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MS: I'm introducing our plenary speaker, Dr. B.J. Casey, from the Institute of Medicine. I just hope you notice, too, I want to point out, session evaluations are on the table, and also this nice handout on the table from the Institute of Medicine. So Dr. Casey will talk about some of the results of that workshop. I was mentioning to her that usually when they put a handout on the table, that means there's going to be a pop quiz at the end, so I hope that gets your attention. Hello? So without further adieu, Dr. Casey.

DR. CASEY: Thank you very much. It's really an honor to be with individuals who are in the trenches, and also those individuals who are really being quite supportive of the research that's important to be done, in terms of thinking about adolescent risk taking, particularly in terms of risky sexual behavior. I just want to clarify that I'm speaking on behalf of the Institute of Medicine as a committee member on this report. I am based at Weill Cornell Medical College, and I am speaking with a background in neuroscience, and felt like I learned an incredible amount. I'm also speaking as the mother of a male teenager, and so it makes the statistics and the data

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all the more alarming. And even though you see them a thousand times, it still gets you, right?

So let me just acknowledge the broad expertise that we had on that committee, really and also give a lot of credit to Larry Steinberg, who's done so much in terms of risk taking and adolescence, but we had expertise from human development, psychology, sociology, public health, child psychiatry, neuro-endocrinology, and neuroscience. And I should also -- I'm actually speaking, I think, in place of Jennifer Gootman, part of the staff, and also Rosemary Chalk. Jennifer's actually donating a kidney to one of her relatives, which is why she's not here probably today to give this. So it's really an honor to speak in her place, as well.

Also, thank yous go out to really three sources of support for this committee, work that they did and trying to really synthesize a lot of information and knowledge. And I've highlighted those individuals there, but particularly the Administration on Children, Youth and Families, and NIDA. But we can't forget the Office of the Assistant Secretary for Planning and Evaluation.

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So I just want to start off, so you know what we felt like our charge was as a committee to work together. Given that we all had different backgrounds, we had to be on the same page and learn to use some of the same language.

Basically, there were three sort of main issues they wanted us to address or cover.

And the first was really just to review the field and sort of say: where are we in terms of the current knowledge about adolescent health? And that's from biology all the way up to culture in society.

And another is to really highlight the important lessons that we've learned. Many times those are lessons that we don't want to repeat. Others are ones where we're seeing some success.

And then really the third, is the exciting opportunities to try to identify those, from where we are and what are the next steps and where we need to go, and understanding the adolescent, and particularly the adolescent as they engage in risky behavior.

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And just the format, just generally, so you can understand how we brought this information to bear. We had three different workshops. The first one really focused on the individual. So let's just look at the individual, and let's look at biological and psychological processes that might, sort of, push them in one way or another in terms of risky behavior, early initiation of sexual activity and the sort.

We also commissioned papers by experts in the field, and we helped them writing those papers. But really, it was a lot of the discussion from all of those workshops that you're seeing in the report that's empirically grounded. And the report is not making formal recommendations. It's more saying, here's where we are and these are the opportunities that may want to proceed.

I think the punch line, and also if you'll look at the handout on your table, you'll see it's . . . adolescence is really complex. So if anybody sees me on a train or a plane and for some reason, you know, we all give talks. They come and they go. And January's the worst time to travel every single week because a one-day trip with the weather, ended up being a week to get to and from.

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But if anyone saw what I was working on the computer, they'd go, how can anybody talk about adolescence? I mean, there's so many factors that come to bear on that. So it was a daunting task, and we'll show you how we tried to carve it out where we felt like we got some traction.

So these are the key questions. And I'm going to try to give you some illustrative examples of some of the data, statistics of where we are, and then what's known in terms of particularly the bio-behavioral influences on adolescents, and end with more of cultural and social factors, including their interaction.

But what are the types of risk-taking behaviors that occur during adolescence? It's very important to look at those that are occurring during this period that are showing an inflection relative to childhood or adulthood, the specificity of that. And then why is it? It's not that all adolescents get in trouble, right? We're all in this room, we're doing pretty well. So it's not that all of us have these drastic outcomes, where we hear about in the news.

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So how can we identify those individuals who will be a bit more risky, and risky in a way that it's negative? I don't want to psychopathologize adolescence in this. And then, to look at all of these processes that I've mentioned before, and influencing their behavior, and then what the implications may be for intervention.

Now, we focused on four risky behaviors. And, of course, I think for each of you, the primary interest that you have would be in the risky sexual behavior. However, it's really hard to talk about one without talking about the others. Because we see so many times that one can lead to the other or one's associated with the other. We know that early substance use can lead to early sexual activity. So it's very important to examine all of these, and look at the developmental patterns.

