Last week for that [inaudible 00:00:01]. [APPLAUSE]. I think we had a really great event last week regarding the evolutionary psychology booster Hall. So thanks everyone for participating in that. Before we get to our esteemed speaker from today, Mike Frederick, I have a couple of housekeeping things. This particular talk is connected with the psychology department subject pools, and so our friend Jacqueline is going to be handing out little slips of paper. Raise your hand if you're in the subject pool and she will hand those out and make sure that at the end, after the talk, just make sure to get those back to her, make sure to fill out all the information with your best penmanship. Jacqueline is also the assistant to the Evolutionary Studies Program, and Tom Nolan from biology and science and engineering is the director, formally, of the Evolutionary Studies Program. If you're a student interested in signing up for this exciting 18 credit minor, you can see any of the three of us and we can help you get into the minor. So if you haven't yet signed up for the minor,
what are you waiting for?

It's a privilege for me to be able to introduce

Mike Frederick from the University of Baltimore.

I first met Mike when he was, 

I don't know how old, but it was 2007, 

so I'm going to say he was a kid. 

He gave a talk at the first ever meeting of 

the Northeastern Evolutionary Psychology Society, 

and I remember being deeply impressed 

with his knowledge and energy then, 

and I think that his knowledge has 

gone only up from there. 

So I'm really excited to have Mike back on campus. 

He is a product of the SUNY system. 

He has an undergraduate degree from Albany. 

He has a PhD from Albany, 

having worked in the esteemed lab of Dr. Gordon Gallup. 

He's been at the University of Baltimore for 

five years and is on a great path there. 

He's doing all kinds of service and 

has really proven to be a very strong academic. 

He's got lots of academic publications and research 

related to all kinds of 

cognitive processes from an evolutionary perspective. 

He is the co-author, 

first author of the article with Gordon Gallup on 

the learned taste aversion hypothesis related
to the possible theory
of the extinction of the dinosaurs.
You may have heard of that,
it's an alternative or compendium
explanation for the extinction of the dinosaurs,
which is really very evolutionary studies
based, and is very cool.
He has served as the Program Chair for
the Northeastern Evolutionary Psychology Society
on multiple occasions,
and we deeply appreciate all that work.
Apparently he is a champion
of Bagchi in the city of Baltimore.
Please join me in welcoming Frederick.

[APPLAUSE]
Thanks everyone. It's really great to be
back here in New [inaudible 00:03:01] .
So the hidden logic of bad decisions,
how development influences our Neurochemistry
and the choices we make.
Who hasn't made some bad decisions in life, right?
So what's going on there?
I'm going to tell you a little bit about
my own path to this area of research,
and then I'm going to discuss
an area known as developmental programming,
and so I'll explain what that's all about.
Then I'll discuss a theory known as life history theory and the implications that it has for developmental programming and behavior, and then I'll conclude with some applications and future directions before opening it up for questions.

So as Keron mentioned, I am a product, a proud product of the SUNY system, I went to the University of Albany for undergrad. I knew I was interested in psychology at that point, but beyond that, I wasn't really sure which area I was most interested in. I knew that I liked human behavior, but the brain, it's seems messy, really complicated, lots of memorization, and so I didn't really think that I wanted to study the brain per se.

I was interested in probing the depths of consciousness, a lot of that neuroscience stuff seems to be in rats and it doesn't really seem like what I'm interested in. But meanwhile, there's something that really didn't add up.

Why are humans so amazingly good at certain things, and yet we habitually do dumb things. So we have these sophisticated,
rational minds capable of weighing all sorts of information.

We have these brains that are able to not only control our bodies as they run, jump and climb around, but as they drive cars and fly helicopters and hurdle down snowy mountains on waxed planks of wood. These are not natural things, like how are we able to do this so masterfully, and write poetry and drama? Yet, we also do really shortsighted, stupid things. Regularly, our emotions get the better of us. We're impulsive we're fitful. Even though this causes us tons of intrapersonal and psychological problems, we seem to fall into these habits that aren't good for us.

So why is this? What's going on? Evolution. Evolution is the answer. This really started to come together for me when I took a class with Gordon Gallup at Albany in evolutionary psychology. You may have heard of Gordon's most famous work on mirror self-recognition. So in the original study, a chimpanzee, while the chimpanzee was asleep,
a red dot was painted on its forehead,
and then the chimp is allowed to explore a mirror,
and chimpanzees and orangutans,
but not other primates that were studied,
would eventually actually reach
up and touch the dot on their forehead,
which seemed to be an indication that they
connected the reflection to themselves.
They realize this is a reflection of me,
which is at least one way
to get a measure of self-awareness,
and subsequent research has shown
that certain elephants can do this,
at least one orca,
dolphins can probably do it,
possibly certain corvids, like New Caledonian Crows,
but most species don't have this ability.
So I thought that that was really interesting.
Evolutionary psychology as a field,
really explained for me how and why we have
these brains that are so powerfully good at
certain tasks and yet also so prone to errors,
fallacies, and short-sighted behaviors.
The reason is because our brains
have certain built-in tendencies and
predispositions leftover for
millions of years of natural selection,
and that's left us very
well-prepared to handle certain types
of tasks and challenges,
but much less well-prepared to handle other tasks,
especially many presented by the modern social world.
So looked at this way,
some behaviors that humans have are hardwired,
or really probably the better term is soft
wired because they're not inflexible,
and you know, it's not like a reflex,
like it always happens.
But there's still some flexibility and
yet we have certain tendencies, certain urges,
certain predispositions, and many
of these are actually left over from
evolution and natural selection over the years.
This is especially true for any behaviors that relate
to survival and reproduction.
Evolution explains many of the strengths and
weaknesses in human nature.
This universal humanness that ties us all together.
We were good at some things,
less good at other things and
evolution really helps to explain this.
Also though, the evolutionary perspective can
take us in new unexpected directions.
When I first started studying evolutionary psychology,
it was interesting in the sense that it was
the nature side of that classic nature nurture debate.

