61| Specific Learning Disorders – With Dr. Robin Peterson

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Speakers: Robin Peterson, John Bellone, Ryan Van Patten

Intro Music 00:00

John Bellone 00:17
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Ryan Van Patten 00:26

...and I'm Ryan Van Patten. We want to remind everyone that select NavNeuro episodes are currently available for CE credits through our partners at INS. You can find them at navneuro.com/INS.

John Bellone 00:43

For today's episode we speak with Dr. Robin Peterson about specific learning disorders, or LDs. Robin is a pediatric neuropsychologist and an assistant professor at the University of Colorado. She is also the co-author of the book "Diagnosing Learning Disorders: From Science to Practice" along with Bruce Pennington and Lauren McGrath.

Ryan Van Patten 01:04

Our conversation with Robin covers the following topics: defining learning disorders, issues around diagnosing disorders of written expression, the concept of academic *g* and its relationship to Spearman's *g*, distal and proximate causes of LDs, cognitive correlates of and risk factors for LDs, the nature of dyslexia and phonological awareness, comorbidities of specific LDs, the resource allocation hypothesis, models for diagnosing LDs, clinical diagnostic decision making in borderline cases, and finally, achievement gaps across groups.

John Bellone 01:51

There are also a few acronyms that come up in the conversation that we don't define, so I'll briefly do that here. The WIAT is the Wechsler Individual Achievement Test. The CTOPP is the Comprehensive Test of Phonological Processing. And, the TOWL is the Test of Written Language. All of these are academic achievement tests that can be useful in assessing and diagnosing LDs. And, finally, VBM refers to voxel based morphometry, which is an approach used in neuroimaging analysis. You can look up these terms on PubMed or Google Scholar for more information if you're interested, but we'll refer to them in passing in the conversation. And, with that, we give you our conversation with Dr. Robin Peterson.

Transition Music 02:40

John Bellone 02:49

We're here with Robin. Thanks for coming on NavNeuro. We're really excited to have you.

Robin Peterson 02:53
Thanks for having me. I'm delighted to be here.

John Bellone 02:55

So we're going to cover Chapters 1 through 8 of your book, if we can get to it. Kind of the big picture of specific learning disorders, or LDs. Some people use LD to mean learning disability, while others use it to mean learning disorder. Can you talk about the different terminology here and why the distinction is important?

Robin Peterson 03:16

Sure. So I think, in the sense that we use it in the book, we talk about diagnosing learning disorders and we mean that to be a broader term than what people sometimes mean by learning disability or a specific learning disability, which is meant to refer to relatively isolated difficulty acquiring certain types of academic skills. Whereas the book meant to cover a broader range of neurodevelopmental disorders that impact learning in various ways. So not just disorders of acquiring academic skills, but also broader, more severe, more pervasive disorders that impact learning. Things like intellectual disability, autism spectrum disorder, as well as ADHD, which is often thought of in a somewhat different category but based on what we're learning about the the high comorbidity between ADHD and other learning disabilities and shared etiologic and cognitive mechanisms, it seemed to make sense to discuss those together.

I think the most straightforward answer is that often the term learning disability is used to imply a relatively isolated or more specific type of difficulty than the sense in which we met learning disorders in the book. However, as I'm sure you're aware, there are certainly widely used and influential diagnostic frameworks that use the term learning disorder for what we might mean as a learning disability. Really, there's many different terms out there that are used that are often essentially interchangeable. So I don't think there's really a hard and fast or absolute difference between some of those terms.

John Bellone 05:08

Right. I wanted to ask you about the word specific and specific LDs, and how it's meant to differentiate these disorders from more general cognitive problems, such as those found in intellectual disability, for example.

Robin Peterson 05:24

Right. So I think, historically, there's been a lot of attention to the specific nature of learning disabilities. That's true in scientific literature, and certainly true culturally. We've had this sense that people who have a learning disability really probably have a very isolated problem. That goes all the way back to the first case report of developmental dyslexia, which was published in 1896, I think, in the British Medical Journal. It describes this 14-year-old who has a very striking and specific profile, where he has severe problems learning to decode and spell but he's smart and he's really good at games and most of his math skills are pretty good. That type of framework, I think, has been heavily influential in the field of learning disabilities. But what we've learned increasingly over the past decades is that there's a lot of people whose learning problems are not very specific. This started, I think, with some of the research on IQ-discrepant versus not IQ-discrepant cases. So, originally, there was a thinking that individuals who had just low but even performance across the board probably had a different kind of problem than people who had intact or high IQ and still had a reading or a math problem, let's say. But in the case of reading disability or dyslexia, that's been really thoroughly tested at this point and we've known for a long time that the distinction between IQ-discrepant dyslexia and garden variety or broader learning problems that go along with reading problems is not well-validated. We know that people who have more general problems still benefit from the same types of reading intervention and have similar underlying phonological processing problems. And I think, more and more - maybe we'll get into some of this as we go on - but I think just learning more and more that this sort of insistence on specificity in order to diagnose a learning disability is really misplaced and leads to a lot of kids perhaps being passed over for needed services on the basis of the fact that they have more widespread problems than kids who do qualify for services, which is probably not very logical.

John Bellone 07:41

Yeah, it's really helpful.

Robin Peterson 07:42

So even though the DSM and the ICD and even the legal definition in this country, they still all retain that terminology of “specific” right now in their diagnostic criteria, I would argue that we should probably be moving away from that expectation and that terminology of learning disability diagnosis.

John Bellone 08:03
If you were to give your perfect definition of what you wanted to see in the DSM, what would the one or two sentence definition be for learning disorder?

Robin Peterson 08:14
I think in moving from the DSM-IV to the DSM-5, it collapsed all of the different possible learning disabilities under a single umbrella diagnosis, which made sense in a lot of ways. I think it's based on good research showing high comorbidity among problems in reading, writing, and math. But what was lost there was the fact that learning disabilities in all of the academic study skills that are currently included in DSM-5 are not all equally well-validated.

We have the most research across levels of analysis and across more than a century really validating a learning disability in basic reading skills - so decoding, fluency - and that would be dyslexia. That also extends to problems in spelling, even though under the current DSM framework, spelling is mostly lumped under writing. I think there are many kids who have dyslexia who don't have a very specific profile, but I think we do have the best evidence for at least some cases of specificity or some degree of specificity for dyslexia. After that, probably the next best validated disorder would be in math. We know that there can be some specificity to problems in math, and also we're just starting to learn more about the etiology of learning problems in math and the underlying brain mechanisms. And then my sense is that, as I've already said, there are certainly kids who have problems in writing but many of them have dyslexia already. So whether we need a separate diagnostic category to capture those kids is questionable.

