National Convention of Youth Drama 2023

Youth Theatre Arts Scotland

Keynote (Video Transcript)

Dr Livia Tomova: I'm really excited to speak here today and thanks for the invitation. This is certainly a venue I have-- this is very new for me to speak to people in theatre convention, but I'm very excited to present my research here. I will speak about the research that I'm doing, which is on adolescent brain development and how loneliness and isolation affects it. I'm really happy to keep this presentation more interactive, so if you have questions that come to your mind, feel free to just shout out.

Otherwise, I don't have to go through all my slides, so I'm really happy to engage in discussion as well. I'll just give a brief outline of what my talk will be about today. I'll give a brief introduction into adolescence and then adolescent brain development, so the major changes that happen in this developmental period, and then I'll speak about my research more directly, about a more specific study that we recently finished where we studied the effect of isolation on adolescent cognition.

I'll start with defining adolescence and how it's defined by research. In research we have a bit of a different definition of the age of adolescence than what is typically known as adolescence in terms of legal terms. Adolescence is defined as the age range between 10 to 24 years. It's longer than what we typically think of adolescence. This is because there is research from cognitive neuroscience showing that brain development continues up until around the age of 24 when it then stabilises. We know that adolescence is a very unique period in development. Often people think of childhood as a very important period and then once this is finished, we're adults, we just age, but this is actually really not true.

Our research has shown that there are really important developmental steps that are occurring during adolescence. A lot of those steps are actually about social development. One very critical feature of adolescence is a so-called social reorientation. We see this and it's something that we actually observe not only in humans but also in other species. This is that adolescence, so the centre of their social world, changes away from their caregivers, their parents, towards their peers.

Interactions with their peers become really important in this developmental period and they're crucial for also fulfilling certain developmental steps, including brain development. This is something that we see across species. Having said this, one thing that's really very critical nowadays to this topic in general of adolescent brain development is something that's relatively new in research. One thing that people have really not looked at that much before, and have started to look at now is effects of isolation and loneliness in young people. This is something that used to be - or loneliness in general used to be - something we thought of as an issue for older people, the elderly who are more isolated. Actually, research has shown that it is really young people who experience the highest levels of loneliness.

There was a study in the UK, so this is on the right side, that was done in 2018, so that was before the pandemic. That has shown that it is 40% of 16 to 24-year-olds that report that they feel lonely often or very often. This actually makes them the loneliest age group across all age groups that were studied. Even lonelier than elderly people.

Also, another study has shown - this is on the second right or your left side is a graph showing self-reported loneliness over the years. This is data from the US and the researchers here started collecting this data in 1977 up until 2017 in young people between 13 and 18 years. We see that there is quite a steep increase in self-reported loneliness that has occurred since around 2009 on.

This heightened loneliness in adolescents is not something that is perhaps just a feature of adolescents. It's something that we observed that has occurred more recently - well, over the past decade. Again, this is all data from pre-pandemic times. Newer studies that have been done during the pandemic have shown that it's actually, again, the 16 to 24-year-olds that have reported also the highest loneliness levels during social distancing measures.

Probably this data actually is even underestimating these effects that are currently experienced by young people. Again, even though this is a very prevalent phenomenon, we don't really quite understand what the effects of loneliness are and especially what the effects are on development in this very important developmental period.

One thing that I'll briefly talk about, which is the basics of brain development, and again, I'm happy to take questions if something is unclear, I'll just outline what the major changes are that are occurring during adolescence and then I'll talk more about my research more directly.

How we study brain development in humans is that we use MRI scanners and those allow us to study brain structures. How the structure of the brain changes over time, but also brain functions. Which brain regions are involved in different cognitive processes? There are two different kinds... a bit of biology, but essentially how we study brain development is that we look at different tissues that are visible in this MRI scanner, and those tissues are divided into white matter and gray matter.

Essentially gray matter is all of our cell bodies, so the neurons that actually produce the cognitive processes while the white matter are the axons. These are the connections between the neurons. We can study those different tissues separately using the MRI scanner. What we see is that they develop in different ways during adolescence. This is showing white matter development over time from age around 10-ish-year-old to 30.

This is data collected across different sites in the US and also in Europe. What we see is that there is an increase in white matter over time that then stabilises around the age of 25 years. Then if we go to the next slide, you can see now the changes in gray matter. Gray matter is something that actually decreases over development, and I'll speak on the next slide why that is.

