"How do we regulate in relationships?" –Research Spotlight with Dr. Erika Lunkenheimer

The field of psychophysiology studies the intersection of physiological and psychological phenomena. Dr. Erika Lunkenheimer's program of research intensifies this intersection by utilizing intricate research designs to study regulatory processes across development, as well as co-regulatory processes in dyads and families. Her work assesses these processes across emotion, behavior, and physiology domains. Dr. Lunkenheimer was kind enough to speak with us about her research path, how she conceptualizes this work, and the challenges it presents.

Dr. Lunkenheimer is an associate professor of Psychology at Pennsylvania State University and an Associate Director of the Child Maltreatment Solutions Network. She received her bachelor's and master's degrees at Northwestern University before working with Drs. Sheryl Olson and Arnold Sameroff at the University of Michigan for her doctorate in developmental psychology. Before becoming an assistant professor at Colorado State University and subsequently associate professor at Pennsylvania State University, Dr. Lunkenheimer completed her postdoctoral work at the University of Oregon under the direction of Dr. Thomas Dishion.

<u>A lot of your research looks at the interplay of developmental psychopathology and then also this prevention aspect of childhood maltreatment. How do you think about this intersection, or how do you tend to conceptualize it?</u>

My background was originally in marriage and family therapy, that was my first degree; and while I was studying family-based treatments and interventions, it really seemed to me like there was a developmental component that was essential and was sometimes missing from more of the classic family studies and family therapy approaches. I thought that piece was incredibly important and that was my first exposure to the question—how do we take developmental principles and developmental pathways and weave them into both prevention and intervention from a family-based perspective? That was formative for me, and so now while I research, I am thinking about the implications for family-based intervention.

In terms of my work, I have researched psychopathology symptoms, risk for psychopathology, and externalizing and internalizing behavior problems. That is where I started and with time I have moved to thinking about childhood maltreatment risk and how those aforementioned psychopathology symptoms might overlap with childhood maltreatment risk. I think it has been illuminating in thinking about how pathways of developmental psychopathology are relational in nature. Another one of the reasons that I have moved into the area of childhood maltreatment is I'm also very interested in regulatory processes. When you think about regulatory processes going awry in the context of a relationship, in early development, on the end of that continuum is childhood maltreatment. I always had an interest in risk and preventing psychopathology, but it has really been my interest in these relational regulatory processes that helped me add on this piece of thinking about it in terms of childhood maltreatment as well.

That's really cool. There are so many rich components to your research. I only recently came across some of your work with the recent *Psychophysiology* article, and since I have been astonished by the richness in your work. You seem to span this developmental range that I think is quite unique. I was wondering what sort of decisions you and your collaborators make when trying to start a specific project—For example, when to focus on being a toddler/early childhood versus adolescence versus somewhere in between.

> ***"I am so interested in the development of self-regulation. In particular, how parent and child co-regulation influences child self-regulation."***

There are probably three main drivers. One is pretty simply that starting earlier is useful in terms of thinking about prevention; prevention of problems exacerbating or getting worse across development. This is a general reason for studying the toddler/preschool period. A more substantive reason I study that stage is because I am so interested in the development of self-regulation, in particular, how parent and child co-regulation influences child self-regulation. In theory, it should be a really critical period because it is the period in which preschoolers are internalizing those processes and skills in large part from interactions they are having with their parents. That is the primary relationship context for regulatory development. I think there is still a lot for us to learn in that period about how parent self-regulation and parent-child co-regulation lead to the emergence of regulatory skills in children, their stability, and corresponding problems. Those are particular drivers for why most of my work is in early childhood.

I have also done some work in early adolescence, and that is because something else that is incredibly interesting to me is transitions. In this work, I am able to think about the transition that is a pivotal shift into adolescence. Part of my theoretical background is in dynamic systems theory, and when you are thinking about what happens dynamically in regulatory processes and in relationship processes, transitions are especially interesting. They can reveal things that sometimes more static measures or cross-sectional measures might not be able to. Sometimes we replicate those types of transitions in the lab, like right now we are doing experimental shifts that allow us to test when the stress levels increase according to task demands, what kinds of pattern changes do we see in the individual or the dyad? However, we can kind of take a step back and think about that from a developmental transition standpoint, too, right? When children undergo these shifts, what changes, how does it change, and how does that type of change reveal something about their functioning?

I recently saw some of your work on the parent-child challenge task. I was wondering what some of the challenges were to creating such a novel task, to get that dynamic piece and then also the contextually relevant piece.

