

# Neuroeducation: Neuromyths, Neurotruths, Student Learning, and Teachers' Understanding

Technical Working Group Meeting Summary June 7, 2018

National Center for Education Research Institute of Education Sciences 550 12th Street, SW Washington, DC 20202

#### **Invited Experts**

Patrice Bain, M.Ed., Ed.S.

Columbia Middle School; Columbia, IL

Julie Booth, Ph.D.

Temple University; Philadelphia, PA

Kara Carpenter, Ph.D. Teachley; New York, NY

Laurie Cutting, Ph.D.

Vanderbilt University; Nashville, TN

Jodi Davenport, Ph.D.

WestEd; Alameda, CA

Blake Harvard, M.Ed.

James Clemens High School; Madison, AL

Jeffrey Karpicke, Ph.D.

Purdue University; West Lafayette, IN

Percival Matthews, Ph.D.

University of Wisconsin; Madison, WI

Richard Prather, Ph.D.

University of Maryland; College Park, MD

Amy Shelton, Ph.D.

Johns Hopkins University; Baltimore, MD

Robert Siegler, Ph.D.

Carnegie Mellon University; Pittsburgh, PA

Melina Uncapher, Ph.D.

University of California, San Francisco; San Francisco, CA

Yana Weinstein, Ph.D.

University of Massachusetts Lowell; Lowell, Massachusetts

Phillip Winne, Ph.D.

Simon Fraser University; Vancouver, BC

Alyssa Wise, Ph.D.

New York University; New York, NY

#### **IES Staff**

Mark Schneider, Ph.D.

Director

Thomas Brock, Ph.D.

Commissioner (through June 2018), National Center for Education Research

Elizabeth Albro, Ph.D.

Associate Commissioner (through June 2018), Commissioner (beginning July 2018), National Center for Education Research

Joan McLaughlin, Ph.D.

Commissioner, National Center for Special Education Research

Erin Higgins, Ph.D.

Education Research Analyst, National Center for Education Research

Amanda M. Dettmer, Ph.D.

2017-2018 American Psychological Association (APA) Executive Branch Science Fellow, in partnership with the American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellowship Program, placed at the National Center for Education Research

The following meeting summary was edited by IES staff for clarity and consistency. Technical Working Group members were allowed to review and comment on it, and their corrections were incorporated. The views expressed in this document reflect both individual and collective opinions of the meeting participants and not necessarily those of the U.S. Department of Education.

#### **Meeting Summary**

On June 7, 2018, the National Center for Education Research (NCER) of the Institute of Education Sciences (IES) convened a group of experts to discuss how to address persistent neuromyths (e.g., "learning styles") that continue to permeate teachers' professional development, curriculum materials, and education technology products. The group also discussed how to improve the relevance and awareness of high quality research within the learning sciences to ensure its usefulness for practitioners, policymakers, and curriculum and education technology developers (see Appendix A for a full agenda).

Discussion followed four topics of inquiry:

- 1. The Pervasiveness of Neuromyths in Education
- 2. Identifying Neurotruths Relevant to Education
- 3. Rethinking Traditional Research Approaches
- 4. Sharing the Science with Practitioners and Policymakers

Technical working group (TWG) participants made substantive suggestions about how to dispel neuromyths; what open research questions need to be addressed; and ways to improve communication between education researchers and practitioners, policymakers, ed tech and curriculum developers, and the general public. This report summarizes the discussions from the TWG meeting.

#### A Brief History of the Cognition and Student Learning Program at IES

To provide some context for the TWG meeting, Drs. Elizabeth Albro and Erin Higgins from NCER and Dr. Amanda Dettmer, an American Psychological Association (APA) Executive Branch Science Fellow (in partnership with the American Association for the Advancement of Science & Technology Policy Fellowship Program) placed at NCER, presented an overview of IES and a brief history of the Cognition and Student Learning program within NCER.