What we see again is that over adolescence there is a decrease in this gray matter tissue that, again, metabolises around the age of 25. What do these changes mean? Again, a bit of biology. Essentially, if you look at a neuron and look at the axon that connects it to other neurons, what happens is that, first of all, the axon itself to the connection grows. Then something that's called myelin, which is a sheath that is wrapped around the axon that helps transfer the signal faster is something that develops over time.

Essentially, this is the white matter. The connections between neurons become more and more during adolescence. The other process that happens is something called synaptic pruning. This is why we see a decrease in gray matter. On the right side, you can see neurons and their synapses from birth, six years old then 16 years old. You can see that there are many more synapses developed in very early development and then they're reduced.

The idea again is that our brain overproduces synapses, so potential connections between neurons, when we're very young. Then those synapses that actually get used by

us in our specific environment, those are the ones that will become stronger, they will be strengthened, the axons will grow more there, and those that we are not using are pruned away. They're eliminated essentially.

These changes highlight that the brain changes that occur in adolescence is really a structural rewiring of the brain. The environment that we are in during this developmental period is really crucial for this structural reviving because essentially the things that we think about, that we do and we learn will determine which connections become stronger and which ones get eliminated.

How does this again play with isolation? Now I'll speak a bit about how isolation loneliness affects adolescent commission and brain development, so what we know so far. I'll speak first about brain development. This is a study that, or this is a review paper that we've done two years ago. Essentially, so one thing that people have not studied much so far, but we are starting to do, is to look directly at the brain changes that occur if isolation is experienced during adolescence.

One set of data that we have is animal models. As I said before, animals also undergo adolescence. There's really a large body of research studying how deprivation of social contact affects development. Actually all periods of animal development, but here I'm focusing on adolescents because it has been shown that it has unique effects. The kinds of things that we see if animals are isolated during adolescents specifically, is an increase in seeking out of rewards.

The brain reward system becomes sensitised and also increase in anxiety. The animals become more prone to be over-anxious in stressful situations. They will adapt slower to stressors, and they're overly in this hyperarousal state. Those changes are accompanied by modulations in certain brain regions that are underlying these processes. It's important to note though, that these are animal studies and while they're really important for us to learn from and to form hypotheses from, we cannot directly translate these results to the humans because well, essentially a rodent social world just looks different than a human social world. I don't have to explain that.

We need to be a bit careful with these kinds of data. We really need more research to really study also. Well, is this really true in the human brain as well? This is a thing that we are now doing in our lab. This is a study that we have recently finished. It's a study where we used experimental isolation of young people between 16 to 19 years.

It was a short-term isolation of three to four hours, but we spent time alone and then we compared in the same people how that affects them in certain cognitive tasks and we compared their performance in these tasks to a condition where they were not isolated to this baseline. In the study, we were also really interested in studying, how do virtual social interactions play into this whole thing.

If we are isolated from face-to-face interactions, but we're able to interact with someone virtually, does that remediate effects of isolation, or maybe do we see other effects come up? We had a third condition. Each person also underwent a session where they were again, isolated, but they had access to any kind of virtual interactions that they wanted to have.

The kinds of tasks that we looked at were specifically tasks that were designed based on animal model research that has shown that these kinds of processes are affected through isolation in adolescent animal models.

We were also interested in looking at the brain, but I won't talk about this in the talk today, but essentially here we were mostly interested in looking at brain predictors, who is most sensitive to the effects of isolation. Can we identify certain cognitive or brain functional

mechanisms or structural predictors that predict who is vulnerable to isolation? Today, I'll focus on the reward tasks.

If you want - the two tasks that we had, and I'll introduce them in a bit. First of all, what we were interested in was to validate our experiment, manipulation of isolation, to look at do people actually feel lonely when we isolate them? We asked each participant in each session how lonely they felt. Every hour of isolation, we ask them. What we see is that-- so you can see in the dark green bars, you can see that there is an increase in self-reported loneliness over time in isolation.

Interestingly, when participants were isolated, but had access to virtual interactions, so this is seen in the light green bars, they also showed an increase in self-reported loneliness, but this increase was less steep. Essentially, to some extent, having access to virtual interactions at least on the subjective level, remediated some of the effects of isolation, but it didn't remediate it fully, so participants still felt more lonely compared to when they started isolation. There's a question, yes?