> ***"It becomes complicated quickly."***

The challenges were more after the fact in terms of thinking about how to analyze it. I think much of developing that task came very automatically and naturally from having, at that

point, coded micro-level interactions with parents and children or children for many, many years. I started doing this micro-level coding right out of undergrad and so at the time I had about 15 years of experience using various types of coding systems and observational tasks. So, when it came time to create my own task, I knew a few things. I knew that a task that prompted shifts could be necessary to see dynamic patterns within the individual or within the dyad; so we used what is an A-B-A design, in which, for example, there is a baseline/positive discussion, then a conflict discussion, and then another positive discussion. Other examples are the Still Face and the Strange Situation. Those are powerful designs that allow us to examine regulatory changes and we have a fair amount of control over what is going on, particularly with set stimuli and set timing. So I knew I wanted that, and continuous coding. I wanted to be able to capture dynamic patterns of affect, behavior, and physiology in real time. It was important to think about something that works in a lab, but also something that could potentially reflect the real kinds of experiences that families go through. On top of that, I was thinking of the level of task structure. The first task is free play, which simulates how parent and child play at home and is fairly unstructured. Then, they have to clean up toys, which has been used before, but we structured it in such a way that the clean up came quickly after the free play so we maximized the chance that children would struggle to clean up the toys that they had just been given. The PCCT, the Parent-Child Challenge Task, is the third, and that is where we really implement the structure. It prompts parent stress—because they need to complete the task to win a prize at the end, and the puzzle designs increase in difficulty, and then there is an unexpected time limit—but it also pulls for how does the parent guide and help and teach their child in a context where the task is above the child's cognitive level. So, a lot went into this task, and then the biggest challenge is an exciting one that we are still figuring out: What do you do with 6 data streams in coordination with one another?

The way we code is we have an affective data stream, a goal-directed behavior stream, and then a physiological stream, and they are synchronized in time. Yet, there are not a lot of common analytic options that allow us to put all of this data together. It is easy to analyze two data streams, and there are some ways that you can look at three. I have just come back from a dynamic systems conference with some new ideas about integrating multiple data streams, and I am very excited to try those. This is particularly interesting, because when you are thinking about co-regulation of behavior or physiology or cutting across those two domains, how do you model such that you don't cut corners? Or collapse one into an aggregate form? I am hopeful that on the methodological frontier we are going to have increasing options for how to fully represent the time series for each of those respective domains, and then across multiple task types as well. It becomes complicated quickly.

Absolutely! That does sound like a challenge, but an exciting one like you said. That takes me back to the richness of your research and study designs. One of the aspects I have really appreciated in reading your work is how you take the view of emotion unfolding on a moment-to-moment basis, and you take it quite literally so you are working on more of those millisecond timescales, and you are also looking at them as iterative processes, between acting partners. Can you elaborate more on the skills, resources, or equipment us researchers need in order to try to tackle all of those things together?

The first thing that comes to mind is that if researchers are interested in the dynamics of emotion, there may be some decisions that need to be made ahead of time about what aspect of emotion you are capturing. The way I have chosen to do it, because I have a dynamic systems frame and I work with dynamic methodologists, my interest is really in rich variability and moment-to-moment changes. So what I select for my own work is looking at intensity of affective expression along a continuum. So this is simplified but we look at high negative, low negative, neutral, low positive, high positive as if they are on one dimension -- we are capturing valence and intensity. By doing that, we can look at fluctuation in valence and intensity over time. If you are really interested in emotions, that doesn't get you everything. For example, work on discrete emotions becomes complicated quickly if you are trying to overlay a categorical emotion variable with something like intensity. Emotion researchers would also argue that those discrete emotions have different functions that vary depending on task demands. My collaborators and I are grappling with this—how do we simultaneously represent both the intensity of affective expression and the more categorical dimension of discrete emotions, the function of those emotions, and the regulation of those emotions? I do not think there is only one toolkit for emotions researchers. I think it involves a lot of a priori thinking through the dimensions of emotion you are most interested in and working closely with methodologists ahead of time to make sure that the nature of your data, and the way in which it will be available to analyze, fits with the dynamics – such as intensity, function, and regulation – that you are particularly interested in.

This really highlights all of the decision points that go into the research that is conducted. Starting broadly or conceptually how we think about things and then focusing in on a specific project and how we want to answer those questions for this round. In terms of decision points, it also seems that with physiological assessments there are a million routes that researchers could choose. In your research, respiratory sinus arrhythmia (RSA) seems to be your particular biomarker of choice. What do you view as the advantages and disadvantages of that biomarker?

