Dr. Katie Linder:

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Mary Ellen:

I am your guest host, Dr. Mary Ellen Dello Stritto. I'm pleased to bring you another episode in our periodic series focusing on quantitative methodology and statistics. On this episode, I am joined by Dr. Kathleen Preston. Dr. Preston is an associate professor in the department of psychology at California State University, Fullerton, where she teaches several statistics courses including introductory, advanced and multi-variate statistics, as well as psychometrics and structural equation modeling.

Mary Ellen:

She earned her PhD in 2011 in quantitative psychology from UCLA. Her research interests are in using item response theory, specifically the nominal response model to develop and refine psychological measurement tools. Dr. Preston is co-director of the Fullerton Longitudinal Study where she applies advanced statistical techniques to long-term longitudinal data. Dr. Preston is considered an expert in statistical analysis using our programming and she has recently published a textbook on analyzing multi-variate statistics using R. She has given numerous invited statistical presentations and workshops at national and regional conferences, universities and federal government agencies. So thank you for joining me today, Kathleen.

Kathleen:

Of course. I'm looking forward to talking with you about my research interests and experiences.

Mary Ellen:

Let's start with your doctorate, which is in psychometrics and quantitative psychology. Could you define psychometrics for our listeners?

Kathleen:

Sure. So psychometrics technically is the field of study that is concerned with the theory and technique of all psychological measurements. So this would include the measurement of knowledge or abilities, attitudes, any sort of personality traits. It's primarily concerned with the study of differences between individuals because we're looking at through the lens of psychological research.

Kathleen:

Some examples of using psychometrics would refer to, for instance, like the design or interpretation of tests that measure those types of psychological constructs such as ability or personality. And we see these tests designed for mental health, educational, and even employment settings. In my research, I have used modern psychometric techniques such as item response theory, which I think we'll be discussing a little bit later on in this segment to design or construct assessments measuring... I've used this to construct measurements assessing prejudice against those who speak accented English, positive family relationships from childhood all the way through adolescence.

Kathleen:

More recently, I've been using psychometrics to construct scales measuring perceptions of personal success in adulthood, as well as happiness. Without just constructing the measures, we can also interpret preexisting measures with psychometrics. So for instance, I've utilized this same modern psychological technique to make in-depth psychometric evaluations of the functioning of scales, mentoring constructs such as depression, anxiety, as well as health efficacy. So-

Mary Ellen:

Fascinating.

Kathleen:

Yeah. So as you can see or hear, I guess in this setting of the field of psychometric kind of encompasses a lot of what we do as psychological researchers. Measuring people and those traits are constructs that we can't see is one of the most fascinating parts about psychological research. I see psychometrics really as the basis for the entire field of psychological research because if we're not measuring our construct correctly, then how do we know that when I take two constructs and try and relate them to each other using correlation or T-tests or something else, that we know that we're actually measuring what we think we are.

Kathleen:

Without sound psychometric tools and techniques to measure them. Kind of the validity of all of our subsequent research, I think becomes questionable. So we shouldn't make, or maybe we can't make statements about how two constructs are related without knowing how those constructs were measured. So I believe and I view psychometrics really as the heart and the basis for all psychological research.

Mary Ellen:

That's an excellent point that you're thinking about these measures as things that are being used in all kinds of studies and they need to be sound. So that's a great point. I'm glad you brought that up-

Kathleen:

Yes, of course.

Mary Ellen:

Very good. So what drew you into this field of psychometrics and quantitative psychology?

Kathleen:

Well, it started when I was an undergraduate. Actually, I guess it started even before then. I was always interested and excited about quantitative math types of things, not necessarily quantitative psychology. In fact, when I was younger, I didn't even know it was a thing. I was in college looking for doctoral program, but I went to high school at a school that has a tech program and so I did a lot of computer programming, had some experience doing computer programming and working with logic models and things like that starting back in high school.

Kathleen:

And then that kind of went to the wayside. I became a psych major because I was also very interested in individual differences and what makes a person who they are. And so I went into the field of psychology with the intent on becoming a clinician and helping others kind of work through any sort of problems that they may have or just being there for their support until I got to my internship. So I did my internship in clinical psychology and about halfway through that I decided that this was not the field for me at all.

