

Podcast 3: Sam Couth 'Quiet time during lockdown is it really a chance for our ears to rest?'

Gaby: Hello and welcome to another ManCAD and British Academy of Audiology podcast.

ManCAD or Manchester Centre for Audiology and Deafness is located at the University of Manchester in the UK. I'm Gaby Saunders, a Senior Research Fellow at ManCAD and I moderate these podcasts.

We want them to support ongoing learning and right now during COVID 19 we are particularly focussing on topics that have some pertinence to the practice of audiology or to people with hearing loss under the current circumstances. We are going to continue with podcasts on into the future and over time will adjust the topics to make sure we are addressing things that are on the forefront of audiology to make sure the podcasts remain of interest going forward. We will have a new podcast each month and these will be posted along with a transcript uploaded onto our University of Manchester web page <http://research.bmh.manchester.ac.uk/ManCAD/Podcast/>

Our speaker today is Dr Sam Couth, a Lecturer at the University of Manchester in ManCAD. He is going to be answering a few questions that I'm going to post to him on a topic that he's picked which he's titled "Quiet time during lockdown; is it really a chance for our ears to rest". Before I begin with the questions, I'm going to hand over to Sam and he's going to tell us a little bit about himself.

Sam: Thanks very much for having me today. I should just say straight off the bat I'm not an audiologist so full disclosure there. My background is more in psychology and cognitive neuroscience, which is what I did my degree in at University of Manchester quite a good number of years ago now. Following my degree I went onto to do a PhD looking at multi-sensory integration, looking at vision, touch and hearing and how we combine these senses and how this process is affected by the ageing process. Following my PhD I went on to look at neurodegenerative diseases like Parkinson's and Alzheimer's disease and looking at ways of using technology to detect these diseases as early as possible. Then I took a complete side step into audiology. I started looking at projects looking at hearing health in musicians. I will talk a little bit about that today and recently started my Lectureship at the end of 2019.

Gaby: That's an interesting time to have started your Lectureship as everything is now disrupted but anyway let's move on to the questions.

As we have all experienced life during lockdown has indeed been quiet but what made you then wonder whether this is a chance for our ears to rest and so what if our ears are rested?

Sam: I suppose to put it into a bit of context why I came up with this title. We have recently been doing a study which is looking at early career musicians and their hearing health and it's a longitudinal study in that we've been getting students from the Royal Northern College of Music to come into our labs and we have been doing a very comprehensive test battery with them year-on-year for up to 3 years. As part of this battery, we have been doing a semi-structured interview with them, something called a noise exposure structured interview, to try to get an idea of the amount of noise exposure that they've had across their lifetime, very methodical and systematic process you go through to get an estimate the amount of noise exposure they've had. What we wanted to do was see cumulatively year on year whether the amount of noise exposure they have had is related to any change in their hearing that we might see over these 3 years. We've just recently finished collecting data for this, fortunately just before lockdown, at the back end of last year that we finished collecting data. Recently just published the findings from the baseline of the longitudinal study so timepoint one. We are just in the process of analysing the data for the longitudinal study.

Coming back to the title of today's talk. The reason I chose that is; if this study had gone longer, if we're still collecting data now, I got participants in pre-lockdown, and post lockdown and we were trying to look at changes in their hearing, very subtle changes in their hearing and how much noise exposure they have had. With no clubs being open, no concerts and no sporting events and for our musicians they are not necessarily rehearsing in large ensembles. We might expect the amount of noise exposure is really drastically reduced so what would we see, what would happen to their

hearing as a result of this quiet time. That's where I've got to with this title. It got me thinking about this and I have come up with three different possibilities;

First one: Is kind of a positive thing this quiet time, the idea is that because we're not being exposed to these loud events and not going out clubbing and that sort of thing, gives us a chance for our ears to just rest so were not getting more cumulative noise exposure . The level of damage that we may have done to our hearing up until lockdown down might be going up and up and up and then suddenly it's going to plateau when we have hit this quiet time and then maybe after lockdown it might start going up again but it gives us a period where there's no further damage. There has been some research on this recently, an animal study Luo et al (2020) earlier this year, and they showed that noise exposure can be cumulative. The effect it can have on hearing can be cumulative particularly to cochlear synapses. We might be having a bit of quiet time so it's just basically a nice little period of time for our ears to have a rest before we give them an onslaught after lockdown. So that's scenario one.

Gaby: But that's not recovery, that's just nothing.