There are many kids who have widespread learning problems that impact them across the curriculum, and that would include reading, writing, and math. But it feels very counterintuitive, I think, to most clinicians and families to call that a specific learning disability. So I wonder if we could have some other kind of terminology to capture that, whether it just be “learning disability” or “generalized learning challenges” or “generalized learning disability” or something along those lines.

Ryan Van Patten 10:40
We're talking about terminology thus far in our conversation. Where we would like to go in our conversation with you today, in terms of LDs, is really to focus more on reading, writing, and math. We would love to talk about ADHD and ASD and ID as well, but because we want to be respectful of your time, we'll focus more on the traditionally defined three LDs. So based on what you just said, there are

differences in the amount of literature, the amount of empirical support for reading LDs, writing LDs, and math LDs, where the most evidence is in reading, then math, then writing. Where would you say - let's take writing for my question, do we have enough empirical support to be making diagnosis of a disorder of written expression?

Robin Peterson 11:33
Some people would disagree with this, and there are certainly people who've done a lot of research in the field of writing and writing development. But, to me, I don't think as a standalone diagnosis, a learning disability in written expression is a well-validated diagnosis. I think something like 75% of kids in the one epidemiologic study of kids had been diagnosed through their school or clinically with a disorder of written expression - at the time, it was under the DSM-IV framework - also met criteria for a reading disorder. So that does leave 25% of kids who didn't. But of course, if we think of these things, they're both continual, and the tests have some error, and nothing is perfect, right? That's a very high comorbidity rate.

I also think for all of these academic areas - so reading, writing, and math - we can think about them as encompassing both basic and complex skills. The DSM makes this distinction, too. So the basic skills are things like decoding in the case of reading, basic calculation in the case of math, and spelling or handwriting in the case of writing. Then the complex skills are higher level things that become increasingly important as you go on in school. So reading comprehension, math, problem solving, and longer written expression like sentence level, paragraph level, essay level. I think it turns out that the complex academic skills are much more difficult to measure with the type of reliability that we would need to be confident in kind of individual diagnosis. And also that the measures we have to assess those things, because they're more complex skills and lots of things go into them, they vary in the skills that they assess.

So Jan Keenan and colleagues have done great work for reading comprehension just showing that depending on what reading comprehension measure you pick, you might identify individuals as having a reading problem because some of the reading comprehension measures are actually pretty heavy decoding emphasizers, so people who have dyslexia would have a difficulty there. We are doing some work, which is currently under revision, but showing something similar for the written expression measures. So depending on which writing measure you give somebody, it might identify very different people as having a disability. Other groups have shown similar things with things like the SAT writing measures or the GRE. The group out of Florida has done some work looking at different essay level writing

measures. So there seems to be a lot of person-by-task interaction and somewhat lower reliability for those measures. For the case of writing, well, we have these basic writing skills and that's largely spelling and spelling problems already well described by a very well-validated diagnosis, which is dyslexia. Then if we want to turn to something like a learning disability in higher-level writing skills, not only is that not well-validated at the group level, but I'm not convinced that we currently have adequate measures to really assess for an individual diagnosis. It's not to say there aren't kids who don't struggle with writing for very real reasons, and that, if possible, we should be supporting them. But does that warrant a diagnosis? I'm not so sure.

Ryan Van Patten 14:59

Yeah. That's been my experience. The WIAT essay or the TOWL, these tests of writing composition are difficult to administer, painful to score. In your book, “Diagnosing Learning Disorders,” which is a great book, I noticed the correlations between different tests of writing composition are very low, in the 0.1 to 0.2 range. We would expect these tests within the same domain to correlate highly and they're not, I think speaking to the difficulty in measuring this construct of writing composition well.

Robin Peterson 15:36

Absolutely. And I should say, I think when we published the book, we were drawing from some unpublished data in the Colorado Learning Disabilities Research Center. Since then we have a larger sample and the correlation between the WIAT and the TOWL has come up some, but it's still quite low and lower than the association between two other academic measures in the battery that are not even purporting to assess the same construct. So the big picture is still the same even if the specific numbers have changed slightly.

John Bellone 16:07

What do you recommend to clinicians who have kids who come in complaining of "specific" writing-related problems?

Robin Peterson 16:18

So, I think that there are some options. So, of course, the first question is, is the problem really just specific to writing or does the child also have an underlying reading disability? And it's important to assess for that because, first of all, we have more reliable measures to assess for it, we have better validated treatments, and we know that the overlap is very high. If it's really a case, where either the reading

piece has already been addressed and the family really wants more detailed information about writing or the family's concern or school's concern is really specific to writing, I think there are some options. One option is to give a lot of different writing measures. I think the Florida group showed that you needed to give at least four measures to reach even kind of adequate reliability, and maybe six measures scored by two different raters to reach high reliability. So that's one option.

John Bellone 17:21
It's a heavy lift. [laughs]

Robin Peterson 17:22
[laughs] Exactly. For some folks in a private practice setting, it might be realistic to really do a deep dive and spend a lot of time with that, and for some families that could be helpful and meaningful. I think another option is really to rely on historical data, record review, and indication of functional impairment. Schools are doing a lot more standardized type testing. So reviewing that information, and then considering whether you have other evidence that would really explain the functional problems. I think most people who have higher-level writing problems are likely to have at least some underlying oral language vulnerabilities because it's really based in oral language skills. And so doing some good reliable measurement of vocabulary, grammar, maybe listening comprehension - that's probably also a trickier domain to assess but it can be done to some extent. And then looking at, as we've already talked about reading, probably more general cognitive ability or IQ, attention, kind of behavioral attention. So looking at those areas and seeing if there is a better validated diagnosis for which we have at least partly validated treatments that might already explain the challenges this child has.

Ryan Van Patten 18:47
Good recommendation. We've already started to wade into reading, writing, and math a little bit. Before we get into more detail, I have just a few more big picture questions relating to definitions and how we think about LDs broadly. A definition that I initially read in Jack Fletcher's LD book that I've really liked is learning disorders as “unexpected underachievement”. And I've explained it to patients ever since then. What do you think about that conceptualization?

Robin Peterson 19:17
Yeah, I think Jack is so thoughtful and has been, I think, so good for the field in getting some of these messages out. And it seems very reasonable to me. There's

always this interesting tension that, of course, as we understand things better and better - what exactly does unexpected mean, right? Well, we know the problems run in families and so if there's a long line of people who have exactly this problem, then it might feel less unexpected in some sense. But I think, certainly, that's a very reasonable definition.