Kathleen:

It didn't mesh well with me. It was not my best semester, but simultaneously I was actually taking an advanced stats course and I loved that class. And I found that it came very easy to me and I thought it was fascinating, all the different things that we could do with these more advanced statistical procedures. And my professor at the time reached out to me to see if I'd be interested in doing research with him.

Kathleen:

And I thought, oh yeah, that'd be great. So I joined his research lab and started identifying that this is something really that is not only fascinating to me, but something that I can do as a profession. When I started out in psychology, I didn't know that we had all of these options. I didn't realize that we had built developmental psychology, social psychology, cognitive psychology, and especially, I didn't know that we had anything to do with quantitative psychology.

Kathleen:

And I think even my students now who take my statistics courses still view statistics as not necessarily part of psychology because they're thinking about it through the clinical lens rather than the entire field, which is encompassing the research as well. So I started going forward looking at doctoral programs and that was when I identified that I could do quantitative psychology as my emphasis, as my main focus.

Kathleen:

And so that was a very long trajectory of how it got me to where I am now. But I think a lot of it had do with that initial experience in computer programming starting in high school. Even before then, my mom was a elementary school teacher and on her days off I would go to her classroom and I would play these various computer games on her Apple two week computer, which was not so fancy as these are. So there was always computer programming that had to happen while you were also playing these games. So I always had little analytical interests and it kind of just grew and developed into my love for psychometrics and quantitative methodology and all things related to quants.

Mary Ellen:

So let's talk next about your area of expertise in item response theory. So can you describe that theory for us and then how you apply it?

Kathleen:

Sure. So item response theory is like a paradigm within the field of psychometrics. And it's one of the ways that we can design or analyze these various tests or instruments that we're constructing. So the field of psychometrics allows us to create and interpret these measures that we're interested in constructing. But specifically item response theory is one of the ways in which we can do that.

Kathleen:

The more traditional theory is classical test theory. And so sometimes folks call item response theory, more modern test approach. So what we do is it's a theory really based on the relationship between an individual's performance on a test item and then the test takers level of performance on the overall measure of ability that that item was designed to measure. For instance, math ability is one that is common as an example of using item response theory.

Kathleen:

If you are in seventh grade and you take a very wide ranging math assessment, you'd probably be really, really good at the addition questions and the subtraction questions and long division, multiplication up until maybe what you're learning in school. So maybe you're enrolled in pre-algebra. So those types of questions start to become more difficult.

Kathleen:

And so your actual level of math ability at that time would partly be dictated, would be... you'd be able to identify that level of math ability by giving increasingly difficult questions. And item response theory allows the difficulty of the questions to be modeled. So it doesn't assume that each item is equally difficult or even equally informative.

Kathleen:

So if you're trying to identify a person's math ability, giving them a whole set, if they're seventh graders, giving an entire set of arithmetic questions is not going to give you much information about their math ability. And you want to give them questions that are maybe slightly less difficult than where their ability level is slightly more difficult to where their level of ability is to kind of find tune where exactly they are on this very wide ranging construct of math ability.

Kathleen:

Giving them a calculus test isn't going to give you any information either because those questions are too difficult for the individual. So it's remodeling the probability or the likelihood of an individual endorsing or getting an item correct. And relating that to the difficulty of the item as well as how informative that item is about the construct. So if it's a good item or if it's a poor item, that will also make a difference as to how important that item is in determining someone's math ability.

Mary Ellen:

Interesting. Okay. So you're talking about an example here in math. What are other ways that something like this would be used or what other areas?

Kathleen:

Yeah, it's widely used in the field of health research as well. So there is a Patient-Reported Outcomes Measurement Information System, which is coded as PROMIS or some folks refer to it as promise and it's funded by the government, I believe it's the NIH who funds this program where various measures are being constructed to help doctors diagnose individuals faster.

Kathleen:

So for instance, if you're going into the doctor's office because you have some issues with depression, we know that doctor's time is very limited. And so when you get in there, instead of giving a whole battery of assessment, giving them an assessment that utilizes item response theory, it can more quickly fine tune the individual's level of depression, for instance.

Kathleen:

And then once you're in the doctor's office, the doctor kind of knows where to start the questions. Rather than starting from square one, trying to get from square one to where the tests ended, they can start with where the tests ended and ask those more important, more in depth types of questions. And that's using specifically the computerized adaptive testing application that item response theory allows for. So it-

Mary Ellen:

Fascinating.