It was all about instinct, your genes,
certain things you're stuck with you're born with,
you can't change them.

This is true, but now we know that there's
this whole landscape of in-between influences,
epigenetics, and ways in which
genes can be tweaked by the environment.

It turns out it's not all about instinct,
it's not all about inflexibility.

There's this whole world of
possibilities in between nature and nurture,
involving complex interactions between the two.

A good understanding of
evolution can really help us when we approach these.

Also, evolution really ties
behavioral science to biology in a fundamental way.

Behavior as a product of brains.
Brains are a product of evolution.

Brains are flexible in many ways but not in every way.

That got me thinking, okay
I guess I have to study the brain, right?

Maybe the brain is important after all.

Seems kind of important if
our behavior is determined by the brain.

Then I went to grad school.
I stayed at Albany for grad school and enrolled in the biopsychology program.
I was kind of nudged away from cognitive into biopsychology and I ended up loving it.
At a certain point, I just reached
this tipping point in terms of
my knowledge of the brain
and it only took a few classes really in neuroscience.
At a certain point it's like,
oh, the brain is like this system.
It all kind of fits together.
I grew to love the brain.
All those studies that I thought were not particularly relevant in rats,
turns out lots of that stuff is actually very relevant.
Turns out rat brains are a lot like human brains and rat behavior,
in certain respects, is often like human behavior.
That's kind of the brief story of how I learned to love the brain.
I worked in Gordon's lab in grad school studying the brain but also human evolution.
I took a variety of physical anthropology classes.
I really think that evolution,
I mean, we often call the field evolutionary psychology,
but it's truly interdisciplinary and extends out beyond just psychology,
pulling in areas of physical anthropology,
biology, economics, and so on.
Meanwhile, I tried to learn everything I could about
the nature nurture debate and the nuances of it.
Funny side note, around this time,
I knew I was adopted from a young age,
but around this time I was actually
contacted by my birth mother.
In my mid-twenties I actually got to know
my biological family and from then
I had this anecdotal nature
versus nurture thing going on
in my own life, which was fascinating.
Then I took a class in anthropology
with Larry Shell called fetal programming.
This really had a big impact
on me and kind of shaped
the direction that I went in the field.
What's programming? What is
fetal programming? Programming is when a stimulus or
stressor early in development has
lasting or even lifelong significance.
And if that stimulus or stressor occurs before birth,
well then we have a case of fetal programming.
What's the fetal environment look like?
Well, the fetus is sheltered from
a lot of outside environment,
but is fed nutrients and also
hormones including stress hormones that
pass through the placenta into the fetus.
So the fetus is basically getting a sense of
the outside environment indirectly through the mother.
You can screw up development.
If you stress out an embryo,
stress out a fetus, stress out a child, it's not good.
It's going to mess things up,
disrupt things, bad things happen.
We all know this.
Not surprising, right?
But even though stress
is bad often and it can have negative effects,
that's not actually the entire story
because we can also have responses to stress.
Sometimes those responses are
adaptive in certain situations.
A big part of this story
revolves around something that became
known as the Barker Hypothesis.
This guy, David Barker,
was an epidemiologist in the UK.
He was studying patterns of disease and mortality.
In the eighties he noticed there were
some interesting patterns in
the research and the data he was looking at.
Here's a map showing where people in the UK were dying of heart disease between 1968-1978. It's a little hard, I mean that, the scale is a little counter-intuitive here, but the light gray means the lowest death rates.

You can see that's mainly around like the Southeast parts, affluent areas around London.

Then if you look at the highest death rates, we find those in parts of Wales and Scotland. That already was a bit interesting because particularly at this time, heart disease was considered a disease of affluence.

That it's only when you have the luxury of living a sedentary lifestyle, sitting around and eating chips all the time, that's when you end up developing heart disease. But here it turns out, that it was actually places with the lower incomes and higher rates of unemployment that had the highest death rates from heart disease.

There wasn't a drastic difference in availability of modern medical care so it wasn't immediately clear why it is that the death rates from heart disease are higher in the less affluent areas. Then Barker came across another map.
This one is showing infant mortality, but we're going backwards in time, 60-70 years. This is between 1901 and 1910. But the maps look by and large similar. It turns out that those parts of Wales and Scotland, where people were dying of heart disease in the 1670's, going back to the early 1900's, that's where the most babies were dying, and since most people tended to stay around the area where they grew up, Barker inferred that this was basically the same population, the places where infants were dying at a higher rate, those that didn't die, when they grew up and became adults, they were more likely to die of heart disease. Why? What's going on there? What could be the link between infant mortality and late-life mortality from heart disease? To get to the bottom of this, Barker and a colleague went through a whole trove of medical records. They have longitudinal data on people, they examined thousands of medical records, and what they found was that you could predict the risk of dying from heart disease, based on birth weight. So birth weight predicts
risk of dying of heart disease later in life, and heavier birth weights lead to individuals that are less likely to die of heart disease.

Now, you might expect this at the extreme ends, because stress is bad, so if you're very underweight, or very overweight, even as a newborn, that could be associated with negative health impact, health effects that stick with you. But more interesting is that it's actually a linear effect, in the middle range.

So yes, at the extreme ends, if you're born at nine and a half pounds, you had only half the risk of dying of heart disease later in life, as someone born at five and a half pounds. But in the middle range, each increase in birth weight, actually gave you a little bit more protection against dying of heart disease later in life. And it's not just for death from heart disease, it turns out that lower birth weights also are associated with higher blood pressure, increased cholesterol, increased likelihood of type 2 diabetes, and in general, the metabolic syndrome,
characterized by high cholesterol, obesity, and heart disease.

