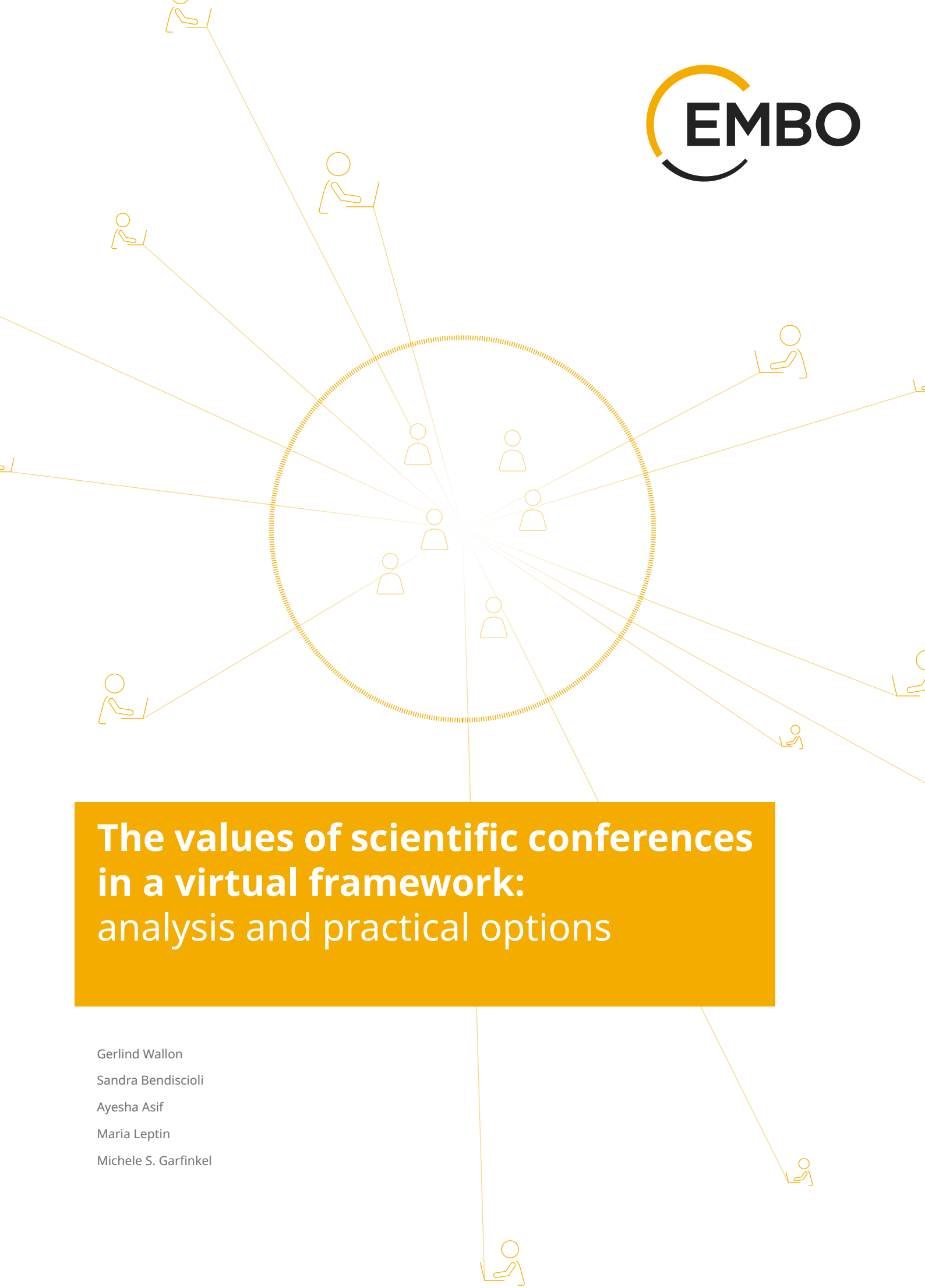

The values of scientific conferences in a virtual framework: analysis and practical options

Gerlind Wallon

Sandra Bendiscioli

Ayesha Asif

Maria Leptin

Michele S. Garfinkel

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Authors:

Gerlind Wallon
Head
EMBO Courses & Workshops Programme

Sandra Bendiscioli
Senior Officer
EMBO Policy Programme

Ayesha Asif
Officer
EMBO Courses & Workshops Programme

Maria Leptin
Director
EMBO
(until November 2021) Current:
President
European Research Council

Michele S. Garfinkel
Head
EMBO Policy Programme

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The authors are solely responsible for this report and the accuracy of its contents.

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Summary

The sudden switch to widespread virtual conferencing during the Covid-19 pandemic in 2020 and 2021 has raised the opportunity to learn about and possibly carry forward improved, or even completely new, meeting services and platforms for conferences. We wanted to first understand what values of researchers are reflected in scientific conferences, how those are currently achieved, and to what extent they can be emulated in fully virtual and hybrid conferences. We do not come to any conclusions but rather suggest that experiments with virtual and hybrid conferences will be needed.

This report outlines researchers' views of what they obtain from and contribute to scientific meetings, and how these interactions further the work of researchers more widely and thus advance science. In other words, we sought to understand what values are important to researchers in attending any scientific conference, so as to be able to later ask whether and how meetings with virtual components can serve these values.

