



AMERICAN  
PSYCHOLOGICAL  
ASSOCIATION

## ESSENTIAL SCIENCE CONVERSATIONS

### DESIGNING A SUSTAINABLE FUTURE: PERSPECTIVES FROM PSYCHOLOGICAL SCIENCE AND HUMAN FACTORS ENGINEERING (OCTOBER 24, 2024)

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#### TRANSCRIPT

**Shandol Hoover:** Hello, everyone, and welcome. Thank you for joining us today. I'm Shandol Hoover, Senior Director of APA Science Special Projects and Implementation. This program is part of an APA series called Essential Science Conversations where panelists and audience members can engage in an open dialogue about emerging topics in psychological science.

Before we get started with today's session, I want to share a few quick announcements. First, we hope you'll visit [apa.org/science](https://apa.org/science) to learn how APA is elevating psychological science, and that you will also subscribe to *Science Spotlight*, a free newsletter delivered right to your inbox every two weeks that has the latest news, funding opportunities, upcoming events, and more. We also hope you'll subscribe to Editor's Choice, another free newsletter that delivers articles to your inbox for free weekly.

Second, thanks to those of you who submitted questions for today's program when you registered. You can also ask a question as a program is taking place in real time. During this webinar, chat will be disabled. We'll be chatting out important resources and links. We ask that you put your questions using the Q&A feature on the dashboard. We'll be monitoring those questions throughout the program.

Finally, this program is being recorded. Once it ends, everyone who registered will receive an email with a link to the recording and a transcript in about two to three weeks. I'll turn things over to Dr. Dennis Stolle, Senior Director of APA Office of Applied Psychology.

**Dennis Stolle, PhD:** Thanks, Shandol. I'm really excited to be here today with everyone to talk about how psychological and behavioral scientists can work with human factors engineers and learn more about human-centered approaches to designing a sustainable future. Sustainability, in my mind, is an important topic that cuts across disciplines. There's no one discipline acting alone that can solve for a sustainable future.

Interdisciplinary research and cooperation is critical, and today's conversation is the result of interdisciplinary collaboration between the American Psychological Association and the Human Factors and Ergonomic Society. In particular, Dr. Mark Chan of APA and Dr. Andrew Thatcher of HFES have worked together along with many others to bring forward this important conversation among the leading experts who we have here on our panel.

I'm pleased to introduce those panelists to you now, I'll start with Dr. Katelyn Stenger, who holds a PhD in civil engineering from the University of Virginia. Katelyn is an engineer and a research scientist at the National Renewable Energy Laboratory in Denver, Colorado. There, she studies energy and engineering issues through a behavioral science lens. In addition, Katelyn teaches courses in behavioral design at the Institute of Design at the Illinois Institute of Technology.

We also are joined by Professor Andrew Thatcher, who is the chair of industrial and organizational Psychology at Wits, where he specializes in sustainability as well as ergonomics and human factors. Andrew is the president of the International Ergonomics Association and is an editor of the journal, *Ergonomics*.

We also have Dr. Jiaying Zhao, who goes by JZ and is an associate professor in the Department of Psychology and the Institute for Resources Environment and Sustainability at the University of British Columbia. JZ uses psychological principles to design behavioral solutions to address financial and environmental sustainability challenges. JZ also develops behavioral interventions to encourage climate action recycling and biodiversity conservation. Thanks so much to all of you for being here today.

One of the things I really love about this topic is that I suspect that for many people, when they think of psychology, they don't think of engineering and when they think of engineering, they don't think of psychology. Really, the two go together quite nicely. To set the stage, what I'd like to do is maybe start by just simply defining some terms. We're going to be talking today about human factors engineering, but what is that? What is human factors? What does that term really mean? I'm wondering whether one of you would be willing to define that for us.

**Andrew Thatcher, PhD:** Maybe let me jump in being from the Human Factors and Ergonomic Society. There's a long history over here. I'm trying to work out where to start. Let me just jump in the deep end. When we talk about human factors, we are talking about a systems discipline that focuses on human system integration, which is another word actually, human factors engineering and human systems integration.

The thing which is a little bit different is that very often when you think about human factors, you're thinking about, especially when it's talked about in the media and they talk about, let's say, an ergonomic keyboard or an ergonomic mouse or something, they're focusing on the physical side of things but it's really about trying to see the human being as a system of which physical is one component and, of course, linking in here with the APA, the psychological is another component.

Those two things are also interacting with one another. For example, if I'm sitting in an uncomfortable chair, it's difficult to think. The physical and the mental are closely linked here. This is where it links in with the engineering side of things, it's largely a design discipline. It's applying that understanding of human beings to the design of systems and primarily looking at making sure that they're working well together.