Sam: That's not recovery. This is where we come to Point 2 potentially there could be some recovery so rest and recovery.

There have been some guinea pig studies, Shi et al (2013), and they were again looking at cochlear synapses. It seems to suggest that after a period of noise exposure and some damage to these synapses that there may be a little bit of recovery afterwards and given that humans have quite a good propensity for synaptic plasticity we might see a bit more repair of these synapses in humans. Therefore, there is potential for rest and recovery here. This is interesting. In our lab, we've been looking at, or trying to look at, the health of cochlear synapses in humans using electric physiology. We've not really seen any evidence to suggest that there has been cochlear synaptopathy or damage to the synapses in young normal hearing humans and it is possibly because we recover a lot better than animals so perhaps the ears are a little bit more resilient. So that's scenario 2, we get rest and recovery from lockdown.

Scenario 3 is a little bit more complicated and is based on the idea that a little bit of noise exposure is actually a good thing for our ears. It helps us to develop a tolerance or toughening to sound over time. So suddenly were not exposed to noise anymore because of lockdown measures; were not going out clubbing, going to concerts, festivals that have all been postponed for this year. Then potential we are going to lose this tenacity and can make our ears particularly vulnerable when we suddenly start going back to gigs again after lockdown finishes. I have found a paper which is nearly 30 years old and which I am going to discuss next week at the journal club. This is by Miyakita and colleagues (1992). They showed that a low level amount of noise exposure for I think 6 hours a day if you expose people to this noise, it can reduce the amount of temporary threshold shift in response to a high intensity noise. The interesting thing is that after a few days after you stop this training you see that temporary threshold shift returns to its normal levels again. Kind of supports this idea that once you stop straining your ears and stopped exposing to noise they might become more vulnerable again to high intensity noise.

Gaby: So how would that work, what's the mechanism of this study you know the toughening bit.

Sam: It's not fully know, so in this 1992 paper they don't really offer any mechanisms as to how it works. They just presented the evidence and I think there's a couple of animal studies before that shows you similar. From having a look around in the literature there is a few different possibilities; so one is a strengthening of the stapedius muscle in the middle ear so there was a study with Swedish rock musicians and it seems to suggest that over time these sorts of musicians strengthen the stapedius muscle basically through years of training and that muscle just getting used over and over again you get a strengthening of it but I think it may take a number of years for this to develop so it probably wouldn't fit with that Miyakita study where after a couple of days they are seeing a reduction in the temporary threshold shift. I think it will take a number of years for this to be true.

That's one possibility. The other thing as well, I don't think it would protect the ears that much if you have a strong stapedius muscle, it would increase the strength of the middle ear muscle reflex but I don't think it protects you from really high intensity noise. The next possibility is that there's an increase of the medial olivocochlear reflex strength. There have been a couple of studies on this more recently as the Wolpert and colleagues (2014) showed a reduction in temporary threshold shift in humans who have stronger MOCR (medial olivocochlear reflexes). The idea here is that you have more noise exposure which increases afferent activity up the auditory brainstem and then you get a feedback down through the efferent system which reduces the motility of the outer hair cells so it's a feedback loop. More noise and you get a feedback where it turns down the volume in the cochlear for you so then you're not getting as much noise being sent up the brainstem, it's kind of a protective effect. A study in 2017 Bhatt (2017) and they show that people with more noise exposure actually have an increased MOCR as well. They predicted it would actually go the other way so they predicted that people with more noise exposure would have a reduced reflex. I think they're thinking was that if you had damage to the auditory nerve then you wouldn't be able to get as much signal going into this system and therefore you get less feedback. They were saying that the volume wouldn't be able to be turned down as much but in fact it looks like it's the other way round. So that's the second.

One more is a study that came out earlier this year with Fan et al (2020) where they were looking at cochlear synapses in guinea pigs. With more noise exposure the synapses can actually strengthen a little bit and maybe less susceptible to a higher intensity noise later on. Similar sort of concept but rather working by the MOCR is working directly on the synapses themselves.

Gaby: We have two mechanisms whereby quiet is good for our ears and one potential mechanism where quiet is bad for our ears, presumably they are not mutually exclusive. Or would you say they are. How would they all fit together all these three things.