Ryan Van Patten 19:55

Another big picture topic that I find interesting is thinking about psychometrics and aspects of the tests we use to measure LDs. We know that in cognitive tests, in tests of intelligence, there's a general factor, Spearman's *g*, that we can pull out of many tests of cognitive functioning and they all share variance, even tests of supposedly dissimilar or less related abilities. You discuss in your book how we can also conceptualize an academic *g*. Any two academic tests, even of ostensibly disparate abilities share some variance. Talk about academic *g*, how it relates to cognitive *g* and how it can be useful?

Robin Peterson 20:40

Absolutely. This is something that some of my colleagues and I are very interested in right now and are pursuing actively. Other research groups have looked at it as well, especially through some of the larger batteries - things like the Woodcock Johnson, there's been published work looking at it in that context. So, essentially, as you said, if you look at a correlation table of kids who've done lots and lots of academic [inaudible], ironically, the correlation between some of our writing measures is on the lower side. But, for the most part, most of the correlations are in the moderate to large range across measures of basic reading, reading comprehension, math calculation, math fluency, math problem solving, handwriting, spelling. And most are substantial.

So using a variety of analytic approaches, folks have tried to quantify this, and this notion that there's some underlying academic construct that captures variance shared to these different measures. And kind of parallel to Spearman's *g*, it's been talked about as academic *g*. There's been a lot of evidence for this across different research groups. As I mentioned, we're pursuing this now and have some work under review, in which we were also able to identify using a bi-factor modeling approach, an academic *g* factor that every single measure our battery loaded substantially on.

So what is this academic *g*? So, for us, one question is just, is it the same as Spearman's *g*? I think the answer there is pretty clear because it's emerged across,

again, several different research groups that there's a lot of overlap, but it's not identical. So I think a lot of the correlation was clustering around 0.8 in many studies. So more than half the variance in academic *g* could be explained by Spearman's *g*, but is large enough to test whether the relationship was unity, and it was not. So there's something else going on there, or some things else. And what that is, is a fascinating question. My guess is that there could be certain cognitive processes that are relatively more emphasized by some academic skills than what we tap into in a traditional IQ test. But there also could be things like the quality of schooling that you've had, or personal success factors, as my kids' school is always talking about them. So things like grit and motivation and just practice, right? Maybe things related to the family environment. And all of those things maybe matter more for these academic skills than they do for things like coding and block design or those kinds of things.

Ryan Van Patten 23:30
The presence of an academic *g* could be thought of to argue against the specificity of specific LDs, right?

Robin Peterson 23:39
Exactly.

Ryan Van Patten 23:39
Yeah. If this test of written expression, which is supposedly very different from a test of math calculation, if they are still sharing variance, all types of academic tests share some variance, then how specific are specific LDs?

Robin Peterson 23:56
Exactly. And what I find maybe most fascinating is that this lines up pretty well with what we're learning at the etiologic level, kind of the cognitive, neuropsychological level, and even to some extent, the brain level. So, at the etiologic level, there's been interest in this notion of generalist genes coming out of Pullman's group for some time. This has been tested now for academic skills in a behavioral genetics framework and finding that there are some genetic influences that seem to have pretty strong effects on reading comprehension and math and reading decoding that are shared. They're also generalist environmental influences on those things. It's not all of the genetic influence. Especially something like decoding seems to have some of its own separate genetic influence, but there are certainly shared genetic and environmental influences that relate to all of those outcomes.

And then, at the cognitive level, we've learned that things like processing speed and oral language are strongly related to multiple different outcomes and probably help account for the comorbidity among academic disorders. At the brain level, first of all, I think we've moved away from the notion that there's any one sort of specific region implicated in dyslexia or math disorder. We know these are pretty wide scale distributed networks. There's not been as much neuroimaging work really specifically looking at accounting for comorbidities among developmental disorders, but there's some that's emerging that is really showing it looks like pretty common brain activation patterns in dyslexia and dyscalculia or math disability. So, to me, that all lines up really well with this notion of an academic *g*. And that just highlights this fact that we shouldn't be requiring specificity in a profile in order to identify kids who are in need of supports at school.

John Bellone 25:59

In your book, you made an important distinction between etiology and brain mechanisms. The etiology you referred to as the distal causes of individual differences, and that the brain mechanisms are more of the proximal causes. So if there's an arrow, it goes etiology, brain mechanisms, behavior.

Robin Peterson 26:22

Right.

John Bellone 26:23

Can you elaborate on that a little bit?

Robin Peterson 26:25

I think sometimes that term, "etiology," gets used in different ways in different settings. But I think the level of analysis framework for understanding really any developmental disorder or developmental phenomenon that I was trained in, is a very, very powerful framework that uses that term etiology to really talk about root causes or ultimate causes or distal causes. Essentially, by that we just mean genetic and environmental risk and protective factors that influence development. Since we're interested in thinking and behavior, really, it's brain development that we are most interested in in that sense. So differences in genes and environmental experiences from the get go have an impact on how the brain develops, and then that in turn, produces differences in - well, neuropsychology would probably be the intervening level there. So we have these hypothesized constructs that we can't directly observe, but we think are really important for thinking and behavior. And then ultimately, we have the behavioral level or the symptom level.

Of course, it's not a neat one-to-one mapping. It doesn't just go from etiology to brain to neuropsychology to behavior, because there's feedback at every level in the system. And we know that people select their environments, right? So you end up having these evocative effects that can, depending on what environment you choose to be in, that, in turn, can further influence your brain development, and so on. So it's very complex. But the idea is that, to have a really complete understanding of any disorder or phenomenon, we really need to understand it across all of those levels of analysis, and no one level is more important than another or has primacy. So even if we had a complete listing of every gene, every specific genetic variant that influenced reading and every environmental risk or protective factor, we still would want to understand what was happening at the brain level, the neuropsychology level, the symptom level.

John Bellone 28:35

Yeah, of course. There was another interesting concept that I wanted to ask you about. You wrote in the book that the word "learning" has a couple different meanings. There's learning in early development and then later learning of academic skills. And so I'm curious how the implicit learning and memory is important in early development and how that relates to specific LDs.

Robin Peterson 29:00

Yeah, and I actually find this interesting to think about. [It's] even something that comes up a lot in clinical work and training because as neuropsychologists we're giving all these tests, and they all have names, and there's things that we say we're assessing, right? So we give things like a list learning task, and we say, "This is our measure of learning and memory." And then we give [a] word reading [task], and we say, "This is our academic measure." And, the kid gets a [score of] 10 and 10, on list immediate and list delayed, and we say their learning is great but their reading is terrible and they have a learning disability. So I think this is just a very confusing message that we are often giving to families.

