Responding to Claims of Misinterpretation

Professor Jo Boaler, Stanford University

The latest line of attacks on my integrity have come from a small cluster of people who claim that I misinterpret studies. The instances in which they allege misinterpretation center on these three areas:

(1) Research on Timed Testing and Math Anxiety
(2) Research on Mindset
(3) Dr Moser and colleague's study of brain responses to mistakes

I will address each of these below. But first I would like to share the harmful nature of this type of attack.

Publishing peer-reviewed research is at the core of my work. When publishing research papers I and other scholars stay very close to the facts and carefully link each peer-reviewed claim to peer-reviewed evidence. However, when we write for a more general audience, about big inspiring ideas in research, that might resonate deeply with people's lived experience and accumulated insights from practice, we often summarize ideas and share insights from other disciplines, such as neuroscience or cognitive science. When we don't get it exactly right, or overstate a finding, we often hear from our colleagues, and a healthy debate and dialogue ensues, with a good-faith goal from both sides that is purely focused on improved communication.

This is not what has been happening in my case.

In my work bringing ideas from neuroscience into education, I do not use the same words as the neuroscientists, as I am working to make the ideas meaningful for a broader audience. I am not alone in this work and many authors are working to "translate" neuroscientific evidence into helpful ideas for teachers. But in my case, people who do not agree with the ideas I am sharing attempt to discredit my integrity as a scholar, as part of their ongoing harassment.

Here are the three cases they focus on:

1. **Research on Timed Testing and Math Anxiety**

A reporter has claimed that "I misinterpret studies" and "make bold assertions with scant evidence." The first example she gives comes from a white paper on youcubed.org called Fluency without Fear, https://www.youcubed.org/evidence/fluency-without-fear/ when I state that:

…'For about one third of students the onset of timed testing is the beginning of math anxiety…'

I have responded that this statement is clearly an estimate, that draws from different scientific papers and decades of work in schools. Some updated studies published in research journals around the world, that support my estimate and the links between anxiety and timed testing, are these:

Suárez-Pellicioni, Macarena, María Isabel Núñez-Peña, and Àngels Colomé. "Math anxiety: A review of its cognitive consequences, psychophysiological correlates, and brain bases." *Cognitive, Affective, & Behavioral Neuroscience* 16 (2016): 3-22.

Estonanto, A. J. J., & Dio, R. V. (2019). Factors causing mathematics anxiety of senior high school students in calculus. *Asian Journal of Education and e-Learning (ISSN: 2321–2454)*, *7*(01).

Geist, E. (2010). The anti-anxiety curriculum: Combating math anxiety in the classroom. *Journal of Instructional Psychology*, *37*(1).

Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating math anxiety in students from kindergarten through college. *The Mathematics Teacher*, *92*(7), 583-586.

Murtonen, M., & Titterton, N. (2004). Earlier mathematics achievement and success in university studies in relation to experienced difficulties in quantitative methods courses. *Nordic Studies in Mathematics Education*, *9*(4), 3-13.

Newstead, K. (1998). Aspects of children's mathematics anxiety. *Educational Studies in mathematics*, *36*, 53-71.

2. Research on Mindset

The same reporter has stated that critics argue that mindset interventions cause “negligible or non-existent” changes in students’ achievement, and they cite research that shows this (eg Li & Bates, 2017). But the research they cite primarily involves small interventions administered to students who are given information to change their ideas about their mindsets, without substantive work with teachers to infuse mindset ideas through teaching. It is no surprise to me that we cannot tell students to change their mindsets to value growth, but then teach in fixed ways, so that students cannot see how they can grow and learn, and expect change. I have published about this very issue myself in a study that showed that applying mindset ideas without infusing them across content and pedagogy is not enough (LaMar, Leshin, & Boaler, 2019). All of my work, writing, and resources on youcubed, has remained focused on changing teaching practices to bring in the ideas of mindset and brain growth. I myself am critical of brief and isolated mindset interventions – such as the studies the critics cite (eg Li and Bates, 2017). In contrast the following studies all show that when mindset ideas are infused into teaching, important results are achieved, or they discuss the conditions by which important results are achieved. All of these studies appear in scholarly peer reviewed journals:

Bonne, L., & Johnston, M. (2016). Students’ beliefs about themselves as mathematics learners. *Thinking Skills and Creativity*, *20*, 17-28.

Anderson, R. K., Boaler, J., & Dieckmann, J. A. (2018). Achieving elusive teacher change through challenging myths about learning: A blended approach. *Education Sciences*, *8*(3), 98.

Boaler, Jo, Jack A. Dieckmann, Graciela Pérez-Núñez, Kathy Liu Sun, and Cathy Williams. "Changing students minds and achievement in mathematics: The impact of a free online student course." In *Frontiers in Education*, p. 26. Frontiers, 2018.