Barker's big idea here, and the thing that became known as the Barker hypothesis, is that this fetal programming we're observing, is actually adaptive. That undernutrition for a fetus is a signal, and that fetus is basically getting a sense of the outside environment based on the nutrients coming from the mother. So what's the signal when there's poor prenatal nutrition? The signal is, you're about to enter a world where food is not plentiful, where resources are scarce. And so to the extent that you can prepare for that, do it. And so according to the hypothesis, the organism then adopts something called the thrifty phenotype, where biology is adjusted and you then have an individual that has a low resting metabolic rate, so they're not just burning calories when they're not active, and a metabolism that's going to store extra calories away as lipids. And these are all things that help you if you're
in a nutritionally scarce environment.
Problem, most of us are not in
a nutritionally scarce environment,
particularly in the developed world.
However, even though pregnant mothers are often well-fed,
that doesn't mean that they always have a heavy baby.
There's something called maternal constraint
that limits the flow.
But all the fetus knows is
the nutrients that it's getting,
so if the fetus is getting fewer nutrients,
according to the Barker hypothesis,
it's going to adopt the thrifty phenotype,
and therefore end up
possibly being at greater risk of metabolic syndrome.
This is a trade-off,
and this is an example of
one example of a life history strategy,
which is something I'll come back to later.
But trade-offs are all about costs and benefits,
or risks and benefits.
In this case, the benefit of
the thrifty phenotype is, you don't starve.
If the environment actually is low in nutrients,
being thrifty could save your life,
could save you from starving early on.
What's the downside?
Well, later in life, when you grow older, you're going to be at greater risk of health problems, like heart disease, and even death. And it turns out, and maybe some of you know this already, but natural selection has less and less influence over you as you get older. Because basically from the point of passing on your genes, once you've reproduced, that's it, right? And so, if something helps you survive before you reproduce, but then the cost is that you die, but probably not until after you reproduced, that's a gamble that natural selection wants to take. Natural selection would rather have you be certain to survive early, even if you are at greater risk of dying later in life, when your survival is less vital for your inclusive fitness in the next generation. Now, that's very interesting, but of course, you can't do a controlled experiment in humans for this, to study the thrifty phenotype, we can look at cohorts' quasi-experiments. So for example, there's a cohort called the Dutch Hunger Winter cohort,
which was a population in The Netherlands, that was nutritionally deprived, while they were occupied by the Nazis. And follow-up studies on that population had found that indeed, the babies who were undernourished during that time, in utero, they are at much greater risk of heart disease and metabolic syndrome later on. Still, though, it's not an experiment. To do an experiment, we have to use an animal model, and the experimental evidence in rats has now confirmed that, yes, the thrifty phenotype thing applies to rats as well. If a mother rat is undernourished while she's pregnant, but then her offspring are fed a high-fat diet, only then do the offspring end up putting on more fat, and having a tendency towards diabetes. So that suggests the offspring is making a prediction, but if the prediction is incorrect, and I prepared for a scarce resource environment, but then there's actually plentiful nutrition? Well, then there's a health cost to that. But it's not as bad as the health cost of the opposite, where if I prepare for plenty of nutrients, and then I find myself in a scarce environment,
I starve to death early on in life.

So this has been stated to be

one possible case of

something that we should expect more cases of,

a predictive adaptive response where the organism

adjusts development in anticipation

of the future environment.

Other examples could be like adjusting

to altitude or climate.

You can move to high altitude and acclimate to a degree,

but you'll never be quite

as adapted to that high altitude environment,

as someone that actually grew up,

and was raised in that environment.

So we lose some flexibility as we age.

According to this, the problems occur

when the prediction is incorrect.

If you prepare for one environment,

you end up in a different environment,

that's the one that puts you at risk.

One great thing about animal studies,

is that we can really probe

the nuts and bolts of what's going on,

and look for the underlying mechanism,

in ways that are not as possible in humans.

And so studies in rats, and other species,

have found that epigenetics actually
underlies many of these programming effects that we observe.

This programming is really fascinating, because someone who's always been interested in nature versus nurture types of issues, this is kind of in-between, because it's not learning, like your biology is shaped, so it's not like learning in the traditional nurture sense.

But it's not completely fixed, it's not in your genes, it's not in your DNA, you weren't born with it necessarily, it's also shaped by the environment. And so it turns out this often involves something called epigenetics.

Epigenetics is basically the packaging, the molecules around the DNA, and how the DNA is packaged. So DNA can be tightly wound up, in which case the genes are less likely to be turned on, or they can be unraveled, in which case those genes become more readily usable.

Although you are stuck with the DNA that you inherited at the moment of conception, you can adjust which genes you use,
by tweaking the epigenetics around those genes.
So the packaging of our DNA affects expression,
and this can have all kinds of consequences,
because your gene expression influences lots of things,
and during growth, it influences even more.
So your entire neurochemistry,
the structure of your body and your brain,
all these things could be
flexible to a degree epigenetically.
I thought all this stuff was really
interesting, Barker hypothesis, metabolism,
but it's not really psychology,
so me coming from a psychology background,
I wanted to know,
well what about behavior?
Can we apply this programming to behavior?
And it turns out I'm not the only one to have this idea,
this is part of a growing area.
What about the possible behavioral programming
of certain traits?
What kinds of traits?
Well, we know that people are different,
personality psychology is a field that studies how people
differ in relatively stable ways from one another.
Well, maybe personality can sometimes be
shaped by your experience in the environment,
and the epigenetics that result.
Any ideas actually for like, do you think of like a personality trait, like something that some people are really high in, and other people are really low in? Can anyone like think of one that would make sense in one environment but not in another? So the traits we think, like extroversion versus introversion, like assertiveness, aggression, impulsivity, neuroticism, any thoughts? Yeah, at the back.