IES was not the first nor is it the only organization to fund research on how people learn. In the 1970s, the National Institute of Education (NIE) funded research and development centers on reading comprehension, math learning, and science education, the National Science Foundation (NSF) funded research on memory and cognition, and the Office of Naval Research (ONR) funded a program of research on training. In addition, NIE and NSF issued a joint funding program called the Cognitive Processes and Structure of Knowledge in Science and Mathematics. In the 1980s, the McDonnell Foundation began a program on Cognitive Studies for Educational Practice. In 1999, NSF began a program called Research on Learning and Education (ROLE) and in 2003 began their Science of Learning program. In 2002, IES began its Cognition and Student Learning program.

The purpose of the IES Cognition and Student Learning (CASL) program is to support research that applies theories of how the mind works to education practice with the goal of developing and evaluating tools and strategies that improve learning in authentic education settings. Projects funded through the CASL program generally fall under one of two categories: 1) the cognitive processes that underlie and support academic achievement (e.g., the relationship between spatial skills and STEM education) and 2)

the identification of learning and instructional principles that promote learning and retention (e.g., test-enhanced learning).

The CASL program has supported 164 projects from 2002-2017. Of those, Development and Innovation and Exploration projects make up the largest proportion of grants in the portfolio. In terms of dissemination, CASL researchers tend to publish most frequently in cognitive science and education research journals.

#### 1. The Pervasiveness of Neuromyths in Education

During this discussion session, TWG participants weighed in on the barriers to preventing new and dispelling existing neuromyths, such as the myth that students have particular learning styles (e.g., visual learners) and learn better when information is presented in that style.

#### 1.1. Why Do Neuromyths Persist?

Even though researchers have made numerous advances in our understanding of how people learn, some research findings have been misinterpreted or overgeneralized, resulting in the creation of neuromyths. Neuromyths are typically characterized by simple, unequivocal statements, such as the idea that people are either right-brained or left-brained, which corresponds to differences in students' academic achievement in particular disciplines. Some neuromyths are the result of shortened, oversimplified summaries of a legitimate empirical observation. For instance, people believe that boys have bigger brains than girls. This belief is accurate when viewed in terms of absolute mass of boys' versus girls' brains; however, when the ratio of mass to body size is taken into account, it becomes clear that the difference in brain size is driven by one's body size and not one's sex. Neuromyths can be particularly problematic within education. For example, some TWG participants noted that substantial funds and resources (e.g., teachers' time in PD workshops) are dedicated to implementing instructional approaches that stem from popular neuromyths (e.g., purchasing tests and tools to teach to a student's particular learning style).

TWG participants discussed the sources from which people acquire neuromyths, and some noted that they are sometimes spread through professional development (PD) courses and teacher training programs. PD courses are often packaged into attractive presentations by charismatic speakers, creating an air of credibility to the content that is delivered. Also, knowing that the school district has paid for the training gives teachers a false sense that it must be true, and few teachers have the time to do outside research to verify claims made during a PD course. Even when teachers do take the time to verify claims, it is difficult to find reliable sources of information with which to properly evaluate them. Speaking to this challenge, one TWG participant recalled reading about a "dyslexic font" that was purported to help teach students with dyslexia to read. The claim seemed somewhat believable, but the participant, an expert in education research, had to comb through a number of evidence-based education resources to make a determination as to whether the font would do what the developer had claimed. Teachers do not have the time nor the training to go through these resources and verify or disconfirm content presented to them in their PD courses.

#### 1.2. What can we do as a field to systematically counter neuromyths?

TWG participants identified several strategies for countering neuromyths, focused around two themes: improving teachers' training and critical thinking skills and improving researchers' ability to communicate with education stakeholders.

TWG participants discussed how teachers need more training and development of critical thinking skills to be able to effectively evaluate content delivered during in-service training and information from online sources. In addition, participants noted that teachers should know more about cognitive development, specifically how students learn, as well as best research practices. The ultimate goal should be to create intelligent consumers of research who expect to see strong evidence backing up a claim.