**Dennis:** Great. Thanks. Katelyn, coming from the engineering side, I'm curious whether you have anything to add to that or a slightly different perspective on it.

**Katelyn Stenger, PhD:** Yes, maybe a different perspective, a complimentary one. I think that engineering sometimes gets framed in a quite technically-minded way and that when we engineer, when we want to achieve a sustainable future, that necessitate people. That's where we start seeing these conversations happening at every scale, whether we're focusing on people, communities, or national-level policies. People have to be making the decisions. That's really where I see the most interesting synergies across the groups, or those kinds of disciplinary mindsets is maybe the way to say it.

It's across all of those scales, but also who is being centered or what is being centered differs quite a lot between the two groups, whether it's a technology-minded focus, which is very common in engineering disciplines, or if it's a people-centered focus. Just to paint the picture a little bit more, I

think some engineering disciplines are starting to engage more with people-centered approaches, particularly as we're moving towards a clean energy future.

**Dennis:** Great. Thanks. We'll also be focused today on sustainable technologies. What does that mean? How would you define a sustainable technology? JZ, can I toss it to you for that?

**Jiaying Zhao, PhD:** Yes. I'm a cognitive scientist. My definition of sustainable technology is any piece of physical equipment that's geared toward environmental sustainability. That could be waste reduction, that could be reducing emissions et cetera, et cetera, recycling stations, these are the examples. My take on human factors is very different from Andrew's and Katelyn's. My research is about engineering behavior change and basically with environmental changes.

One key component there is how do I design the choice environment where we make decisions to steer behavior change, and that can involve bike lanes, to menus that you order food from at a restaurant, all the way to the designer policies and programs that will guide collective action. That's how I see human factors.

**Dennis:** [crosstalk] Go ahead, Andrew.

**Andrew:** I was going to jump in with JZ there. I don't think our definitions are-- I think they're complimentary. They're next to one another. That's actually the area which I work in mostly. I work in designing information flows to enable people to adopt and take up sustainable technologies, which is getting what I mean by sustainable technology. I think I agree with JZ here. It's any technology or any technological system or any system that has technology in it, that has, as its goal, some form of sustainability, whether that's water saving or whether it's energy or whether it's waste reduction or whether it's just more efficient use of the resources that we have around it.

**Dennis:** Great. Katelyn, you've got maybe a little different perspective on it because you come at it from a slightly different angle. How does your definition of sustainable technology fit in with what JZ and Andrew described?

**Katelyn:** I think I align mainly on the material aspect of the technology whether that technology is being used in a-- A solar panel is very clearly sustainable technology, but then sometimes we have other pieces of technology that are social pieces of technology that help to create the conditions that JZ was mentioning about. The contexts that are supporting these decision-makings, but also the infrastructure and the system-level parameters or contexts or abilities that support that--

I talk about transition a lot from fossil fuels to clean energy. That's my world when I think about sustainable energy and that's primarily derived from our climate goals that we have. I think that's like being a responsible researcher is making sure we're aligning with or maybe identifying gaps in existing climate goals. That's how I end up aligning a lot of my thinking around sustainable technology, but just both in the material sense, but also in the social sense of technology is a lot of different things.

**Dennis:** You mentioned solar panels. JZ you mentioned bike lanes. Can you give me more along those lines? Can you give me more concrete examples of a particular product or technology that has somehow furthered sustainable behavior. Maybe you'd even be able to speak to how psychological principles are built into that.

**JZ:** Yes, I'll give two examples to be brief. The first one is solar panels. Solar panels are expensive, they're not widely adopted yet on a global level, but one psychological principle of the adoption of solar panels is simply visibility and peer effects.

If I install solar panels on my roof at home, chances are I'm going to start a ripple effect where my neighbors will see the solar panels and now they will start to talk to me about it and I can spread the information and knowledge about how and how much it costs, et cetera. Actually, that's been documented well in the literature, that there is the social diffusion starting from visibility, peer effects in terms of the social adoption of solar panels. That's one example.

The second example is climate icons. These are simple icons that we can put up to products, to things that we purchase as consumers that inform consumers about the carbon intensity of this product. Carbon labels have been shown in studies to increase the choice of climate-friendly products. I think these are the different psychological factors that can drive decision-making for sustainable choices.

**Katelyn:** I would love to build on that as well, just because I love this point of what's salient and what's not being salient. What is immediately apparent and what isn't? An area where I think our consumption is increasing rapidly in the course of the last year, but is not salient, is actually our consumption of AI and generative AI. It is oftentimes in a chat form, but it's extremely energy-consumptive. That particular interaction is so disembodied from our experiences of how we interact with those resources.

I would actually love to see some research on people's perceptions of energy and AI and how that gets connected in a more meaningful way because right now, the way it's presented to us or the form factor it's taking is a chat box.

