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Yoga Alliance
>> (Music).
>> What do you think of when you think of yoga? Poses on on a mat. Perfect alignment. Reaching far beyond your toes. The beauty of yoga is that it's much more than a sequence. Yoga is also activism. Yoga is about a quiet internal journey and a growing powerful outward voice. Yoga is action, curiosity, empathy. Join us as we celebrate yoga. With diversity of millions who practice it, and the power it gives us all. Because we are all for yoga, and yoga is for all for us. >> Good evening and thank you for joining us. My name is Steph. I'm a scientific research here at Yoga Alliance and I'm joined by Dr. Dr. Jonathan Rosenthal. We're really excited to you have this evening. We don't always do a fight webinar. So it's really fun to be together this evening. If you're coming from North America in the U.S. or Canada, et cetera, in South America too or maybe you're in Europe or somewhere he will extraordinary in the world, you might have seen a poll pop-up. And we're just asking what region you're joining us from today. It's really exciting to sort of see where people are. And this has been our webinar and digital events have shobe shown us our big our community is and wide-reaching and how wonderful it is to be united and to learn. So you might see that poll pop-up. You might click to answer and you might see the results. I sometimes forget if it does that or not for us. But thank you so much for joining us tonight. We've got an one-hour scientific research on yoga webinar titled learnings from 2022 yoga and neuroscience conference. You might know that yoga is a practice and improves how we feel, perform, and think. But have you ever been curious about how yoga does this? Tonight we're joined by Dr. Jonathan Rosenthal, he's a chief resident physician and neurology at NYU and dedicated yoga practitioner. And tonight he's going to share a lot with us about are the scientific research findings on yoga and executive functions, stress, mood, and risk tolerance from the 2022 neuroscience and yoga conference from the insights from those experiments. And tonight we'll learn about the theoretical background and practical implications of these yoga and neuroscience study. We'll learn the science how yoga affects the brain and how to harness these benefits for yourself, how to get involved in research with the upcoming 2023 neuroscience conference, which is quickly approaching. We're very excited about it here at Yoga Alliance. And, yeah, I mean, I met Jonathan at a research conference on yoga presented by our director of yoga research at Kurpalo. And when I met Jonathan, I knew he was a real Yogi. The way he conducts himself is so humble and down to hurt and incredibly kind. And has been passionately sharing about neuroscience and yoga since 2014 as doctor of medicine and chief resident physician at NYU. We are in very good hands to learn a lot tonight. So thank you so much, Jonathan, for joining us. I can't wait for everyone to get to know you more. What's also exciting we usually have the chat disabled. And it is for most of tonight's presentation, but there will be moments where you might be able to see the chat pop-up on the webinar tonight. If you're joining us live, please feel welcome to engage with Jonathan's presentation, Dr. Rows that you will that you will is a really creative and educator this way and it would be fun to play and connect in chat if possible.
And also you'll notice when the chat is disabled, that we've got the Q&A question and answer function

of the webinar up and what we'll do is, Jonathan will present for a good period of tonight's hour. And then by end of the presentation, we'll have some open space to take your questions live. And Dr. Rosenthal will answer those as best he can for all of us this evening. I am sure I missed something. But without further ado, I'm going to pass the Zoom microphone over to Dr. Rosenthal. Thank you so much for being with us.

>> Thank you, Steph. I'm honored date of birth here and that introduction was way too generous, so thank you. I'm going share my screen and make sure everyone can see it well. And as this is pulling up, I will say hello, everyone. Welcome. I'm really, really excited to be here. And my goal in being here is to share neuroscience and yoga with everyone. I hope you will walk away with better understanding of both theory and practical behind all of this. And also that you'll be inspired to support and participate in scientific research on yoga.

I'm very excited for this presentation in particular, because the neuroscience and yoga online conference is something I'm really passionate about. And for those who haven't been to the conference, I'll just give you a quick rundown. So it's basically a neuroscience outreach event. And as part of it, there are yoga classes every day taught by amazing yoga teachers. And before-and-after the yoga classes, we have kind of these hands-on fun neuroscience experiments. And they relate to the theme each day. So for the 2022 conference, we had 3 themes one for each day. Yoga and child development, yoga and brain aging and yoga and addiction, and so that's what we're really going to focus on. And for today, I do have the opportunity to ask questions as Steph mentioned. So please, as you're listening, feel free to write down your questions, put them in the Q&A Box, and we will do our best to get to all of them. Okay.