Audience Member: Sorry. Just because I'm looking at the graph there, does the duration of time affect the level of isolation that they have essentially? You know what I mean?

Dr Livia Tomova: Essentially, it means how long they were in isolation. We were interested in looking whether their subjective experience of feeling lonely was increasing the more time they spent alone. This is what we - Is that your question?

Audience Member: Yes.

Dr Livia Tomova: It's more of a manipulation check because obviously, there's other things happening while you're isolated. We were interested whether the driver of our effect is really this experience of loneliness or whether it's other things like just being, I don't know, in a room. This is what we were interested in. Then we went on to look at how these changes in loneliness affect reward processes. The first task that we used was a task in which we measured reward seeking.

I mentioned this is something that has been shown very consistently in animal models and the task that we used is an experimental task where essentially participants are undergoing something that's effortful in order to obtain rewards. The way we did this was that we made a task where they had to press a button in order to pump up a bar and the effort that they would have to put in was either hard or easy, so either higher or low, depending on their level of how quickly they could pump up a bar.

It was calibrated to their own manual how quickly they were able to do that. It would actually be hard or easy for each person. Then they could get points for each task they were either a large amount of points or a small amount of points, and those points were translated to money after the study so it would be real-life rewards. We were interested in, would isolation change how much effort a person is willing to undergo in order to get these rewards.

We always asked them, *"Well, do you want to undergo this task?".* When they saw these combinations of level of effort and reward. If they said yes, they would see a bar like this, then they would have to pump it up. Then what we observed in this task was that essentially was that we saw it at baseline, so at the very left. You can see response times, so how quickly participants decided to do the task on the Y-axis.

Then you can see the different sessions and then you see that at baseline it took them around two seconds to decide. Yes, I want to undergo an effortful task. After isolation, this was significantly reduced. That means they were faster in deciding that they wanted to undergo an effortful task for a high reward. When they had access to virtual social

interactions during isolation, we saw a small decrease as well, but that was not significantly different from baseline.

This data suggests to us that isolation appears to increase reward sensitivity in adolescence, which is again, in line with what has been observed in animal model studies. The second task that we had that we used to study reward was the reward learning task. We were interested in how well were participants able to learn about rewards after they were isolated.

The task is a quite standard task in psychology. We'll walk you through. Essentially, it's a task where people are seeing on the upper left side, you can see these two slot machines and this is what they were presented with and they had to decide which one they chose. They wouldn't know anything about the slot machines, but they would figure out from feedback through trial and error that one of them would give them more rewards than the other.

You can see that the right one in this case would be rewarded 80% of the time while the left one only 20%. While you do the task, you figure out, oh, well this one gives me more rewards. We were measuring how quickly did they learn this. Then after several trials, once they had learned this association, we flipped the contingencies. Now the right one would be the one that would be rewarded less often, and the left one, the one that would give more rewards.

Again, through trial and error, they would have to figure out that now there was a change in these contingencies and they would have to relearn. We would again, measure this and then we were also giving feedback in different ways. We were interested in whether the way we gave feedback would matter how well participants would learn. One version was that we gave non-social feedback that was to symbols either a plus or a zero or we would give feedback through facial expressions.

That was our social condition that would be either a smiling face or a neutral face. You might notice that those faces look a bit weird. They are on purpose that way, so they are average faces from the large database of faces. That was done on purpose to make them more - well, to avoid that people would find certain faces more attractive or more interesting than others.

This is just average. They're also not clearly male or female, so they're averaged across gender and they're black and white to also control for these effects. What we saw in this in this task was that if you look here you see the learning rate. This is essentially a measure of how quickly participants learned to first of all, learn about the report contingencies and then also to reverse them.

It's a parameter that captures already both kinds of processes. We see that at baselines at the very left, participants learned relatively well. The maximum learning rate would be one. They were quite good at this and they learned somewhat better from the non-social feedback. What we then saw after isolation when participants had access to social media, so that's the two graphs in the middle, we saw that learning from non-social feedback was not really affected at all.