So, I don't know that I have a great straightforward answer to your question except to say that we know that some of the same processes that guide acquiring knowledge from the very beginning of life in the long run are going to be important for acquisition of academic skills. But the academic skills are, of course, for the most part a relatively recent cultural invention. So this interesting thing that has happened, which is that maybe in some other environments or some circumstances, some of the types of learning challenges that lead to very significant

academic skill problems might not otherwise cause a whole lot of functional impairment for kids. But in the current academic technological society that we live in, if you don't readily acquire things like reading and written calculation, those sorts of things could cause much more substantive difficulties for you.

John Bellone 30:41

If those procedural sorts of abilities, implicit abilities, aren't there early on, it's going to have a domino effect. And, later on, where you're trying to learn the academic skills that's going to be affected because those early abilities were developed. Am I getting that right?

Robin Peterson 30:57

I think so. Yeah. And, of course, if somebody has a really profound impairment in some of those implicit procedural learning skills, we would likely see much more widespread developmental problems than we typically see in the case of a learning disability. But I think a hypothesis [that] is being pursued in some circles is that we might be able to identify some - again, it's all relative, right? - but relatively specific or isolated types of implicit learning challenges that could predict some of these downstream academic difficulties.

Ryan Van Patten 31:33

I like the analogy from an evolutionary standpoint of academic skills as aftermarket add ons. Human beings [didn't] always need these skills, it's relatively recent in the grand scheme of things. And, thus, they may be a bit more vulnerable to troubles with certain types of learning.

Robin Peterson 31:54

Exactly. I know there's been some debate about this, but thinking of reading in particular, just because of how recent a cultural invention written language is, there probably wasn't selection pressure on that, whereas basic math probably mattered for even some earlier societies. And so, that might be one explanation for why we sometimes do see this somewhat more specific profile for dyslexia.

Ryan Van Patten 32:22

You had mentioned the importance of neuropsychological constructs, I'd like to move into that area. I'm thinking about cognitive risk factors for reading disabilities, which include letter knowledge, phoneme awareness, processing speed. Talk about these abilities. How are they related to the expressed impairments in reading LDs?

Robin Peterson 32:46

One thing that I think is really fascinating about dyslexia is that the best predictors do change with development. Scarborough's work going back to the 90s showed that you could find precursors in oral language for dyslexia in kids as young as toddlers, but they weren't necessarily the same problems that you would find in a 5-year-old or an older child. The early predictors are mostly oral language predictors. So things like vocabulary knowledge, later grammar, speech articulation. The big predictors that you mentioned really have their most power starting around [the] kindergarten level. So by age 5, across languages and countries, we do know that phonological awareness, rapid naming and other measures of speed, speeded tasks, and for alphabetic languages, letter knowledge are the strongest predictors. Of course, the speeded tasks are stronger predictors of reading fluency than untimed reading, but they also do predict even accuracy. What we've learned about processing speed is that it is highly correlated with rapid naming, I think it's around 0.7. But at least in the work that I've been a part of in the Colorado Learning Disabilities Research Center, we did find that the non-rapid naming processing speed seems to be a better predictor of the overlap between say, reading disability and ADHD or even math disability and ADHD. So it seems to account for comorbidity in a way that is powerful and important.

Ryan Van Patten 34:34

Processing speed is such a diffuse skill, right? The white matter integrity can affect many things, but it's helpful to know that at least to a small extent, we can differentiate different types of processing speed where rapid naming is more directly related to reading LDs.

Robin Peterson 34:49

Right, which makes sense because it requires processing of print in a more direct way. So sort of a microcosm of the reading task in some sense.

Ryan Van Patten 34:58

Before we move away from dyslexia for a moment, I'd like to hear your thoughts on this myth that dyslexia is a visual disorder that leads someone to read letters backwards. I've heard this all my life, and I don't know where it comes from. [laughs]

Robin Peterson 35:14

I think it goes all the way back to Samuel Orton in the first part of the 20th century. That was at one point a scientific hypothesis to explain dyslexia. But what's been

fascinating is just that it has lived on so strongly in the cultural understanding and has been hard to get rid of. There's work going back to the 1970s trying to rigorously test this. So Vellutino published some work. There is a higher rate of reversal errors in people with dyslexia. But reversal errors are something that happen in normal development as well, they just drop off over time. And so Vellutino compared reversal errors in one's own language versus in learning a new kind of written system. What he found was that the increased rate of reversal errors in dyslexia was restricted to processing print in your own language. So it suggests that it's really not a visual problem, but it has more to do with making that mapping between oral language and sound. I do think it's important to dispel that myth clinically when meeting with families, and just to explain that this is not a visual disorder, it's not about seeing things backwards. It does seem to relate to how we make those links between print and language and so we might sometimes see those types of errors, but we don't need visual treatments for this for the disorder. We need reading treatments.

John Bellone 36:49
At least that's less egregious than the myth that we only use 10% of our brain. [laughs]

Robin Peterson 36:54
Yeah, yeah. [laughs]

Ryan Van Patten 36:55
So many myths. [laughs]

Robin Peterson 36:57
So many myths. Yes.

John Bellone 36:59
You mentioned phonological awareness. I wanted to quickly define that concept. My understanding is that it's an awareness of the sound structure of words. Can you hear, identify, and manipulate the sounds of a language? Is that right?

Robin Peterson 37:12
Exactly, exactly. It's an oral language and metalinguistic skill. It has to do with awareness of the sounds in language. For phonological awareness, that's a more generic term that could be anything about the sound structure of language. There is

a developmental progression in which kids start out with some level of awareness of the sound structure of language and it gradually gets fine tuned to the point where they can pay attention to individual speech sounds or phonemes. So phoneme awareness really is the ability to pay attention to and manipulate those individual speech sounds. That is really what is most closely related to dyslexia, reading and spelling development. So, a preschool level phonological awareness task could be rhyme awareness - you know, bat-cat-mat. That's a pretty big chunk of a word, and then later being able to narrow down to the individual speech sounds. If you think about some of the commercially available phonological awareness tests, a lot of them start with those bigger chunks or bigger grain size, and then as items get more difficult it zeroes in on the individual phoneme.

Ryan Van Patten 38:27
The CTOPP, right?