So I'm going to introduce myself a little bit. One of my favorite parts of doing these kinds of presentations is I get to hear everyone's personal stories. So please continue introducing yourself as well. And I guess it's only fair if I want to hear you introduce yourself, I should introduce myself too. So I'll tell you about me through pictures. So I am a yoga student. This is a photo from 2013 with Shre dar me tra. And this is another photo of us from February 2020. Right before COVID hit. And so, yeah, yoga is a huge part of my life. And, of course, it inspires me to do the work on neuroscience and yoga. Another side of my life as Steph mentioned, I'm a physician. So I'm a resident physician in neurology, which means I'm in my training. And I help patients with stroke and epilepsy, and multiple sclerosis and Parkinson's and many, many more. So here's a photo of me from the VA hospital, one of my favorite places. The VA is the Veteran hospital for those who aren't familiar with it and lastly, this photo is a combination of the two. So neuroscience outreach and yoga, and this is from one of our events when we used to have all of them in person before COVID. And here we're going over neuroanatomy on a plast Nateed brain. Someone donated the brain I'm holding in the photo so people can learn from it and that was generous of them. I share all this so you see me as approachable and immune so always feel free to reach out and put your questions in the chat and make this a fun discussion. Okay. Now, before we get into the actual studies and the background and everything, I do have to give you a disclaimer. I don't want to over sell what I'm presenting here. So the first thing to note is studies I'm about to present were really part of a conference. They weren't conducted under controlled conditions

or standardized scientific research environment. Right? So they were cross many different time zones, maybe people are glitchy Internet and maybe the dogs came up to them and licked their face. There were a lot of things that weren't controlled in these studies.
So as with a lot of things, but particularly, with this, you should take any findings and conclusions with some skepticism. And also note that our samples were really quite small. They range from 4 to 8 participants per experiment. And I think even more than that, the theoretical background is probably going to be the most interesting thing to take away from this presentation. And another thing to bear in mind is that for certain tests such as like the cognitive test I'm going to present, participants more familiar with them the second time they took them. So after the yoga class. And this definitely could confound the results so it could make it look like the yoga class led to the improvement, when in fact, they got better at the task doing it a second time. Right? So we try to mitigate this confound by having a practice round before the test were done for the first time. But this is not a perfect way to do it, right? The right way to do it would to have a control group and last thing to note everyone who participated in these studies is really enthusiastic about yoga. So that's going to bias the results a little bit.
And what we're going to go over is for each of those 3 topics I mentioned, the 2 experiments that we conducted before-and-after the yoga classes. So for yoga and child development, we're going to look at experiments that had to do with stress regulation and executive function. So those are the perceived stress scale and the go, no go task. For yoga and brain aging, we're going to look at visual attention and positive and negative affect. Affect here means mood. And so for those we'll be looking at the concentration grid task and the positive and negative affect schedule otherwise known as PANAS. And lastly for yoga and addiction, we'll be looking at temporal discounting and risk tolerance and seeking. And these will be done through the ED50 which I'll go into more detail about in the Iowa gambling task.

Okay. We get to start talking about my favorite thing, which is neuroscience. So neuroscience is a huge field. And it's very important to recognize that this field of science spends every possible level of science. So it goes all the way down from molecules in genes up to behavior and cognition. And all of this is inter-related. And because the conference experiments were conducted over the Internet, you know, we really were only able to focus on behavioral and cognitive interventions, but I will present some data from the other levels of neuroscience that have been published in the scientific literature.
Okay. And with that, we can finally start with yoga and child development. So for the child development day during the conference, the 2022 neuroscience and yoga online conference, the presentations by all of the researchers focused on topics like self-regulation, emotional control, attention, ADHD, and all of these are very important for pediatric populations as they go through school and also as they develop personally.
And so for the experiments corresponding to the topics, we really focused on executive function and stress regulation. And I want to ask all of you, how do you define stress? So Cybill, now is a good time to open up the chat. And I would love to hear what people keep in their own minds as the definition of stress. And this gives me a chance to drink some tea. Anxiety. Overwhelm. Worry. Fight or flight. Tense body. A motivator. Ooh, I love these answers. When I can't seem to stay focused.

Misalignment. Shall breath. Panic attacks. These are really, really great answers. So I'm going to give a definition of stress from the literature that I really, really love. So stress is really about deploying resources. Meaning that it's about getting energy and other kind of physiologic resources where they need to be in time. And it is a brain determined process that affects the whole body. This summary of it is I think amazing, because those 3 components really tell you all the good things and the bad things about stress. So it's brain determined, it affects the whole body, and it's about deploying resources to respond to kind of a stressor. And if we look at this pictorial representation of the stress system, you can see there are psychological stressors and physical stressors that start at the top. Physical stressors would be things like infection, injuries, hunger. And psychological stressors would be things like deadline, financial strain, or grief. And these two big arrows that feed into the stressor response are probably the most interesting part of this diagram, but also the least understood. And that's really how does the brain identify a stressor? Right? Sometimes hunger is really stressful and sometime it's not. So how do you determine when something is stressful? Once that does happen though, there are two different pathways that can then be activated to mobilize resources. And the first is the hypothalamic pituitary access which is APA access and other is simple sympathetic medullary access. And sympathetic system is really fast and works via nerves. So nerves work like electricity. If you think about it, you can get an electrical signal from your brain to move your big toe in less than 200 millisecond. So nerves move really, really fast. Whereas the hypothalamic pituitary adrenal access workers slower and works via hormones in the blood that take on the order of seconds to minutes to work. And these two systems then have I innumerable effect throughout the brain and body. So the body is going to change how energy is metabolized sending more energetic resources to muscles and dissection and reproduction. It will also change how the immune system works. So kind of acutely or very quickly. It can increase immune system but overtime it decreases immune function. If then in the brain, it has tons of affects that change how neuroplasty works, decreases reaction time, it actually makes you faster and affects memory in learning, which we're going to talk more about. And ultimately, the goal of all of these change are adaptation. So you get the stressors and you're able to adapt to it and not die. (Chuckles softly) And I will say this image is really beautiful. It comes from a paper. And I'm going to show you all the references from this presentation at the end and you can take a picture or whatever you want to do with it and look these papers up. And just know some of them are quite long. They're really good, but if you want to dive deeply into them, you're going to have to dedicate couple of hours. Okay.