It's pretty much the same as in baseline, but interestingly, learning from social feedback was decreased. This is something that we did not predict and it was quite a surprising finding. We actually thought it would look more like baseline. I'm happy to speculate what we think this might mean, but we're not really sure. We need more research to study whether this is a true effect or maybe something that was induced by our experimental setup.

The interesting part here is to look at the isolation. When they were fully isolated, we see that learning from feedback increases specifically learning from social feedback. While

there's also an increase in reward learning to the non-social feedback, the one from social feedback is really strongly increased. We might be tempted to think, well that means if we isolate teenagers, they just learn better.

Essentially, what this data shows is not necessarily whether this learning - or let's just say the learning rate essentially - means how quickly did I update my bahaviour based on feedback that I got? Given that we see this really high learning rate in the social condition, it just means essentially participants paid a lot of attention to the social feedback. After almost every instance of feedback they received from these faces, they changed their behaviour.

This is something that potentially could be optimal if the feedback I'm getting is actually formative, it could be good to really rely on it. That's not always the case. Sometimes the feedback we get from others is essentially not helping us to learn about things. It might be wrong. This is something that we also see here that essentially, they over-rely on social feedback. Whether that's good or bad, again, that depends on the specific situation. Just to put this in context.

I guess this is already my last slide. This is a summary slide just to summarise what we found in this study. Essentially, what we found is that isolation leads to increased reward-seeking and reward-learning, which is again in line with animal studies. We were showing this is also true in human adolescents. Having access to virtual social interactions appears to remediate some of the effects of isolation.

Participants reported less subjective loneliness when they had access to virtual interactions. They also did not show this effect in reward-seeking. Interestingly, it looks like it has also unique effects as well. We did observe this decrease in learning from social feedback after this session. Again, we were not really anticipating this result. The way we think about this, what it could mean is that engaging very excessively with virtual interactions on social media could also be something that's in a way biasing our experience of rewards.

The images that we see on social media are very nice and colorful and all. We already get very sated perhaps from social rewards. Then coming into a different environment and getting other social feedback just might be less interesting. At least our data suggests that our task perhaps was then less interesting to adolescents after this session. Again, I should add that this is a task and we need to really also study whether this translates to the real world because, obviously, the implication of that will be quite strong. If it was true that real-life social feedback would become less interesting after someone spends a lot of time on social media, that would be something that's possibly alarming. I would not yet draw this conclusion from this data, but it's something we want to follow up on.

I'm at the end of my talk. Oh no, sorry, I'm not [laughter]. This is the most important part [laughter]. In preparation for the talk, I was looking at actually whether there's research looking at involvement with arts and how that affects loneliness. Actually, this is a study done by someone who used to be in our lab but now went down to a different lab at UCL. She was looking at how engagement with arts predicts social support in adolescence. In this study, what they found is longitudinal studies, so in the same people they studied this question repeatedly over time and they found that when adolescents engaged in activities that were associated with art - well, they included many different ones into that, so it was not just theatre, but also different forms of art.

Essentially, what they found was that, above other extracurricular activities that you could do with others, really this engagement with art activities seem to have an additional effect in enhancing how much social support from peers participants were receiving. Again, I think this study is a first and hopefully a series of studies. We need to explore this in more detail. I think it's a really cool and an interesting finding showing that specifically, engagement with art seems to do something that heightens the social support that we

feel from others. To conclude with that, I'll finish now. For real. [chuckles] I want to thank everyone. Thank you all for your attendance.

[applause]

Kenny: Break time, but I wondered if anybody might want to ask any questions or any comments because we've got a few minutes and we could just - I'm sure we can eat into a little bit of our time later on as well. Does anybody have any questions or any comments? Stuff that's - yes, there's a few already.

Rikki: About the second or third slide. Sorry, I'm Rikki, I'm from Scottish Youth Theatre. About the second or third slide, there was a graph that showed an incremental increase in young people and adolescents reporting loneliness. That's a report of loneliness. Now, it seemed to start, this incremental increase about 2008, 2009. It's continuing to soar. Is that social media? Is that the factor? If it is, is it the same to report loneliness as it is to be lonely? I wonder if social media changes the context in which you report loneliness because as you were saying later in your speech, you see lots of people do really nice things while you think *"I'm lonely here in my room in front of my phone."* Because the only time you see people doing that is when you're sitting in room on your own. Is that what you think? Is it social media?