Yeah.

Interesting, yes. So if you're not getting attention in the home environment, possibly being extroverted could be adaptive if it leads to you forming connections with other people.

I like that. Yeah.

Maybe narcissism [inaudible 00:26:40]

Yeah.

Narcissism seems to pay off sometimes. Certain people, despite their narcissism, seem to get pretty far.

But on the other hand, can narcissism backfire? Yeah.

Yeah, right. You could basically wall yourself off.
Nobody's going to want to deal with you. Nobody's going to want to cooperate with you if your narcissism is too much for them to put up with. That's a great one.

One way that environments can vary is between a really harsh environment or a really nurturing environment. A harsh environment is one that's dangerous, unpredictable, competitive, has scarce resources and has a high pathogen load. A nurturing environment, it's the opposite of those. It's safe, it's stable, people are cooperative, it's not as cutthroat, resources are more plentiful, and pathogen load is lower.

So maybe certain personalities are better suited to one of these than the other. If so maybe that can help explain those bad decisions that we constantly make. If we're often doing irrational things, why is this? Why do we lash out at people? And why do we often act in ways that are shortsighted? We can think of those traits. Being shortsighted is impulsivity. Lashing out at people is aggression. Like gambling your money away at the casino, that's risk-taking.
Doesn't seem smart. I'm not a gambler, so I have trouble relating to people that are willing to see their money basically trickle away as they play games of chance that are rigged against them. But there's a lot of research on risk-taking, even in animals. Risky foraging theory says that if you're not getting enough food, doing what you would normally do in the environment, it's time to take risks. If the environment's not meeting your needs, now it's time to take risks. Because trying to play it safe is not working, so now a gamble is better than a sure fail. So there's ways in which risk-taking can actually become the smart move. Let's think about impulsivity. Impulsivity is a preference for immediate rewards. Traditionally in psychology we frame it as maladaptive, that it's a failure to plan ahead or you didn't take all the information into account. But impulsivity can actually be adaptive. There's a really great paper by Daly and Wilson on this, where they argue that, especially in environments that are harsh, where competition is fierce or where mortality rates are high,
impulsivity becomes the smart move.

Think about this, you're a primate living in the forest, you eat fruit, that's a big part of your diet.

The ripest fruits are the most nutritious.

We all know that. They're the tastiest, they have the most sugar in them.

Flowering plants are really fascinating from an evolutionary perspective because when flowering plants came on the scene, suddenly there was an incentive for plants to attract animals, where before, it just wanted to avoid getting eaten by animals.

But now animals can help the plants by dispersing pollen and seeds.

Now plants start to evolve these ways to entice animals to come visit.

One of these is through offering edible fruits, which then became a major part of the diet of various species, like many primates.

So you're a primate, subsisting on fruit. You know, you want to eat the ripe fruit, and maybe there's a bunch of fruit that's not ripe yet.

What's the smart move then? Assuming you're not starving, the smart move is to wait until the fruit ripens. It'll be much better. You'll get more out of it.
But what if competition is really fierce?
What if there's not enough fruit to go around?
Now suddenly eating the fruit
before it's ripe starts to make a lot more sense.
Because if I wait until this fruit ripens,
somebody else could come along and eat it first.
So now, I'm better off
eating that less nutritious piece of fruit,
because the environment,
and really the social environment, is different.
You could apply this also to sexual behavior.
Being sexually impulsive or
promiscuous can sometimes incur costs and risks.
But on the other hand,
it can sometimes boost reproductive success.
Often we like to
not reproduce until we find
the ideal long-term pair-bond partner,
but what if things are just too
chaotic in the environment?
Like what if it's just so unlikely that I'm going to
find someone and we're going to have
a stable long-term relationship?
Then at a certain point,
it starts to make more sense to be promiscuous,
because at least then I have a shot at reproducing.
Whereas otherwise I'm waiting for
this ideal situation that never happens.
If that's the case, this could be
an example of what we could call
a fast life history strategy.
A fast strategy is one that
makes more sense in a harsh environment,
and I'm going to say more about that in just a moment.
But it's very interesting
to me that these traits, impulsivity,
aggression, risk-taking, these are all heavily
influenced by hormones and our neurochemistry.
Those hormones and that neurochemistry can be
shaped by epigenetics and by development.
Even risk-taking, I don't know if you're aware,
but when people are given
dopaminergic drugs to treat Parkinson's disease,
that can sometimes help the symptoms
of Parkinson's for awhile but there are
various side effects to taking these dopaminergic drugs.
One of the side effects is
actually an increased likelihood of
impulse control disorders like pathological gambling,
risky sexual behavior, compulsive shopping.
These all become more likely when someone's
taking a dopaminergic drug because that
influences our neurochemistry and then that actually
shapes what we're willing to do in life.
So all of these are susceptible to the epigenetic programming that I mentioned before. There's some really fascinating research on grooming in rats. Little newborn rat pups are basically blind and pink and hairless and helpless, and they are fed and cared for and licked and groomed by their mothers. But there is variation into how much licking and grooming the pups receive. In the lab, we can manipulate this experimentally. So if you remove the mother, and the pups are not licked and groomed by the mother, they're just fed and nourished, they end up developing differently, in terms of how sensitive their stress hormone receptors are and how sensitive they are to stress. So the rat pups that are not licked and groomed end up having higher levels of corticosterone, which is a glucocorticoid like cortisol in humans. Then those offspring are actually higher in anxiety. Then if they're female offspring and they go on to have their own litter, they're actually less likely to lick and groom their own offspring in the next generation. Whereas those that are licked and groomed a lot,
they have lower levels of stress hormones, lower anxiety, and tend to lick and groom their own pups quite a bit. It turns out as an experimenter, you can actually substitute for the licking and grooming with a Q-Tip. That is, you can actually just pick up the little rat pup and stroke it with a Q-Tip, and that tactile stimulation is enough to trigger the less anxious phenotype. So it's really fascinating that tactile stimulation is somehow translated into epigenetic tweaking of these glucocorticoid receptors in ways that affect behavior. So it involves epigenetic tweaking of stress hormone receptors. It might be adaptive because, think about this in a kind of naturalistic setting. If a rat mom is not available to lick and groom her her pups very often, what does that mean? It could be that maybe the environment is harsh. Maybe she has to be out defending the nest or looking for food, so then the pups basically are not getting as much licking and grooming because the environment is stressful. But then if they develop being more anxious,
that might help them in a stressful environment.