So one of the parts of the brain where the avenue effects of stress has been studied extensively is the hippocampus. And this is the part of the brain that contains circuitry that underlines episodic memory which is memory that has to do with events. So how we recall what happened to us, what we ate for breakfast and what's going on. And it's so interesting how stress affects the hippocampus, because timing matters. And what we can see in these two different images. So A and B, if we look at A, the stress and the thing that we need to learn happen at the at the same time. Right? So that's right here. And when that happens, there is a change in the neurotransmitter signaling in the brain so that's norepinephrine, cortisol that ultimately happen while we're perceiving the stressor, and then these lead

to that delayed response, the HPA access activation that during consolidation expresses unrelated information. So while you're being presented information you need to learn, you're hyper-focused on it, and then when you're not, when you're consolidating it and storing it as memory, you suppress other information. And that's when the timing of the stress lines up in this way.

But if the stress happens much before the learning, not at the same time. So there's stress before, but of course you have stress from something you're trying to learn. You can see that now, the HPA access is actually suppressing information when you're paying attention. And so now you don't even attend to it as well. And I'm sure we've all experienced this when we're really stressed out, we can't even attend to what aware trying to learn. You know, this is like pulling an all-nighter in college, and you can't each read the stuff anymore. Of course, you're also tired.

So this is just one way that the timing of stress affects learning and memory. But it also happens where in your lifetime. So the timing of stress in your lifetime affects your ability to learn. Particularly, during what we call the critical periods. So during the conference, we had a lot of discussion about what critical periods are, and just to summarize, they are periods of someone's development when learning and neuroplasty is very heightened, and then that critical period closes and what you've learned has, you know, kind of in set. And so a very intuitive example of this is when babies are learning to see, right? You can see babies looking around and learning what the world looks like. Well, if you were to cover their eyes and unfortunately, there have been experiments where people have done this to baby cats, they will actually become blind, right? So their eyes were working, but because they weren't seeing, the brain doesn't learn how to see with their eyes. That's a critical period for vision and they have to see while that critical period is ongoing. So some of the stressors that can happen during the critical periods of childhood are things like child abuse, neglect, hunger. And those can interrupt and permanently change how the brain learns.

And this has to do with change in epigenetic, change in neurodevelopment, so actually how the neurons grow and evolve. And it also reprograms the stress system and the immune system, and then has lifelong consequences, including cognitive deficits, increases in many diseases like asthma, COPD, cancer, psychopathology. So depression, anxiety, personality disorders. And also psychosocial problems like unemployment and incarceration.

And so these are really serious outcomes that we need more interventions for to help with, and wouldn't it be great if there was a tool that could help temper the stress response, maybe when we're trying to learn or, really, also especially during critical periods in childhood. And I think you know where I'm going with this, but I'm going to give you one more slide, which is it has to do with how we identify stressors. So those two big lines that I said were really interesting, right? So how do you know when something is a stressor? And there's a complicated brain network that does this computation. And just to put this in context, each line of this diagram is someone's Ph.D. Right? So people spend decades figuring this stuff out. And there's still a lot that we don't know. But one of the main takeaways from all of the research so far is that the prefrontal cortex, which is in the front of the brain here has connections to many of the other parts of this network and is able to regulate the stress response. So change, how you perceive stressors. And yoga's affect on this complicated network seem to be by by