Countering neuromyths can be tricky. There is a danger that done without care, attempts to thwart neuromyths can help perpetuate them. One TWG participant made the point that a neuromyth needs to be replaced with something that is equally attractive. Also, acknowledging the grains of truth in neuromyths and walking teachers through how these facts have been misinterpreted when applied to education settings may be more effective than simply stating that a neuromyth is false. Along similar lines, it is important to emphasize to education stakeholders that all science changes over time. Research findings and best practices will most likely be modified, clarified, or even overturned in the future.

Other strategies for dispelling neuromyths offered by TWG participants included:

- Creating a cultural shift toward evidence-based education;
- Implementing change management systems;
- Implementing data-informed decision making;
- Drawing on conceptual change research to identify instructional approaches for changing people's beliefs about what works in education; and
- Informing neuroscientists and cognitive scientists of the importance of communicating in ways that reduce the perpetuation of neuromyths.

#### 1.3. What can IES do to dispel neuromyths from education?

TWG participants had two specific suggestions for what IES could do to counter neuromyths. First, TWG participants noted the value of the IES practice guides (<a href="https://ies.ed.gov/ncee/wwc/practiceguides">https://ies.ed.gov/ncee/wwc/practiceguides</a>), and suggested that IES staff continuously evaluate and revise them to reflect current best practices. A practice guide is a publication that presents recommendations for educators to address challenges in their classrooms and schools. They are based on reviews of research, the experiences of practitioners, and the expert opinions of a panel of nationally recognized experts. Second, IES could incorporate experts who understand how to address misconceptions in order to draw on evidence around how people's minds are changed.

#### 2. Identifying Neurotruths Relevant to Education

Our understanding of how people learn has progressed immensely in the past decade. TWG participants discussed how this science has progressed and how to communicate research findings about how

people learn. In addition, TWG participants identified critical open research questions relevant to education practice.

#### 2.1. What neurotruths do researchers agree on?

Because neurotruths are not written in stone—and can change with updated research—the TWG members agreed that rather than listing out the concepts they regard as neurotruths, it would be more effective to describe how neurotruths differ from neuromyths. One participant noted that neurotruths tend to lack the factors that allow neuromyths to gain popularity. For example, it is much less interesting to believe we use 100 percent of our brains (neurotruth) than it is to believe that we only use 10 percent of our brain (neuromyth). Additionally, multiple TWG participants lamented how neurotruths can come across as an unconnected series of trivia and suggested that they should be consolidated into a coherent, guided schema of practices.

#### 2.2. What are the constraints on what we know about how people learn?

While the fields of cognitive science and neuroscience have produced a number of robust findings about how people learn, some TWG participants, including neuroscientists, stated that it is still premature to use neuroscience findings to guide education practice. One barrier with translating neuroscience research directly to actionable change in the classroom is the way in which neuroscience research is conducted. For instance, the environment inside an fMRI scanner shares little resemblance to a classroom. It is loud and constrictive, and the tasks and materials used are not accurate reflections of students' classroom experiences. Also, TWG participants agreed that neuroscience is not a scalable method for understanding how individual students learn. One suggestion for improving the relevance of neuroscience research is to identify behavioral assessments that can be linked to students' neural activity. By linking behavioral assessments to neuroimaging data, inferences can be made about the connection between brain and behavior.

Much of the research on how people learn is conducted in laboratory settings, making it difficult to generalize findings to education contexts. Education stakeholders are wary about endorsing research findings from other contexts, whether it is the laboratory or from schools in another district. Therefore, evaluating new tools across a variety of contexts is important. Even when research is conducted in a variety of contexts, it is usually done over a fixed period of time. One TWG participant suggested a new model of research where researchers aim to collect data in continuous cycles, providing more opportunities for the data to be relevant across multiple time scales. Another TWG participant noted that research tends to focus on learning experiences that can be added to existing practices; however, adding to pre-existing curricula is unrealistic and burdensome given that a teacher has limited time and resources to get through content during the school day.