To this end, we interviewed members of the life science community at different career stages and different continents, as well as organizers of scientific conferences and institutional conference organizing groups. Additionally, we carried out a survey of the EMBO Young Investigator Network.

Interviewees and survey respondents reported that the key value of conferences is the communication and exchange of scientific knowledge in a compact format. The added value of in-person conferences is the opportunity to directly discuss with other scientists in the field, thereby learning about unpublished data, experimental details, and the possibility to forge collaborations. Advantages of virtual formats include increased inclusiveness and reduced environmental impact. While these values do not necessarily need to be partitioned between in-person and virtual conferences, the difficulties of achieving some of them in one or the other setting is clear.

Most interviewees and survey respondents expected that future conferences would combine the advantages of virtual and in-person conferences in the form of hybrid conferences, and there was widespread support for funders encouraging experiments with the format. This enthusiasm assumes that hybrid conferences will continue to embrace the values that in-person conferences sustain.

The challenge for hybrid conferences will be to maintain the best of both worlds: to host a significant number of participants on site, who are representing the right mix of speakers, senior scientists, post docs and students as to make it worth the in-person participants' investments, both financial and time; while also delivering a good experience for the virtual participants. We discuss possible formats of hybrid meetings, the implications for participants and technical challenges.

EMBO will encourage organizers of EMBO Courses & Workshops to experiment with different meeting formats and extra funds will be available to cover additional costs. Experience from hybrid conferences and courses held in 2022 and 2023 will be used towards developing policies for the future.

Introduction

In 2020 and 2021 meeting organizers, including individual scientists and professional conference centres, had to convert many planned in-person conferences to virtual meetings. The experience gained from these has led to researchers re-evaluating the way scientific conferences are held.

The aim of this study was to provide decision-making support to meeting funders and organizers when considering possible conference formats. We hope this will help meeting organizers to make informed decisions about whether and how to hold conferences in person, online, or a combination of the two, depending on what purpose their conferences are meant to serve. In-person scientific conferences as we know them now have been held for almost 200 years. Virtual conferences or virtual components of conferences are much more recent. We want to lay out the current situation and provide options for conference organizers to consider.

EMBO, since its founding more than 50 years ago, has been involved in the funding and running of scientific conferences, and in developing ways to make conferences more responsive to the community and to improve the experience for conference participants. The foundational principle of all programmes at EMBO is that the work and activities are driven bottom-up from the researchers who benefit from them.

To be able to make well-founded decisions, it is important to understand what purposes conferences serve and how these are valued by the scientific community. EMBO regularly solicits and evaluates feedback from participants of each EMBO-funded conference, but what EMBO had not done to this point was to analyse the values of scientific conferences in general for the research community.

For the purpose of our analysis, we wanted a good understanding of what the positive values of conferences are for researchers, as well as any concerns. Understanding those values would allow us then to assess which type of conference mechanisms would address those values, and which might undermine them. We collected this information by interviewing conference participants and scientific and professional meeting organizers.

We also began to look at how these values and purposes are served by in-person and online conferences using both a directed survey and information we gleaned from the values analysis.

Methodology

We concentrated our analyses on international scientific conferences with around 80 - 450 participants. We did not look in detail at small meetings (such as expert technical workshops) or practical courses, nor at “mega” conferences with attendees numbering in the thousands. Several interviewees volunteered comments on the latter, and some of those are included here.

Due to the impossibility of convening a physical workshop during the pandemic, we conducted structured interviews with 31 individuals via Zoom between July 2020 and April 2021. This included researchers who attend scientific conferences and institutional organizers of scientific conferences.

For the component focused on researchers, the interviewees were selected according to the following criteria: career stage (PhD students, postdoctoral researchers, young group leaders, established researchers), geographical location, and roles (researchers, scientific organizers of conferences).

The researchers were mostly from the life sciences, plus two established researchers from the social sciences. Interviews were structured and conducted by Ayesha Asif and Gerlind Wallon (EMBO Courses & Workshops) and Sandra Bendiscioli and Michele Garfinkel (EMBO Policy Programme).

For institutional and professional conference organizers, interviews were conducted by Gerlind Wallon and Michele Garfinkel.

The initial set of interview questions is provided in Appendix 1.

The information from the interviews was arrayed for comparisons; these are in Appendix 2. We carried out a qualitative analysis of the information from the interviews and reviewed existing literature in this area. In addition to the consolidated information presented in this document, we also collected quotes from many of our interviewees. These are presented in Appendix 3. In addition, as noted above, EMBO itself has many decades of experience in running conferences and we were able to draw from our own knowledge of the area.

In August 2021 we also conducted a survey of present and former members of the EMBO Young Investigator Network, which consists of present and former EMBO Young Investigators, Installation Grantees and Global Investigators. All respondents are active PIs with one to 25 years of experience leading a research group. We received a total of 206 responses. In this questionnaire we placed some emphasis on scientists' attitudes towards potential hybrid conference formats. The survey questionnaire, the full results and a summary can be found in appendices 4, 5 and 6.