modulating the prefrontal cortex. So that yoga might be helpful to temper the stress response during the critical periods. And other interventions besides the yoga affect these systems, but this is a yoga talk. So experiments that we included, we'll start with the perceived stress scale. This is how we measured stress during the confidence. And conference. And this is be validated measure of someone's subjective experience of stress over the past month, if this score can range from 0 to 40 which is high stress. And the other task we included is the go/no-go task. And this is a measure of executive function which is like that prefrontal cortex function. And specifically, the go/no-go task measures response and inhibition. Which is ability to have a motor response only with a certain stimulus. And you might be like, whoa, what does that mean? But you've all done a go/no-go task. This is no-go. So green is go and red is to not go. And so you're able to take a stimulus and know what motor activities to do. But, of course when you're doing this in a study, you make it harder than this. So I'm just going to give you an example of kind of fake acute go/no go task. I'm going to ask you to clap your dog every time you see a dog and not a cat. I'm going to move quickly so give this a try.
Okay, so you can see when it's like moving fast and something you're not used to trying to do, it's actually quite difficult. Right? To have that response inhibition to not clap your hands when you see a cat. And so this has been studied very extensively, this go/no-go task. Particularly in relation to stress. And so how does stress affect performance on-the-go/no-go task? The study I'm showing you here, participants were randomly assigned to either a rest condition which is the gray bar, or a very significant stressor. And it's actually really funny with the stressor. They made them stand up and present in front of people, which is like mean.
And what you can see is that the reaction time significantly increases with the stressor, right? So people, when you stress them out, their performance on-the-go/no-go task with their ability in response is impaired. But they then took other people and randomized them to the same groups of rest condition versus a stressor. But they trained them in regulating their stress response. And so what you see is that they have no difference. Right? So that means that it is possible to regulate the stress response and to prevent it from impairing some of these brain functions that we're so interested in.
So, again, just to reiterate how this is done, it's really the prefrontal cortex. I think that neuroanatomy wise, that's probably one of the most important areas you should know about after this talk. And this is just a beautiful picture showing some of the components of the prefrontal cortex. Okay. So during the conference, what did we actually do? So this is the experimental design on the left. Participants started by taking a go/no-go task and we're calling this 1. And we did a perceived stress scale called PSS1. And then they did a 60 minute yoga class with Eddie Stern that was virtual. And they repeated the measures of the go/no go stress and perceived stress score for us to compare. And we had a few hypothesis based on the prior research we talked about. So our first hypothesis was that their perceived stress score will decrease after yoga, because yoga will reduce the identification and experience of stimuli as stressors.
Our second hypothesis was that reaction time on go/no go 2. This will be lower than the reaction time on go/no-go 1 because yoga reduces the effects of stress. And third, that change and go/no-go task performance will correlate with change in perceived stress scale, because stress is the main draifer of

driver of the difference. So what did we find? Well, looking at perceived stress score, so before yoga is on the left. After yoga is on the right. We had 8 participants in this study. And you can see that there is a trend towards decreased perceived stress score. And this is pretty interesting, because this was a 60-minute yoga intervention. Usually when you do this scale, when you do the perceived stress score in other studies, you're doing it with yoga intervention weeks and weeks long. So they're doing yoga 2 to 3 times a week for 8 weeks or something. But even a 60 minute yoga class once started having this trend. So people perceived their stress as less in the prior months from just 60 minutes of yoga.
And this was not a significant finding. So you can always look at the P value which tells you what is the, what percent -- what is the percent likelihood this is due to chance? Meaning that it isn't due to the intervention, it's just due to random noise. And this shows us there's an 18% likelihood that this is due to chance. Which I still think is quite interesting.
Okay. And then forgo/no-go task performance, what we see is main finding is that there's a significant difference in the average reaction time. It decreased. And this wasn't really driven by change in the fastest trial. It was more driven by change in the slowest trial. So slowest trial performance seems to increase by decreasing reaction time. And I think that's all there is to say on this. Okay, the next slide. So this is where I think it gets really interesting. So this one was hypothesis 3, about how they will be correlated. And what we see is that before yoga, there's a relationship between their perceived stress score and their slowest trial duration. So each dot represents an individual in the study. Their perceived stress scores on the x-axis and their slowest duration is on the y-axis. And so before yoga, when they're at their slowest, it seems to depend on how stressed they are. And the amount of variation explained by the perceived stress score is 53% here, which is quite high for behavioral intervention. But after yoga, this affect completely goes away. You can see there's no relationship between them here. So this really suggests that yoga prevented stress from affecting their performance.
And I think that's really interesting finding. Okay. So just to summarize from the yoga and child development day, we hypothesized perceived stress score 2 will be lower than perceived stress score 1 because yoga will reduce the identification and experience of stimuli as stressors. And this is what we found. So there was a trend towards decreased, you know, stress perception of stress, which supports the model that yoga impacts higher order stress network in the brain. The second hypothesis was that the reaction time on go/no-go 2 will be lower than go/no go 1 because this reduces the effects of stress. And we found average reaction time was significantly improved after yoga, but I just want to emphasize when we're interpreting this, we have to remember that practice affects contributed to this. So we really should be comparing this to a controlled group to take away any meaningful conclusion from that. And then lastly, change in GNG performance will correlate with perceived stress score, because stress is what's really driving the effects in GNG performance. And really interestingly, this is what we found. Now, we have to be cautious. Sample sizes are very small in this and this can be tricky in correlation sample sizes but we cautiously report that slower reaction times on the GNG task were associated with higher perceived stress scores before yoga but not after yoga.
So this really is supportive of a model where yoga reduces the effects of stress on performance in the