That is just disembodiment so much of the actual behind-the-scenes, what's being happening, what resources are being consumed, and how that relates to our energy footprint. Just building on that point, one area where I would love to see stuff, I don't have the time to do it, but [laughs] I would love to see more research on that area.

**Andrew:** Also, two areas, although just to comment on Katelyn's one, it's not just AI, it's also search engines and the huge amount of energy that goes into just using Google or whatever other search engine you use. The other area which closes in quite closely to psychology is not just whether you can see it, but also how it presents itself to the user. How you make it more attractive so it becomes aesthetically maybe or more useful in another sense.

How you make something more aesthetic and more useful so that you prefer the sustainable product over the less sustainable product. It actually gets a market advantage is one way of looking at it. The second thing is just moving through space. How we move through space and how we interact with things around us. Designing that space so that it's actually easier for us to act in an environmentally sustainable manner than it is to act in a non-sustainable manner.

That might mean recycling bins, which are just really easy to use, or as I saw in an example in China where you actually get money back for recycling. There's a financial incentive to recycle as we actually get recycling machines. You put it in and it gives you a credit on WeChat. You can use that to go and buy something at the shops. Actually, it becomes a more easier way and a more financially easier way to do something.

**Dennis:** Right. It seems clear, at least to me, that sustainability can only be achieved through group action. One person acting alone is not going to create a sustainable future. We need large-scale action. Maybe I'll look to you first, Katelyn. I'm wondering whether you have thoughts about that. You're an engineer, but does somehow applying principles from psychology and behavioral science help you to scale your work?

**Katelyn:** I appreciate this question. I think there's maybe a universal belief among the practice that if everybody changes their individual behavior, it will result in system-level change. I would really like us to hold onto that tension because I don't think it's always true. If the rules of the system and the rewards of the system aren't fundamentally changed, there's always going to be friction.

No matter if everybody in the world recycled, it still doesn't change the fact that a good proportion of what is recycled doesn't actually end up being recycled. Even when we talk about these discrete behavioral changes, we have to still think about the system context, system rules, what's governing these kinds of decision-making. I want us to hold onto that thread, but also acknowledge the good work of individual behavioral change. We still need to be developing that. It's not a no/but, it's actually quite more of a yes/and.

One area where I see opportunities for psychological science to be applied in a more systematic way is actually scaling. We have the scales of the individual behavioral change that can scale across contexts, but we also have the opportunity to nudge or influence people who make decisions at higher order, whether that's engineers, whether that's designers or policy-makers, and thinking about their psychology in specific ways, how they make decisions and how those decisions can create the conditions for an entire system change is something worth exploring. It's extremely hard to do.

**Andrew:** I was just thinking about this. It was the first review question I got back from my first paper writing in this area some 20-odd years ago. What's the point of this? How are you going to scale it up? We can't influence sustainability at a global level unless we can scale up. That's been a constant question on my mind for the last 20 years, is thinking about how do we scale up. Katelyn's right. It's not just bottom-up behavioral change, it's also top-down change.

Myself and a colleague of mine from Malaysia developed something which is called the sustainable systems as systems. We don't think about it just as a single system of a human scaling things up, but we think about top-down and bottom-up together. The fundamental theory actually comes from complex adaptive systems in biology, for example, how do you change a grassland and how does a grassland change into a forest over a period of decades?

It uses the same type of principles and understandings that we get from biological systems to understand how we affect change at higher and higher levels. Sorry, JZ, I interrupted you.

**JZ:** I would just like to add to that. I want to give an example of Norway. Norway is probably the most successful country with EV adoption. Now, almost 100% of the new cars manufactured in Norway is EVs, and more than half of the cars on the road are EVs at this point in Norway. Now, how did Norway achieve this transformation in the transportation sector? Katelyn and Andrew, I agree with you, we need system-level changes. We need policy changes.

That's what the Norwegian government did, but it didn't work. From 1990, for a good 16 years or so, the Norwegian government has removed taxes for EVs, have given EVs free tolls, free parking, access to bus lanes, made no difference in EV adoption. The problem was there are not many options for consumers to choose from. There's also not a lot of chargers. It wasn't until 2013, 2014,

when Tesla, BMW, Volvo, a lot of EV options models are available and now becoming cheaper, and chargers are being installed at a faster rate, that's when you see the tipping point of adoption. That's how Norway was able to achieve this EV success.

It's both government-level policy changes, incentives to consumers as well as businesses, and the availability and the attractiveness of EVs and affordability of EVs to consumers. That made the transformation possible. Then that led to another question, which is, what is this diffusion point? There's a whole diffusion of innovation theory out there that says, you need the early adopters and early majority, late majority and laggards and all that. That's always a theoretical argument of how many people do you need on board before the mass, the collective came on board.