Section 1:
Analysis of the value of scientific conferences, and some areas of concern

The value of scientific conferences seems readily apparent. Scientific conferences provide researchers with important scientific information, help them in their careers, and foster a sense of community.

In our interviews we first asked researchers what values they identify in attending conferences, without regard to whether in-person or virtual. Most of the experiences at the point we conducted the interviews with individual researchers were still from in-person conference attendance.

Universally, researchers indicated the key value of any scientific conference is communication and reception of scientific knowledge, and the advancement of science generally. Other ways of addressing these values exist (the scientific literature, one-to-one discussions) but most of our interviewees indicated there is something special about conferences that amplifies the communication of knowledge and the advancing of science.

We heard that conferences lead to progress in science in different ways: they allow exchange of information and ideas and identify knowledge gaps in a field; bring inspiration, motivation, new ideas; foster new perspectives on a topic, inspire individuals to start new directions of research or to take new approaches to a research question; and provide opportunities to start new collaborations. New ideas or work can be presented before publication, and the reaction of colleagues can be tested immediately while the informal personal discussions during conferences inspire creativity.

Through formal presentations and informal discussions at conferences, new developments are communicated, and scientific information is exchanged and discussed. While knowledge could be obtained also by reading papers, discussing face-to-face with other researchers brings more insights and immediate responses: personal interactions give privileged access to information.

Benefits for individual researchers were also readily apparent. In addition to providing occasion where it is relatively easy to identify and initiate potential collaborations, researchers gain visibility by speaking or presenting posters, by contributing to discussions, and by learning details of research early on. Direct discussions at a conference helped some interviewees to solve discrepancies in scientific opinion.

Interviewees pointed out that many of the personal interactions during an in-person conference are serendipitous and could not happen otherwise. Possibilities of interactions are not confined to scheduled discussion sessions, but mostly happen in the corridor, during social hours or after meeting hours during social events or dinners.

In some cases, these interactions may help improve the possibility of later publication of the work[1]. Some reported that by meeting and talking with people at conferences, beyond simply clarifying issues, they ended up publishing back-to-back papers with researchers who were working on the same topic. There was recognition as well of the possibility of gaining knowledge that may not be explicit in

1 We interpret this to mean the work improves by discussions of it at meetings, or by being alerted to others' relevant work. This could allude to the idea that reviewers are more likely to be positive about paper submissions when they know the researcher. We would not try to interpret here whether that is correct or not, but rather would note that this could possibly constitute a conflict of interest.

papers, particularly related to techniques but also of understanding the longer history of a piece of work.

Interviewees emphasized the motivational aspects of attending a conference resulting from formal or informal discussions with peers. Such interactions can also facilitate the search for new positions.

Many researchers identified as a benefit of in-person meetings the cultural experiences that often go along with attending a meeting away from home, and the building of friendships and the possibilities for taking breaks from the scientific work. They also generally appreciated the sense of scientific play, where meetings are a place to explore new ideas without being bound to any further work on them. This was felt to be an integral part of the creative endeavour of scientific research.

Finally, the institutes that are home to the researchers may sometimes benefit from the participation of those researchers at meetings, especially if their talks are highly visible (e.g. keynote lectures) and the meetings are deemed "important" by the institutions. Institutes may also accrue some benefit from hosting meetings.

Many of the interviewees also noted negative feelings or experiences about scientific conferences.

The clearest negative (though not identified universally) about conferences appears to be that there are simply too many of them and that too many of these conferences cover the same topics with the same speakers. There was recognition that making conferences virtual rather than in person could in fact exacerbate rather than mitigate this problem.

We note one area where individuals' views were particularly disparate was in thinking about a conference as a welcome break or as an unwelcome disruption from daily obligations, in view of the fact that attending requires a considerable amount of time. Travelling time and being away from home is disruptive; parents and caregivers especially see this as a challenge.

Most interviewees recognized the negative environmental impact of air-travel to the conference. For example, two of the interviewees had decided to try to attend only conferences in locations that they could reach by train.

Another common concern was the high combined cost, including registration fees, travel and accommodation, for attending conferences. Although most interviewees had not had to miss a conference due to cost, it was recognized that this is an impediment for many potential participants.

We also heard about a general set of bad behaviours, including both abuse or harassment of speakers or participants. Another frequently voiced concern was about presenters' research findings being "stolen" (i.e. used without attribution) or information from presentations being used to scoop a presenter from either oral presentations or posters. This is a critical point for all types of meetings, whether in fields where the presentation of unpublished data is encouraged, or in others where unpublished data are not presented for fear of data being inappropriately used.

A related concern is that of individuals who during conference attendance feel they cannot participate in the discussions. This may be because of insecurities of their standing in the community, reduced facility with the language of the meeting, or shyness.

Section 2:
Virtual meetings: maintaining and adding positives, and mitigating some negatives

Although the comprehensive switch to virtual meetings is recent, we have some understanding now of views of those meetings, both from our own experience running them and from hearing how participants have experienced them.