So I'll begin by just presenting some of those alarming statistics. Even though many of the trends are saying these statistics, the numbers, are coming down, they're still really alarming. The first is -- this group knows better than any group ... are in terms of sexual behavior leading to teenage pregnancy. While the U.S. loves to be number one, it's really daunting to see that the U.S. is

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rated number one here in teenage pregnancies, those individuals under twenty. Even though again, I know the trend seems to be coming down, this was something I wasn't prepared for when we started to put the report together.

Another area where we may have been able to get a little bit more traction, it is a little bit more concrete. Policies are already being made. In terms of risk behavior is driving and reckless driving. And when you look at this plot, we see that -- I'm going to use my cursor, can you see that, okay.

So really, this is where the danger zone is. I don't know if anybody remembers Dr. Smith in *Lost In Space* -- warning, warning, danger is approaching. You're just seeing warning, warning, danger is approaching. And it makes you want to lock up your child until they're twenty-one before you let them out. But that's not really going to help them; it might protect the streets, but it's not going to give them the skills and ability to learn how to function and drive correctly.

We know that there are two important factors that affect accidents, particularly fatal accidents, during this period

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of adolescence. The first is the time of driving, time of day. And the second is the number of individuals in the car. How many peers are in the car? As that number increases, the chance of an accident also increases. But the time of day statistics are really very interesting. If you look here, you can see that the fatal crashes are occurring at night, as opposed to at day, in terms of the larger majority.

So we already have states that are changing policy. New Jersey is already starting later, in terms of individuals being able to drive. Also, in terms of the number of peers that can be in a car, the number of individuals in the car, and whether or not they can drive at night or during the day when they first get their license or permit.

Unfortunately, these fatal crashes that we see have been linked to substance abuse, and particularly drinking alcohol. And I just want to show you some of these statistics, because this shows you that there's just a different pattern of behavior when adolescents drink, as opposed to when adults drink.

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So what you'll see on the left is just how many days in a month an individual drink as a function of age. So it goes from young teens, very young adults, and then older adults. And we see that they may be drinking more days of the month. But what's most significant is how many drinks they're having at each point in time. So this probably doesn't surprise any of you. This pattern looks very much like binge drinking and that behavior. And it's also the case that the use of alcohol and other substances has been linked to risky sexual behavior too.

It is also just a point to mention that Linda Spear, who was on our committee -- actually she ended up being commissioned to write one of our papers, so she was an invited speaker -- she's done some really interesting work in animal models to show that adolescent rats don't have the negative, sort of, effects of alcohol that adult rats experience.

So they have less of the motor coordination problems after alcohol, relative to adults, and they appear to have less of the hangover. So they're getting more, perhaps, of a positive effect from that than a negative. It's something

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to keep in mind when we think about how this goes in hand with other risky behaviors.

The other is adolescence and substance use. And it just kind of blew me away to think that my son in the eighth grade, that almost 40 percent of his peers had used alcohol. That was being very naive, I'm sure. That increases to roughly 70 percent by the time they reach high school. Then if you look at the other substances, nicotine and marijuana and illegal substances, they increase as a function of age over this period of time, but to a lesser extent. Cigarette smoking has declined overall in the general population. Unfortunately, it looks like there may be an upswing again in teenagers with cigarette smoking, but that's to be followed.

The last of those four risky behaviors, I wanted to mention criminal behavior. There is an inflection, the time in which you're getting the most arrests are during this period of adolescence. This is just tracking violent and property arrests. And it really isn't as indicative of the serious crimes related to rape and murder. Most of these are forms of confrontation and assault.

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But again, I also just want to point out that I can give you these statistics. I can tell you when in a developmental period of time they seem to be the highest. But we do need to keep in mind that we are seeing a decrease in the number of arrests.

I'm also working on another committee on juvenile justice reform, and that's been very interesting, in terms of thinking about certain subgroups where there's a disproportionate number of minorities in our juvenile justice system, and thinking of ways to intervene there, too.

So basically, as I mentioned, these risky behaviors, they cluster together. And the way in which they emerge and cluster together, makes it a little bit difficult to actually predict the problem behavior down the road. It's very complex. And I'll just kind of show you one sort of graph. And this is from Hawkins & Monahan, where they're showing that all of these are kind of coming together right around mid-to-late adolescence, with the risky driving, some of the antisocial behavior, substance use, and of course, the sexual activity.

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So now, I just want to start breaking it down and talk about the bio-behavioral influences, and then more social and cultural ones, emphasizing the bio-behavioral ones more because again, that's my expertise. And it really was the case in the media for the longest time, that when you talked about adolescent sexual behavior, teenage pregnancy, substance abuse, reckless driving, really the punch line that journalists were putting out there for us, is that it's all because this rational area of the pre-frontal cortex, the frontal lobes, were not fully developed. And so that explained why so many adolescents got into trouble during this time.

But as I think each of you would logically recognize, if it's about slow graduate development of the pre-frontal cortex, then children should be as bad, if not worse, than adolescents. And that's not what those reflections in our health statistics are telling us. So we need to have a better understanding of what's driving this risky behavior.