#### 2.3. What open research questions about how people learn need to be addressed?

Many education practices are evaluated for efficacy based on pre-test and post-test assessments. TWG participants noted that developing new instrumentation for measuring the learning process in real time could reveal important insights into how people learn. In addition, it would be helpful to know what percentage of time students are actually engaged in learning in the classroom and how long most students can continuously engage in the learning process. A different set of open research questions

identified by multiple TWG participants focused on better documenting the learning environment and how factors of the environment affect how students learn.

TWG participants also noted that once a research question has been answered, a new set of questions about what to do with the findings arises:

- How should educators design a curriculum around new findings?
- Should educators wait until a finding has been replicated before fully embracing new findings?
- When new findings do inform changes to a curriculum, how can researchers continue to play a role in the research that underlies that curriculum?
- Assuming researchers find that changes to a curriculum improve learning, how can they
  disseminate their findings in such a way that other schools will adopt similar changes?

#### 2.4. What can IES do to address open research questions?

TWG participants made a handful of recommendations about what IES can do to facilitate answering open research questions about how people learn, including:

- IES could endorse a set of questions that the field of neuroscience could answer in order to enhance its relevance for education;
- There are problems in education research that are not easily addressable by the currently
  offered grant competitions (e.g., focusing on pre-service teacher training programs), but this
  could be solved by increasing the number of flexible funding mechanisms; and
- Grants focused on implementation would help translate research into practice.

#### 3. Rethinking Traditional Research Approaches

TWG participants discussed how updates to traditional research practices and the adoption of new technologies are driving innovations in the way researchers answer questions about how people learn. They also weighed in on best practices for developing research-practitioner collaborations.

### 3.1. What innovations are helping us answer new questions about how people learn in education settings?

The gold-standard model for scientific experiments is the randomized controlled trial (RCT). TWG participants had numerous suggestions for modifying the RCT in ways that capture important individual differences between students. One TWG participant noted that designing more selective trials specifically designed to test an intervention for a specific subgroup of students will yield more precise results. Another idea raised by one TWG participant was to make a list of all the variables that may impact student learning, implement assessments of these variables as widely as possible, and then mine those data to identify promising interventions for particular subgroups of students. Another TWG participant proposed applying the personalized medicine approach (i.e., establishing what works given a person's particular health profile) within education to help tailor education practices for individual students.

TWG participants discussed how new technologies can provide innovative methods for studying how people learn. For instance, education technology devices can measure how a student interacts with

course content, which provides researchers with a moment-by-moment picture of goal-oriented learning in an authentic, ambient environment. Because of the relatively low cost of tablets, this sort of research approach is highly scalable, amenable to quick, a/b testing, and can easily be adapted for multiple contexts. Data from technology tools, combined with pre-test and post-test measures, can provide more information about how the learning process unfolds and how an intervention could be improved.

### 3.2. What are best practices for researcher-practitioner collaborations and how can they be encouraged, developed, and disseminated?

Increasing the relevance of research requires interactions with education stakeholders. TWG participants discussed the ways in which collaborations between researchers, educators, and education technology and curriculum developers can be established and sustained within this research community.

TWG participants noted that an important first step in building a new collaboration is developing a line of communication founded on mutually respectful, bi-directional dialogue. Part of creating a respectful dialogue is acknowledging the time and effort that teachers will put into implementing research in their classroom, and then offering something in return such as offering PD for teachers. Another way for researchers to develop a respectful collaboration is to involve teachers as early as possible in the research planning. Many TWG participants suggested that, in general, researchers wait until too long in the process to approach teachers about potential collaborations. The result is that teachers can feel like a research question is imposed on them, rather than molded to fit their specific teaching needs, classroom environment, and overall school culture. TWG participants noted that researchers benefit from early conversations with teachers as well. Practitioners can provide insights into the most relevant challenges and issues that researchers could help resolve. One TWG participant noted that one reason these early conversations do not occur as often as they should is that they take time and resources.