The key concerns about virtual conferences for EMBO (and all conference providers we interviewed) is whether they will deliver on the values laid out by the research community, and how to maintain the high quality that conference participants appreciate. From these interviews and meeting feedback, our understanding is that the delivery of high-quality scientific talks is of most importance. Thus, in principle, meetings could simply be online delivery of talks, as long as there would be mechanisms for allowing discussion. In fact, organizers and participants have noted that discussions at virtual meetings are more inclusive because younger or insecure researchers come forward to ask questions in writing. Discussions continue in writing via the chat fora provided by the platforms, meaning that information that otherwise may be confined to personal communications in the conference hall is available to all participants. On the other hand, these online discussions do not seem to reach the intensity of discussions outside the lecture hall that are experienced at in-person meetings.

Some of the values that are best reflected at in-person conferences, particularly those having to do with aspects of community-building and play, are the most difficult to replicate in virtual conferences. Some of these problems may be alleviated with improved conferencing platforms, but the ways that people interact with others, in a group setting, will not be replicated even with the best current virtual platforms. The concept of hubs for meetings (gatherings of people in-person at a local or regional level, with virtual connections between groups) might be the best currently available mechanism (though still dependent on good virtual software). This is an area that will require its own analysis and we will not discuss it further here.

Poster sessions are an integral part of scientific conferences and provide participants with the opportunity to present and discuss their research. Feedback on online poster sessions has been mixed and organizers have been experimenting with different options. Which of these work best will need to be evaluated as more virtual meetings are held.

The problem of too many conferences, with too many of the same people presenting, needs to be solved independent of platform. Concern was expressed in some of our interviews that the repeated speaker problem would in fact get worse with virtual conferences. Especially if it were not required for speakers to stay at the conference the entire time, it would be easy for different organizers to have the same scientists speak at essentially every conference on a particular topic. This could be exacerbated further if organizers would agree to allow speakers to use talks that had already been recorded for other purposes.

Thus, for all conferences, but now as virtual conferences become more common, it is critical for organizers to carefully consider the breadth of their speaker lists compared to other conferences.

Related to these concerns about the number of conferences and repeated speaker lists is the complexity of travel. Cost, ease, visa problems, concerns about environmental impacts, and general discomfort were brought up to us, and have been discussed elsewhere. Further concerns focused on disparities in travel access, due to individual's differing levels of mobility, caretaking responsibilities, or lack of access

to funds have been expressed as well. Many conference organizers have funds to assist with travel, though these are frequently insufficient. We do not look to virtual conferencing to solve these problems, but for those who do not want to or cannot travel, virtual meetings (or meetings with virtual components) will provide mechanisms to expand possibilities for participation. We note here and elsewhere that while it is a net positive that virtual meetings allow for more inclusion for people who otherwise cannot travel, we do not want to see this become a way to avoid dealing with the hard problems of people in the position of not being able to travel.

Altogether, when asked about the main advantages of virtual meetings our interviewees listed increased accessibility and social inclusiveness for scientists not able to attend for personal, financial or visa issues, being able to view (and review) talks at a convenient time, less disruption of work and family or care duties, the ability to sample conferences of fringe interest and the lower environmental impact.

Harassment

In some of our interviews we noted suggestions that virtual meetings could protect participants from some types of harassment that may occur at in-person meetings. Harassment, and more broadly any abusive treatment of conference speakers or attendees, is an absolute wrong, and cannot be accepted. It would be antithetical to the values of EMBO to tolerate harassment by dismissing it as something that can be solved by sitting someone behind a screen rather than fighting it directly in the in-person setting. Thus, we do not cite the mitigation of harassment in virtual meetings as a good, but rather that the anticipation of the use of virtual meetings has further uncovered negative feelings about in-person meetings that we must address.

We recognize of course that online harassment exists, and there is no reason to think that this would not infiltrate virtual conferences, for example in online chats or when microphones are opened for discussion. To date, in fields we are familiar with, online harassment at virtual scientific conferences has not yet been a significant problem. If incidences of online harassment at meetings become significant, organizers will need to have already thought about appropriate actions, as they should for in-person meetings. Many organizations have already added virtual- or online harassment to their harassment mitigation trainings.

Unpublished data protection

Another worry for many researchers is that the presence of virtual participants makes it easier for them to be scooped. There is no evidence for this as yet and it is not clear that this problem is restricted to virtual conferences. Since the introduction of smart phones, possibilities for clandestinely capturing meeting materials has already been a major issue to be dealt with.

Some conference organizers have participants sign a code of conduct or other understanding that they will not photograph speakers' talks or share information via social media unless the speaker has given permission, and this would of course apply as well for online conferences. This is much less of a technical problem and more of a responsible conduct issue. In virtual settings, scientists feel that they are talking to an anonymous audience who, in theory, could record the presenter's data, use it inappropriately or share it widely.

Survey respondents mostly felt that both published and unpublished data are equally presented at in-person conferences. But this is an area of concern that will require more attention: more than half felt that the percentage of unpublished data presented drops when meetings are online, which is confirmed by the fact that 52% said they are less likely to present unpublished data at a virtual conference. If this becomes even more extreme as virtual and hybrid conferences become more common, it will be important that we have already considered how this might threaten the utility of scientific conferences generally.