Being easily stressed out,

although they might get

rat ulcers or develop an anxiety disorder or something,

but at least they're

surviving the predators and threats in the environment.

So being especially jumpy,

especially reactive,

might serve you well in a stressful environment.

All of this actually involves

the hypothalamic pituitary adrenal axis,

which is the hormonal axis that

releases these stress hormones.

Maybe a less attentive mom is

basically a signal that times are tough

therefore the offspring become extra vigilant to threats.

I'm going to turn to this thing

I've been mentioning, life history.

I've mentioned life history strategy,

well, what is life history theory?

Well, we can trace life history theory

back to a concept that was outlined in

1967 by MacArthur and Wilson when they proposed

the r-K scale of reproductive strategy.

They were biologists, they were looking at

cross species and this is,

I mean, in a way it's a
common sense thing that we all know.
Some species play the numbers,
they just have a massive number of offspring,
most of them die, hopefully a few of them survive.
On the other hand there are species that
have only a very small number of offspring,
but at much higher survivability and
often much higher levels of parental investment and care.
We often think of rabbits as
the prototypical rapid breeders
that are going to have lots and lots of baby rabbits.
That's true, a rabbit can reproduce about 12 a year.
But on the other hand, if you think
about it in the grand scheme of things,
all mammals are really over here on the K side
which is the having
fewer offspring but investing more in them.
The way I try to remember it is
like r side is just reproduce,
reproduce, reproduce lots and lots of offspring.
The K side is reproduce with care.
So you're going to care for
your offspring, not have as many.
What's the defining feature of
a mammal? Anybody know this?
Nurse their young.
Yes, mammary glands, nursing your young.
That's the defining feature of a mammal. Any creature that nurses its young after they're born is already on the K side of things. You're putting investment into them as opposed to just laying a million eggs and walking away. It turns out an oyster can reproduce up to 500 million other oysters in a year, and then you've got various fish and reptiles, basically more on the R side of this spectrum.

Where do humans fit? Pretty far on the K side, not all the way though. Actually, a human, naturalistic setting it's estimated probably about one child every three years during the reproductive period. A gorilla one every five years, and then we have certain porpoises and whales who have longer periods. Elephants, longer periods of care in between successive offspring. Humans are on the K end but not quite as far as a few other mammal species. There's a trade off here, do you go for quality or quantity of offspring? Do you have a few but you try to give them the best chance possible, or do you just play the numbers and go for quantity?
Life history theory then says that the timing of development is shaped by natural selection to maximize reproductive output. The timing could affect lots of different things like how long you stay in adolescence? When do you reach sexual maturity? When do you first reproduce? How many offspring do you have? How much do you invest in each offspring? Even how quickly you age and how soon you die. These could all be shaped in ways by the environment. According to life history theory each individual adopts a particular life history strategy based on various factors including genetics, but perhaps more interestingly including environmental cues and possible epigenetic changes that go along with them. Here we can take the r-K scale and look at it in a new way where at the K end we have a slow strategy where you develop slowly and carefully, wait a longer period of time before reproducing. On the R side, we have the fast strategy, reproduce as early and often as possible. This is known to vary across species, which is how it was originally looked at. Now subsequently people have looked at it
within species, including humans.

Do some humans seem to go for the quantity versus quality approach of reproduction?

I would argue, yes,

I have a brother who has five kids.

Me, I'm the older brother,

and me and my wife are like,

are we ready to have kids yet?

I don't know, clock is ticking.

So it's completely different approaches in a way.

There could be a range of strategies going along this slow to fast dimension.

At the slow end, we've got the live long and prosper approach, like Dr. Spock.

Live carefully, plan, be rational, develop carefully, slowly,

acquire resources, find the perfect mate,

have a nice secure setting, nice secure status,

and only then think about reproducing but invest a lot in those offspring.

On the fast side,

we have the live fast/die young approach. Any M.I.A. fans? Live fast/die young is you just need to reproduce as fast as you can, times-a-wasting.

On the slow end, we grow slowly and carefully,

wait to have kids until we're sufficiently
wealthy and paired with the ideal mate,
invest heavily in a few children.

On the fast side, we develop quickly,
reproduce early and often,
and we invest in mating rather than parenting.

Other things that might go along with this?
Well, maybe a slow strategy
involves a lower level of aggression?
Maybe that would be better suited to
a more stable environment?
Maybe they're more cooperative, less promiscuous?

On the fast side, well,
those individuals, maybe they're more competitive?
Maybe they're more threat sensitive,
and maybe they are less sexually restricted?
That's the basic theoretical side of this,
the reason why we think it's possible and, in fact,
likely that lots of our behaviors are shaped by
epigenetic programming by way of
our neurochemistry and hormones.
Let's look at some evidence that lines up with this.
One study in the UK in 2010 looked
at longitudinal data and they were interested
in teen pregnancy when
women would become pregnant at a young age.
They did a longitudinal study,
so they actually surveyed women at age 16.
They asked them, when do you want to have your first kid?