> ***"If RSA processes are really embedded in social contexts in meaningful ways early on in infancy, and throughout childhood and into adulthood, there is a lot to work with."***

Focusing on that specific biomarker, some of the pros are the rich theoretical literature that supports the role of, more broadly, the autonomic nervous system, and more specifically the parasympathetic nervous system in relational processes. So for me, a particular interest is, how do we experience and regulate stress in relationships? Between Porges' polyvagal theory, Thayer's neurovisceral model, and the excellent work that Ruth Feldman has done on thinking about these things from evolutionary standpoint, there is rich theory to draw upon. If RSA processes are really embedded in social contexts in meaningful ways early on in infancy, and throughout childhood and into adulthood, there is a lot to work with. A major interest of mine is empirical tests of those theories. It is also appealing that we have a fair amount of knowledge on RSA and psychopathology to date, there is a nice empirical literature to draw upon there as well. What I think is challenging about this area is figuring out what norms we should expect for individual RSA and especially dyadic RSA, which we have a lot less empirical

work on. I think we have a ways to go, and one of my goals has been to, in a descriptive way, start to model what parent-child parasympathetic coregulation looks like, what are the norms, and how it relates to both normative/adaptive behaviors and maladaptive behaviors and developmental psychopathology.

There are a lot of different ways to do that, and that is where maybe the challenging side comes in. We are coming to understand that RSA can vary by the age of the child, the context in which it is assessed, whether it is individual or dyadic, what the dyadic goal or stressor is, who is stressed or not stressed, who is driving the interaction, and the level of risk. There are also multiple ways to measure coregulation. Synchrony is just one, and one of the most popular, but we are learning that synchrony in RSA can be adaptive in relating to adaptive covariates, but in some cases, when level of risk is higher, synchrony can be maladaptive. So we are starting to see some complexity in the empirical literature as we look at variation by task, by risk, by age. That certainly adds complexity to this field, and another thing that adds complexity is that we have come to appreciate that biological systems do not operate in isolation. We then have to think about how the PNS and SNS are working together; with Thayer's neurovisceral model we have to think about how the prefrontal cortex and other brain structures are related to these processes. So this isn't a "con," but it is something to think about—that these processes are complex and we have a lot to learn. But again, the theory is very compelling in delineating what we should expect in terms of social relationships around these processes. This shapes things for me and even as the theory evolves and we learn more through empirical tests, it is very compelling to think about how we deepen our understanding of biological processes in the context of relationships.

I love what you did there- that subtle reframe where instead of considering these things to be cons, they really are these interesting challenges or complexities that we're unraveling and they lead to the next line of research.

I think another challenge, to add on to that, is how we model the data because there are probably ten different ways so far that people have looked at coregulation or concordance of physiological patterns. They are not yet integrated and there is not one paper out there that says, 'here are the ways that we could analyze that, and here is what they each represent and how well they conceptually map onto what we mean when we say coregulation." So that is also another challenge for the field: thinking about optimal analytic approaches.

Speaking of multiples ways to do things, and you touched on this a bit earlier, your professional path seems to include multiple decision points that were critical to your development as a researcher. I am wondering if you might elaborate on a couple of them. For example, starting with a master's in marriage and family therapy and then transitioning to a PhD program, what led to that transition?

I got into my master's program and I loved the content but I also realized fairly quickly that the more day-to-day nature of doing practical work and being a therapist was not for me. I enjoyed it, but I found myself wanting to teach my clients and I had this strong drive to do the

science. I found myself being so excited by the research and the potential to reach broader audiences, and thinking about fundamentally about what we know about these different approaches to therapy and how can we improve them. I had an awareness that more of a scientist role would be a better fit for me and I knew that I would be moving toward a PhD in developmental psychology.

It is neat to hear how it is still informing your research, too.

Yes, it was definitely pivotal and I also did work as a research assistant both before and after that degree in doing very rich micro-level assessments and coding of relationship processes. I was already interested in that piece, and that piece was constant throughout. My time in the masters program really did shape the way I saw families and the development of children in families.

Dr. Lunkenheimer, thank you for your time, provided insights, and discussion of your interdisciplinary work!

For readers interested in Dr. Lunkenheimer and colleagues' recent article in *Psychophysiology,* it can be found below. Related work will also be presented by her graduate student Amanda Skoranski at the upcoming 58th Annual Meeting of the Society for Psychophysiological Research as part of the symposium entitled "Diathesis-Stress across the lifespan: Measuring markers of risk for psychopathology from infancy to adulthood" co-chaired by myself and Paige Ethridge.

- Lunkenheimer, E., Tiberio, S. S., Skoranski, A. M., Buss, K. A., & Cole, P. M. (2018). Parent-child coregulation of parasympathetic processes varies by social context and risk for psychopathology. *Psychophysiology*, *55*(2), 10.1111.