Section 3:
Logistics and technical issues as potential obstacles to successful virtual conferences

While the first virtual events during the pandemic were, of necessity, mainly video adaptations of traditional conferences with the same programme and line-up of speakers as the in-person ones, in the following few months organizers had already understood that a simple one-to-one translation does not work and became increasingly sophisticated and creative about how to make the virtual experience work best, given both opportunities and limitations of video platforms.

The market supplying virtual platforms has expanded rapidly over the last two years. We discuss this in Appendix 7[2].

We heard from speakers that the preparation for some online conferences is becoming "too much". This includes the necessity of a technical test prior to the meeting and recording the talk if required by the organizers, or recording the talk as a backup even if live. An additional disadvantage of pre-recorded presentations is that speakers are not able to respond to other speakers who have talked about a similar topic and cannot make last-minute updates.

Whether pre-recorded or presented real-time, speakers noted they miss the audience, the excitement and motivation provided by a live conference setting. There are concerns as well that recording talks ahead causes speakers to become disengaged from the meeting itself, even if they are in attendance during a live discussion session.

A further annoyance for participants in general is the necessity to review and assemble information about the platform and logistics of the conference ahead of time, which has not yet become integrated into people's thinking about meeting preparation (which for physical meetings is more focused on knowing when their flight or train depart or where the meeting site is). This will likely become less of a concern over time. As well, many individuals needing to work at home and even some institutes did not have sufficient bandwidth for high-quality streaming. This situation has been rapidly improving over the last 18 months, but has not been solved universally.

While at in-person international meetings a key discomfort is that of jet lag, for virtual meetings it is time zone differences. One of the positives of virtual formats is that talks recorded either before the meeting, or during the live presentation, can be made available afterwards to those who cannot attend in person due to time differences, even though this eliminates the possibility of being able to participate in a live discussion, unless organizers schedule each discussion twice during the day.

Virtual poster sessions and chat/ question functions

Meeting organizers have struggled with online poster sessions and are dependent on the options that different platforms provide. Some online formats have the advantage of allowing the addition of small videos to the traditional poster or even using only videos as 'posters'. Discussions of posters during the poster sessions have in many cases been confined to the chat forum only, but options for live online discussion are now used more commonly. We have recommended to organizers of EMBO virtual workshops to use breakout rooms for individual poster presenters during the poster session. Participants can switch from room to

2 A blog on virtual conferencing on the EMBO web site provides further information: https://www.embo.org/news/?term=blog

room to talk to the poster presenters. A chat forum facilitates continued discussion after the poster session.

We note that for chat functions many individuals who have participated in online meetings want these to be maintained even at in-person events. This applies as well for tools used to send questions to the moderator of discussion sessions, providing a benefit especially for individuals who are uncomfortable asking questions live. The maintenance of these functions even during in-person meetings should be easy since attendees at an in-person conference will have a laptop or smartphone, and will just require a moderator to follow the online discussion.

Section 4:
Hybrid conferences

Most of our interviewees expected that future conferences would combine the advantages of virtual and live conferences in the form of hybrid conferences. This view was shared among the conference attendees and the professional conference organizers. Designing a viable form of hybrid conference is a difficult problem, both technically and in trying to capture the general values of conferences.

While not a new concept, the idea of mixing in-person and virtual elements in one meeting needs development for scientific conferences. The simplest format is an in-person meeting that is streamed to remote listeners, or one where the talks are filmed and made accessible to registered, virtual participants. Technically, this requires a web platform to host the event, a camera, microphones and other equipment on site, combined with sufficient bandwidth for the stream. The camera has to be operated and the platform created and maintained, requiring additional personnel or extra efforts by the organizers beyond setting up an in-person meeting.

With little additional effort, virtual participants can be included in the Q+A sessions (e.g., via Twitter, or an online chat platform), as can further add-ons such as the possibility for virtual participants of giving short talks.

On the other end of the scale, we can imagine a fully hybrid meeting, where virtual and on-site participants interact intensely. While current conferencing platforms are already very good at assuring virtual attendees have visual access to material, they are not good at allowing visual access to people. This would require the use of broadcasting technologies that show both the speaker and the room, as well as the reverse: the array of those attending virtually should be accessible to participants physically present in the room.

Solutions would also have to be found for joint poster sessions, meet the speakers and discussion sessions as well as social interactions, such as speed networking, and virtual coffee breaks, receptions, or dinners. In order to promote interaction between virtual and on-site participants, on site participants will have to enter the virtual space. Practically this means the conference venue needs sufficient Wifi capacities as well as rooms to accommodate the on-site participants who will be speaking to the virtual participants via their computers. This places a limitation on the time that in-person participants can interact with each other on site and thereby counters the main benefit identified for in-person meetings.

Given the complexity of the fully hybrid option, it can be assumed that very few conference venues will be able to handle such requirements, and possibly very few organizers are willing or able to put in the considerable extra effort.

The role of the speakers is crucial. The opportunity to hear first-hand from some of the best scientists and meet them face to face is a major motivation for many to attend a certain conference. This draw will be diminished if a good percentage of the invited speakers decide to attend remotely only. Organizers will have a much easier time to recruit speakers if they do not have to travel, but it is unlikely that in-person participants will be satisfied with mostly remote lectures, and therefore may not register for in-person attendance in the first place.

