledge by creating a computer algorithm that could find all of the fastest changing components within phonemes and syllables in the context of ongoing speech and extend and enhance them in real time. Using neuroplasticity training principles, we hypothesized that we could improve the precision of phonological discrimination, vocabulary development and grammatical comprehension by providing language impaired children speech therapy type exercises that began by using this easier *enhanced speech* signal. As the child began to progress in their linguistic abilities, the goal was to reduce the amount of acoustic *enhancement* so that the child would be able to process regular, fast speech and language at more age appropriate levels.

Our initial studies were done with children with language-based learning impairments in my Rutgers lab. Children with language impairments were quasi-randomly assigned to two matched groups that received the same language training, one group with *computer enhanced* speech and *temporal training* and the other with natural speech. The outcome results from these studies were stunningly positive, and published in two papers in *Science* in 1996. Results showed that within only four weeks of daily intensive intervention, this novel, neuroplasticity-based training approach resulted in highly significant improvements (1.5 – 2 years growth) in temporal thresholds, speech discrimination, language processing and grammatical comprehension**. This was the first demonstration in children to demonstrate that fundamental perceptual thresholds were "plastic" well beyond critical periods of development and could be significantly sharpened with neuroplasticity-based training.**

<u>The "Translational to Education" Roadmap</u>

It was clear that this new intervention approach had considerable promise as a clinical and educational tool for children with language-based learning problems. However, we had little experience in knowing how to go about translating our scientific advances into

practice in real-world clinics and classrooms. Despite growing mandates for scientists to translate their research into practical application, **similar to the goal of this current READ bill H.R. 3033, there wasn't then, nor is there now, agreed upon guidelines or a "roadmap" to follow that lead scientists through the complex, iterative maze of actual translational application into classrooms *on a broad scale*.** With the help of technology transfer offices at our respective Universities, we were encouraged to co-found a company to accomplish our translational goals, and Scientific Learning Corporation (SLC) was founded in 1996.

Scientific Learning Corporation has developed two major lines of educational software products for students K-12, that are marketed under the brand names Fast ForWord® and Reading Assistant®. Fast ForWord® (Language and Reading series) is individually adapting educational software designed as interventions tools for elementary, middle or high school students struggling with English language development, phonological awareness, and reading to build the Language to Literacy Continuum. Fast ForWord Language® programs are designed to provide explicit training in the fundamental auditory processing, cognitive and oral language skills that research has shown are deficient in struggling readers. **It is essential to note that once a child develops these foundational perceptual and linguistic skills that are the building blocks for reading, only then are they ready to succeed with explicit reading instruction.** The Fast ForWord® Reading series was designed to provide explicit training in K-12 reading instruction.

Reading Fluency

A hallmark of dyslexia is slow and effortful (non-fluent) reading. Research has shown that the best way to improve reading fluency is to have a student read out loud to an adult who corrects the student's reading errors in real time. Unfortunately, there is limited time for teachers to provide the struggling reader the amount of individual attention they need to develop fluent reading. Many new technologies provide increased opportunities for helping the struggling reader receive the individualized practice that they need. For example, as a "virtual tutor" Reading Assistant® uses state-of-the-art voice recognition software that allows a child to read stories out loud off of a computer and receive real-time correction of errors.

Over the past twenty years Fast ForWord® and Reading Assistant® have been used in over 12,000 U.S. schools and, currently, during peak seasons, as many as 70,000 students a week are using these programs. While no method works for all students in the hands of all scientists or schools, and there are certainly examples of studies that have failed to find significant language and/or reading improvements after Fast ForWord® use, the *cumulative* efficacy data based on standardized language and reading measures, electrophysiological and brain imaging data, as well as high-stakes state-wide achievement test scores, obtained when school and clinics implement these programs rigorously is very positive, especially when compared longitudinally to students' and schools' performance before the use of these products. For example, before

implementing Fast ForWord® in 1996 at Thomas Gibbs Elementary School in St. Mary's Parish, Louisiana, only 19 percent of their 4th grade struggling students scored basic or above in Language Arts and 9 percent in Math on their State-wide achievement test, placing this school in the bottom quartile state-wide. After implementing Fast ForWord® a year later achievement scores had increased to 40 percent in Language Arts and 47 percent in Math. Reading Assistant® was added to the curriculum in 2007. By 2008, the school had moved into the top quartile State-wide, with 81 percent of students scoring basic or above in Language Arts and 72 percent in Math. **Building foundational processing, cognitive and language skills not only improved Language Arts scores, but also generalized to improved scores in Math.**

Other evidence of efficacy comes from the What Works Clearing House (that ranked Fast ForWord® - Language the number one program for improving language for English Language Learners. Of the eleven programs that met the stringent evaluation standards of the What Works Clearing House, Fast ForWord® showed an Improvement Index of 31 (on a -50 to +50 scale); the average index of the other programs ranged from +21 to -1). Specific examples of these types of efficacy data are presented in the PowerPoint supplemental materials accompanying this testimony. Additional efficacy data from hundreds of schools and clinics, as well as scientific studies can also be found at www.scientificlearning.com/results.