Kathleen:

Yeah, takes those questions and kind of puts them into a larger bank. And one of the assumptions or one of the nice aspects of item response theory is that it person and item independent, so these are items kind of stand on their own. And so you know how difficult a particular item is. And so you can map a person's response onto that item to see what level of depression they are. So if it's a harder item than the person would need to be more depressed in order to endorse that item, if it's a quote unquote item than someone who just may be a little bit sad might endorse that item.

Kathleen:

So all of these tests, all of these items go into a test bank, and then you go in and you take this computerized adaptive test and based on a previous response, you'll either get a more difficult question or an easier question. If you endorse the more difficult question, you'll probably get a more difficult question next to see if you'll endorse that increasingly difficult question to see where you are in depression.

Kathleen:

And then once it fine tunes your response as much as possible, then it gives a fairly decent depiction of where the individual stands on that latent trait. And that's using computerized adaptive testing. So in education, that's the graduate record examination, the GRE uses that same kind of methodology.

Mary Ellen:

Yeah, I was just thinking about that. We hear a lot in the education world about adaptive learning, especially in online ed. So it sounds familiar.

Kathleen:

Yeah. So when you're taking the GRE and you're going through those verbal questions and you get some analogies that you think, oh, maybe I didn't get that right. And then the next question that you get is like red as to fire truck is yellow as to when you know that you've probably got the previous question wrong.

Mary Ellen:

That's a great example.

Kathleen:

Within item response theory, there are a variety of models that have varying aspects and allow you to look more closely at items and have these various assumptions. The ones that I utilize is the nominal response model, which is the most flexible of all of the item response theory model and it allows us to take even a category like a response format look at items.

Kathleen:

So not only is the item overall informative, but like psychological scales are commonly assigned like a five, seven, even like a nine point Likert type response format. And many researchers just kind of slap it on there without really any justification for how many response options are needed. And it's been assumed traditionally that those response options are kind of ordered evenly across the construct and that they function equivalently across the entire range. But many folks don't evaluate those response options explicitly.

Kathleen:

If you're giving a happiness scale, how are you responding to an item? Are you happy, five? Happy, six? Happy, seven? And what does that mean? Are you able to evenly meaningfully distinguish between responding or endorsing an item that you're happy five, six, seven. And there are also cultural differences into response format. Depending on your cultural background, you may have an aversion to responding in the extremes of those response options. Cultures will more often respond in the extreme. And then there's always the question of what's the point of the neutral response option?

Kathleen:

Does it really mean that you're in the middle of the construct or does that that item is not applicable for you or that you just really have no opinion about it at all? So the nominal response model allows us to look at all of those various types of scenarios and fine tune and modify the response format.

Kathleen:

The response categories to make the question the most informative that can the most informative version of itself. And also maybe reduce some of the cognitive load on the test takers so that they don't have to make those impossible distinctions between being happy five or happy six.

Mary Ellen:

Very interesting. We're going to take a brief break and when we come back we will hear more from Kathleen about her experience with longitudinal studies.

Dr. Katie Linder:

The research and action podcast is delivered to you by Oregon State University eCampus, the university's top ranked online education provider. One of the greatest things about working for eCampus is hearing the success stories of our online students like Orman Morton, III. After being suddenly let go from a decade long stint working at a steel mill, Orman turned to Oregon State eCampuses environmental sciences program online. As a Native American, passionate about improving the land, earning this degree changed his life for the better. Ultimately leading to his dream job in a field he's passionate about. Read more about Orman and his journey at ecampus.oregonstate.edu\Orman.

Mary Ellen:

So Kathleen, your research has included some longitudinal studies. Can you talk a little bit about the Fullerton Longitudinal Study?

Kathleen:

Yes. The Fullerton Longitudinal Study is a contemporary long-term longitudinal study in which 130 children were followed from infancy age one year to the entry of middle adulthood. So our last data collection was in 2017 when these, which were infants are now 38 years of age. Alan and Adele Godfried are really the spearheads for this project. They launched the study in 1979 and I joined them in 2011 when I started working at Cal State Fullerton right after my doctorate at UCLA.

Kathleen:

In 1979, they found infants... they were selected from notifications of all births at hospitals surrounding the university. So really just went into all of the hospitals, public databases, and randomly selected infants.

Mary Ellen:

Wow.