go/no-go task. So I'm going to take a little pause so everyone can get their question in the chat. For the sake of time, we can come back to the questions. But take about 15 to 30 seconds, get your questions in the Q&A Box.
>> And one thing we'll add here is that when using the Q&A, you can actually upvote questions. So there's a little thumb there. And you're welcome to upvote any questions. We'll currently take the most upvoted questions sort of first as we work through all the great questions that are put in the Q&A.
>> All right. I'm going to move on to the intersection next section now. This was day 2 and this is all about yoga and brain aging. This is of particular interest to me. I don't know about you guys, but I feel like I'm aging rapidly. So what we focused on during the conference is how many chronic diseases affect brain aging, things like diabetes, high blood pressure and cholesterol and how it affects cognition and all these are prominent components of brain aging. For the experiments, we really focused on two things. One was mood, which we measured via the positive and negative affect schedule. And as a reminder, affect means mood here. And this is a validated subjective measure of the tendency to experience stimuli positively and negatively. So like you see a flower, some people experience it making them very happy. Other people are pretty neutral about it. Sometimes people see something that's actually pretty negative and some feel it really negatively. Others are kind of more neutral about it.
And then the second experiment was the concentration grid task. And this is just like a fun measure of sustained visual attention. And you basically have to find order number on a gigantic grid. I'm going show you what this looks like. It's a nightmare. So you have to start with 0 and then find 1, 2, 3, 4, and then 5. And you really have to sustain visual attention to accomplish this task. And now we should talk about how cognition change overtime as people age. So on the x-axis here, you can see age, 50RBGS 60, 70, 80, and what you notice is there's a normal range of decline in cognition overtime. And where things start to become abnormal is when it starts to impair function. And this is a term we're all familiar with, dementia. So dementia is when impaired cognition affects function.
At the beginning, this starts to impair higher order functions like dealing with your finances, balancing a budget, making poimentsz, showing appointments and showing up for appointments. This can affect brushing your teeth, dressing, feeding yourself. During the experiments that we're doing, we're really focusing on more of this normal range of aging. And how yoga affects that.
And just to give a little more of a breakdown how cognition change with age, there are two types of cognition we're going to pay attention to. So the first on the left is fluid cognition. Now this is not fluid, that doesn't mean anything is flowing. It's kind of just a weird term that was chosen in the literature. But it means this is cognition that change as we age. And it includes things like processing speed, attention, executive function, maybe verbal memory, like recalling words, recalling names, things like that. And what you can see from this graph is that with age, the fluid cognition tends to decline. But there's another type of cognition that stays constant. And this is what people refer to as crystallized cognition. This tends to be like factual knowledge, life experiences, and culture. And so people tend to always remember how to cook their traditional food. Right? P that they That they grew up with. Or they tend to remember their children's name. That's more accurate crystallized knowledge and we talked

about visual attention before. So just think in your head which is visual attention, is it more fluid cognition or more crystallized cognition? Okay. So I'm going to answer. It's fluid cognition. Right? Because visual attention is something that declines with age. And so that's what makes that concentration grid task such a good measure of normal cognitive outcomes. We're not measuring function, so we can't comment on abnormal. But we can look at how their fluid cognition is compared to other people.

And so we would expect someone's performance on something like the concentration grid task to decrease with age. And another really interesting thing about visual attention is that mood affects visual attention. And what they did in this study is they basically tried to influence people's mood with music. So they gave people music intervention and saw how their visual attention changed. Some of the people got a positive musical experience. Others got a negative musical experience. And the third group neutral. What you see is after the intervention, those who got a positive experience had improved attentional breath. Those who got a negative experience decreased. And those who had a neutral musical experience had no change.

And another thing that we know is that this is very strongly demonstrated in the literature. Yoga affects mood. And this study was from a two-week yoga intervention. So that was it. Just two weeks of yoga, couple of times a week. And they showed that on that same test that we were using in our experiment, the positive and negative affect schedule, there was a significant increase in the positive affect. So how likely someone is to perceive a stimulus as positive. And a decrease in the negative affect. So how likely someone is to perceive a negative thing as negative. And obviously, our intervention was much, much shorter than a two-week yoga intervention than like in this study. So for our intervention, we had a two and a half hour yoga intervention with ShriDemetra and yoga and meditation. And we're going to hypothesize the same results for our study even though the time difference, you know, even though it's not two weeks like in this one.

So for our experimental design, very similar to before, we had a concentration grid task. Positive and negative affect schedule. The yoga class. And then we repeated those two. Our hypotheses were that the positive and negative affect schedule after yoga will have more positive affect and less negative affect than before yoga, because yoga will improve mood. We also hypothesized that concentration grid reaction time or, you know, task duration time will be less than before yoga, because yoga will improve visual attention. And third, that the improvements in mood will correlate with improvements in visual attention, because mood is one of the main drivers of visual attention.

So let's see what we find. So for the first hypothesis, this was the duration of the task before-and-after yoga. And we can see that after yoga, there's about a 40 second decrease induration of the task. So people were faster after yoga. This was a trend. So it was not a statistically significant finding. And I will also add that there were probably a lot of practice avenue effects that contributed to this. But this was supportive of our model. For the second hypothesis, which is that yoga will affect mood, we see a significantly decreased negative affect score after just two and a half hours of yoga. There was a trend towards increased positive affect, but this was not statistically significant.