Dr Livia Tomova: I guess that's two questions. These are really good points. This speculation that, does it have to do with social media or not? It's something that people have already had. It's very obvious that the time coincidence with the rise of social media, so around 2010 was one of the two major platforms back then, so that was YouTube and Facebook really hit it off. It might be a coincidence, but maybe not.

The thing though is it looks like it might be, but it's a correlation. Both things seem to be associated, but we really don't understand well how they're associated with each other. One potential interpretation is yes, maybe social media made people more lonely. It could also be that maybe there's something else, in a way our society has changed, adolescents already felt more lonely, and that made them use social media more, or other kinds of effects.

I think we need to be careful with this. I think it could be and people are researching this association now more and more. I think one thing that we tend to do a bit, especially when it comes to social media research is that a lot of people tend to have a very - how should I say? All the things are seen in a very negative light. I think that is a bit unfair to social media. I think it's true to some extent, but there's also research showing that social media does have a lot of very positive aspects. It can help people who are otherwise quite isolated to connect with others or find groups of their interests to connect with. It looks like social media is a very complex phenomenon. Obviously, it is. There are different ways you can use social media.

How I would interpret it is I think it really matters how you use social media. There's some research already showing, for example, that if you use it actively, so if you really use it to talk to other people, it actually does not seem to have harmful effects. The harmful effects seem to come more from a passive use. If you just scroll to pick through pictures on Instagram where you don't engage with others, you just see others do things, that seems to have a negative effect on wellbeing. Perhaps through, I don't know, comparison as you just said, you see others do things that you would want to do. Again, I think we need much more research to better understand how those are linked with each other.

Rikki: I've got a 14-year-old son and that wasn't the answer I was looking for.

[laughter]

Dr Livia Tomova: Yes. Well, this is a really interesting question, especially with adolescents because they do spend a lot of time on social media, and in many ways, even if they have the possibility to interact with others in real life, they sometimes choose to use social media. That's interesting because we as adults who did not grow up with it, we think that's really weird with them. [chuckles]

I think we need to keep an open mind, and I think we really need to observe what the real effects are and whether there is some benefit in that as well. We saw during the pandemic that having Zoom and all these things was also helpful. So yes, I think there was a second part to your question that I now forgot.

Rikki: I forgot it too.

Dr Livia Tomova: Okay, I think there were other questions.

Audience Member: I was just going to ask do you define what loneliness is? How do you define it? I think it's just what you were saying about maybe is it inadequacy or is it loneliness. Do you give participants a definition of what loneliness means?

Dr Livia Tomova: The way we define loneliness in research is really the subjective experience of having fewer social interactions than one would want to have. It's an inherently subjective experience. It's somehow related to your objective levels of social interactions, but not fully, so it doesn't explain it. This has been shown by other research. Some people feel lonely even though they really quite have a large social network, while others are actually quite fine, even though they have very few social interactions.

We really care about this subjective experience. I think your question, I remember it was if we ask someone, *"how lonely are you?"* Is that really that thing that we care about and actually, yes, it is. It's really about the subjective experience. How people interpret this question, that's another very good point because yes, it might be that some people think of it differently and now that loneliness has been more and more also in a public debate through the pandemic, it's perhaps something that also changes meaning and this is something that we're actually interested in studying as a next project. This is something I am really keen on looking at what does loneliness mean perhaps to different people and especially over development? Does it change in meaning? I think as far as we have it well defined, it now is really just this experience, I would want more interactions than I'm having. I think there were other questions.

Audience Member: I have another correlation question **[unintelligible 00:32:33]** rise of social media, the financial crash, and whether there was any link in your study between absolute loss of income **[unintelligible 00:32:43]** numbers.

Dr Livia Tomova: I'm not aware that there is specifically, but I think it's an excellent point to make, that other things happened and it could be really driven by other things. We should not be so quick to conclude social media is an evil process happening, but perhaps it's really economic challenges that led to people not being able to socialise with others perhaps because they had less money to go out actually. All these things matter. Yes, I think this is a really good point to highlight. We need really more research to understand what's going on but we don't know to answer your question, yes.

Audience Member: Sticking to the same graph, I noticed that before it got really bad, there was a huge dip in self-reported isolation and I was wondering whether any of the research speculated as to what might have caused that decrease in the previous 10, 15 years.