Sam: I think it's probably a very fine line. In order to get this toughening, you've got to have a certain level of noise, but then once you go beyond that sort of level of noise it's obviously just damaging to your ears. There must be a sweet spot where the sound is good for you potentially and if you go too far it's not good for you and if it's not enough it's not going to develop this potential toughening. So I think they are not mutually exclusive. There is a con factor. I think in terms of the mechanisms as well, if you think about if you are toughening up the cochlear synapses themselves this might increase the afferent signal going up the auditory brain stem which could then increase the efferent signals coming back so there are a couple of different mechanisms which could be working simultaneously alongside each other.

Gaby: So you said that in the one study the toughening lasted for a couple of days. So if this is all true are you therefore suggesting that over this quiet period we will have all lost any toughening that had taken place?

Sam: Well it's kind of difficult saying that. We don't really know, again everything I'm saying today is also a little bit speculative and I'm drawing on different studies. I think it may depend on a number of factors, so first one is amount of noise exposure that you've had before. If think pre lockdown going to lots and lots of clubs listening to lots of music you may have developed more tolerance and it may be longer lasting. There has been a study looking at the MOCR in musicians. Musicians tend to have a greater reflex than non-musicians and the idea maybe that because they have more years of noise exposure this reflex has got stronger. So it might be that depending on the amount of noise exposure you had previously you might have a longer-lasting protective effect and it might last over however long lockdown lasts.

We don't know whether it's going to go away or not or it's going to stay with us. I think it also probably depends on the mechanism of this toughening. So as I mentioned before with the stapedius muscle I think it would probably take a good number of years to develop any sort of strength in this muscle, you have to train it over and over so I don't think that would disappear very quickly and same with plastic changes in synapses whether that's cochlear synapses or synapses from the medial olivocochlear system. I think may be a little bit longer lasting so they wouldn't disappear within a couple of days.

With the Miyakita study it seems to suggest that that toughening does disappear or the resilience does disappear after a couple of days so maybe these mechanisms I am suggesting are not the same mechanism that they saw back in 1992. One thing to bear in mind, that study was done with children, so don't think it would get through ethics now. What they did they asked teenagers about 11 to 13 years to listen to 6 hours of music a day at approximately 70 decibels and then they induced the temporary threshold shift using 105 decibel noise for 10 minutes or something.

I think, basically because this was done on quite young children who had not necessarily had a lot of noise exposure before that. They might not have quite the same amount of toughening as someone who's 20/30/40 years old which is maybe why you see this temporary threshold shift return to normal quite quickly after the training has stopped. Again, I'm speculating but it's a possibility.

Gaby: So that might suggest that there are individual differences in the extent to which this may or may not happen in terms of previous noise exposure, potentially your age.

Sam: Exactly I think it's very multifaceted. Amount of noise exposure you had. In terms of lockdown, how much you have before lockdown, how much you are having during lockdown.

For musicians obviously that they are having more noise exposure before and suddenly not having it now.

I think you need to consider other genetic factors such as melanin in the skin, so there is some evidence to suggest that people with more melanin or darker skin and darker eye colours have more tolerance. Have a great tolerance to noise damage than people with lighter skin. Many other factors, age as well.

I think when you think about musicians it is not necessarily just the noise exposure that's caused an increase in this MOCR feedback. There is also evidence to suggest that there is more of a top-down influence as well, so to do with auditory attention is modulating this effect or some sort of enhanced auditory processing skills they have developed through years musical training. It's not necessarily just noise exposure, could also be some other cognitive training effect or auditory processing effect which is influencing this feedback loop.

Gaby: So you can argue that noise like machinery that you really don't want that it's just there would be less effective than something you might actually be listening to. Is that what you are suggesting.

Sam: There is a debate around about this; there's a difference between noise induced hearing loss and music induced hearing loss and whether they're going to have the same sort of effect. For one is a desired output one is not, like factory noise or machine noise or what have you.

I'm not too sure. If we knew the mechanism of this toughening then we could say one way or another it's either noise exposure or some other sort of musical training exposure that's having an influence but I don't think we know one way or the other.

Gaby: That brings up to me and this is not what you and I talked about up front, machine noise and such like, if I'm not mistaken causes stress. Just having unwanted noise around, causes stress in the body to change. Whereas presumably music which you choose to listen to doesn't cause that. Would that be a link somehow or other to the stress?

Sam: Possibly so. I'm not sure exactly how that would work. Factory noise tends to be impulse noise, less predictable. Whereas with music noise you know what's about to happen next, especially if you are a musician. Theory is that they got this top-down effect, which is maybe modulating the amount of noise that's coming into the ear because they're expecting it to happen.