It wasn't until a couple of years ago when Damon Centola from Penn, he actually did an actual experiment to manipulate the tipping points. From his experiment, we saw the tipping point is around 25%. What this means is that you need about one in four people to get on board first, and then that's when the mass will start to take off. That's highly both theoretical and empirical. It needs to be demonstrated in the climate and the sustainability domain when real behaviors are involved. I think that's a super interesting question.

**Katelyn:** It brings up timelines for me because the EVs are so-- Adoption and transition to EVs, I think that's a beautiful story to tell. One area is the sustainable technologies we talk about sometimes are entirely out of sight, out of mind, particularly in the building space. I'm thinking of heat pump technology, specifically where we can-- it replaces an air conditioner and a furnace.

It's an extremely efficient piece of technology that just uses electricity for those who are not familiar with heat pump technology. It is a form of sustainable technology. When we think about sustainability, sometimes we think about the forefront of salient behaviors, both what we're personally responsible for and also the choices we make. When it comes to things that are more behind the scenes or ought to be just running or ought to be just it's part of living, that's where I think that these kinds of diffusion curves actually struggle to predict future behavior.

I see this in my work all the time. Sometimes we predict adoption of heat pumps, and we think that we've hit a tipping point in a community, and we haven't. That's because both the time of the technology as well as the way that the infrastructure is built out and how people relate to it is fundamentally different. I think we have to keep those in mind across transitions towards clean energy or sustainable features.

**Andrew:** I was thinking about it. I also looked at diffusion innovation theory a lot in our work, looking also at solar panel adoption and sustainable domestic products. Actually, for us, the change happens when there's some crisis in the community or just even in a person's life. They don't adopt it, even though it is better-looking, it saves you money, it's easier to use, all of these things. It's only when a crisis happens, so when you get a tipping point in some other system, that it actually tips the system which we're trying to influence.

What we've learned is just not looking at only our system, only trying to do one type of thing and one type of technology but looking at how it might interact with the suite, with the family of technologies that are there.

**Dennis:** I'm starting to get the sense that this is complicated [laughs].

**JZ:** No.

**Dennis:** No. [laughs] Maybe another factor that comes into all this, and at least in my experience, I sometimes hear friends or family members react to sustainability as if it's a burden. They have maybe the sense that achieving sustainability means they're going to have to cut back or they're going to have to not do things that they enjoy doing. They're thinking, "Oh, no, I'm not going to be able to travel where I want to go. I'm not going to be able to eat the things I like to eat. I'm not going to be happy."

I'm wondering what your reactions are to that, whether you have any thoughts on whether there are ways to prioritize human happiness and well-being while simultaneously tackling these big issues around sustainability, including things like climate change.

**Katelyn:** I want to come out and say I am absolutely for a society that is promoting well-being and happiness. In fact, I think sustainability is part of that. This deficit approach to sustainability of restriction or changing has maybe been promoted or researched in certain ways. I think that's a paradigm within our research community that needs to be examined more.

I don't think lecturing anybody is going to-- [chuckles] it's not going to change their behavior, and it's not going to change my behavior. Making sure that it's both easy and accessible as well as something that aligns with people's identity and culture and values is essential to affecting change in a meaningful way. I firmly believe that all the solutions we should put forth, we should be okay, and not just okay with, but celebrate our own participation in them.

**Andrew:** I had a PhD student who looked at pretty much the type of thing, Katelyn, which you were talking about, which was trying to understand how people would make these changes. What we realized is there isn't just one person. Each person is their own little-- what's the word? Constellation of ideas and values and backgrounds and education, et cetera. At the one end of the scale, you have people actually who love the minimalism, you think of those tiny houses, or trying to have as few clothes as possible at one end of the spectrum, and then you've got high-end consumers that every single new product that comes on, you have to buy these new products.

You have to tailor solutions for different groups of people. It's a little bit like what you do in market research. You have to try to understand what these different groups are and what the drivers are for these different groups. There isn't one solution. There's multiple solutions for different groups.

**Katelyn:** Yes, I absolutely agree. Designing for a plurality. [crosstalk] Pardon?

**Andrew:** JZ, I'd like to know your thoughts on this one.

**JZ:** I'm writing book on that as we speak- [laughs]

**Andrew:** Yes. I thought so.

**JZ:** -about happy climate. I gave a Ted Talk last year about this. This is my whole new research program about making sustainable actions feel happier. We need to move away from this sacrifice, giving up, reduce, giving-- This is not going to work. This has not worked. Let's just stop there. Now, there are many suggestions coming next year. I want to do the seminar again next year to tell you more about my book [chuckles].