And then the really interesting findings, so the correlation, the third hypothesis, so what we see here is

that before yoga, people's positive affect, their positive mood was not correlated with performance on the task. But after yoga, the higher their positive affect, the more they interpreted stimuli as positive, the faster they were on the task. Negative affect did not seem to have any relationship. And so what this really suggests was after this yoga, we are seeing that the change in mood affect people's visual attention. One of those fluid cognition areas that change with age. Okay. So just to summarize our conclusion. So we hypothesized that a positive and negative affect after yoga will show more positive affect and less negative affect than before yoga. And we found a trend for positive and a significantly decreased negative affect. And this really suggest broad effects of yoga on many mood networks because our positive affect and negative affect network in the brain, believe it or not, are separated. And second hypothesis that visual attention after yoga will be faster, take less time than before yoga, because yoga will improve visual attention. We did see this again with the caveat there were practice avenue effects. So people might just be better at the task. And then our third hypothesis, the most interesting that improvements in the positive and negative affect schedule will correlate with improvements in the concentration grid task. And this is because mood may be one of the drivers of visual attention. And, yes, we did see this correlation of positive affect with performance on the concentration grid task, the visual attention task after yoga, but not before yoga.

And this strengthens the argument that some of the improvement and reaction time was related to yoga's affect on mood. Okay. So, again, I'm going to give you about 15 to 30 seconds to put all of your questions in the chat or in the Q&A Box. And remember to also upvote the other ones. Okay. So for the sake of time, I'm going to move on to the third section, and I'll do it little faster. So this is the yoga and addiction section. And this was very, very interesting during the conference. We had Taylor Hunt who is a yoga teacher who personally struggled with addiction and he's very open about it and yoga is a huge part of his recovery process and we had many people who studied yoga and mindfulness for addiction. And for our experiment, we really focused on two things. One is temporal discounting. And I find this fascinating. So this is our tendency to perceive the same objective value as less valuable in the future. So for example, if I offered you $100 today, or $100 in a month, forget inflation. Inflation doesn't exist. One hundred dollars today or $100 in a month, you would definitely choose $100 today. Why wait? But if I offered you a $100 today or $110 in a month, how would you feel? Most people would actually choose $100 today, even though objectively, $110 in a month is more valuable. They value things in the future as less, and that's why it's called temporal discounting. And the way we measured this is something called ED50 which is taken from pharmacology research but this basically asks how long does it take for the value to lose 50%? So at what point do you value $100 at $50? Is it 100 days? Is it 200 days? Something like that.

And what's -- I'll go in a more about temporal discounting and addiction in a little bit. So now we can talk about the Iowa gambling task. And so the Iowa gambling task is a measure of risk calculation in decision-making. So participants choose between high-risk high reward options and low-risk low reward options and this really demonstrates their risk tolerance. I'm really simplifying when I say all of that. There's much more to it, but that's kind of the big picture. So for temporal discounting, what happens is the task asks people, you know, do you want $100 tomorrow or $101.301 days later.

Based on how they answer, it keeps where they're breaking point is. So where are the two equivalent. And that's where the temporal discounting task looks like. For the Iowa gambling task, you start with $2,000, virtual dollars and not real dollars. And you choose A, B, C, or D and watch your money go up or down based on what you choose. And as you're doing the task, you're learning what's the risk, what's the reward of each of these options? And after you click one of the options, you might find out you won $100, but you're also going to lose $250. This is high-risk losing $250. And this is a table of what our paradigm looks like, similar to the Iowa gambling task which has been modified to a million different situations. But A and B are the same and C and D are the same. So those are the buttons people could click. So with A, they could gain $100, but they could also lose $250. For C and D, they could gain 50, but they could also lose 50. And how often would they lose? It would be about 50% of the time for all of them.

And so over 10 trials for A and B, you would lose $250 net. For C and D, you would gain $250 net. So rationally speaking, everyone should choose C and D all the time. Yet, that's not what happens. So people pursue higher risk, higher reward is based on their own internal preferences. And that's what this task is really measuring. And what we know about the relationship of addiction and temporal discounting is that it's demonstrating to be a really useful behavioral marker in addiction. So temporal discounting correlates with addiction severity and predicts treatment. And we know that temporal discounting like how someone is going to discount depends on certain genetic markers they have, and these same genetic markers are related to addition. Lastly, we know that some of the neural networks that underlay temporal discounting also underlie addiction. So there seems to be a pretty strong relationship emerging between addiction and temporal discounting. Same is true for the octane. If ing Iowa gambling task. This is addiction and Iowa gambling task relationship and they were closely related and it basically shows that people who engage in more higher risk, high reward behavior tend to have higher levels of addiction.

So for our experimental design, very similar to before. I think you're catching on to how we do this, so we had temporal discounting, Iowa gambling task, and then we had yoga intervention with Taylor Hunt and we repeated foam and Iowa gambling task after yoga. Our hypotheses were that temporal discounting after yoga will have a higher ED50, meaning people will be more patient, because yoga has this affect on kind of executive function and change how patient we can be. Second, that Iowa gambling task after yoga will show lower risk seeking because yoga will real estate do you see impulsivity. And lastly, the chawdges in temporal discounting will correlate in change in the Iowa gambling task, so high-risk, high reward, because yoga affects the same underlying decision-making networks.