One concern in the context of conferences is the future distribution of on-site versus virtual participants. It is impossible to predict now how people will re-adapt to conference attendance. When a previously fully in-person meeting becomes hybrid, there could be the same number of in-person participants and the virtual participants being additional attendees. At the other end of the scale, if all or

most previous in-person participants decide they would rather not travel, this could result in a small, non-sustainable number of in-person participants.

But if we accept that the benefits of in-person conferences laid out above in Section 1 are to a large extent due to networking via non-scheduled, often serendipitous personal interactions, then as those who run or fund conferences, we must be more attentive to the details of that. The features that are difficult to emulate virtually are in the realm of networking. It may be necessary to ensure that there is a critical mass of speakers and participants on site, to safeguard a positive experience for all attendees, virtual and in-person. Some institutional organizers suggested that the on-site format might have to be made more attractive to get participants to join in person. Whether that will be sufficient to pull in sufficient numbers of in-person attendees for a successful event remains to be seen.

As reported above, many scientists have noted that not having to travel for meetings is of some benefit to the environment. However, depending on how they are attended, hybrid meetings may contribute little or nothing to the reduction of travel to meetings; for example, if the online component merely adds participants to an in-person meeting running at the same capacity as it would without the virtual component. If a successful hybrid meeting is an in-person conference with additional virtual participants, no travel will be saved (and this could be exacerbated by additional energy requirements for streaming on the organizer's side and network requirements on the participant's side; we do not analyze that here). Half of the respondents to our survey stated that they would be travelling to fewer in-person meetings overall. This might result in conferences having fewer participants, whether hybrid is an option or not.

If diminishing numbers of on-site participants threaten the viability and value of in-person conferences as currently constructed, we might conclude that the personal networking components were not as important as they were made out to be in our interviews and survey: scientists would literally have voted with their feet.

For the moment though, we simply cannot anticipate people's decisions as to whether they will or will not travel for hybrid or fully in-person meetings. Thus, funders and meeting organizers will need to carefully consider the absolute numbers of in-person and virtual attendees, and how those numbers change over time.

An important question then is how many participants on site make for a good conference experience in the first place, noting that there will be disparate views between conference attendees and (professional) conference organizers. Whereas conference attendees in our Young Investigator Network survey generally felt that between 50 and 200 participants is optimal, this is not necessarily always the ideal size for all purposes. For example, an annual conference with the purpose of bringing an entire research community together will normally be much larger. Professional organizers will be looking at numbers from a completely different angle, because they need to recover their costs. These organizers were already balancing income from very popular meetings with expenses for meetings of emerging or generally smaller communities. General cost models for both hybrid and virtual meetings are being studied closely.

Virtual and in-person participants

For any hybrid model, meeting organizers and participants will need to accept that there will be two unequal types of participants: those on site, and those who join virtually. For the near- to mid-term, the most practical attitude to take to this problem is to recognize that the opportunity to join scientific conferences remotely has arisen serendipitously but is only sustainable if it does not become too much of a burden to those organizing, participating in, and funding conferences. This is confirmed by the responses to our survey. Three quarters of respondents think that the hybrid format brings new opportunities for scientists to attend who otherwise might not attend.

In addition to any other downsides of remote participation at an otherwise in-person meeting, no matter how much technology improves, one problem for virtual participants

at in-person meetings that cannot be solved is time zone differences. Understanding that everyone around the world will not be able to participate simultaneously, it will be important for organizers to find ways to assure participation throughout many time zones.

Cost and technical challenges

Making meetings hybrid is an additional service, with the possibility of providing access to the latest scientific developments to a much broader part of the scientific community than ever before. But a hybrid event comes at a cost both to the organizers and to the funders, and the scientific community will have to decide whether the gains are worth the efforts.

In terms of monetary cost, as we have already seen for fully virtual meetings, attendance at a hybrid event as a virtual participant will not be for free. The extra costs for administration and technical support need to be covered. Funders will also have to take this into account in their level of support for hybrid events.

The technical delivery poses another challenge. A virtual platform is needed, which can range from a simple web page on which the talks can be viewed, to a more complex site that hosts abstracts and posters, and chat and other features. Significant work may be necessary to create the online programme, depending on the level of sophistication of the platform chosen.

On site, cameras and microphones, technicians to operate them, and sufficient bandwidth to stream the talks are required. Solutions to this range from simple to sophisticated, possibly requiring the hiring of professionals to deliver the service.

Many EMBO-funded conferences take place in hotels. We have conducted a survey of 23 of the most highly rated hotel locations used for EMBO Workshops (based on the scores given by previous participants) to find out if they have the technical capability to host a hybrid meeting. Most of the hotels contacted indicated they had the necessary bandwidth for the streaming and most would be able to procure technical equipment and staff, the cost of which would be charged to the organizers.

For very large meetings (in the thousands of participants with many parallel sessions) the situation is even more difficult. To make such a meeting a true hybrid, any streaming and visual technologies would have to be placed in each room with potentially prohibitive costs. For this type of meeting, we heard the suggestion to make plenary sessions hybrid, leaving most parallel or breakout sessions in-person only.

