

Making music during the pandemic – What does science advise?

About infection risks when choral singing and playing music with wind instruments.

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Introduction

Singing and making music are wonderful activities that delight many people, whether in a small group among friends, in the church with the community, at festive events or large concerts. In times of SARS-CoV-2, the carefree times of making music are also over. Concerts are not allowed to take place, churches do not sing together and even small parties are prohibited. Since many musicians work as freelance artists and often live on smaller income, this profession is particularly affected by the pandemic.

In addition to financial aspects, another major problem for this professional group is that joint rehearsals as well as complete rehearsals by large orchestras and ensembles may no longer be practiced. However, the perfect interaction of the artists require a lot of work in advance so that a concert can succeed and become an experience for the listeners. It can be assumed that these preparations do not take place in the large halls, but rather in small, unventilated cellars in the event building. The often limited space on the gallery loft in churches or in the orchestra pits of the opera houses illustrates the reality of the spatial situation and the need to develop concepts that enable safe playing during the pandemic.

It is currently completely open when and under what circumstances the cultural operation can be resumed. The fact that wearing suitable respiratory masks when singing and playing music with wind instruments is not possible. Protection against droplet infection must therefore be provided via safety distances. However, as long as there is no reliable information about how strongly singers or brass players distribute the viruses in their environment in the event of an infection and what influence indoor air currents play in the transport of the viruses, distance rules can not be sensibly determined.

The Hochschule für Musik Freiburg recommends in one and the Verwaltungs-Berufsgenossenschaft (VBG) has been demanding rehearsals since the 27th April. Even a safety distance of 6m for singing or excessively speaking and for wind instruments of at least 12m in the blowing direction. The Robert Koch Institute (RKI) held a press conference on 28th April. Expressed the suspicion that the droplets fly particularly far

when singing. But is this distance information appropriate and is the RKI statement correct? Risk assessment dated April 25, 2020 a distance between singers and brass of 3 to 5m and the administrative professional association (VBG) demands since the sample operation 27th April.

Experiments

Prof. Dr. Christian Kahler and his assistant Dr.

To clarify the questions, Rainer Hain conducted detailed experimental studies with a professional singer and vocal lecturer at the Mozarteum in Salzburg (Marion Spingler), two amateur singers, five professional musicians from the orchestra of the State Theater on Gartnerplatz in Munich ((Michael Meinel (clarinet), Uta Sasgen (flute), Ursula Ens (oboe), Cornelius Rinderle (bassoon), Michael Herdererten (trumpet)), and a lay brass player ((Max Schaefer (trumpet, trombone, euphonium)) at the Bundeswehr University in Munich. The aim of the investigation was to determine both the spit-like (ballistic) spread of large droplets and the flow-related spread of small droplets (aerosol) when making music. For this purpose, the droplets of saliva emerging from the mouth and the wind instruments and the air set in motion during exhalation were illuminated with a laser and recorded with special digital cameras. The evaluation of the recorded image series was realized with a computer program in order to quantitatively determine the movement of the droplets and the air and to determine the area which can be contaminated by the droplets.

At what distance does singing become dangerous?

The experiments of Prof. Kahler and Dr. Hain clearly show that the air is only set in motion in the immediate vicinity of the mouth, see <http://youtu.be/0JmcjRhV-rs>. The experiments with the professional singer have shown that at a distance of around 0.5m there is almost no air movement, regardless of how loud the tone was and what pitch was sung. Virus propagation beyond the air flow generated during singing is therefore extremely unlikely beyond this limit. Lay musicians who do not use the diaphragmatic breathing that is used by professionals, but rather use natural chest breathing when singing, do not go beyond this range.

Update dated 08.05.2020: The recommended minimum distances for singers and wind players have meanwhile been changed by the Hochschule fur Musik Freiburg to 2m, see <https://www.mh-freiburg.de/hochschule/covid-19-corona/riskassessment> (accessed on 08.05.2020).