Okay. So what did we find? So for the temporal discounting task, we found a trend towards increased ED50. So it's almost like people were 100 days more patient, meaning that things lost value slower in the future. They were willing to wait longer. So they might take the $110 in a month, because it was more objective and rational. For the Iowa gambling task, so we saw that reaction time significantly decreased. And of course practice avenue effects tributed to this. But we saw a trend towards increase high-risk high reward behavior. So what this shows is how likely they were to choose the high-risk high

reward. So at the beginning, it was like 50% of the time. But after yoga, it was actually closer to 60% of the time. So pretty interesting. We'll talk more about that.
And then for the correlation, I'm actually going to ask you guys. We don't have to open up the chat, but just look at this, don't let me know, but just think. Is there a relationship here between these? Do we see a correlation? Okay. So I'm going to tell you the answer. And it's actually no. And I bet a lot of people said yes, because it looks like these lines are slanted that suggests there's a correlation. But this is a really good lesson in data analysis, which is this is driven by an outlier. This is online reason why this looks like this. If you took this out, there would be no relationship among these other data points. And so, really, there was no relationship between temporal discounting or Iowa gambling task in our data sample. So either it's because our data weren't reliable or because these two actually are different networks and yoga is affecting them differently in different people. It's unclear, but for whatever reason, they were not related. And so just to summarize, we did find increased -- decreased temporal discounting. So people were more patient after a yoga intervention. And it was like by 100 days they were willing to wait.
And for Iowa gambling task, we actually found the on, right? So people were more risk seeking and one idea of why this could be is that it has to do with change in fear processing so people were less afraid after yoga class. I don't know, that's a speculative hypothesis. (Chuckles softly) And third that we would see this correlation, we did not see this. Okay. So please continue writing your questions as you're doing that. I just want to give a huge shout-out to the team of people who contributed to this. Rukmini, Claire, and they helped design and implemented these data so huge shout-out to them.
While you're putting more questions in chat. I'll tell you about our upcoming conference, which is going to be March 16 to March 19 this year. So 6 weeks away. And we're going to focus on different topics this year. Every year we do different topics. And this year we're focusing on yoga and trauma. Yoga and empathy. Yoga and neurological conditions, like stroke and epilepsy, and multiple sclerosis, and Parkinson's. So if you're interested, and you want to learn more about the confidence, please feel free to use this QR Code which I learned how to set up. [Laughter] Or the link here. And, yeah, I'm always open to questions about the conference too. I'm sorry that I ran a little bit late. But I am happy to take questions now. And I'm happy to stay as late as necessary. Thank you, everyone, for listening to me talk so long.
>> Thank you, Dr. Rosenthal. I hope everyone can see the wealth of knowledge that you bring and the enthusiasm that really is paired with that. So if you're interested in learning from Dr. Rosenthal and some other amazing folks, we definitely encourage you to attend the conference coming up in March. Jonathan, you're welcome to keep the slides up for a while. So just keep, I think that's helpful to actually keep this up for folks to access it if they desire it. The QR Code, you can take a smart phobe and Smartphone and put your camera on and point the camera at the QR Code and it should populate a link for you to click.
I have never in the many webinars that I've done with our amazing production team, selfishly and Tricia, I don't think I've seen so many chats and questions in the Q&A. So that just speaks to your way to engage folks, Dr. Rosenthal. There's 128 questions in the Q&A right now. And we will absolutely not

get to even maybe 1% of 128. But we'll get to 1 to 2% of them. So one of the upvoted questions is what kind of yoga classes that Yen, flow, or any other, was there breath work or meditation part of the class and I know you mentioned 3 other teachers. Darma and Eddie, and Taylor hunt. So tell us little bit about their lineage use or practice and if those classes included meditation and practice and Osina.

>> So what did the intervention include? That's a huge part of research, because if we want to replicate this and help people with what we learn, we have to know what they did.
>> Definitely.
>> So the yoga classes were all, they included posture, breathing, meditation and relaxation, all of them. The degree to which they included that varied and depended on the lineage someone came from. So Eddie Stern taught kind of beginner Osh Tang ga yoga class. Taylor Hunt taught an immediate. And Dharma shawt maha Shakti that is beginner class that is not beginner to anyone else but Dharma. And yoga afterwards. Yeah, I'm happy to go into more details, but they included every one of those components, Dharma also included some discourse on yoga lifestyle and ethics, and things like that.
>> Beautiful. And we heard that before from other researchers too that, like, for key exoantsz components of yoga practice to share therapeutic factor benefit from yoga includes os in a, physical movement, meditation, deep relaxation and breath work. And I love hearing that you included every class four of those elements but at different proportions based on the lineage use. The next question is what are your plans to repeat these studies and increase your number of participants? Alicia says the information is interesting, but it's hard to argue for yoga intervention in a professional and clinical setting with n of only 8. And this is something we hear all the time. Jonathan and I were at this symposium we mentioned, and I think this is one of the challenges across-the-board in yoga research, both casually and very, very scientifically. So do you have plans? Are you going to repeat something like this at the upcoming conference?
>> That is such an excellent important question. And the answer is, so there are people who have done much bigger randomized control trials that are way more convincing and meta-analysis that I have not presented. So body on yoga is way bigger just to be clear. And the plan is, yes, I really do want to expand the mission. Like mission of the neuroscience and yoga on online conference to include contributions to research. So during the conference, we do have these experiments, which serve a little bit of a research purpose, but also help educate people about how research works. At the end, we will be launching a study that people can participate in. So we will kind of be adding on to this, and including people in studies if they're interested. We will also be including any ongoing study that the researchers who are presenting. We have over 10 presenters from all over the world who will be sharing their work with us. And they will also have the opportunity to join their studies if they offer remote options. So that would be another way to kind of contribute to yoga research and improve the n's across all the studies.
>> I love that. We're always, even our last series that we did on, like, scientific research on yoga literacy, the third session was all about getting involved in scientific related research and a lot of folks