I think the number one barrier for sustainable action or adoption of technology is, one, it's too expensive. It costs too much. Two is, it's just not attractive. It doesn't make people feel good. I do

want to make an argument for plant-based food. Plant-based food has not taken off because it tastes horrible. Of all these successful plant-based businesses, products that have really taken off or are the tasty really tasty ones, I can't tell you.

There are vegan restaurants. I'm in Vancouver, British Columbia, there are vegan restaurants that don't advertise that they're vegan. Instead, they focus on perfecting their dishes to make them as tasty as meat dishes and even tastier. After you go and try out their food, you think, "Why would I ever eat meat again?" I think that's the barrier. One is, can people afford this technology or this product? Two is, would this product make them feel happier, make their life better off, instead of feeling like this is a sacrifice I'm making for the planet, which will never work? I think that's a rethinking of our approaches and framing.

**Katelyn:** I want to be specific about who we're talking about here when I think we are all on this, maybe thinking about the same group of people, which is general population. I think it does need to be said that there are hyper-consumers. If you are flying 30 minutes to go from one place to another, you are a hyper-consumer with the notable exception of Alaska, but I do think it needs to be said that there are people who maybe ought to be shamed because their consumption is so outrageously expansive and disproportionate with maybe needs or wants or desires or even just happiness and wellbeing. That's a conversation about maybe regulation, maybe policy, something a little higher order that psychologists ought engage with--

**JZ:** I'm not entirely sure we should shame them. They tend to be high-income, high-consumption individuals that are a tiny fraction of the population, but yet they have disproportionately large impact on the environment. No, I don't think we should shame them because shaming them is not going to work. It has not worked. [chuckles] Yelling at them, being angry with them.

**Katelyn:** Well, then what do you think?

**JZ:** The suggestion is tax them more. They need to pay proportional to their impact. That's the whole point of carbon tax. I think they need to pay their fair share of their impact.

**Katelyn:** Yes.

**JZ:** If you're traveling this much, if you're flying this much, if you're consuming this much, you can, but you need to pay proportionally for that.

**Katelyn:** Agreed.

**Andrew:** I suppose, JZ, just a country case study to that happened in one of the cities here in South Africa, in Cape Town, they had a drought, the city almost ran out of water in Cape Town. They did all the things you're saying over here, the higher taxes. They did, basically, the more water you use beyond a certain point, and it ratcheted up. If you were a hyper consumer, you were getting taxed 30%, 40% per liter that you were doing to try to do that, and the people were just saying, "Well, I have water, I'm going to use it."

What changed that was actually what Katelyn said, they created a map of each individual house and showed not how many liters they were using, but they just showed in red the houses, which were over-consuming. Within three weeks, they had completely changed their profile. Now, we had no more hyper consumers anymore because other people could see who were the high consumers in that area, and so they changed their behavior.



Again, that's an unusual situation because I think going back to what I said earlier, you've created a crisis point that had something which was called Day Zero. That was the point at which the city would run out of water. Think about that, a city of-- I'm trying to think, there was close to eight million people living in the city. Eight million people without water. That's a serious crisis.

I think you can use different techniques in different scenarios, but generally, I think you're right, generally shaming and creating-- we know this from psychology, going back to basic behavioral psychology, you know that the stick doesn't work nearly as well as the carrot. Generally, we need to start looking at how we can find carrots for sustainable technology adoption and sustainable behavior adoption.

**Dennis:** As you've been talking, I've heard at least a couple of barriers to change identified. One is cost. Can I afford to make this change even if I want to make the change? Another one is this happiness factor. Is this going to make me less happy if I end up doing it? Are there others? What are the other psychological barriers to change in this area?

**Andrew:** The other one is about values. Does this link in with what my values are about, my value statements? For example, some consumers value the environment, and that's the small proportion of the population that JZ is talking about that we've actually managed to get to now. Now we have to think about what are the other things that people value, valuing power, valuing the good life, and those types of things.

Then there's another bit which we haven't really tackled. Perhaps it's not a big thing in North America, but it's huge in most of the areas in the global south. That's about what we can do for our community, so it's community and community links. For example, across Africa, there's a general kind of trend that is, "I'm only a person because of the people around me." It's called Ubuntu. It's about feeding into that. I'm doing something because I'm helping other people. We haven't really tackled, we haven't got anywhere near that type of value system yet.

**Dennis:** I love some of the concrete examples that you've shared with us, and I'm curious whether there are other examples of interventions that you've maybe been involved with or that you've heard your colleagues talk about that have been effective for actually changing sustainability-related behaviors? Because we know it is so hard to change behavior. It's easy to talk about it, it's really hard to do. Are there specific examples that you can point to that have worked?