How old do you want to be when you have that first kid?

Not a lot of them said at age 16 or 17,
but quite a few said,
"I want to have my first kid at age 18 or age 19."

A few said a little bit
later but basically many of them actually
said they intended to get
pregnant at a relatively early age.
That predicted when, later on,
they actually did get pregnant.
An intention to have a kid earlier
led to them actually having kids sooner.
If you look at the numbers you can see
that many of these young women were actually
having their first kid a couple years after
they said originally that they intended to.
That's kind of interesting
because from a public health perspective,
teen pregnancy is often viewed as a failure to educate.
That if we could just inform people,
make sure they know about
contraception and have access to it,
and understand the benefits of waiting,
that they won't be getting pregnant anymore.
But here we see that there's some intention to this.
That often people actually want
to have kids at a younger age.

If that's true, that could be a short-term making a fast life history strategy- times-a-wasting, reproduce quickly.

Well, if that's the strategy, then what are the cues?

What tends to nudge certain women onto the faster trajectory?

In this particular study, the two predictors that jumped out were father uninvolvement and low birth weight.

Both a father not being around, which could be an indication that stable pair bonds are less likely, and low birth weight which could be an indication that the environment is harsh and nutritionally deprived.

Those two factors tended to lead the women to both want to get pregnant sooner and actually do that.

Another study actually also looked at birth weights, and they looked at neighborhood deterioration. So they weren't interested in the overall wealth.

So they controlled for socioeconomic factors, ethnic effect, and just overall wealth.

Then on top of that, they looked at the deterioration factor. So were the neighborhoods really nicely
kept up with manicured lawns
and fresh paint on the houses,
or is the paint peeling
and there's garbage strewn around,
broken windows and such.
It was found that even after you
control for socioeconomic status,
the women who were getting pregnant in
the deteriorated neighborhoods tended
to have children with lower birth weights.
So what's going on there?
Well, perhaps the deteriorated neighborhood
is a signal to the mother that says,
the environment's harsh, so you
should pursue a fast strategy.
What's one part of a fast strategy?
Investing less in any one offspring.
I want to have lots of offspring,
but I want to not put all my eggs in one basket.
So, from the pregnant mother's perspective,
of course, not consciously,
but her body may actually be
restricting the flow of nutrients to
the fetus as a way to hedge
her bets and save some for the next offspring.
Meanwhile then,
what does that under-nutrition do to the child?
Well, it's a signal that
the environment is harsh and that leads to,
among other things, the thrifty phenotype
that we talked about.
In general, that child's going to develop in ways
that prepare it for a higher stress life.
Then the mother is getting the signal
from the environment that says,
don't over-invest in this current child
because times are tough,
this child might not make it and you want to
basically spread the resources around among
as many offspring as possible.
So turning now to
just some applications and future directions for this.
Why do people make bad decisions?
Well, often, I think if we look closely,
decisions that seem misguided
have some kind of underlying logic,
maybe that does or doesn't fit the situation at hand,
but either way, there's kind of this leftover logic
left over from evolution.
Being aggressive and impulsive might
not serve you very well in many cases,
but there are certain environments,
particularly harsh ones, in which
those behaviors actually do pay off.
So as Allen Wilson said, especially if the environment is very unpredictable or dangerous, impulsivity starts to become actually the more rational move. But on the other hand, planning ahead too much can have its own drawbacks. So when you think, if you're very fast end of the spectrum, you might do short-sighted things, you might make decisions that backfire later and then you come to regret later on. But if you're on the other end of the spectrum, on the slow end, you're constantly trying to plan ahead, constantly trying to anticipate what's going to happen and meticulously plan everything. But that doesn't always work out so well, does it? We can't plan for everything. What is worry about the future? Anxiety. Anxiety disorders are one of the biggest categories of psychopathology. So tons of people suffer from too much anxiety, and too much anxiety could be worry about the future, over planning. So being too much on the slow side of
the spectrum could have its own drawbacks.

Marco Del Giudice has proposed

that this fast-slow spectrum could actually
help explain cycle pathologies in various forms.

So still kind of
early in the stages, kind of theoretical,
but there's some evidence that
possibly externalizing disorders like
anti-social personality disorder might
be better suited for a fast environment.

Schizophrenia, possibly extreme fast.
For OCD the endogenous types, that is,
the type that have intrusive thoughts,
might be a fast spectrum disorder.

Depression, it's unclear. ADHD, well,
to the extent that impulsivity is
kind of a hallmark feature of that,
then yeah, that would fit with the fast strategy.

How about the slow end?
Well, we know individuals with
autistic spectrum disorders tend to
get very attached to routines.
They like things to be very predictable,
it's distressing when there's deviations from routine.
That sounds like it could be
maybe an extreme slow manifestation.