So what several, repeated scientists as they came and talked to us and in our own research too, were all focusing on that adolescence is this period of really an imbalance in the development of brain systems. So yes, there is

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graduate development of this rational, pardon, sort of the vulcanization of our behavior. That is gradual. But at the same time, with pubertal onset, we're seeing an activation and functional maturation of brain systems that are really key to desire, and fight and flight. So that's sort of the disconnect that we think is happening. And that might explain why we're seeing much more novelty and sensation-seeking, and I'll give you examples of this, and lack of self-regulation during this period.

So here's sort of a simple illustration of this imbalance model. Basically, what it's suggesting is during childhood, these two brain systems -- the emotional and the rational -- they're still developing. But right around adolescence and when puberty hits, you're seeing earlier development of this emotional, these limbic regions. And you're seeing this gradual build-up of the pre-frontal cortex.

Then, when you have a mature individual who's had all the wonderful pro-social experiences and opportunities to regulate their behavior in an adaptive way, you see less of an imbalance in these systems. So really, it's this gray

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zone here, where one is more active and mature than the other, where you're going to get into trouble.

So that if you're in a situation that is emotionally charged, and you have information about what the rational response is, it's probably the case that the emotional system is going to lead the way, and hijack that rational one at this time. So that's one hypothesis.

Let's see how this actually plays out in behavior, though, and how we understand it in terms of being able to control our impulses and urges, as opposed to that sensitivity to what's going on in our environment, and our peers, and potential mates that occurs.

So first, if we just ask each of you, and many times I have people interact and they do this task which allows them to see how well they can control their impulses. Basically, you tell them that they respond whenever they see, let's just say the letter A, and they always withhold a response when they see the letter B. What happens if you have more times that they respond than when they don't. So there's a rare, sort of, target where it's a sign that says, don't do this.

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You see that our ability to perform on those tasks improves with age, almost in a linear way. No inflection here like we've been talking about with the health statistics. But also note that in late adolescence, you're already seeing some adolescents who can outperform some of the adults. So there's a lot of individual variability . . . again, the importance of identifying subgroups that may be at the greatest risk for poorer outcomes, teenage pregnancies, STDs, and the sort.

Now, what we want to know, though, is now let's put you in an emotionally charged situation where I've given you \$10.00 every time you saw the letter B. But now I'm telling you not to press to the letter B. But before, you got \$10.00 every time you got it. The type of behavior you see then is much more difficulty in the adolescents relative to both the children and the adults when you have some incentive in front of them.

You get this pattern if you just tell a teenager not to press to a happy face. Because happy faces are associated with peer acceptance and incentives, as well. So here's

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where you're seeing the behavioral data actually fit the inflection with the health statistics we reported earlier.

So now what I want to do is just show you the brain regions that map on to these two systems: the impulse control, and also this sensitivity to environmental cues that have some sort of emotional or a motivational appetitive content. We see this really interesting area. It's called the ventral striatum, but you can think about it as one of these rewards area. It process information related to money, food, juice. Larry Steinberg's recently shown peers and peer interactions. And it's also been linked to addiction-related behavior as well, and drives.

We're seeing that it's elevated in adolescents, relative to children and adults. But you're seeing this protracted development of the pre-frontal cortex -- remember that vulcanization of the brain as that region develops. Now, let's link this back to risky behavior. It is the case that this area that's exaggerated in adolescence is tightly coupled with the likelihood of engaging in risk-taking behavior.

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So if you anonymously ask participants -- after they'd been in this brain imaging studies where you can look at changes in their brain, the monetary reward, happy faces, interactions with peers -- when you get them to rate the likelihood of leaving a party with a stranger, you can ask all ages that, children, adolescents and adults, or for just the adolescents and adults, the likelihood of engaging in unprotected sex. You see that their response in affirming that they would do that is tightly coupled with the amount of activity in this region. And again, I'm showing you, the general pattern is it's elevated during this period of time.

So just to sort of summarize the behavior then, risk taking and sensation seeking really is showing a blip during this period of time, whereas impulse control is protracted. But it's the interaction of these two which is what's occurring when we adolescents engage in some of the risky sexual behaviors that they do that lead to the outcomes that they do. And then I've already just presented the brain areas that go hand-in-hand with that as they develop during this time.

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This is very important for us to think about with regard to interventions, points in time in which they may or may not be most receptive to an intervention, by taking a developmental perspective of how behaviors and receptivity to information is changing across a life span.

Now, if we continue to focus on the biology of adolescence, it's very important to consider endocrine changes during this period of time. And these pubertal changes really seem to be the ones that are activating these deep structures that we think about, in terms of adolescent behavior with desire, and also others that I'm not talking about today with fight-and-flight that are also enhanced in response to environmental cues.