Robin Peterson 38:29
Yeah, exactly. Like Elision on the CTOPP. One thing that's really fascinating about phoneme awareness is that because we all are fluent readers and writers of an alphabetic script, we have this very strong sense that those individual phonemes are out there. That they exist in the speech stream in this very objective way and, of course, every healthy adult would be aware of them. But that turns out not to be the case. If you look at developmentally normal adults who are illiterate just because they were never taught to read, by and large they don't have good awareness at the level of the individual phoneme. And same thing in adults who read more like logographic scripts. Their individual phoneme awareness is reduced compared to folks who use an alphabetic script. But then if you take, again, in the case of what we call “natural illiterates” and start training them to read, they very quickly move to having individual phonemic awareness. The point there is that there's a reciprocal relationship between reading and phoneme awareness. We often think of phonemic awareness just as a predictor, something that's important to measure in 5- and 6-year-olds to know what their risk for dyslexia is. But as they become better readers, that's also, in turn, going to influence their phoneme awareness.

Ryan Van Patten 39:51
Fascinating.

John Bellone 39:52
We talked about the cognitive underpinnings of reading disorder, do we have a sense at the neuropsychological level regarding math and writing LDs?

Robin Peterson 40:02

For math, there is a good amount of work on that. There are some predictors that are relatively specific to math. Things like number sense, which is like your letter knowledge for reading - so that basic building block of math skill. There's some experimental measures, at least, that try to get that. And then I think fine motor skill, and even like finger-nosis turned out to be good predictors of later math ability, which is interesting how important those fingers are in learning that basic addition and arithmetic. But, beyond that, the listing of cognitive underpinnings for math is largely a listing of what we would think of as pretty general skills and looks a lot like the different domains that's tapped by an IQ test, per se. So oral language, including general verbal comprehension. There's even some evidence for a link between phonological awareness and math. Fluid reasoning or nonverbal problem solving. Working memory seems important to math outcomes. Processing speed. So a lot of what I would think of as more general or generic cognitive risk factors.

John Bellone 41:20

Yeah, not so specific in terms of the specific disabilities, like we talked about before.

Ryan Van Patten 41:25

People may not appreciate particularly the language contributions to math because many people think that about those as separate.

Robin Peterson 41:31

Exactly right. I think there's this sense that math is the visual-spatial or the nonverbal skill. But actually, I think there's more research highlighting the importance of oral language skills to math outcomes. We also think that probably helps explain the comorbidity between math problems and other academic skill problems.

John Bellone 41:51

Earlier we talked about the shared influence among different disorders. Given the shared etiology and cognitive risk factors between the different LDs, comorbidity is to be expected. It's the rule more than the exception. Can you talk us through the common comorbidities that come along with disorders of reading, writing, and math?

Robin Peterson 42:13
Sure. Yeah. So, well, I think as we've already talked about, first of all, problems across academic skills are very commonly comorbid. So that is always a really good thing to be thinking about. And, as I've argued, in some cases so much so that it's not even clear we should be having distinct diagnoses. After that, I think the most important or most common comorbidities to be tuned into are with ADHD, as we've already talked about. We think that the comorbidity between reading disabilities and ADHD is probably around 25%. There's less work on math and writing, but we would expect, certainly based on what we know, we think the comorbidity is higher than would be expected by chance.

Speech and language disorders are certainly comorbid with academic learning disorders. That's, again, best understood or best characterized in the case of reading, but it's probably true across the board. The data there look like it's probably a language impairment that carries the biggest risk. So if kids have an isolated speech sound disorder, where they have trouble pronouncing some words, they are at increased risk for later reading problems. But the risk is not that elevated unless they also have broader oral language problems in things like vocabulary and grammar.

There is an overlap between academic difficulties and internalized emotional concerns. In contrast to the overlap between dyslexia and ADHD, which we know very well now as a primary comorbidity and related to share the underlying etiologic and neuropsychological risk factors, I think that's less well established for the case of internalizing concerns. But there's at least some thinking that some of it might be more secondary. So [it] may be the case that because somebody is having difficulties in school that leads to downstream challenges with self esteem or anxiety or those kinds of things.

Ryan Van Patten 44:20
You mentioned the comorbidity between reading LD and ADHD, specifically inattentive ADHD. So this is the most well-researched of all pairs of neurodevelopmental disorders. We could use it as a model to understand comorbidity more broadly. Because they're both so common and they commonly occur, it's useful in its own right because people are relatively likely to see a child with both inattentive ADHD and a reading LD. You started speaking to this, you alluded to it. Talk a little bit more about what underlies the comorbidity cognitively. For example, you referenced processing speed. What are some of the other genetic, brain-related, and cognitive underpinnings?

Robin Peterson 45:05
So at the cognitive level the best support [is] for processing speed. At a genetic level, there's been behavioral genetics work just showing that there are shared genetic influences on these two outcomes. They seem to also be shared with processing speed. So that story makes sense. But there's no molecular findings yet being able to say it's these specific genes. So the field is at a relatively early phase in terms of identifying specific genetic variance that are influencing reading outcomes or attention outcomes. So I don't believe, last I looked, we're there for the comorbidity at this point.

As far as brain level, that's also at an early phase. Certainly a reasonable place to look would seem to be white matter pathways based on the processing speed. I think there's been - my colleague, Lauren McGrath, I know has been involved in some work on this, at a VBM level. I think she did identify some regions in basal ganglia, if I recall correctly. I would point you to that work. But I think that's at a very early stage of development as well.

I think, clinically, the important thing for people to remember is that you can have both. I think sometimes clinicians might spin a story that, well, this is all attributable to ADHD, or they're making some reading errors, but they look inattentive or something like that. And I just think it's important to remember that this is a true primary comorbidity and it's continuous. So, you might have very full blown, clear cut ADHD and then you might have a more subtle manifestation of the reading challenge, but it doesn't mean that it's not real or it shouldn't be identified or pointed out as such.

John Bellone 46:59

I was going to ask you about the clinical implications, [and] you beat me to it. [laughs] So. And so, yeah. So it might be tempting to say that ADHD caused the reading disability, let's say, but you don't necessarily know that.

Robin Peterson 47:16

I worked as a teacher before I went back to school to become a neuropsychologist and that was my gut feeling about this. Just talking to a lot of people over the years, I think it makes sense. It's very common that sometimes it just feels less clear cut or less parsimonious to say, "Well, this person has two different problems." And so if we know they have an attention problem, we might just assume, "Of course they would have a reading problem because they're not paying attention to the lessons." Or, "If they have a reading problem, of course they're going to look inattentive in

class and that's why it looks like they have ADHD, but they really don't." There could certainly be individual children for whom that is playing a role or as part of their overall story. But, at the group level, this has now been very well worked up. And, as we've talked about, over and over again, we know that there are shared underlying genetic factors that influence both outcomes. We know that even in kids who are at family risk for reading problems, even before they get to having a full blown reading disability, they're also more likely to show some of these symptoms of ADHD. So we think it's real, it's based on genetic and brain factors, and that if both problems are present, it's usually helpful to identify both of them in order to guide treatment.