Gaby: I am thinking about constant noise, people who live next to a main road, standard ongoing if you live near the motorway that causes stress.

Sam: I don't know whether that will have any effect on toughening or not as I don't know how much noise you need to toughen the ear.

Gaby: I'm going to put on a clinical hat - I'm saying thinking it sounds like a very dangerous message to be giving. Well exposing yourself noise is going to toughen your ears. I mean it's funny because I've had research subjects say exactly that. When you try to ask them do they work in noise etc and they will say things like yeah well I've toughened my ears by listening to lots of noise along the way. I'm sure they didn't read any of the literature you are talking about but it seems a dangerous message to give people. Is that true.

Sam: I think that is completely fair to say. We can't really say anything about how protective this toughening effect is. If you go back to this Miyakita study from nearly thirty years ago the fact of the matter is you're still seeing a temporary threshold shift which might suggest some sort of damage so it's not as if it's completely gone away. You're still seeing some sort of change to hearing after exposure to a loud noise. I don't think it's fully protected it might be offering some sort of level of protection. The other thing is, we don't know how much noise or what level of noise, is needed in order to bring about this tolerance. As I mentioned before, it could be a certain amount of noise is good for you and then if you go 5 decibels higher it's suddenly very, very bad for your hearing. We can't really say whether it's a good thing or not.

Thinking about these previous studies the level of noise that they use to toughen the ears is around about 70 decibels. When you compare this to factory noise or going to a concert or nightclub, which can often be over 100 decibels, I think you are probably more likely to get damage to the ears than you are going to get toughening. I don't think there's going to be much benefit of just exposing your ears to these really high intensity noise. If you're trying to train your ears I don't think that's a sensible thing to do. I would encourage people to actively protect their ears in those sorts of situations. So make sure you use earplugs if you're in those situations.

Gaby: Question is should audiologist be changing the message that they are currently giving regarding hearing protection?

Sam: I definitely wouldn't be giving them the message that people should be trying to toughen their ears. I don't think it's sensible at all. It's not a good message. I think what I'm trying to say is that it could be happening naturally, possibly, but I'm speculating. I wouldn't like to say yes we should all go and listen to a certain amount of noise because we don't know how much we need or if it does have any protective effect. I think the advice kinda stays the same; make sure you're protecting your ears, looking after them and not exposing yourself to these extremes without any hearing protection.

Coming back to this MOCR reflex as well. There's one study that suggest that actually that in itself is an indicator of noise damage and it could potentially be, if it becomes permanent, it could lead to other effects such as tinnitus and hyperacusis because you turn the volume down too much and therefore centrally within the brain it is trying to turn the volume back up again. It could have some trade off there so it's not necessarily a good thing if you've got this better MOCR functioning system not better but stronger functioning MOCR system.

Gaby: The bottom line really is that this is a truly fascinating topic that needs more research before we really know the implications. Is that a fair summary?

Sam: That is entirely fair. I have brought together few different studies here to try and backup an idea that I have had based on being on being on lockdown.

I mean hindsight is a wonderful thing and we would have loved to have tested a lot of peoples ears just before lockdown and then tried to find out how much noise exposure they were having during lockdown and then testing again just before they start experiencing high levels of noise again. So once clubs are reopening and concerts are on again and festivals be nice to catch people just before they start exposing themselves these high levels of noise again and then get them back in immediately after as well. So essentially in an ideal world we have three or four time points that we can test their hearing.

We have actually in our group talked about running a study like this obviously wouldn't have that pre lockdown measure but we could try and find out how much noise exposure people had before that.

We can try and find out how much they had during lockdown but we need to act quickly cos obviously things are starting to reopen again now we're if we are going to get a study going we need to be pretty quick.

I think there's going to be a festival in August or September in the Northeast somewhere. Some bands lined up for socially distanced music festival. That's maybe an opportunity for us to recruit from, I don't know?

Gaby: Is there anything you would like to add?

Sam: Just like to say, I am speculating and I'm certainly not giving any advice to people here that they should be exposing themselves to dangerous levels of noise. Just make sure you're protecting your hearing still. Don't want to give off the wrong message at all.

Gaby: Thank you. It's been really eye-opening. If you want to ask follow-up questions or give feedback or share ideas about future topics for podcasts send me an email

Gabrielle.saunders@manchester.ac.uk

Hope you enjoyed this discussion and will come back to hear our next podcast. Until then farewell and stay well.

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