Another constituency that researchers should make efforts to partner with is school administrators. One TWG participant noted a "concierge model" implemented by Stanford University in which an individual working for the university acts as an interface between local school district leadership and Stanford's education research labs. The concierge asks administrators about their goals for the coming year. She then takes the answers back to researchers to see who can address the goals and works with the administrators to identify ways to implement the solution in the classroom. As promising as this model sounds, one panelist noted that we need to study whether this model is effective. For instance, it would be helpful to know which issues generated by practitioners have been effectively addressed by researchers, and which researcher generated conclusions have been successfully implemented by practitioners.

One barrier that researchers face is that they are unsure of how to establish collaborations with a school or district. TWG participants recommended developing an online forum for researchers to post success stories and ask questions about best practices for developing and maintaining collaborations. In addition IES should curate resources for their researchers that discuss how to establish strong collaborations.

#### 4. Sharing the Science with Practitioners and Policymakers

While a considerable amount of time, money, and effort goes into discovering new principles of how people learn, education research can have little impact on students in the classroom if there are not

good strategies in place for sharing research findings with relevant stakeholders, including teachers, administrators, students, parents, other researchers, and government agencies. TWG participants discussed innovative methods for dissemination, barriers preventing stakeholders from being aware of education research findings, and what IES can do to support communication efforts.

### **4.1.** What innovative dissemination approaches are effective for reaching practitioners and policymakers?

Dispelling neuromyths and replacing them with information about current research widely accepted by education researchers requires innovative approaches for reaching out to a wide group of stakeholders.

Before discussing the best venues for disseminating messages, deciding on the most effective types of messages is critical. One TWG participant outlined the following characteristics of the optimal message:

- Pervasiveness—The same message should be presented in different formats
- Coherence—Effective messages are not piecemeal, but rather present a cohesive schema
- Consistency—Stories should be consistent over time and across school years, but still allow for change when warranted
- Reinforcement—Messages that are followed up across platforms (i.e., professional development courses, academic journals, mass media articles, social media, personal communications) have a better chance of affecting changes in behavior

Even within specific audiences, there is enormous diversity. Some messages will resonate better with some factions of these audiences than others. For example, while some teachers express a high level of interest and capacity for adopting new education practices, others do not. Also, some teachers may be very willing to adopt new practices and concrete tools and approaches, whereas others would appreciate a less prescriptive set of guidelines. Do unique messages need to be crafted based on teachers' needs and preferences?

As for how to disseminate information, TWG participants highlighted the following social media platforms as particularly effective for education research:

- Twitter
- YouTube
- Blogs
- Sharable online infographics and posters
- Podcasts

One challenge with using these platforms is that it is difficult to identify high-quality information. TWG participants noted that there are organizations that try to offer only high quality content, but more systematic efforts to evaluate the content being distributed are needed. Various news organizations are also developing programs around educating news consumers that education researchers could emulate.

Another suggestion for disseminating new information was to develop a new type of journal that focuses on best practices and standards for education, similar to medical journals that are written for practitioners to stay up-to-date on standards of care. Teachers could be encouraged to read this type of publication through the disbursement of continuing education credits. Though the idea of such a journal was well-received by TWG participants, three concerns were voiced: it needs to be affordable; it needs

to be written in simple, accessible language; and it needs to be careful in the way it approaches political topics.

Another low-tech way to disseminate new information is in-person communication. Teachers may benefit from more in-person discussions. Follow-up conversations with professional development trainers could be an effective means of communicating best practices to teachers. Likewise, in-person seminars between parents and teachers may work well to disseminate information to parents. Along the lines of enhancing in-person communication, multiple TWG participants noted that there is a need for individuals with backgrounds in education research, classroom teaching, and communications to act as "boundary scientists" or "knowledge brokers" to facilitate communication among various stakeholders.

#### 4.2. What are the barriers to disseminating research to different stakeholder groups?

In order to design optimal messages for various audiences and disseminate them in the most effective way, many barriers need to be overcome, most of which revolve around (1) the traditional formats researchers use to communicate research and (2) the delivery of teacher training.