John Bellone 48:35

The other big takeaway that I pulled from this high comorbidity between reading disorders and ADHD is that if you assess for one you should assess for the other because it's a much higher probability. And the other one is that interdisciplinary collaboration is really key here, because you're working with disparate problems, potentially.

Robin Peterson 48:54

Absolutely. Absolutely. Right. And at the basic science level some of the people who are exploring these questions are different, but then also at the individual clinical level, some of the treatments would be coming from very different kinds of professionals. So those are excellent points.

Ryan Van Patten 49:12

Also clinically relevant to the overlap between reading disorders and inattentive ADHD would be that if we label the reading LD as secondary to ADHD, we may be preventing our patient from getting services that they otherwise could benefit from. Because the assumption would be, “Well, the secondary disorder will just remit if I treat the primary disorder.” So there could be reading LD specific interventions that would benefit the child that they would not get if we say, "Oh, it's just secondary to ADHD."

Robin Peterson 49:50

Exactly. That's a great example that you picked because not only do we now know a lot about how to treat reading problems, but we also know that treating them earlier works better than waiting until the problems have had more time to accrue. That's probably partly because one way you get better at reading is by reading a lot. And kids who have a reading problem, read a lot more slowly. So they just get

less experience with print even aside from the fact that they're selecting reading for themselves a lot less. So it can become very difficult to close that gap, especially in reading fluency as more and more time goes by. So certainly in the case of a comorbid diagnosis, but really anytime that there is some kind of early concern about reading, whether or not the child would meet full criteria for a disability at that point, I think it's it's usually indicated to be pushing for at least increase evidence based literacy instruction and practice, just because it works well at that early time.

Ryan Van Patten 50:55

Earlier in our conversation you had mentioned - this is with respect to reading, writing, and math abilities - you had mentioned a distinction between basic low level abilities such as word level reading, calculation, and handwriting and spelling, compared to complex academic skills, such as comprehension, math problem solving and writing composition. I think that distinction seems to be well supported and really important. With that in mind, tell us about the resource allocation hypothesis and how it's relevant.

Robin Peterson 51:29

Sure. I hope I don't butcher this too badly. But, the way I think about it is that for most kinds of cognitive skills or cognitive tasks, we don't have infinite resources. So they have to be allocated and used in different ways. Let's take the case of reading comprehension. The simple view of reading, which is now very well-supported, tells us that reading comprehension is based mainly on two things - decoding and your oral language comprehension. So you've got to turn the print on the page into words, and then you have to comprehend those words. So relatively early on in the process, the developmental course of reading comprehension, decoding is still very difficult and effortful, and requires a lot of those more generic cognitive resources thereby leaving fewer of them available for listening comprehension. So that decoding early on sets up a bottleneck. But as the decoding becomes more automatic, then that frees up some of those more general cognitive resources to devote to oral language comprehension. This is best studied and established for the case of reading comprehension, but there are certainly theoretical reasons to expect that something similar would be the case for other higher level academic skills, including math problem solving and written expression.

Ryan Van Patten 53:04

So if I have trouble with basic, low level abilities, I have trouble with a word level reading deficit, even if I am great at comprehending what I read, I will be constrained by the fact that I'm spending all of my attentional resources on the

basic building block and so I don't have so much to devote to comprehension. Is that accurate?

Robin Peterson 53:28

Exactly, exactly. And we can see this for a few different reasons. We could see it for the case of a disability or disorder, just individual differences as you're alluding to. So somebody who has a reading disability might have a downstream problem in reading comprehension, even if their oral language comprehension is good. We also see it in the course of normal development. So, 1st graders, their listening comprehension or oral language skills are pretty well developed by age 6 or 7. A normal healthy 1st grader can't read and comprehend anywhere near the level of what they could understand if you just spoke to them orally. We could also see it in the case of reading because of differences across language systems. So some written systems or orthography are easier to learn to decode than others. English is somewhat more challenging than many alphabetic scripts because the mappings between letters and sounds are more complex. So it's not just that they are worse or as some people think, but in English we preserve meaning in our spellings over sound. So, the morphological level is more important. Whereas in languages like Spanish or Italian or Finnish, the mappings between individual letters and individual sounds are very consistent. And so kids reach the ceiling on decoding in those consistent languages very quickly, like within the first year almost of formal literacy instruction they're very effective decoders. And so by 2nd grade, there's been good work showing that already at that point, individual differences in oral language comprehension matter a lot for reading comprehension. Whereas that is actually less the case in English. It takes longer in English, for most kids' decoding to get good enough for that oral language comprehension to really matter.

John Bellone 55:24

And for English second language learners - some of my friends, they lament that it's so hard to read in English. The different words have different ways you pronounce them…

Robin Peterson 55:37

Exactly.

John Bellone 55:38

So I'm assuming that parsing out this difference between simple and complex forms of disorder, that this maybe makes a difference in terms of the treatments? The interventions that would be pursued?

Robin Peterson 55:51

Yes. I think, hopefully, this will continue to be kind of more and more the case as the field goes on. As we probably alluded to, I think, from an evidence-based treatment standpoint, the field is farthest along for dyslexia. There's definitely been growth in terms of math. But I think we're at a pretty early state with how we really remediate reading comprehension problems, for example. There's some work on it, but we will need more going forwards.

Ryan Van Patten 56:27

Yeah. Taking a sidestep briefly, in today's world of typing on laptops and spell check, do handwriting and spelling problems typically lead to functional deficits? Is this something we need to assess for?

Robin Peterson 56:43

That's a good question. I don't think we have great standardized measures of handwriting. So, personally, I will often look at that qualitatively just as another kind of interesting information about how the child is functioning in the world. But I don't know that we have great data on long term functional problems associated with weak handwriting, as you said, given that there's very easy work around since kids are learning to type. Spelling problems are a little bit different because they're so integrally connected to dyslexia. And we do know that there's long term functional impairment that comes out of that. And, at least in English, spelling is one of the more sensitive measures. So I typically do. If there's a question of dyslexia, as part of the evaluation, spelling is easy to assess. I think it's a reliable test, and it's pretty sensitive. So I typically would include that.