Role of funders

After an experimentation phase, funders, institutional conference organizers and the scientific community will be in a position to weigh the advantages of hybrid and virtual formats against their disadvantages. Funders may find that the inclusion of a larger number of scientists is an important value and should be supported. Hence the inclusion of a virtual component at all conferences could become a requirement.

Fully virtual formats would address the issue of inclusion as well as helping to protect the environment by reducing travel. If the protection of the environment is a declared value of a funder, such a funder may decide that all conferences should be held virtually or, in the case of conference series, alternate between the virtual and in-person format.

It seems clear that in the next one to two years hybrid conferences will be an experiment of sorts. According to our interviews and survey there is support for experimenting with hybrid and virtual conferences. The challenge for hybrid conferences will be to maintain the best of the in-person format and include the advantages of the virtual options: host a sufficient number of participants on site, with the right mix of speakers, senior scientists, post docs and students, while at the same time benefitting those who are not able or willing to attend in person.

Section 5:
The future of conferences

Exchanging research results at scientific conferences is an integral part of the scientific process. Researchers value the intense exchange of information and the opportunity for intense discussions with their peers. During the pandemic, essentially all scientific conferences were held online. While scientists were grateful that the exchange of scientific information continued, in our interview and survey groups, the majority stated that the online format did not provide sufficient opportunity to personally meet with colleagues to get feedback and discuss science.

Scientists appreciated the low environmental impact, inclusivity, and lower time commitment required for an online conference, and the opportunity to sample different scientific fields. Scientists with parenting responsibilities in our survey cohort stated that the online format had been of benefit to them.

Even when in-person conferences become possible without restrictions again, we nevertheless conclude that most scientists would like to preserve some of the advantages of virtual conferences.

Organizing meetings in hybrid format may serve all purposes and requirements, if done with care. However, a major caveat of hybrid meetings that needs to be addressed by both funders and organizers are the technical requirements, both in terms of equipment and operations.

EMBO will encourage scientists to experiment with the different meeting formats to work out what best serves the scientific community. We already offer a virtual platform and will provide additional funds to our organizers. Feedback from organizers will be collected and summarized to work out the best ways to run conferences with virtual components. A blog post on our web site deals with some practical aspects of virtual and hybrid conferences.

Once sufficient experience has been collected, funders (including EMBO) can decide if certain hybrid components should become mandatory in their portfolio, taking into consideration the values that the funder holds.

Appendices

Appendix 1:
Interview questions

Questions for researchers

Information on your conference experience

1. How many scientific conferences per year do you attend, and why that number?
2. How do you select the conferences that you attend?
3. Do you have any budget limitations for attending conferences for yourself and for your lab?
4. What is your role at these conferences?
5. Do you attend conferences that are not relevant to your specific area?
6. In which world regions do the conferences you attend mainly take place?
7. Have you organized conferences yourself? How many?
8. Why do you organize conferences?

Value/advantages of conferences for individual researchers

1. What purpose does attending conferences serve for you?
2. Has the purpose changed over the course of your career?
3. Can you give concrete examples of direct outcomes of your participation to conferences?
4. Are you expected to attend conferences by your employer?
5. Does your employer acknowledge your contributions to conferences as a speaker? How?
6. Do you send your students or lab members to scientific conferences?
7. What is the benefit of attending scientific conferences for your lab members and your lab in general? And for your institute?

Value of conferences for science/research

1. What is in your view the role of scientific conferences for science in general? What are their main purposes?

Disadvantages of in-person conferences

1. Could you mention any negative aspects related to attending conferences in-person?
2. If there is one thing about conferences that you would like to change or improve, what would that be?

Advantages and limitations of virtual conferences

1. Have you ever attended a virtual conference?
2. If no, why?

   If yes:

   3. In which role?
   4. How was your experience, as a speaker or participant?
   5. Did you experience a different level of engagement on your side compared to in-person conferences?
   6. Have you noticed a difference in the quality of the presentations and the Q&A sessions compared to in-person conferences?

General: in-person and virtual conferences

1. If most conferences would be turned into virtual ones, which aspect of in-person conferences would you miss most?
2. Does every conference have to be in-person? Or what kind of conferences do you think could be done entirely in virtual format, and which ones as hybrids?
3. One of the advantages of virtual conferences is that they allow participation of researchers from economically disadvantaged areas, who would not be able to travel to a conference. What is your view on that?
4. Potentially, people from any part of the world can attend virtual conferences. This will invariably result in a time zone disconnect, so there will be a very narrow time window where everyone can get together. Do you have concerns about this?
5. Are the benefits for research (mentioned before) the same in virtual and in-person conferences?

Questions for conference organizers

Information on individuals' conference experience

1. How many conferences have you organized? How many per year do you organize?
2. Have you also organized virtual conferences? How many?

Values of virtual vs in-person conferences for research and researchers

1. Why does your organization organize conferences? What are the aims of scientific conferences for you?
2. As a conference organizer, would you want to turn all conferences into virtual ones?
3. If no, which conferences could be turned into virtual ones?
4. What are the main reasons for turning in-person conferences into virtual ones?
5. Is the value of in-person vs virtual conferences *for research* the same? If not, what is the difference?
6. In your view, are the benefits of in-person vs virtual conferences *for individual researchers* the same? If no, what is the difference?
7. Do you notice a difference in the acceptance of virtual conferences between younger and established researchers?
8. What is the participants' feedback on virtual conferences?
9. Are speakers more willing to accept to talk at virtual vs in-person conferences?
10. What are the main challenges of organizing virtual conferences?
11. How do you see the future of scientific conferences?