**Andrew:** What I'm thinking of, and it actually-- when Katelyn was talking about it earlier, I'll call it the stealth option. Other words, what you do is you're creating an intervention that looks like it's dealing with this thing, but actually, underneath it's dealing with something else. What you do is maybe it's not stealth, it's more like piggybacking. Working with a community, we were working with a really, really indigent community living in an informal settlement on the banks of a river. What we were trying to do was solve a wastewater problem.

We didn't want all this wastewater to end up in the river, but they weren't particularly interested in that. What they wanted was flood protection. What we did is we created a collection system that provided flood protection. Now we're saving the environment by providing them with what it is they actually want, and retrofitting and fitting on what the environment actually needs onto that. I can think of thousands of different ways in which we can do that with just about any technology. Take what it is that people want, and then fit onto that in a stealth or in a piggybacking type of way, the things which actually the environment needs.

**Dennis:** That's fantastic. JZ, I think I can see the wheels turning there. Did you have something you wanted to share?

**JZ:** Yes, I want to maybe talk about recycling. It's a boring topic, but we made it very fun. In British Columbia, we have a policy where if you return a bottle or beverage container, you get 10 cents back. That's the bottle deposit refund system that's available in a dozen countries in the world. Now, that system has increased recycling rates, but not enough.

It certainly hasn't increased anywhere close to 100%. The problem is, one, recycling is burdensome. It's effortful. It's not fun. It smells, it's messy. I get 10 cents back per bottle. That's not very attractive. Why would I spend all that energy and time to get 10 cents back? What we did was we turned each bottle into a lottery ticket. Instead of getting 10 cents back per bottle, you have a remote chance of getting \$1,000.

This is like gambling for good, gambling for the environment. We show that in our experiments and studies that, one, people prefer the lottery option. They rather play the lottery than getting 10 cents, and two, having this lottery option make people feel happier, even though they didn't win any money. Just the idea of having \$1,000 or even higher amounts gets people excited. We measured happiness in those experiments. They feel happier after choosing that lottery option compared to the status quo.

Moreover, the lottery option increased recycling by almost 50%. People bring more bottles to recycle, compared to the status quo. I think that's a simple change in terms of policy and programming, without adding additional cost, because the expected payoff of the lottery is still 10 cents per bottle. That, actually, I think, has huge impact on recycling rates for the environment, reduced pollution, as well as on human happiness and wellbeing. I get pushback from people who say, "Oh, you're promoting gambling."

I'm like, "First of all, people are gambling anyway. Why can't we make that good, make that better, so people can gamble for the environment to reduce pollution." Second, I'm going to go back to Norway again. Norway is the only country in the world that has the recycling lottery in place. I think they have this reverse vending machine. These are actual machines.

Andrew, you talked about China had those machines that take bottles. Norway has those machines, but then the difference between China and Norway is Norway gives you the lottery option. You can stick with this status quo, which is 10 cents per bottle, or you can choose the lottery option. To date, since the implementation of those machines, Norway has produced, I think, eight millionaires from this lottery.

Now, having said this, the operations, the recycling machines actually donate half of the revenue to the Red Cross. They actually generate quite a bit of revenue from this machine. Having said all that, I think there are ways to design smarter systems that work both for the planet and for human wellbeing at the same time.

**Andrew:** You hit on another important psychological point here. Sorry, Katelyn. [laughs] Which is the issue around fun. I've also seen that done in some countries around the world, where they've gamified the sustainable behaviors. You see it on your social media profiles. People would start collecting these sustainable behaviors so that they can show that they're creating more of a forest than someone else. Sorry, Katelyn, go ahead. I didn't mean to interrupt you.

**Katelyn:** No, no, no. It's a conversation. One thing I wanted to add on about is, I think there's an exhaust. There's no shortage of lists of interventions and solutions to supporting sustainable behavior. I would like us to think about there's all these phenomenons that we have, but as we start applying them more, starting to think about what kinds of solutions pair with what kinds of problems. Starting to form these patterns of both practice and application, and really forming the foundation of taking applied psychology, and institutionalizing it or translating it to practice.

I think there's a very rich world where some of these patterns overlap in interesting ways. When I talk about patterns, it can be something as simple as like a community agreement, helping to facilitate the sustainable management of resources. I think we all understand, everyone has to agree to manage a shared resource effectively. Taking some of these problem and solution pairs, and starting to develop out how they can be applied in more interesting ways is an area of both expanding what we know in a different way, but also applying it to a greater set of contexts

**Dennis:** When we talk about sustainability, I get tempted to really focus on climate change. Because that's such an important issue. Maybe there's also other things to consider. I'm thinking about things like accessibility, broadly defined. Accessibility for those who are living with disabilities, accessibility across geographies and cultures and economic circumstances. Are those kinds of things part of the field of human factors, or am I getting too far afield at this point?