Ryan Van Patten 57:41

That makes sense. I like to talk for just a few minutes about different models for diagnosing LDs. So I'd like you to compare and contrast for us the more traditional IQ-achievement discrepancy model, the response to intervention or RTI model, the simple low achievement model, and the patterns of strengths and weaknesses model.

Robin Peterson 58:05

Sure. So, I think, all current definitions really center around having weak academic skills in a given domain in the absence of some exclusionary conditions. So typically, like severe environmental deprivation or never having had access to education, blindness, or deafness, a much more severe developmental disorder like intellectual disability, or not being proficient in the language of instruction, those

kinds of things. So we kind of take that as our base and then think about the different models that you suggested. Those are really all low achievement models in some sense. So the older IQ-discrepancy model, just additionally required that there be a pretty severe mismatch between the child's IQ and their achievement. So if their reading scores, let's take the case of reading, were in the 70s but their IQ was also in the 70s, then according to that old IQ-discrepancy model, you didn't actually have a learning disability, you just had a garden variety reading problem. But as we've already talked about, that distinction turned out not to be well validated and IQ and achievement are correlated, as we already talked about. The overlap between cognitive *g* and academic *g* is probably in the 0.8 range. So it doesn't make a lot of sense to insist on that kind of discrepancy. So I think after decades of work, there's now pretty good consensus in the field that we should be moving away from requiring an IQ-discrepancy.

To me, where that gets interesting is, well, is it ever okay to use an IQ-discrepancy as part of your diagnosis? So this comes up in the case of a very bright, exceptionally high IQ score. If that person's reading is still within normal limits for their age, but well below what you might predict for their IQ, would it be appropriate to render a diagnosis in that case? And my own view on this is, yes, it can be appropriate. And the reason for that is that there's a lot of research that would suggest, again, that it's probably a genetically influenced problem. Macko's (?) group has looked at brain bases of high IQ poorer than expected reading and found a lot of overlap with what we think of as the typical kind of neural signature for true dyslexia. So, to me, even if the person's reading isn't way below age expectations, if it is way below IQ expectations and there's evidence of functional impairment, I think it is reasonable and often very clinically helpful to provide a diagnosis. But you have to be clear about what that means and doesn't mean. So it doesn't necessarily mean that you qualify for accommodations on the SAT or ACT or something like that. It's a way of understanding this person's challenges and perhaps of guiding intervention.

And then you also asked about RTI, and patterns of strengths and weaknesses. So the RTI framework essentially is arguing that we have to have this base of providing all children with evidence based academic instruction. Then we should be monitoring everybody and if we find kids are falling behind or not making expected progress, we don't necessarily need to jump to intensive testing and diagnosis right away. But instead, we could just increase the level of support that we're giving them and wait to see who doesn't improve with that slightly higher level of support. So we go through a few iterations of this type of process starting with empowering classroom teachers to give higher support, and then maybe another person within

the school system before really going to a higher, resource intensive specialist and diagnosis.

I think there are a lot of things to like about the RTI model. It is explicitly recognized by the legal definition in this country as one of the ways that kids can be identified for special education. I like that evidence on supporting everybody. I like the evidence on early intervention. And I like the fact that we're not requiring diagnosis in order to provide more intensive supports just based on the reasons we discussed earlier. But I think the RTI model is not without complications, at least from what I've seen in practice. Sometimes it does lead to support being delayed, kids not getting the appropriately intensive supports in time, even though it's not supposed to do that. The other issue is that this type of monitoring by classroom teachers is well suited probably to most early academic skills, but they're probably not in as good of a position - and I say this as somebody who was a classroom teacher and has tremendous respect for what they do every day - not in as necessarily a good position to be screening for things like intellectual disability, or autism, or even ADHD. So I think we need with RTI to be thinking about how we would capture other potential more severe diagnoses or comorbidities.

John Bellone 58:05
[inaudible]

Robin Peterson 1:03:33
I could mention PSW briefly. If you want.

Ryan Van Patten 1:03:34
Please.

Robin Peterson 1:03:34
Yeah, I know, it's a lot. Okay. So on the PSW. This, interestingly, is also recognized by federal law currently as an acceptable way of identifying kids for special education. The idea here is that we can find patterns of strengths and weaknesses either within their academic profile or within their cognitive profile. So, you know, worse math than reading [skills] and we might say, that's a math disability. Or poor working memory and visual spatial skills as evidence of having a risk for a math problem, for example. There's a lot of problems with PSW and it's really not well validated. I think the research, again, this coming largely out of Jack Fletcher's group in Texas [and] others as well showing, first of all, that most kids who have clinically significant academic problems don't meet PSW criteria and that these

categories are unstable. So very small changes in your diagnostic criteria result in really dramatic shifts in who gets identified and who doesn't. So, I don't think PSW is the way that we should be going as psychologists for diagnosing learning disabilities.

John Bellone 1:04:51

Thanks for talking through all those. I know it was a lot of information, those models, to compare and contrast them. In terms of gray area, diagnostic cases where a child might fall near a diagnostic threshold, reasonable clinicians could potentially disagree on what to call it. I know you advocate for considering the functions of a diagnosis and using this to guide the ultimate clinical decision. You have a great example in your book about this. Can you talk us through your thought process here?

Robin Peterson 1:05:21

Yeah, I'm glad that you raised this issue. I think this is, in some ways, one of the most challenging and most important kinds of issues that comes up when we're dealing with individual diagnosis. I thought about this a lot over the years. I think, just as humans, we like to think categorically. Here we are trying to impose these categories on something that is in nature an underlying continuum. So I've been in many heated discussions over the years, you know, group discussions about whether somebody does or doesn't have a learning disability. I think almost every time, it boils down to either this issue of severity - is the problem severe enough - or sometimes specificity, and we've talked a lot about specificity already. So, for me, I think as uncomfortable as it can be just finding ways for clinicians to really internalize this idea that you don't have to make a hard black and white call in every single case, and finding ways to communicate that to families and schools. It's going to be an easier message for some audiences to hear than others, so knowing your audience is important.

I think metaphors can be helpful. I rely on the high blood pressure metaphor a lot. So we know that blood pressure is really continuous. There is a certain point at which if you're over a certain number, your PCP might say, "You have hypertension and I recommend you take this medication." Well, hopefully, if you have a good PCP, if your score is one number below, they're not going to say, "You've got a clean bill of health, don't worry about it," right? So we need to be doing something similar, which is finding ways to have conversations to say, "You know, these reading skills are falling in a concerning range.” Or, “I'm seeing some weaknesses here. This is similar to what we see in children with dyslexia, although her problems

are maybe not quite as severe as we typically see. Regardless, I think we need to monitor it, or some extra practice would be helpful. And let's have her come back in six months or a year and measure her progress, and see how things are going at that point." Whereas sometimes people feel the need to say, "Oh no, she doesn't have dyslexia. I have to rule that out because it doesn't meet criteria." And then that leaves the family with this feeling of, “We don't know what it is. What else could it be? Is it a visual problem? Is it…” right?