But if that is the point of activation and we already have this imbalance in the development of these systems, and then we start getting earlier and earlier puberty, we're prolonging that imbalance. So let me just show you -- perhaps not the best, but a simple diagram -- this magenta is those deep structures of the brain developing, the pre-frontal cortex protracted development, and then the red area is when you have earlier onset of puberty, what you're

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doing is you're increasing the magnitude of that imbalance, as well as its duration.

And also, if we define adolescence, and maybe I should have done this from the get-go, adolescence is really defined as moving from relative dependence on the parent to independence, with the onset right around puberty. Then what we're seeing in our society, where we're relying on our parents until forty sometimes, we're really prolonging that period of time, particularly financially.

So now, if we think about all the different ways in which you can exaggerate this balance, you know, one can be earlier puberty onset. But I think Ron Dahl did the best diagram here, and he's really sort of putting it on a balance. What he's saying is, with puberty onset, you're increasing affective load. And affective load are the emotions, the attraction to the opposite sex, that movement into wanting to be accepted by peers, and how that's influencing your ability to regular your behavior at a time when it's not fully mature. And if you don't have the protective mechanisms of good social support or strong family and community relations, can really tip the balance. So that you're really getting everything weighted from an

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emotional factor and the world is viewed emotionally. And each of us dealing with adolescents, we do see how even a somewhat neutral world can be interpreted as emotional at points in their development.

All of these factors can also be modulated by additional environmental stressors, cumulative risks related to socio-economic status, issues with regard to the family dynamics there. It's also the case that individual bring biological predispositions that can be driven, in part, by genetics, and also biology that might suggest a particular temperament coming into this development period.

So if you're already a risk taker, as sort of a trade marker, and then you come to adolescence, it's almost like a double-whammy in terms of the activation of that system perhaps. And particularly with stress, if it's down regulating these control systems, and up regulating emotional systems, it's going to be much harder to sort of make logical and rational decisions without your decisions being hijacked by the emotional self.

So this is a nice, sort of, intro to psychological processes that we need to keep in mind, too. There's a lot

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of work that's been done on, really, adolescent decision making and the task that they have. There's such a push/pull at this time for individuals, in terms of their own self-identity. But there's going to be a push/pull. You're kind of leaving the safety of the nest where they've imposed control on you, to having to learn to regulate it yourself. And the tasks at hand are really, you've got to stand out, right? So you have to develop this identity. But at the same time, you have to fit in and conform to your peer group in ways. And you also have to measure up.

So this is a time where it's very important to develop competency and passion about a competency, and feel that self, sort of, admiration when you accomplish opportunities that we think are going to be very important for interventions, allowing that pro-social behavior and empowering these teenagers. And then we also need to take hold of these commitments, these views, these attitudes, and these beliefs. And that really needs to happen very early in adolescence, before, perhaps, the problem behavior begins, because then we know how many other problem behaviors can emerge as co-occurring factors.

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So again, not to psycho-pathologize adolescence, it's a lovely time in terms of the passion. For some marriages, it might be great for partners to have the same crushes that they felt during the adolescent period for long-term partners later in life, perhaps. But also the risk taking can also really impede their success. And then a lot of the research, as you probably very well know, when an individual begins to fail at something as they're trying to master their own independence, is a time in which they turn toward drugs, alcohol, and many times, sex, for acceptance. So we do need to keep this in mind.

There are several models for how the adolescent thinks. I mean, the classic one in terms of how an adolescent makes decisions is that they must weigh the risks differently from the rewards, with a bias more towards the rewards. Others suggest that the way that the teenager functions when they're making a decision, is they will remember a concrete experience they had. And that's going to drive their behavior.

And the most really effective way to make rational choices is to use all of your knowledge and experiences. And probably not knowledge alone -- it's with the experience

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integrated in that knowledge -- that will then help them form a gist of, this is what you do in this situation. So Valerie Rain has done significant amount of work in this area, showing that adolescents really don't make risky decisions from a gist point of view, like adults do. And so that's important.

Whether or not an adolescent perceives risk -- if they do perceive risk, when they do -- it does affect their behavior. And again, I'm going to refer to Valerie's work, where they have been tracking risky behavior over a few decades now, several, maybe back in the '70s I think. I'll pull up the graph in a second and we can see. So they've been looking at a risky behavior in marijuana use, but you could put it in other contexts of the risky behaviors that we've been talking about today.

So basically, if the perceived risk is low, then the perceived use or action is high. But right around in the '90s, when there was an increase in perception that marijuana may not be good for you, it may be bad for you, you see that the behavior began to decrease too. And now that's back on the upswing, particularly in teens. It's all over New York and New Jersey. It's how they're

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defining the schools many times, when the children are talking about which ones they want to get placed in. It's hard to be on the streets and hear those conversations.

So it's not the case that they can't perceive risk, and that when they do, it alters their behavior. But there's another fallacy that I think we really need to keep in mind. Because the way that they act many times, you think they think that they are invulnerable and immortal. And that is not the case.