OCD, in this case we're
talking about the reactive sub-type.
So these think like your compulsive organizers, compulsive hand washers, right?
Always worried about what could happen, trying to plan, over-plan, over-organize.
That could be an extreme slow manifestation.
Eating disorders have been suggested to possibly be an extreme slow spectrum.
It's interesting too, from the reproductive angle, because an eating disorder could actually physiologically delay your ability to reproduce.
So it could actually be a very, very unhealthy form of birth control in a way, and a way to delay reproduction.
Generalized anxiety, worrying too much about the future. Too much planning, over-planning.
So the point here, it's still early, but we need to understand this programming and all the epigenetics beneath it to really understand and treat mental illness.
So current research trends, how exactly do we measure this strategy? So if you're a fast strategy or a slow strategy.
One of the most commonly used scales is up here, it's known as the Mini K. So there's items like, I don't give up until I solve my problems. I avoid taking risks.
I have a close and warm romantic relationship with my sexual partner.
I get emotional support and practical help from my friends.
So the degree to which you agree with these statements is indicative of a slow strategy.
So more agreement with all these items tends to mean that the individual is thought to be more slow, more of a planner, and less of a fast strategy.
You can see some of it is also social about the connections that you have.
Because another part of this theory says that in a very harsh environment, unpredictable environment, competitive environment, you can't really rely on cooperation from others.
Be they relatives or friends or your community, you're more likely to just go it alone in a fast strategy, or is it a slow strategy.
The status quo, the stability is working out for you, and so therefore forming relationships with authority figures, but also with friends and family that tends to be more characteristic of the slow side.
There are some issues with this as a measurement scale.
People have been working on trying to
refine survey measures for life history strategy and improve the ways in which we try to assess whether people are fast or slow. But, recently it's been suggested that, well, maybe it's not just uni dimensional, maybe it's not just fast versus slow. One view says that maybe there's two types of fast. I said before that the research often shows that if offspring experienced stress very early on, they grow up to be more sensitive to stress, and so the rats that are under groomed grow up more sensitive to stress. They're more jumpy, they're more reactive, their stress hormones tend to spike more in response to threats in the environment. That seems to happen up to a point but interestingly, the research seems to indicate that if your stress levels stay high enough for long enough, it flips the other way and then you actually have less reactivity to stress. Basically, as your environment starts to stress you out, you move from a slow strategy to a vigilant strategy where you're very sensitive to and responsive to threats from the environment. But, if those threats are so intense and numerous that you can't cope with them,
you basically flip and try the other strategy
which is to ignore it as much as possible,
not be as physiologically reactive.
In fact, we see this when people are experienced to
extreme stress over a long period of time,
they start to show a flattened cortisol profile
where their cortisol levels are,
or stress hormone levels are actually lower and
flatter as a consequence.
That's two different opposite forms of fast in a way,
things are nice and stable and not stressful
if you go for a slow strategy.
But as things get more stressful,
you might try the vigilant approach,
and then if that doesn't work,
now you just become unemotional, less reactive.
You basically become numb
to all the stress in the environment.
Vigilant is high reactivity,
prone to anxiety and depression,
and higher in reactive aggression,
as I'm more likely to react
if someone aggresses against me.
The unemotional type involves low stress reactivity,
lower levels of empathy,
and an increase in impulsive and competitive behaviors,
as well as an increase in proactive aggression.
You're less emotional, less empathetic, less considerate, insensitive to the way other people feel, and therefore more likely to employ strategies that end up harming other people. Many people are working on ways to measure the strategy side of it, the outcome. That is, how do we assess what type of life history strategy one has, is it fast? is it slow? Is it a certain type of fast? But, what about the other end of it? That is the programming side of it, the influences. I feel like we haven't made as much progress in this area actually. Many of the studies I showed you use birth weight. Birth weight is one measure of developmental stress, but it misses a lot. First of all, it's at birth and then it doesn't capture anything that happens to you after birth, and it's one measure at one time based on your nutrition basically. So then what other things could we use? Well, you could try to use like maternal surveys and ask the mothers if they were very stressed during the pregnancy? Sometimes socioeconomic status is frequently used that if you grew up in a low SES household,
then that could be something that would nudge you towards a faster strategy.

But, none of these are really great.

Socioeconomic status when it's self reported especially, it's very prone to bias,
and like we said, birth weight has its limitations.

Self-reported childhood SES, not really the best, bio-markers are better.

A bio-marker is an objective measure that you get that's not susceptible to that subjective human bias, and it reflects a biological condition.

Birth weight is a bio-marker, it's an objective measure at one time it reflects something physiological.

Others include hormone levels.

Currently, I'm very interested in a protein called interleukin 6, or IL-6 for short.

It's cytokine involved in the immune response.

It has both inflammatory and anti-inflammatory effects, I'm told.