**Andrew:** They're definitely part of human factors. Whether they're part of human factors and sustainability, it depends a lot on how you define sustainability, I think. The sustainability question fundamentally is actually about humans. I know we think about it as being about the environment, and we talk about environmental sustainability, but fundamentally, sustainability is about whether humans can survive on whatever planet we create.

That relates to issues about access to water, access to power, access to air, access to all the resources we need to create all the technologies around us. If we completely destroy it and we manage to kill ourselves, the planet will still be here. We're not talking about whether the planet will be here or not, and it will be life. It won't necessarily have human life, but it will have life. The questions about what type of planet do we want to leave for our--

I'm quoting now, though, and our ascendants, the people who come after us, is really the question about sustainability. When we start getting that way, it is politically fraught. Because each person wants a different future. It's difficult for us to get into those types of questions. I know what I want, but that isn't necessarily what my neighbor wants. We tend to avoid those questions when in fact they're actually fundamental to sustainability.

**Dennis:** One of the questions that's come in from the audience relates to teaching, and it seems like an appropriate question. Because all three of you are involved either as a primary part of your profession, or as a part of your professional activities in teaching, and I suspect a good number of people in our audience are as well. The question is, what can you say about changes that can be made to further sustainability in education? How can we communicate this to students and get them excited about it?

**Andrew:** Wow. [laughs] That's a hard question. Katelyn, you can go first.

**Katelyn:** [laughs] Well, I think tackling complexity and taking on challenges that people care about is essential to one's own journey of learning. We want to learn things that are relevant. Oftentimes, sustainability in one frame or another is relevant to almost all students. Whether that frame is one that we are imposing of a certain kind of behavior, but it can also be other things. Like

climate change has to do with resiliency and being able to have the life you want to live, and that is relatable to everybody.

I also want to emphasize that we talked about accessibility and inclusion, and I think it's also a part of that too. A sustainable future is a sustainable future for all people. Allowing the conversation to have a plurality of frames and values and lived experiences, both in the classroom and in practice, is essential to reaching those goals. It's not the power of one, it's the power of many in our goal to actually achieving what we're looking for.

**Andrew:** I'm going to steal an answer which JZ gave earlier. It's not just about trying to tackle the scary future. It's about making the problem-solving fun. They are complex, wicked problems. In your intro, you talked about it, it's multidisciplinary, no one single discipline. I've just looked at one of the comments coming through in the Q&A.

It's saying, "Well, we're focusing on humans and things like that." I think we've been doing that because this is a conversation about human factors and psychology. Yes, part of our solution finding is working with the biological sciences, working with engineers and sociologists and anthropologists.

Those are the types of teams that I try to put together when tackling sustainability problems, try to put together as multidisciplinary as we can. Luckily, the background discipline, which I focus on the human factor side of things. Generally, that's something would be easily adopted. It is about bringing in psychologists and engineers and things like that.

There's also other aspects, other people with the biologists into some of these problems. That project I talked about earlier actually was a project about using constructed wetlands. We need biologists. What types of plants do we need here in this wetland that will help clean the plants that are there? That point also raises another whole aspect, which we haven't tackled.

That is the issue about biophilia. Our inherent. We are nature. We are not separate from nature, we are nature and our connection to nature is an important part of these change processes. Realizing, connecting ourselves back to that. There's a lot of research done both in human factors in the psychological field about wellbeing from contact with nature. Not just contact, but immersion, working with nature to actually solve some of these problems.

If you think about it, if you're never really in contact or you don't love nature, what's the point? Let's just build big cities and soon we'll have *Blade Runner* type environments all around us, and we'll all be happy living in these gigantic multi-story buildings and flying airplanes around from one place to another. It's fantasy now, but maybe it's a future we might create for ourselves unless we are able to connect back with the natural systems that provide us everything that we need.

**Dennis:** JZ?

**JZ:** I'm an educator. I'm professor. I'm teaching one class on environmental psychology every year. I've moved away from the textbook lecture style classes, because when we present information on climate change, on pollution, it gets really depressing really fast, and it demoralizes students. People think, "Oh, I will just give up. Why should I try? I'm only one person." Those are the psychological barriers of just education.

The way I'm teaching this class is actually I do a bit of lecturing just to give them the foundational knowledge, but most of the class is spent on doing research projects. I team up with basically

people who run the UBC campus, the waste managers, the food services, the chefs, people who run buildings, provide energy to the buildings. I work with these stakeholders on campus to design projects, to design actual research projects for students to take on.

The students actually love this. This is probably why my class is always oversubscribed is they feel like they have agency. They feel like, "I can start with this problem. Let me fix this problem on my campus." On biodiversity even. Last year we worked on how to combat misperceptions and harmful behaviors toward wildlife like coyotes and bats and raccoons in urban spaces.