If you ask them about their relative risk for many different problems, health, fatalities, whatever, they show an exaggerated rating. They think that they're more vulnerable than the rest of the population, their chances of experiencing these are higher. It's very, sort of, egocentric in terms of thinking about their vulnerability there. And again, it's because they're not using experience to get more of a feeling of where they are relative to all of society based on experiences that they've had and that the knowledge they've been exposed to.

So I think I just want to switch to the contextual processes, and this really involves a whole lot, and it

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gets very complex. When we start thinking about environmental influences that are everything from the schools, the family, the community and the media, and trying to get a handle on controlling those in any way and empirical studies, in terms of being able to measure those with precise ways, it's very difficult. When it's nice to be a basic scientist, as opposed to a person in the trenches.

So again, it's an honor to work with people who are trying to think about how we can begin to work in this complex environment in which the individual, who's already sort of coming in at a potentially higher risk, has to then adjust to. But we know that these influences are positive and negative. The family can be a good thing. There can also be terrible things happening in the family that can actually be detrimental for the child.

I guess what was really striking in the reports as the data was being presented is that it became clear, depending on the type of risk behavior, that interventions -- sometimes the best intervention was at the individual family level, and others should be at the population. So I think probably the best example of that is criminal behavior, or

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behavior that's associated with anti-social behavior. I'm just going to maybe talk about this in a second.

But many times, if you put peers with peers, and they're engaging in bad behavior because of the sensitivity and influence of peers on the individual's behavior, it can do more harm than good at times. And so being clear and being able to assess that, the types of behaviors where you benefit, as opposed to those where you may actually be more harmful -- do no harm.

But really, again, any time an individual spoke about their work in intervention, they were always trying to emphasize the earlier we intervene, early in adolescence, and a way in which they can have pro-social opportunities -- even though I want to lock my son up until he's twenty-one in some of these contexts -- but make sure that they have those pro-social opportunities and role models so that they can then have the behaviors they need to not only regulate their behavior, but regular their behavior within a particular society or culture.

Here's the complexity, and there's an even more beautiful picture in the handout that was given. And this is just

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one of the illustrations from the larger report that we developed. But we have to move away from thinking about the adolescent as an individual alone, and just that one domain of, if we understand the biology of adolescence, we're going to understand everything about risky behavior.

That's just not going to work. Because that individual is operating at this micro-level in the environment. And while they may be traits in biological predispositions to the situation, the influence of the environment -- the schools, the family, the community -- are really going to tip that balance one way or the other.

And it can lead to adaptive behavior in this wonderful community. Let's see if we can get it back up. But even if we don't, a picture's worth a thousand words. It came right back up. It's always good to know that you can give you talk without your slides, too. It's very hard in brain science, but that has happened to me. And I was actually amazed how much implicit memorization we do and we don't even realize it. Probably the implicit knowledge that adolescents pick up, too, from the media. We might want to come back to that -- media being positive and negative.

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But I just want to show you one example. This would probably be from the family stress model might be a nice example. In the context of socio-economic status, because we know that is a big player in terms of identifying individuals that may be at greater risk because of the cumulative risk or bad experiences that occur to them over a lifetime.

But if we think about this from the family stress model, you basically have a low-income family. They're in debt. And the debt's higher than really what they're getting in income. That subsequently leads to the economic pressure of not being able to pay those debts. That leads to the stress on the family, and really subsequently leading to the relationships with the family deteriorating. And then the child not having that family support that they need.

I really have to tell you, I was going to bring this video tape. There is a neuroscientist who's been trying to get a handle on how, sort of, a socio-economic situation and the rat's world could alter emotional and, sort of, impulsive behavior. The work is by Tallie Baram at UC Irvine. What she does is she takes a way a little bit, just a little bit, of the nesting in the cage of the dam with the pups.

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And if you look at the videotapes of that dam interacting with her pups relative to those who have all the nesting, the typical nesting that you would put in a cage. You see two things. One is the really reduction in time that that dam spends with the pups, instead of nursing them, running around the cage. And the second is the abusive behavior, in terms of just running on them erratically on top of them. And then you follow these pups that had that experience, and you see that the juvenile then is engaging in more aggressive behavior right around puberty.

So there are a number of ways in which scientists are trying to be clever to even capture a tiny percentage of what might be going on in environments where the resources are really, really tight, and the emotional drain and stress that that has on the family, and on the individual's development.

So looking to the future, I just want to mention a few other things and highlight some interventions that have, and maybe have not, worked as well. And thinking about where the lowest-hanging fruit is, with regard to where we have to go next.