John Bellone 1:07:50
There's a confidence interval around every decision we make, and we need to be mindful of that.

Robin Peterson 1:07:57
Exactly.

Ryan Van Patten 1:07:58

Yeah. I like the example language you provide in the book for what we might include in our reports, when a child has a weakness in an area, say reading, but it doesn't quite meet that threshold for a diagnosis. You're talking through it now. I think we should be empowered to do that when it's appropriate and not feel pressured to fall on one side of a line or the other.

Robin Peterson 1:08:20

Thank you. I'm glad that was useful. And, yeah, I think especially given what we talked about before that we know early intervention is so helpful and powerful. So the consequences of saying, "No, we're gonna rule this out," could be significant.

John Bellone 1:08:36

Right. We're nearing the end of our time with you, I want to maybe ask about achievement gaps a little bit. Can you tell us what that term means and what the scientific literature says? How might we address that issue?

Robin Peterson 1:08:51

Sure. That's a huge issue, and probably a whole podcast topic by itself. And right, [there’s] probably better people than me to talk about it. But I think the idea here is that while most of the book was focused on individual differences, we also know that there are group differences in academic skills. We know that members of certain groups are at higher risk for having academic problems. So for example,

children who come from lower socioeconomic status homes - you can read the nation's report card that comes out every few years, and you'll see children who qualify for free and reduced lunch have, on average, lower scores across the board than children who don't. So I think the point of discussing that in the book was just to try to highlight, certainly, how important this is from a public health standpoint and to be thinking about how we can be supporting the development of all children. And what's interesting is that in some ways, it's not surprising that there would be these gaps because there are true environmental etiologic risk factors that would lead to difficulties for kids who fall into those categories. At the individual level, being a member of any kind of at risk group has a relatively small effect. So in every group, there are kids achieving at every level. But it is something certainly to be paying attention to as a potential risk factor when we're evaluating kids.

Ryan Van Patten 1:10:31
It's been a great discussion, Robin. I'm really glad that we've been able to cover LDs with you. So thank you for the time. Before we let you go, we do have two bonus questions for you. So these are not specific to LDs or necessarily pediatric neuropsych, they're about the field of neuropsychology more broadly. If you could improve one thing about the field, what would it be?

Robin Peterson 1:10:56
Hmm. That's a great question. I think I had a little warning that this question was coming, but I'm still not sure I have a great answer.

Ryan Van Patten 1:11:06
[laughs]

Robin Peterson 1:11:06
So let me think about that. I'll see if something really insightful comes to me in the next few minutes. What was your other bonus question?

John Bellone 1:11:13
What's one bit of advice you wish someone told you when you were training, or maybe someone did tell you that really made a difference? Just an actionable step that trainees can take, [that] they might not have thought about doing that can improve their training.

Robin Peterson 1:11:26

Okay. Well, the first thing comes to mind here, and I don't know if this is an actionable step or not, but I think it was for me, so hopefully it will be for other people - which is, you know, I was someone, just to give a little background, I went into neuropsychology knowing that that was really the specific subfield of clinical psychology that I wanted to specialize in. So I worked as a teacher, I got really interested in learning disabilities through that pathway. I consulted with some clinical neuropsychologists, I just thought what they did was super cool. And so I went off and applied to grad school, and then sort of halfway through grad school interviews, it kind of dawned on me, like, "Oh, I'm going to have to learn how to do psychotherapy as well. This is going to be part of this package." [laughs] So I know that's different from some people's paths, but that was my path. And relatively late in my training, a piece of advice that I got that was really influential and powerful for me was to remember that every good clinical neuropsychologist is a clinical psychologist first. I think the further I go in my career, the more and more I rely on things like good interviewing skills and the softer side and people skills and feedback. And I just am so convinced that that is probably some of the most important and powerful things that we can do. So certainly being a master of psychometrics and test interpretation is great, and brain behavior relationships and all of those things are great and important. But I would just say to be spending at least equal time and energy really developing some of your basic clinical skills will take you far.

John Bellone 1:13:05

I like that. Yeah, a lot of neuropsychologists think that they don't do psychotherapy, so why do we really need that training? But every part of our evaluation involves some sort of psychological background that we really need and it's useful to us - the interview all the way through the feedback session.

Ryan Van Patten 1:13:23

Did you ever consider a school psychology or an EdD? Or were you always from early on convinced about neuropsych?

Robin Peterson 1:13:30

I never did. I thought about speech language pathology, actually. But I think that I - I'm so glad that I worked in schools. I think that was such a rich experience, and it influences me kind of all the time. But I think after being in schools for several years, I was ready for a different type of environment. So that was probably part of why I didn't look at school psych.

Ryan Van Patten 1:13:58
Yeah. I hear you.

John Bellone 1:13:59
Do you want to give another shot at the first question? [laughs] It doesn't have to be earth shattering.

Robin Peterson 1:14:03
Maybe I'll pass on that one.

John Bellone 1:14:05
Sure. That's fine.

Robin Peterson 1:14:06
Is that okay?

Ryan Van Patten 1:14:08
Yeah, of course. Thank you so much for your time, Robin.

Robin Peterson 1:14:12
Yeah. Thank you. I really appreciate the opportunity.

Ryan Van Patten 1:14:15
We truly love your book very much. It's very helpful. So we'll link to it on the website.

Robin Peterson 1:14:21
Thank you. And I have listened to some of the episodes and really enjoyed them. I should have some time to listen to more. But I think this is a great service to the field that you guys are doing.

Ryan Van Patten 1:14:29
Thank you so much.

John Bellone 1:14:30
That's nice for you to say. All right. Take care.

Robin Peterson 1:14:32
Okay, take care.

Transition Music 1:14:33

John Bellone 1:14:37
Well, that does it for our conversation with Robin. Be on the lookout for upcoming episodes on multiple sclerosis, the effects of obstructive sleep apnea on cognition, rare pediatric disorders, SuperAging, and many other topics. And, as always, thanks so much for listening, and join us next time as we continue to navigate the brain and behavior.

Exit Music 1:14:59

John Bellone 1:15:23
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Ryan Van Patten 1:15:34
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