Dr Livia Tomova: Interesting. Not that I know of. Again, I think we could speculate quite a lot and again link it to historical events. I don't think people have from this study. I think the major conclusion was mainly this increase. Again, I think what we really need is longitudinal

studies that measure at the same time your loneliness and all the things that happen in your life and then try to really separate these things as a person develops.

In this data, we can't really do that because we now just have the data over time and can only do associations. I can't really answer your question, but I think there was another question at the back.

Simon: Simon from the Necessary Space. I was interested, you said at the beginning of the talk, it was unusual to present this evidence to this type of audience. I'm wondering what audiences you do it present to, and what conclusions they come to in terms of the evidence saying the arts helps things, and is there a way that we can break down silos and connect these audiences so that it benefits everybody?

Dr Livia Tomova: That's really a good point. Usually, I present either to academic audiences or schools, so teachers often or medical professionals, so NHS specifically those who treat adolescents. Those are the people who are mostly interested in this kind of research so far. [chuckles] I would think that probably - especially teachers, I think, for sure are quite interested in these findings and would be quite keen to explore other ways how their students can feel better.

What I get often as feedback is that they notice the students are really feeling lonely and unwell, so how can we help them? It's really hard as a researcher then to - I mean, we have this data and it's just this and this and this. Obviously, we didn't do an inventive study, so we need to try other things. I think that's a really good point, so perhaps collaborating with schools that would be a really-- I'm assuming you're already probably are doing that or a lot of theatre probably happens in the school settings. I'm not sure I answered your question. Did I? [laughs]

Simon: Yes, it's an interesting thing. I'm wondering why the audiences that you might present to aren't beating down the doors and saying, *"Let's get more of this into the schools."* Or, *"Let's get this more into policy and practice."* It's brilliant. Thank you for all of that because it gives us another way of evidencing the value and the worth of youth arts.

Dr Livia Tomova: Definitely.

Kenny: I think we probably just got to take one more question. Sorry for that.

Anna [Sign Language Interpreter]: Do you want me to...?

Craig [via Sign Language Interpreter]: Really, this is coming from a deaf person's perspective because obviously we've both grown up as deaf young people. The research I can see here on the graph, well, things are moving a long way and it's interesting because we were talking about that and we were looking at who is in the group that you're researching, who's involved in that participant-wise, have you got minority groups represented in the group people that you're researching and so on? Because they all obviously have different perspectives and different experiences growing up and different ways of communicating and cultures.

I was just wondering for us as deaf people it would be fantastic to see because social media, we use FaceTime all the time to talk to each other. That's how we really engage through social media. My question really is who you were researching, who was in that group, and who specifically also involved in that? Because if they were all hearing, I think it would be really interesting to see the perspectives from a deaf point of view because I think the contrast would be massive.

Dr Livia Tomova: This is obviously a very important point. I think it also highlights how different people use social media in a way that perhaps is actually quite helpful, but in our study, we tried to diversify our sample which is in experimental studies sometimes tricky

or often tricky. The sample we usually get is - well, if it's adults it's often undergrad students, but in our case it was adolescents, so it was from the local community.

We tried to diversify our sample, but we did not have anyone who was deaf in our study. To add to that, this research is pretty new, so what we're now trying to first of all establish is just show any effect or how can we - what kind of mechanism is going on? I think as a next step once we have established some hypotheses it will be really interesting to study different groups and how they perhaps react to these studies or their experiences, how they're perhaps different.

Often people also ask about people who already experienced chronic loneliness which is another question. We also don't include people who are for example chronically lonely already because we want to study the effects of acute loneliness. Again, the question then, how these two interact is really interesting. I think there's lots to continue studying and looking at how different groups react to these things. I hope that answered your question. You're not sure.

[laughter]

Craig [via Sign Language Interpreter]: Sort of, yeah. I don't think there's a right answer to that. I don't really think there is right answer there because it's still a big study. It's something that we're all still learning. I mean, we're all really interested. We don't know about it and a lot of people here don't know about deaf culture. We've experienced it growing up. I think that why this research needs to just keep continuing and growing.

Dr Livia Tomova: Yes, definitely agree.

Kenny: Can we just give a big round of applause to... [applause].

[Fade out]