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One, I really think that the group as a whole felt that we need to begin to understand all these different domains that influence the adolescent, but more importantly, how they're interacting. There's very little research in terms of looking at how they're interacting, and very little in terms of cross-interdisciplinary research. So we need to really integrate those ideas. And we think that's going to be hard in terms of trying to integrate that knowledge and try to come up with novel interventions, particularly during these times of hard financial and limited resources of our own, and trying to move in new directions.

But in doing that, what we really have to keep in mind is that in preventing our teens from ending up in jail or pregnant or just trying to keep them alive, we have to really promote the positive behavior. Because that is them becoming an adult. Right? It's that moving from dependence on the parent, to having all the coping skills and regulatory abilities to allow them to function as a mature being in a society in their culture, and with their own emotions.

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Another, sort of, point that the group came away with from reviewing the literature and then all of the discussions is that because these problem behaviors are correlated, and because individuals as well as larger social units, can have protective, sort of, are protective factors and can help. We need to focus on them. But unfortunately, protective factors and negative factors seem to weigh in differently.

Let me just show you what I mean. I think I have a slide here from the report. So let me just break this down for you: this is prevalence of problem behaviors. These are number of risk factors. And then what we're coding here are a number of protective factors. And what you'll see is while protective factors are good, they can help, the cumulative risk factors as you increase really high. It's really hard for protective factors to play a role. Now, this is emphasizing to us that we then need to intervene at a point where we can try to prevent as many of these other risk factors, the co-morbidity among the different problem behaviors, as we can.

In the interventions, again, evidence to suggest definitely try to begin early, focus on risk and protective factors,

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definitely target those high-risk groups. And when actually looking at protective factors and risk, we need to think about those that are going to affect many problem behaviors, because of the co-occurrence of the problem behavior, as opposed to specificity necessarily.

Here's just one example that I wanted to give you, in terms of thinking about interventions: What we know from those, as I mentioned before, sometimes interventions are less effective with a group, as opposed to an individual, and this is more with criminal behavior, anti-social behavior, or problem behavior in schools. We see that you're not getting a very big affect at all when you put it in a group, and a slightly larger effect on the individual. So let's keep that in mind.

Also, central to this group, are the number of programs that indicated affects on social behavior. So there are changes in social behavior that we're seeing with abstinence programs and educational programs. But if you look at the significant impact that they've had on the behavior, it's still not good enough.

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This is where, I guess, I want to come back to, what we know about the bio-behavioral sciences, and we were talking about this earlier before I began. You know, when you have an imbalance in a system, in these developing systems, you know, it's one, you want to go. And the other one's like, it's not too good to go. And you're in that emotionally charged situation. Whether you know -- even if you know it's a bad thing to do, it's really hard to break away from that emotional center.

So we have to think of ways to empower our youth to help them have those regulatory abilities, so that they can say no and they can stop engaging in those behaviors, to complement other programs that have had some success and think more broadly about how can we have bigger successes?

So I guess I'll just end -- I think that these are really self-evident. We have to get a handle on not just each of these domains, and these different disciplines within themselves doing the research. There has to be much more cross-talk that's inter-disciplinary. And that really is happening that suggests really great opportunities for intervention, sort of, research in terms of bringing that input across many different domains. And really, to

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underscore it's not an enough to just focus on a single domain, or think you understand the cause in terms of the intervention, the determinants are not enough.

And again, I know I probably emphasized this a lot, but I think in the report, what the evidence suggested, is that it is very important to focus on positive factors, pro-social opportunities, role models, support. But when doing that, do it as early as possible before the problem behaviors emerge, and then start to sort of have a life of their own, in terms of the additions. So I'm going to stop there and open it up for discussion. [applause]

MS: Just make sure you use the microphone for your questions.

DR. CASEY: And this is when I learn the most.

FS: Hello. Thanks for that talk. I had the pleasure also to hear Dr. Laurence Steinberg speak as well on a similar subject. He also mentioned the importance of not only is adolescence or puberty starting earlier, but brain development continues way past where we had originally thought. So twenty-one, maybe even twenty-two years old. So when brain development and prevention, or even

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interventions, were not ending, I guess, just to clarify from you, maybe you can just let me know that we're not supposed to be ending these interventions at nineteen years old, that it should be continued on, is that correct?

DR. CASEY: I think this is a really important point. Also, that's an optimistic point, particularly for the -- pardon me -- the old farts in the room, including myself, that you continue to get brain changes throughout life. In terms of significant structural changes that you can see in the brain, they proceed right on up until 25, 26. We know that connections between brain regions continue up until the 30s, in terms of those increases.

What is really important, in terms of the development of the brain, is not so much us seeing those structural changes, but that the structural changes are the right ones to occur, that the right brain systems are talking to one another. So the rational vulcanized part of the brain is able to talk to that emotional center and help shut that center down. When that doesn't work, we see time and time again, a number of psychiatric disorders manifesting, where treatment is absolutely called for.