Many researchers focus on communicating their new findings at research conferences and through journal articles for other researchers. This is problematic because conferences are typically only attended by other academics and journal articles are often difficult to access because they are hidden behind paywalls. Journal articles tend to be long and difficult to understand since they are written for other researchers and not for other audiences. In addition, universities and grant-funding agencies offer little to no incentives to researchers for disseminating research findings to any stakeholder groups other than other researchers.

Another barrier is related to teacher training. Qualified trainers are hard to come by, making it difficult to disseminate quality information widely. Also, educators may be skeptical of new information, as demands on and expectations of teachers are constantly shifting and changing over time based on new policies within the state or district, new curriculum standards, and other factors. Education researchers and trainers should consider looking to research on behavior change to figure out the best instructional approaches for conveying new information to educators in these contexts.

Finally, it's not always clear when researchers should disseminate findings to stakeholders (e.g., as soon as a finding is published; once it is replicated by another research group; or when an advisory board makes a recommendation?).

#### 4.3. What can IES do to facilitate more effective dissemination from the research community?

TWG participants shared many recommendations for IES to facilitate the communication of new research findings. These recommendations focused on creating and expanding platforms to encourage better communication across stakeholder groups, updating and revising the content and distribution of practice guides, funding studies focused on effective methods for disseminating to different stakeholder groups, working with journalists, incentivizing grantees to communicate more broadly about their research, and creating a communications advisory board.

Many TWG participants expressed a desire for IES to be more involved with social media. In addition, there were suggestions to identify popular YouTube channels devoted to promoting education and getting in touch with the owners of the channels to offer updated information about education

practices. A related suggestion was developing a network of social influencers that could help push out critical messages to specific audiences. In addition, IES could also consider putting together a dissemination advisory board with representatives from different stakeholder groups along with communications professionals.

TWG participants spent significant time discussing IES's practice guides. TWG participants agreed that these guides provide educators with the best available evidence on current challenges in education. However, one participant noted that the guides were not reaching a sufficient number of education stakeholders. Other participants said that the vast majority of school administrators and teacher trainers are likely not aware of the guides. The participants agreed that IES needs to do more with social media and on-the-ground promotion at teacher conferences and association meetings. It was also suggested that paying an outside marketing firm to promote the guides would be worth the investment. Other suggestions were to produce more timely guides and update existing guides more frequently.

TWG participants also noted that IES can do more to encourage their grantees to improve their dissemination practices. Even though dissemination plans are required for most of the grants that IES funds, there is little follow up to measure the success of these plans. IES could provide recognition for dissemination plans that work particularly well. IES could also fund research projects to examine the dissemination methods that are most effective. IES funding could be used to expose teachers to new education research by offering travel grants to teachers who want to attend education research conferences.

### 5. What Is the Most Important Thing IES Can do to Dispel Neuromyths, Address Open Research Questions about How People Learn, and Widely Disseminate Best Education Practices?

The meeting concluded with individual TWG participants' observations of the major recommendations that came out of the meeting's discussions. They generally fell into two categories: communicating new education research findings and improving capacity to answer open questions about how people learn.

#### Communicating new education research findings

- IES should engage with social media and be more accessible.
- IES should fund grants focused solely on dissemination.
- IES should amplify voices of teachers discussing high-quality education research.
- IES should look to other countries for best practices in disseminating learning science research.
- IES should look to outside experts to engage more effectively on social media.
- IES should do more to incentivize researchers to write about their research for the public.
- Practice guides need continuous revision to reflect the most up-to-date research findings.
- IES should think broadly and diversely about mechanisms for dissemination.
- IES should more actively engage with parents to communicate the importance of their role in their children's cognitive development.
- IES should expand its efforts to work with journalists to convey education research to various stakeholder groups.

#### Improving capacity to answer open questions about how people learn

- IES should create flexible funding mechanism to address education research questions that do not fit well with current grants.
- Research tools are needed to better capture what is happening in the learning environment.

- In developing partnerships with schools, researchers should propose to do a "study" rather than to do "research," as parents are wary of "research being done on their kids."
- Education researchers should develop a new model of research based on continuous cycles of data collection and iterative improvement.
- Education researchers should develop an "engineering approach" to translating learning science research to classroom applications.
- As part of getting new funding, IES could ask universities whether and how they have used IES-funded research in their teacher training programs.