Yeager, D. S., Carroll, J. M., Buontempo, J., Cimpian, A., Woody, S., Crosnoe, R., ... & Dweck, C. S. (2022). Teacher mindsets help explain where a growth-mindset intervention does and doesn't work. *Psychological Science*, *33*(1), 18-32.

Yeager, D. S., & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of educational Research*, *81*(2), 267-301.

3. Jason Moser el al's study

Moser, J. S., Schroder, H. S., Heeter, C., Moran, T. P., & Lee, Y. H. (2011). Mind your errors: Evidence for a neural mechanism linking growth mind-set to adaptive posterror adjustments. *Psychological science*, *22*(12), 1484-1489.

The same journalist claimed that my interpretation of Moser et al's study is incorrect because I have said that the study showed that people's brains reacted even when they were not aware they had made a mistake. I drew this conclusion from the part of the paper, shown below, that communicated that the brain responded with two distinct neural signals, one came when there was a conflict between a correct and erroneous response (ie when people made a mistake), the second came when people became aware they had made a mistake. As stated in Moser et al's (2011) paper:

> *Current conceptualizations suggest that the ERN (error-related negativity) and the Pe (error positivity) are dissociable neural signals involved in error processing, with the former reflecting conflict between the correct and the erroneous response and the latter reflecting awareness of and attention allocation to errors (Hughes & Yeung, 2011; Nieuwenhuis, Ridderinkhof, Blom, Band, & Kok, 2001; Steinhauser & Yeung, 2010).*

The two different reactions are summarized elsewhere as:

> *"The first response indicated that something went wrong. The second reaction only came when test-takers treated the mistake as a problem that needed greater attention" (https://www.snexplores.org/article/secret-science-mistakes-boost-understanding)*

Dr Moser himself, is quoted as saying:

> *"When a participant experienced conflict between a correct response and an error, the brain was challenged," he says. "Trying to make sense of this new knowledge was a time of struggle and need for change. (https://www.snexplores.org/article/secret-science-mistakes-boost-understanding).*

The journalist also claimed that my writing about people being aware of mistakes they made, in Moser's study is inaccurate, as "the study was not about being "aware" or "unaware" of mistakes". In response to this claim I would like to share these quotes from Dr Moser's paper:

> *These results suggest that neural mechanisms indexing on-line awareness of and attention to mistakes are intimately involved in growth-minded individuals' ability to rebound from mistakes.*
>
> *Specifically, we examined the error-related negativity (ERN) and the error positivity (Pe), two widely studied ERPs elicited during error processing that relate to adaptive behavioral adjustments following mistakes. We therefore directly assessed the relationship between mind-set and the monitoring of one's own performance and immediate self-initiated reactions to mistakes.*
>
> *Our findings substantively extend this prior work by showing that a growth mind-set is associated with heightened awareness of and attention to errors.*

The following comes from an article about Dr Moser's study and a quote from Dr Moser, talking about people's attention to mistakes:

> *He also found two typical brain responses to a mistake. The first response indicated that something went wrong. The second reaction only came when test-takers treated the mistake as a problem that needed greater attention. Participants who responded to their error by giving it more consideration were able to do better on the test after making their mistake. Moser concluded that "by thinking about what we got wrong, we learn how to get it right."*
>
> (https://www.snexplores.org/article/secret-science-mistakes-boost-understanding)

Another claim of misinterpretation was that I had written that "in the Moser study there was greater brain activity and growth when people had a growth mindset," the journalist states the article was not about brain growth.

In responding to this I would like to highlight this extract from the same article:

> *The participants' brain activity rose when they made a mistake, Moser and his colleagues found. "When a participant experienced conflict between a correct response and an error, the brain was challenged," he says. "Trying to make sense of this new knowledge was a time of struggle and need for change." This is when the brain reacted most strongly.*
>
> (https://www.snexplores.org/article/secret-science-mistakes-boost-understanding)

The difference between my interpretation and Dr Moser's seems to be in the language used. I said that mistakes caused greater brain activity, while he states that times of challenge and struggle cause "brain reactions". I am, of course, totally open to changing and improving the ways I communicate about this study to make them more accurate, while still being accessible to audiences. I have now sought clarification on these different interpretations to improve communication moving forward.

My work and research are aimed at improving mathematics learning outcomes for all students. As always, I will continue to invite healthy debate of research and writing, but attacks on my scholarly integrity, intended to discredit me, are not something I will engage with. I appreciate the support of those who use our ideas and resources and know the difference they make for students.

Additional references:

LaMar, T., Leshin, M., & Boaler, J. (2020). The derailing impact of content standards–an equity focused district held back by narrow mathematics. *International Journal of Educational Research Open*, *1*, 100015.

Li, Y., & Bates, T. C. (2017). Does growth mindset improve children's IQ, educational attainment or response to setbacks? Active-control interventions and data on children's own mindsets.