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But I also don't want you to walk away, as someone who's done brain development research all of her career -- I don't want you to walk away and think that brain development is this magical thing that happens, right. Brain development is the brain navigating the environment and adapting to the environment that it has. And for some individuals, their environment is going to be very different than others, and behaviors that might be adaptive for that, may not be adaptive in society. So we have to keep in mind how experiences are fine-tuning and hard-wiring the brain across adolescence and into early adulthood. But that behavior can change, an old dog can learn new tricks, as my 86-year-old mother tells me when she learns something new. But that's very important.

Larry's done some really instrumental work in terms of getting some of the policies changed with driving, particularly his work with regard to the influence of peers, not only on behavior, but a recent study where they did the imaging study. And there's several ones that are seeing that it's not just that peers act as rewards or reinforcers to sort of reinforce and substantiate that behavior, it's also interesting that during those teenager years, there's a sensitivity to not getting a reward. So

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if you think about that in terms of peer acceptance, it makes a lot of sense. So that is still an area of research that's occurring.

Q: Are there any gender differences?

DR. CASEY: So that's an important point. There are some gender differences in terms of impulse control. It's somewhat delayed in males relative to females developmentally, and you tend to see a more preponderance of a male to female ratio in impulse-control related disorders, ADHD, some of the disorders related to externalizing problems, like conduct disorder. In risk taking, males are generally thought to be bigger risk takers. But in a lot of the controlled empirical studies, you're seeing females be as risky. So it depends on the domain.

Q: You had mentioned that sometimes interventions were more effective if they were developed on an individual versus a group format. Could you offer some potential explanations as to why that might be?

DR. CASEY: So I think, again, it gets to this sort of sensitivity to environmental cues during this period, but

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particularly the sensitivity to peer acceptance. If it's a problem behavior, like criminal behavior, and the individual identifies with that peer group of this is who I am, that self-identity is occurring.

I guess the best example here is the problems with the Scared Straight program, where we thought we could scare our teenagers straight and keep them out of jails, and it actually ended up that they identified with the criminals, and it was not helpful. So again, we don't want to do harm when we try to come up with important, clever, new, novel interventions, but that's an example. It's not always the case. So it's going to depend on the type of behavior as to whether or not the individual or a group is going to be receptive.

Another area that I thought was just really fascinating, and I think it's really low-hanging fruit is, how do we use technology to our advantage, as opposed to our disadvantage? A lot of laws have changed in terms of the texting and the use; young teenagers are some of the worst at driving at texting. Driving laws have changed there.

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But there were examples that were presented, where people were using technology where you could text a support group. And instead of -- you wouldn't pick up the phone. It's interesting how a teenager might text their parent, but they wouldn't for the life of them pick up a phone and answer it and have to talk to their parent.

And it seems that -- and I want to say seems here, because this is an area, a real opportunity for us, where they would be more likely potentially to text or to electronically try to engage with a support group when they were feeling suicidal -- that's been some of those -- or when they were having questions about peer influence on substance use, and also sexual behaviors.

So that's going to be an area we really need to invest in, because the technology's not going away. And to say it's bad, again, it gets back to understand the basis for why we might be getting this bad behavior isn't going to exactly change the behavior. So what we have to do is be very creative in coming up with ways to work with what's going on in that situation to create the right intervention or the pro-social way of using, in this case, technology.

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Q: First of all, thank you for the overview. My question is, earlier you talked about the neurobiological model, which is universal to adolescence. But I'm also struck by two graphs and something that was presented earlier. And that is, though we have a universal model to understand adolescent behavior, I'm struck by the variability across nations, which is several magnitudes. And I'm also struck by the variability by geographically in this country, and by demographics, say, race.

So how do you -- are we looking at something that may be attractive because we have a new tool looking at the neurobiological model, but that may not be where the answers are? Or should we go back to the contextual processes to help us explain this tremendous variability, particularly we're focusing on sexual behavior and sexual activity?

A: I think the context is incredibly important, and that's what I was trying to leave. It's not a single domain, particularly, as someone that does brain science, it's just one little tiny piece of the puzzle with adolescents. There are times when it helps, and there are times when it hurts.

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I know it helps when I present to teenagers, which we do during brain awareness week and the sort, for them to understand why sometimes they have these emotional outbursts or they feel certain ways -- it helps them get a handle on it, they actually feel empowered by that knowledge, so that's a nice piece where it works.

With regard to the context, there are context where adolescents are allowed to be adults, in some definitions of the word, sooner in other cultures, in terms of really taking responsibility in the community and being able to take pride and a sense of accomplishment there. You know, we're really lucky in the U.S. in terms of how well off we are. Our children don't have to work as hard, many of them don't.

My son would just shoot me if he heard me say this. But when I was his age, I grew up on a farm. And you got up before school and you did work. You went to school, you came home and you did work after school. And on the weekends, you didn't even want to go anywhere. I mean, we would, but you're so tired you always wanted to come in early.