#### Appendix A: Agenda

## Neuroeducation: Neuromyths, Neurotruths, Student Learning, and Teachers' Understanding

Technical Working Group Meeting
Institute of Education Sciences
June 7, 2018
550 12<sup>th</sup> St SW, Washington DC 20202, Room 4090

#### **AGENDA**

9:00-9:30: Welcome, Introductions, Overview of the day **Thomas Brock,** Commissioner, NCER

9:30-10:00: A Brief History of the Cognition and Student Learning Program at IES

Elizabeth Albro, Associate Commissioner, NCER

Erin Higgins, Program Officer for Cognition and Student Learning, NCER

**Amanda Dettmer**, AAAS Science and Technology Policy Fellow, Sponsored by the American Psychological Association

10:00-10:45: Topic 1: The Pervasiveness of Neuromyths in Education

Persistent neuromyths (i.e., misconceptions about how the brain works) continue to permeate teachers' professional development, curriculum materials, and ed tech products (e.g., *learning styles*). We need a comprehensive plan to identify why they continue to exist and to dispel them from education practice.

#### **Discussion Questions:**

- Why do neuromyths persist?
- What can we do systematically as a field to counter them?
- What recommendations do you have for IES?

10:45-11:00: Break

11:00-12:00: Topic 2: Identifying *Neurotruths* Relevant to Education

Our understanding of how people learn has progressed immensely in the past decade. It is time to take stock of what *neurotruths* (i.e., how the brain actually works based on research in neuroscience/cognitive science/developmental science) the field agrees on that are relevant to education as well as identify critical open research questions.

#### **Discussion Questions:**

- What neurotruths does the field agree on?
- What neurotruths have been revised/updated since originally identified (e.g., in the IES Practice Guide) based on more recent research conducted outside the laboratory?
- What are the constraints on what we know? What open research questions need to be addressed?
- What recommendations do you have for IES to share out what we know and address open research questions?

#### 12:00-1:00: Lunch – Informal discussion of barriers to addressing critical research questions

• What are the barriers preventing us from answering open research questions? For instance, what are the practical constraints? Methodological impediments? How can we overcome these to advance the field?

#### 1:00-2:15: Topic 3: Rethinking Traditional Research Approaches

Learning science researchers have made substantial progress in making their work more relevant to education practice, and some have even engaged in researcher-practitioner partnerships to increase the relevance of their work. In addition, researchers are exploring the potential of using approaches such as a/b testing, data mining, and neuroimaging to address their research questions.

#### **Discussion Questions:**

- What innovations in methods and analysis are most promising for helping us answer new questions about how people learn in education settings?
- Most interventions combine multiple instructional factors and attempt to improve multiple cognitive processes at once. How can we design studies to address these potential interaction effects?
- Methods such as a/b testing, data mining, and neuroimaging have been growing in interest in the education space. To what extent are these methods valuable for addressing questions that inform education practice? How can they be used effectively, if at all, and what are their limitations?
- How can researcher-practitioner partnerships be encouraged and incentivized and what best practices to approaching partnerships will ensure that they are informative for both theory and practice?

#### 2:15-2:30 - Break

#### 2:30-3:30: Topic 4: Sharing the Science with Practitioners and Policymakers

Disseminating research to practitioners, policymakers, parents, and students is critical for ensuring that we dispel *neuromyths*, replace them with *neurotruths*, and have a measurable, positive impact on education practice. Despite its importance, dissemination to these stakeholder groups does not often occur.

#### **Discussion Questions:**

- What innovative dissemination approaches are effective for reaching practitioners and policymakers?
- What are the barriers to disseminating research to different stakeholder groups?
- What are additional recommendations for IES to facilitate more effective dissemination from the research community?

#### 3:30-4:00: Lightning Round: Reflections from the Day

• Each participant has one minute to provide reflections/suggestions to IES based on the discussions from the day.