The small spread of air movement is not surprising, according to Prof. Kahler, because when singing no large volume of air is expelled in a jerky manner, such as when sneezing or coughing. Rather, the art of singing is to move as little air as possible and still produce a beautiful and powerful sound. The experiments have shown that even

when singing a deep tone lasting almost 12 seconds, only about half a liter of air is exhaled. With high tones, the same amount of air was moved in just under 5 seconds, but the air is often inhaled to produce high tones, so that the risk of droplets spreading is very low in this case. But even if you exhale at high tones, the flow rate is comparatively low because the mouth opening tends to increase with increasing pitch, thereby reducing the flow rate accordingly. In principle, strong air movements when singing can be considered as undesirable side effects that must be avoided, since the propagation of sound does not require air flow. An air flow is only required to generate sound. If you do not believe that the air in front of your mouth is hardly moved, you should hold a lit candle in front of your mouth, then sing or speak and at the same time slowly and calmly remove the flame from your mouth. As soon as the flame stops flickering, the distance at which the flow movement is negligible is determined. The same experiment can of course be carried out with wind instruments.

Recommendations for protection while singing.

In a choir, a safety distance of 1.5m should still be maintained in order to protect yourself effectively against a droplet infection even if you cough without observing the hygiene label (coughing into the crook of your arm and doing so from others avert people). With a simple shock cough, the droplets can be transported over a meter and with long-lasting irritating cough, even over 2 meters. The researchers have already proven this in another study (see <https://youtu.be/SM2QrPFC3MY> and https://www.unibw.de/lrt7/bericht_atemschutzmaske_unibw_lrt7_06_04_2020.pdf). In addition, a staggered arrangement of the singers is always recommended when the choir consists of several rows. This arrangement is also recommended for worshipers to protect others and themselves from a droplet infection. If the churches are well visited and the safety distances can no longer be maintained, then only FFP2/3 respirators as self protection and third party protection help according to the above mentioned study by the scientists. According to these studies, it is hardly possible to infect people in the distant surroundings. In reports that give singing as an explanation for the infection of large parts of a choir, it should be questioned whether the social behavior is not the actual origin of the infection. When particularly sociable people greet other choir members with hugs and kisses, have a lively conversation during the break, have dinner or a glass of wine after the rehearsal, drinking with each other before saying goodbye, it can be assumed that this social behavior in case of infection is more critical than singing itself.

In addition to adhering to the distance rules and installation recommendations, it is also very important to ensure good and correct ventilation in the sample rooms in order to minimize the risk of infection from slow indoor air flows. To insure this, on the one hand the air exchange rate should be increased significantly in times of the pandemic, on

the other hand, with ideal room ventilation, the air should be supplied from below through the floor and sucked off across the ceiling. A side discharge of air can cause the air contaminated with viruses to flow to non-infected people, which can lead to infection even over long distances under unfavorable conditions. Therefore, fans in the rehearsal room are not recommended if they move the air from person to person at low speed (less than 0.3m/s). This risk is reduced with increasing speed because the exhaled air volume is diluted by a cross flow and thus the viral load is reduced, but speeds greater than 0.3m/s are perceived as unpleasant. Sucking down the room air is also unfavorable with regard to a virus infection, since the droplets can then increasingly settle on objects. This can cause smear infections when objects are shared.

There is another point that needs to be considered: As a rule, an ascending convection current forms across the warm bodies of people and above their heads, since the air warmed by the skin and the exhaled air is lighter than the air in the area. This effect also speaks for a suction of the room air through the ceiling. The size of the room is also important. If the rooms are sufficiently high, the droplets stay longer above the people and the droplets will evaporate if the air humidity is not too high. Even if the viruses remain infectious without droplets, which is by no means certain, the risk of infection due to the mixture in the upper air layers of the room will continue to decrease if the ceiling height is sufficient. In the low rooms, the droplets can flow down again before they evaporate and possibly cause a droplet infection elsewhere if they are not suctioned through the ceiling. For safe music operation, the air conditioning and room size are therefore important in addition to the distance and installation rules.

How dangerous are brass instruments?