It is interesting for me because levels tend to go up as you get older and they tend to go up if you're in poor health and there's an acute spike where if you experience a lot of stress and that goes up more in the short-term.
But, what's interesting for me is that over a lifetime, your levels of IL-6 buildup more if you're undergoing a lot of stress. If you control for age and BMI, your levels of IL-6 roughly reflect how much stress you've had in your life. That I think is potentially a much better bio-marker for measuring these life history factors. Chronic IL-6 levels reflect the cumulative effects of stress across the lifespan. My current project is exploring whether higher levels of IL-6 in blood plasma predict a faster life history strategy. We're also looking at cortisol levels, and this will be interesting because the cortisol like I showed you can go either way. In response to stress, you can have high cortisol or high reactivity or low cortisol, low reactivity. But either way, the stress should still cause your IL-6 levels to go up. I don't have results yet, all my blood samples are getting organized on April 13th, so I'm having my fingers crossed that we get nice, neat looking data and we can start to tease this apart. But, the prediction is that people higher in IL-6, they're going to tend to score higher
on the fast end of the spectrum, which means like lower mini case scores, higher scores on impulsivity scales, higher scores on socio-sexuality scales, and last year I just have all my references. But that's it basically, I hope I've given you a glimpse of this particular area within evolutionary science and psychology. It's something that I find really interesting and I think we're really just in the early stages of figuring out how our biology is programmed by things that happened to us in life. With that, I thank you for listening I'd be happy to take any questions [APPLAUSE]. Yes. I have two questions. One I know we talked before, but I'm more like if the environment we live, and how much time and energy going to spent on raising offspring of different protect offspring from gradual development could both nature and nurture might have influence in different behaviors like aggressive level, or empathetic levels [inaudible 01:03:02] in this? Yeah. I think that's
getting at a question that sometimes comes up which
is like can you learn
your way around your biological predisposition?
You're like chemical predisposition.
Maybe my experience has
shifted my biology in one direction but then,
can I learn to outsmart that?
Can we outsmart our brains and the sensor?
Can you learn strategies so like maybe I
happened to have neurochemistry
that makes me more prone to impulsive behaviors.
But then, can I develop
cognitive strategies that would cause me
to only do that when it makes sense
and hold back my impulses and other cases.
That's like really fascinating.
It gets to this interplay between
cognition and biology and how
much we can nurture our way out of the nature.
But yeah, you can up to a degree,
but then it's like your biology is still
your biology so to a certain extent,
that's always going to be with you.
You're always going to feel that surge of
stress hormones when you hear a noise or something,
if you have a really hair trigger stress response.
There's ways to manage that
you can like learn to manage it,  
but you may not be able  
to make it go away completely. Does it make sense?  
Also, I guess that already answers my other one.  
It doesn't apply to people with  
physical and/or developmental disabilities like autism,  
ADHD, schizophrenia, that kind of stuff?  
Well, yeah, as you saw on the one slide  
the theory says that could help explain this.  
I wouldn't say autism is adaptive or ADHD is adaptive,  
but it's like a manifestation of  
underlying traits that can be adaptive.  
You might get pushed too  
far but with autism, like there are savant.  
There are people that clearly have  
exceptional abilities and  
talents not unrelated to  
the same traits that are debilitating  
in autism and so yeah,  
I think, it could apply if autism really is  
extraordinary slow strategy than you know it.  
It may be some people just get pushed a little too far in  
that direction and maybe that's  
what's leading to the disability.  
You have a quick question? Yeah.  
I just wanted to know if there is any  
[inaudible 01:05:35].
Yeah, yeah. It's fascinating that certain people seem drawn to these very high stress occupations and it's like fuel for them. They get excitement out of it. You'd think that probably you'd want to have low stress reactivity to be able to tolerate that high stress occupation. So then is that because you experienced a lot of stress and ended up in the unemotional end, I don't know, or is it that you're out on the slow end. But either way, you're not vigilant. You don't have that hair trigger stress response and therefore you can tolerate more. But I would love to do things like that. I recently had a participant come in to take the survey and give a blood sample, and he was explaining to me how he was interested to see how the corazole stuff would come out because he was in the military and was deployed overseas and experienced very intense stress for a prolonged period. Basically, after he came back, the doctors told him that his adrenal response was basically flat. He was in that unemotional flat.
They said that over time, over months and years, it will actually come back. It would be really great to look at a sample like that. A sample that's under a lot of stress. I don't think I would have to go far to find people under a lot of stress in Baltimore. Yeah?
[inaudible 01:07:41] Oh, is there? Oh, that's definitely true. Yeah.
[inaudible 01:08:07] The depression thing, I'm not sure how to respond to that because I don't find that argument particularly convincing. I don't really quite see how depression fits as a fast strategy.
I didn't find the rationale for that one particularly strong. I think you could potentially have cases where you have comorbidity of things at opposite ends. But I think if this theory is correct, those should be much more rare. You should be much more likely to see comorbidity of things that cluster together on one end or the other. [inaudible 01:08:47] Really? Okay, yeah. I mean,
an eating disorder is kind of, I mean, you're delaying. It seems kind of like the opposite of impulsivity to me in the sense that the impulsive thing to do would be to eat the cake, but then I really like sweet things. I don't know - it seems like it's not impulsive per se, but then I don't know. That's a good question. [inaudible 01:09:45] Oh, right. Yeah, I guess you'd have to maybe say only certain sub-types of eating disorders. That's a good point. Yeah? [inaudible 01:09:59] Yeah, could be, yeah. Thanks. Yes? [inaudible 01:10:35]. When it develops? [inaudible 01:10:59] Well, that's fascinating, because ordinarily developing quickly is the fast strategy and developing slowly is the slow strategy. But if you're developing the parts of your brain that enable you to plan, then you could be actually accelerating the development of that to achieve the slower strategy.
I hadn't thought of that, but that's a really interesting point.

Yeah, I don't know.

The myelination part is the last thing to happen, laying down of those myelin sheaths in the prefrontal cortex.

I'm actually not sure how they measure that or if it's possible to measure that in a living human, but it could be. I'm going to have to look into that now.

That's a great point.

Yeah, in the back?

I think quite possibly, yeah. There is so much comorbidity there and anxiety leading to depression, depression leading to anxiety.

I suspect that they are, I don't know if they're one and the same, but that they both involve some underlying biological predisposition.

I wouldn't disagree with that. I think the clinical psychologists that I know, it seems as though the field is really trying to make an effort to go beyond just splitting everyone into all these different categories.
with checklists and actually try to understand the underlying biological features that underlie all that comorbidity that we see. So I think it's there. I honestly wouldn't be surprised if we saw depression, many forms of depression end up actually over on the slow side with generalized anxiety. I think it's a possibility. Maybe take one more question? Okay. Yes?

[inaudible 01:13:50] Somebody asked a question of me earlier about the timing of it and are you still flexible once you reach a certain point in development, if the environment is telling you this strategy doesn't make sense anymore, can you still switch? I think you can to a degree, but we also do lose flexibility as we reach adulthood. I think in humans it probably helps us that we have that protracted adolescence period, and we don't go through the final stages of puberty until after quite some time. That preserves that flexibility because you haven't fully developed, you have the epigenetic tweaking
can make more drastic changes, so your strategy is still more flexible early on. Then once you reach the end of puberty and once your prefrontal cortex myelinates in the early twenties, at that point, you still have this amazing flexible brain that can learn and you can change your behavior based on that. But the physiology underneath it is going to be more fixed than it was, and so you lose that flexibility.