Kathleen:

And they got a 130 children to, or I guess 130 parents to agree to have their children involved in this study. They assess these kids semi-annually, before they entered school, and then annually, once they started school up until the age of 17. Then they collected data from these kids again, which were now adults at age 24 then again at age 29. And then most recently when these participants were aged 38. And across all of this, the participant retention was consistently high, which is unique to a longitudinal study. We had over 80% returning.

Mary Ellen:

Wow, that's incredible.

Kathleen:

Across the 38 years, and even this most specific or this most recent data collection, we had an 82% return rate. And so that's one of the most difficult aspects of longitudinal research is you have to maintain contact information for these families as these youth were growing up and now becoming adults and then moving across country and everywhere else.

Kathleen:

So when the investigation was initiated, the families resided within one hour of the research site, which at the time was Cal State Fullerton.

Mary Ellen:

Wow.

Kathleen:

And they've got, there's all sorts of geographic mobility happened for most of these families. So this study sample gradually resided not only just within this small community but across the United States and some folks even abroad. So the findings, even though it started out as this fairly homogenous sample, a lot of the findings that we have are not restricted to any specific geographic region and can be fairly fairly generalizable across United States' population because we have this geographic mobility in our sample.

Mary Ellen:

That is quite a long-term study. There aren't very many studies out there that follow people for that long of a period of time right?

Kathleen:

There are not. There are a few in Europe and those are generally government funded. It is more rare to have the battery of assessments that we have with the FLS really looking at all aspects of the person growing up. We have temperament at infancy, we have the mother's personality, we have parental employment. With kind of a lot of aspects of the family, there's also teacher report when the kids were in school.

Kathleen:

So we have kind of a 360 view of these kids as they're growing up at various age points. So we have for instance, the mother's report of their behavior problems and the teacher's report of their behavior problems and even their own report of behavior problems or various constructs. We've got self-concept, self-esteem, various types of health measures as they're going through puberty.

Kathleen:

And so now we're able to start looking at maybe what their health was when they were in adolescence, how that relates to some variables two decades later, specifically looking at what makes someone successful. So maybe health at the age of 17 is related to success at the age of 38 or self-concept at the age of 38. And we've been able to look at a variety of those types of questions with this unique dataset.

Mary Ellen:

That sounds like a fantastic set of data.

Kathleen:

Yeah, we have over, I think it's over 17,000 variables in the data.

Mary Ellen:

Goodness, I can just imagine the code book on that. What are the benefits and drawbacks of doing these kinds of large scale longitudinal studies?

Kathleen:

There were a handful that kind of went to the very first assessment and then disappeared from then on. But of those that we maintain contact with throughout, they maintain contact throughout high school. Almost all of them came back for these various adult assessments. So age 24, 29 and 38, we did see a drop in one of the lowest years was age 16 and that was coincidentally when they all got drivers license.

Mary Ellen:

Oh.

Kathleen:

And so folks wanted to send them to the study and maybe they chose not to attend this study. So if you also have these various kind of events surrounding not only the research assessments, but also things that go on in their lives outside of just being a participant in this long-term longitudinal study.

Kathleen:

But many of them, when we contacted them a couple of years ago to be a part of this study again, part of another round of data collection, most of them were very excited and said that they have kind of this pride that they are involved in this study for such a long time and they know of some of the research that's gone on. Not many of them, they don't really follow it, but just kind of an interest in how cool it is that I'm one of these 130 that have been followed for the past 40 years.

Mary Ellen:

That is something. Yeah, I would be proud of that too if I was in that study. That's really great. What are some of the other benefits of this kind of a large scale study?

Kathleen:

Asking these very long-term types of questions. For instance, we have a paper that we published not too long ago that looks at how parental stimulation of curiosity at the age of eight relates to the children's science interests, science course accomplishments and also career skills all the way in high school. So we have this, we were able to look at these contextual, how the family provides this stimulation of curiosity, exposing them to new experiences, promoting curiosity, taking them to museums, encouraging them to ask types of questions, how that relates almost a decade later when they're graduating high school to their interest and also their accomplishments in the field of science.