The students love those projects. They get to pick which one they want to work on. They work as a team on each project, and they collect data, they analyze data, they write a report, do a presentation to the campus stakeholders. They feel like they are helping. They're contributing to the campus that they have lived on for about four years, and they feel hopeful. They feel empowered. Now they graduate. I teach fourth year, so senior level courses.

Then they graduate, they go out to the world, and then often they come back to me and say, "This course actually made a huge impact on me and now I'm working for the city of Vancouver or the government or some NGO using the skillset I've learned." I think this is something that we as educators can do, is not just transmit information. That's the bottom. That's the least we can do is actually how to teach people how to give them real experience in tackling a problem, and making students feel hopeful and empowered again. I think that's what education should do.

**Dennis:** That's great. We're getting close to our end time, but we've got a question that's come in here that I don't want to skip over because it looks to me like it came either from a student or from an early career professional who essentially is saying, "I want to be like you." [laughs] They're asking, "What advice do you have to try to get into the fields that you all are talking about?" What skills do they need to make sure they learn? How do they network to get into this? Is there a pathway to doing this kind of work? Are there opportunities out there to do this?

**Andrew:** JZ, go first.

[laughter]

**JZ:** I'm a professor, so I'm going to speak from academia perspective. Get in touch with faculty members, volunteer in a lab or work in a lab to gain some research experience to start. I think that's what I recommend to my students. Reach out to faculty members, work in the lab, take classes, but also gain some hands-on research experience, first of all.

**Andrew:** Also, professor here, but most of my students are going off and working in organizations afterwards. For me, it's about creating curiosity about the world around you. I focus on the sustainability issue, so it is about saying, "How can we make it better?" You see the world around you, but how do you make the world better around you? How do you get more efficiently, more effectively than we currently do? You can see it's inefficient. You can see that it's wasteful. You can see that there are many different ways about doing this better. Have a curiosity.

Then there's a lot of really great books out there. I made a comment in one of the Q&A things. I was trying to think where to start, but again, I think you probably have to be guided by your curiosity. If you're interested in solving water problems or energy problems or waste problems, air quality and air quality problems, there are books on all of those that'll start your minds thinking about those things.

Mine started off work thinking about green buildings. How do we make a building that's better for people and better for the environment? The answer to that is don't build a building in the first place, but if you have to build a building, how would you go about doing that? Of course, that question's evolved over time, particularly with COVID-19 that's changed the whole way in which we think about office and office space.

**Dennis:** Katelyn.

**Katelyn:** My advice is very simple. Tell people, tell everyone. If there is something you care about that you want to be working on, tell the people who you're working with, even if it doesn't seem like the first thing that they're going to be working on. People will make the space, particularly if they think you're passionate about it and you're interested in it. It might be a small space initially, but that's something you can grow over time, particularly in the nonprofit and the research and consulting world.

I think just being explicit with people that that is something you want to do, that's something that you have done, that you're interested in it. Write about it, even if it's informally, like blog posts. I know we're in the academic world, but people will read what you write. It doesn't have to be a big, huge research paper. It can be something that you care about and that you want people to associate with you. Those are things you can do today. The networking and all this other stuff is almost secondary because there's so much that we can't control, and there's the opportunity for serendipity along the way as long as you keep telling people that this is what you want to do and what you care about.

**Dennis:** That's great. Given the time, which is just actually flown by, we need to wrap up, but I want to just give each of you an opportunity to give 30 seconds of any final takeaway you may have or to repeat anything that you feel bears repeating.

**Andrew:** Off the top of my head. [laughs] I suppose if I had one final point, and that is, we are one species of many millions on this planet. In some sense, regardless of your religious or political background, we are responsible for all of them. It is about acting responsibly, whatever background it is that you come from. At the same time, we're also curious human beings. We have to have fun and be curious while we try to solve these problems.

**Dennis:** Katelyn.

**Katelyn:** I love that piece of advice. I absolutely agree.

**Dennis:** Ditto?

**Katelyn:** Yes, ditto. I think a world where wellbeing is the norm is entirely attainable and finding work that supports that is a joy to be able to do and also a responsibility to be able to do.

**Dennis:** Great. JZ.

**JZ:** Do something that makes you feel alive.

**Dennis:** Excellent. I want to thank all of you so much. This has just been a fantastic conversation. I want to thank our audience for participating today. I hope that you enjoyed it. You'll receive a one-minute survey to complete after today's broadcast. We value that feedback. We also would love to hear from you on topics that you'd like for us to cover in the future. You can email us at

science@apa.org with recommendations. Last, we invite you to subscribe to *Science Spotlight*, which is your source for the most relevant news and resources for psychological science. Thanks again to all of you, and we hope to see you at future events. Thank you in advance for sharing your feedback on the short survey. Thank you.