on the call tonight were at that webinar also. So actually having this like tangible opportunity to show folks like how to get involved and participant in yoga research as well as seeing like how to do quasi experiment versus fully controlled RCT. These are all exciting developments in the yoga science world. So thanks for sharing them with us, Dr. Rosenthal.
>> I love that.
>> Go ahead.
>> I was just going to say that I love that you guys are doing sessions on science advocacy and learning about the way to conduct science.
>> Yeah, I think the fact there's 151 questions in the Q&A right now continues to sweep this volume that folks are interested and we're hungry for it as yoga educators, or teachers, or clinicians. That there's a great desire to learn a little bit more. It is top of the hour. And Dr. Rosenthal, can we answer maybe one or two more questions? Is that all right with you?
>> I'm happy to keep going as long as it's acceptable.
>> Yeah, we'll see folks drop-off. So answer one or two more questions. Folks just asked again how long people spend in the breath practices. But I know you mentioned it varied. One other question that I think is a great one to answer from your perspective is what are the barriers to include more participants to do bigger studies? And I know that's a big question.
>> Yeah. So for this, for what I'm presenting, I will be clear this occurred during a conference that is a global conference. So people are attending from all over. And the experiments occurred at particular times. So let's say it's 5:00 p.m. That might be, you know, 10:00 p.m., 11:00 p.m. in Europe and that really limits people's ability to participate. And so that's one barrier for us. But across research everywhere, one of the main barriers right now is when you're trying to recruit people for a study, you take a flyer and you put it up, and put it in local stores or yoga studios and around the University and people have to come in and be there and it's a time investment for people. So otherwise, you know, people sometimes rightfully so are skeptical about research. People don't want to participate in research, because there have been times research has harmed people and this is a whole thing about ethics in research that has changed traumatically since the 1970s and it left a scar or stain on research. And it's important for all of us to hold research accountable, but still participate in it, right? We need it.
And so, yeah, I think those are two of the main barriers. I'm very interested in this problem, which is why part of the Yoga Alliance and conference will include asynchronous virtual study. So people will be able to actually join the study remotely on their own schedule eliminating our barriers, and then because it's virtual, they're able to participate from any geographic location and eliminating some of the other barriers. So I'm hopeful with this, we'll be able to increase the number of people participating.
>> Jonathan, thank you. And I've been that research coordinator running around with posters at NYU back in my grad school days. And I know how hard it is to recruit folks for research. So thanks for, you know, helping us in the trenches and sharing what that's like. And also finding this unique and explore active and creative ways to engage more of us in the yoga space in research as part as participants and as you might be able to tell already from the way Dr. Rosenthal has presented this material, if

you're looking for ideas or collaboration, and support, that he might have some great practices going on at the yoga and neuroscience conference. Well, that brings us to the end of our time together. I want to call out before we close, there are extraordinary questions in the Q&A. Lots of talks about where to find research on stress, and yoga practices, and proYam practices and specific questions about the research study and development and stress and brain function. And these are all really creative, thoughtful, and like intriguing questions. So I hope you will engage with us more in the future. We are also working to reduce the barriers to access for yoga. So it's really grateful for partner with Dr. Rosenthal for this webinar tonight. Please attend the upcoming conference. It's such an honor to have you. I know there was a lot of information shared tonight. So know that process might allow insights and questions to percolate as time goes on. And that we're really honored to be with you and I know you ice this practice daily. So thank you, Dr. Rosenthal, for being a leader in this space.
>> Thank you so much for having me. And I did promise I would share the slide. So I should uphold that end of my promise. These are papers and books that you can learn more about the things I presented.
>> Thanks so much, Dr. Rosenthal. The slides, Jonathan's slides will be posted with the recording of this webinar. So if you have caught the recording in the future, I hope the future is bright and we can't wait to meet you there. But thank you so much. And Dr. Rosenthal, I'm going to let you say the last few words in any way you like. It's been an honor to learn from you tonight.
>> So I did scroll through some of the questions and this is clearly an advanced audience who knows a lot. So all the Yoga Alliance is doing is really beneficial to our world. And I really appreciate all the efforts from Steph, and Cybill making this possible, this community of people learning together. And so thank you, again, for letting me be a part of it. And, yeah, I look forward to getting to know everyone as best I can a little more. I'm sorry time was limited.
>> Thank you! And have a great night or day, wherever you are. Thanks for joining us.
>> Goodnight, everyone.