In the experiments with a trumpet, a trombone, and an euphorium, it was found that the area of air in front of the instruments set in motion is larger, the smaller the horn of the instrument, the lower the tone and the more shocking the sequence of notes, see <https://youtu.be/0JmcjRhV-rs>. Overall, the area set in motion is smaller than 0.5m in this case too. These results are also understandable in terms of fluid mechanics. The actual tone is generated in brass instruments by stimulating the slightly biased and flowed lips to vibrate. The design of the instruments then only changes the timbre and volume of the tone. Just as with singing, the aim of the brass section is not to blow out as much air as possible in a short time, like when coughing and sneezing, but to let the lips swing as relaxed as possible according to the desired pitch. The better this works, the cleaner and clearer the sound. However, the researchers will recommend maintaining a safety distance of 1.5m and arranging a staggered arrangement of the musicians to protect themselves against a droplet infection from cough. Against the background of these results, it is not understandable why the above-mentioned facilities require a safety distance of 3-5m and 12m.

How dangerous are woodwind instruments and flutes?

With a clarinet, an oboe, and a bassoon, larger flow movements can be generated due to the smaller blow-out openings and the lower flow resistance due to the straight design than with the brass instruments examined. Especially deep and long-lasting tones can lead to flow movement in the range of 1m. An even greater range can be achieved with a flute with long, deep tones, see <https://youtu.be/0JmcjRhV-rs>. With this instrument, the air is quickly blown with the mouth slightly open over the curved lip plate with the actual blow hole. As a result, the air enters the room almost unchecked. Due to the curvature of the lip plate, the air is deflected downwards due to an aerodynamics effect, which is called the Coanda effect. Since the air is not slowed down by the flow resistance of the instrument, the risk of infection from this instrument is significantly greater than from all the other instruments examined. From an occupational point of view, it would therefore make sense to position the flutes in the front row during rehearsal or concerts and to use measures to curb the spread of droplets.

Which safeguards are effective?

In order to effectively limit ballistic saliva emissions and flow movements, it makes sense to attach a very thin and tightly woven silk or paper towel before opening the instruments. A dense pop protection as used in front of studio microphones is also suitable. The ballistic flying droplets are quite large and can be intercepted effectively with these simple protective measures. The spread of the aerosol is also effectively prevented, since the spread of the exhaled air is prevented. If the protection is at a distance of about 20cm from the instruments horn (trumpet, clarinet, oboe, bassoon) or the blow hole of the flute, neither the flow resistance when making music nor the propagation of sound is affected and therefore not the sound experience such as the experiments show. With the trombone and the euphorium, no ballistic saliva leakage could be observed due to the flow resistance and the low flow velocity. In this case, the saliva is collected in the instrument and then released in a controlled manner. Of course, hygiene is also important here. To prevent liquid accumulated in the instrument from being expelled from the instrument as a liquid film at high blowing speeds, or to prevent small droplets from forming when the liquid flows over it, which then fly out of the instrument with the air flow, the liquid should be drained more frequently than usual, since the danger increases with the amount of liquid. In the case of wind instruments that have just been built, the instrument should be wiped as often as possible to avoid these effects.

How dangerous is making music outdoors?

Making music outdoors can be considered largely safe if the clearance and installation

rules are followed, unless there is a light and steady crosswind that transports the contaminated air over a greater distance without reducing the viral load due to turbulence or strong expansion of the droplet cloud takes place after exhalation. But there is another very important point to be considered. If the music in the beer garden or a marquee tends to play in the background, for example to create a cozy atmosphere, the music should not be loud. Loud music means that people who want to talk can speak very loudly and get closer. Both are fatal when there is imminent danger of droplet infection, because the number and size of the droplets that arise when speaking increases sharply with volume. In addition, the virus load increases significantly when the distance to an infected person is reduced. Therefore, the organizers must not only keep an eye on the safety of the musicians, they must also include the safety of the audience. And it is not only distances, positioning, air conditioning and room size that count, but also the behavior of the people with loud music. Celebrate sociable e.g. in the context of carnivals or Oktoberfest, but also in discos and ski bars are to be classified as critical with regard to loud music. But musicians at festivals should also keep their volume down until the end of the pandemic so as not to induce people to behave riskily. See <https://youtu.be/0JmcjRhV-rs> Version: 08.05.2020