Lessons Learned over a 20 Year Period from a Real-World Translation Effort

It is important to emphasize that one of the great advantages of software programs and technologies is that they are not necessarily "evergreen" -- that is, they can be easily adapted and improved over time. As they move through the translational process over years of use, this advantage allows for an ongoing, iterative process between the consumer (educators, clinicians, students, parents) and the producers (scientists, developers, business professionals) for continuously refining and re-evaluating usability and efficacy in real-world settings, based on actual data and feedback from the users. The disadvantage from the scientists' perspective is that it is cost prohibitive to continuously conduct what many scientists consider the "gold-standard", double-blind, randomized control trials in real-world settings on products that are constantly adapting and changing over time.

Another conflict is that while scientists publish study results in peer-reviewed journals, outcome data from schools are made publicly available primarily as State-wide Achievement test scores. This conflict of goals creates considerable tension between scientists and end users throughout the translation process. **We need to develop new methodologies acceptable to both scientists and educators for assessing efficacy of non-evergreen (particularly, but not exclusively software based) curricula, tools and technologies that take into account *cumulative* data collected by end users themselves, across many different settings and over many years.**

The New Science of Learning

NSF recognized the gulf between scientific knowledge pertaining to learning and translation of this knowledge into education practice and set out to bridge this gulf by creating a new focus on the "Science of Learning". Over the past 15 years, the Social and Behavioral Sciences Directorate, under the leadership of Dr. Soo- Siang Lim, has established six multidisciplinary, multi-university Science of Learning Centers. These Centers were tasked with integrating research across multiple scientific disciplines that address learning, per se, and focus on how this knowledge might be translated to educators. I have been fortunate to be a Co-Director of one of the Science of Learning Centers, The Temporal Dynamics of Learning Center at the University of California San Diego. Our Center focuses on the role of time and timing in learning from milliseconds to days, weeks and months. **These Science of Learning Centers are limited to 10 years of funding and will not be renewed. H.R. 3033 "READ bill" should capitalize on advances from these Centers that 1) have particular promise for Professional Development pertaining to the Science of Learning and 2) further translation to education, specifically as applied to early identification and remediation of auditory processing, cognitive, language and reading impairments.**

<u>Recommendations</u>

HR 3033 is a vehicle to build on the sound scientific research sponsored to date by NIH and NSF. This bill can guide NSF's investment portfolio in dyslexia toward the development of a roadmap for effective, ground-breaking translation of research into application. Representative characteristics of such a roadmap include:

- Development of criteria for ranking and giving priority to research proposals focused on translation to education, with specific attention to the **feasibility and plan for scaling up new curricula, tools and technologies for broad dissemination to classrooms and clinics**.
- Identification of incentives for educators to collaborate with scientists to evaluate effectiveness and impact in real world classroom environments including adequate and **sustained professional development and time to evaluate various methods to determine the efficacy in their classroom.**
- Identification and use of new tools and technologies, based on scientific discovery, to determine how new tools and technologies compare directly against traditional reading instruction the school is currently using in terms of improvement on high stakes tests. Recognition that translation of scientific knowledge from the laboratory to education may be best achieved by the use of new technologies. In other words, **let computers (and other innovative technologies) do what computers do best, so teachers can do what teachers do best.**
- Development of a new research method specifically designed for testing and accumulating data on the efficacy of educational programs and products across multiple, real-world classrooms or clinical settings. The bridging of the "laboratory-classroom gap" requires a new, ecologically feasible model that

creates a bi-directional, collaborative, systemic approach that leverages the strengths, competencies, knowledge, and expertise of both the researcher and classroom teacher. **New research methods should allow for *cumulative* efficacy data of a variety of types (peer-reviewed, published laboratory results, longitudinal high-stakes test data from schools, State and Federal Agency evaluations such as What Works Clearing House) on non-evergreen (continuously changing versions) curricula, tools and technologies.**

- Development of a new training grant or other funding mechanism focused on "Translation of the Science of Learning to Education" **to support seasoned educators or clinicians who wish to pursue a Master's or Ph.D. degree while continuing to work, to do translational laboratory research in their own clinic or classroom.**
- Development of a new funding mechanism to support **collaborative networks of scientists, teachers and clinicians to work together on bi-directional professional development curriculum and translational research.**

Summary

In closing, I want to thank the Committee for allowing me the opportunity to share 3 key components for consideration in the development and implementation of H.R. 3033:

1. Federal investment (NIH, NSF) in research has been instrumental in providing a data driven understanding of language-based learning impairments, including dyslexia, and have specifically shown that foundational rapid auditory processing, cognitive and oral language skills are essential for building strong reading skills.
2. Educational technologies, specifically those based on an understanding of how the brain learns and changes based on experience (neuroplasticity) can play a significant role in addressing learning and reading challenges.
3. The next logical step for Federal investment should focus on the development of a more ecologically feasible "translational to education" roadmap to bridge the gap between research scientists, school administrators and classroom teachers to apply data driven research into real world application including evaluation and assessment of impact.

As I mentioned at the beginning of this testimony "What is urgently still needed are actionable methods for using evidence based laboratory research to achieve demonstrated improvement in our students' literacy outcomes." Legislation such as HR 3033 has the ability to guide and inform public policy on this critical issue and improve the prospects of millions of children for decades to come.

Mr. Chairman, I would be happy to respond to any questions you or the other Members of the Committee may have.

Suggestions for further reading

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