Kathleen:

So we can see we've also seen how books in the home and how often the mother reads to the child, how that relates to success in high school as well. So we can see these very long-term longitudinal benefits and we can answer those types of questions. What makes a person successful in high school? What makes a person successful in middle adulthood? Which we're just starting to answer now. We've actually working on a paper where I'm looking at temperament during infancy, the mother's perception of the child's temperament and how that relates to positive family relationship much later on in high school. And then our next step has been how that relates to adult success in a variety of aspects. Maybe health benefits or their own personality development.

Mary Ellen:

Yeah. This is really intriguing to me as a parent that you can have this kind of rich data that actually can see the impacts of these things over time. Let's talk about some of the statistical methods you've used to analyze data from these studies. What can you tell us?

Kathleen:

Variety of them. As we were chatting about before with item response theory and most of my research being in the nominal response model, in 2015, I applied the nominal response model to create a scale that measured positive family relationships across multiple years.

Kathleen:

And then I was able to use our long-term longitudinal data and customized with the nominal response model, customize the scale for each age so that it contains only informative items. And then had an empirically derived response format so that only the response options that were relevant at the time were the ones that were utilized.

Kathleen:

So I was able to use the nominal response model and apply it within a long-term longitudinal framework to look at these nine annual assessment waves going from age nine to 17 to construct a measure of positive family relationship. The nominal response model was used to assess longitudinal data and look at how these scales change across time.

Kathleen:

For instance, at the age of nine there are certain questions you would imagine that are relevant at the age of nine. We talk about the day's problems that remain relevant all the way through the age of 17. Like we talk about the day's problems or we talk about our daily lives. Other items, my opinion is used when deciding what we're having for dinner is important at the age of 17 not as important at the age of nine.

Kathleen:

So that was an item that wasn't included early on that ended up being relevant to positive family relationship as they age. Really when they started in high school, it became more important for their opinions to be incorporated into the family. So we see that what makes a positive family function or have a positive relationship, specific aspects of that change across time, just like families adapt across time.

Kathleen:

And so we're able to utilize an nominal response model to identify those items that are relevant for specific time points throughout from late childhood through adolescence. So what we did with the nominal response model after constructing these scales at each age, the next step is to put all of the responses really on the same metric. And this is something called... well they're a variety of ways to talk about it, but the most common is [inaudible 00:33:08] quading. And that's where you take scales that overlap to some degree and link them together to put them on the same metric. Another way to talk about is parameter linking, so we all the paper are clinking paper and we referred to it very lovingly as our clinking paper.

Kathleen:

And this is just to make sure that we're not focusing on various nuances because we were dealing with scales that don't contain the exact items, the exact same items [inaudible 00:33:42], which is one of the big no-nos in classical test theory. So using longitudinal data and using the nominal response model, what happens is we link the overlapping items together and then we have these other items, those are called the anchor items, the ones that are linked together because they're the common items across time.

Kathleen:

So you have to have at least one common item from one scale to the next or from one year to the next in order to do the linking procedure. And once you have this common item, then all of the others kind of align themselves and rank order above and below the item so that now those two years are linked. And we use this procedure that ends up creating a common metric across all of the informants and across time to establish measurement in variance.

Kathleen:

So after we've done this, then I use structural equation modeling to develop a longitudinal network of relations where we looked at how the positive family relationships construct related to some contemporary variables such as family cohesion, family conflict, the perception of social support, perception of negative interactions as well as self-concept. We also looked at how positive family relationships predict and relate to higher levels of academic performance in high school and also almost two decades later their educational attainment at the age of 29.

Kathleen:

Those that rated their positive family relations as higher went further in school, they had more cohesion, less conflict, more social support, their self-concept or self-esteem was higher and they had fewer behavior problems. And so I used a structural equation modeling to develop this kind of longitudinal network of relations where I related PFR, positive family relation to these various outcome measures.

Mary Ellen:

Fascinating. So from this research, what was the most surprising thing?

Kathleen:

I think the long-term benefits of having a positive relationship within the family. How that related to something that was not even self report necessarily, was self report, but it was educational attainment at age of 29. Also, the performance in high school was the GPA reported by the high school itself. So that was not a self report measure. So we can see that the family is an extremely important context in which all of these other types of outcome measures are related, and then even future positive family relationships are related to earlier positive family relationship.

Mary Ellen:

So thanks for talking with me today, Kathleen. And thanks to our listeners for joining us for this week's episode of Research in Action. I am Mary Allen Dello Stritto. Join us next week for another episode.

Dr. Katie Linder:

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