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You know, something that Larry Steinberg would say, I'm sure too, is we have to monitor our kids, and we really need to keep them busy -- there's a lot to be said for keeping them engaged, and these extracurricular activities, they can at any level, it can be volunteering. But it really needs to be regimented so you know where the child is and they're responsible.

So it can be work, it can be sports, it can be volunteer work, working in the community, working with a church and feeling a sense of pride in taking on that activity -- not just babysitting after school, which is what is happening with some of the teenagers.

You know, when speakers get up here and start telling you anecdotal stories, and talking about what their kids would think -- sorry, but they do influence us.

Q: So I was thinking, as you were speaking, that the slides you brought up about the environment, and there was a nice slide you had that talked about it. So one of the things you did mention was that certain behaviors may work in

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certain environments, it may not be as good for other environments.

And as we think about those kids who are at most risk, those in those very low income populations, densely populated that have to deal with drugs, violence and everything, I think one of the struggles we have as a field is, how do we identify those behaviors that we may not see as good, but they view them in a protective factor, like a protective manner. And how do we then identify them and how to, I guess, alter those, because we're more like -- that's not what we want you to do, but that may be something that has protected them so far.

I think there's a great parent/child connectedness by ETR, where they identify for parents, like authoritative on parents based on race and culture, and how some of those styles are more protective in certain environments, but they may not be desired in a broader society. And I think that's one of the struggles we may have as we work with kids on very low income populations, or kids of color who may have different ways of approaching these problems based on their environment.

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DR. CASEY: I think that's an important point. I mean, it is very adaptive behavior when you can survive in certain communities. And there are aspects of that that are going to hard-wired with that individual. And being clever -- and this is where I'm not, relative to what the audience is really thinking about -- being clever in ways in which you can use that.

A very, very simplistic way of thinking about this, not with regard to a lower SES, but just when you know you have an individual that's a real risk taker -- real risk taker - - trying to find outlets for that risk taking that are safe, but still allows them to feel that accomplishment and sort of get that rush.

I live in the Harlem area, there's some after-school programs where there's indoor climbing, which is such a rush. But it's a very controlled setting. So they're safe. But they're using something and they're empowered when they're really doing it well relative to their peers. It's so nice to see when they just can feel good about something in themselves, when otherwise, they're so busy just thinking about survival, food, and also their family and protecting their family.

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There have been some incentive programs that have been discussed with me, where people come to our institute -- I'm not speaking for the IOM now, these are examples. I should have said that from the get-go in terms of, any time that I'm speaking just from personal experience.

They wanted to have incentive programs to give points to individuals in the class if they come to school every day. Because being in school is associated with lower drop-out rates and lower teenage pregnancy. Well, there are situations in people's lives where they have to stay home and protect someone or take care of someone, and it is not in that child's control.

And to then punish them, and for their peers to look down on them because their class didn't have perfect attendance. I was just like, whoa, wait a second. Let's think about where you can really help and where you may potentially hurt. Again, that's just we kind of have to get into the heads of the context, the culture, the families. It's going to be huge in terms of thinking creatively on how we can best come up with novel interventions that are given as

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higher success rates of where you want to be and where I want everyone to be, in terms of a parent of a teenager.

You struck a nerve there. I love it when people have great ideas. But then I really want them to work with -- this is an example where I immediately called up Rosemary Chalk on our board, and said, there's a group that really wants to support an intervention, and here's one idea. Let's let them talk to people who know how to do interventions, so that they can then understand the pros and cons of them. Because I'm just a basic scientist that knows the influences of behavior and experience.

Q: Your comment about the incentives made me think of, there's an area of research on contingency management, where it would feed that adolescent risk taking need. Because I'm familiar with it through gambling research that's done out of the University of Connecticut, where the incentive to come in, like to have studied it or collect it or to come to the session or whatever, you draw something out of a bowl. And you may get \$5.00, you may get \$100, but it's that risk that brings people in, and that's why they use it for gambling research because gamblers like to take risks.

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So if you're interested in maybe incorporating something like that with your adolescents, if you look in the literature for contingency management research -- and if you give me five minutes I'll think of the name of the woman who does it -- it might be something that might be helpful to you.

DR. CASEY: It is true that teenagers do, and this is another point that I made to that group, it's got to be a little bit unpredictable, because predictability is kind of like when things are really easy and you know what's going on or things are just so confusing and it's too difficult, that's when you're going to get drop offs. It's kind of in the medium, where it's kind of also like the stress model. There's this sort of happy balance where you kind of have to keep them guessing a little bit, and that they don't feel like they're being manipulated or told what to do, or that they don't even understand what to do. So hat's off.

It seems much more complicated than anyone could ever get a handle on. But I just think this is the richest opportunity, looking at all the basic research and the real appreciation for the context, but working across

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disciplines, and bringing all that expertise to hand, where we may really get more traction. [Applause]

(END OF TRANSCRIPT)