Information about technical aspects of virtual conferences

1. What platforms do you use for virtual conferences?
2. In your view, what kind of networking activities work best in virtual conferences?
3. The length of the talks is shorter in virtual conferences, as viewer's attention span is shorter on-line. Are these talks able to convey the same amount of information as longer in-person talks?
4. What is the best way to have Q&A sessions with the speakers after their talks?
5. What is the best way of organizing virtual poster sessions?

Other

1. How important is the conference location for you when you organize a conference?

Appendix 2:
Comparison tables

Table 1:
Comparison between in-person and virtual conferences: Benefits for research

In-person conferences	Virtual conferences
Building and maintaining an international scientific community	*Less* building and maintaining an international scientific community?
Scientific advancement	Scientific advancement
Summarizing the latest scientific information with a quality filter	Summarizing the latest scientific information with a quality filter
Intense exchange and discussion of information and ideas	*Less* intense exchange and discussion of information and ideas?

Table 2:

Comparison between in-person and virtual conferences: Pros and cons for individual researchers

In-person conferences	Virtual conferences
Networking, personal interactions	*Less* networking, personal interactions
Serendipitous encounters	Better structure to assure meetings if desired
Communicate and promote own work	Communicate and promote own work
Immediate feedback from and to peers on own work	*Less* immediate feedback from and to peers on own work?
Visibility for speakers	Visibility for speakers
New collaborations	*Fewer* new collaborations?
Learn details about research that are not shown in published papers through informal interactions	May be possible to learn details about research that are not shown in published papers, but interactions need to be organized?
Opportunity to learn about unpublished research results, but fear to be scooped	Opportunity to learn about unpublished research results, but more fear to be scooped ?
Discuss with competitors and peers in informal meetings	May be possible to discuss with competitors and peers but meetings need to be organized?
Influence on publication of research work through meetings with authors, reviewers and editors	Influence on publication of research work may be possible , but meetings need to be organized?
Motivation, encouragement	?
Inspiration, new ideas and creativity because experiencing research in a different environment	?
Emotional engagement	*Less* emotional engagement
Immersion in the research during the conference	Not able to focus as work and care obligations continue on the side
Find new jobs and positions	?
Build communication skills	Build communication skills
Learning about new technologies and skill training in exhibition area and on-site training	?

In-person conferences	Virtual conferences
Building and cultivating friendship	?
Cultural experience and break from daily routine	?
Time consuming	*Less* time consuming since no travel involved
Difficulty to concentrate when jet-lagged	No jet-lag, but time-zone differences
Too many conferences with similar programmes/speakers	Even more conferences with similar programmes/speakers
Disruption of work and care responsibilities	Trying to combine conference participation, work and care responsibilities
Negative environmental impact	Minimal environmental impact
High registration, travel and accommodation costs	(High) registration, but no travel and accommodation costs
Limited reach (exclusionary)	Available to more scientists
Abusive and negative behaviour (physical)	Abusive or negative behaviour (via social media, email)?
Talks can only be watched live (mainly)	Recording of talks provides access on demand
Q&A sessions only after the talks and might exclude introvert participants	Q&A sessions can be more inclusive, and can be continued throughout the conference
Conference room fatigue	Screen fatigue
Selective participation less likely	Selective participation (only presentations of direct interest will be followed)
Speakers can see and hear audience's reactions, body language	No rapport between speakers and audience
Mainly static presentation of posters	New technological opportunities for poster sessions
Attendance limited to space available, high additional costs due to travel and accommodation, travel restrictions due to visa issues	Wider attendance
Other participants might prevent view of speakers in conference room	Better view of talks and speakers on the screen

Appendix 3:
List of interviewees and selected quotes

(Affiliations at time of interview)

Interviewees

Researchers

- Jesús Alvarado Valverde, *EMBL Heidelberg, DE*
- Vaishnavi Ananthanarayanan, *Centre for BioSystems Science and Engineering, IN*
- Margarida Araújo, *Gulbenkian Institute, PT*
- Pascale Cossart, *Pasteur Institute, FR*
- Michael Glotzer, *University of Chicago, US*
- Edith Heard, *EMBL Heidelberg, DE*
- Eva Hörmanseder, *Institute of Epigenetics and Stem Cells, Helmholtz Zentrum, DE*
- Lijian Hui, *Shanghai Institute for Biological Sciences CAS, CN*
- Jürgen Knoblich, *Institute of Molecular Biotechnology, AT*
- Maria Leptin, *EMBO, DE*
- Sonja Lorenz, *Rudolf-Virchow-Zentrum Würzburg, DE*
- Zoi Lygerou, *University of Patras, GR*
- Moisés Mallo, *Gulbenkian Institute, PT*
- Brian Martinson, *HealthPartners Institute, US*
- Sarah de Rijcke, *Centre for Science and Technology Studies CWTS, NL*
- Pere Roca-Cusachs, *Institute for Bioengineering of Catalonia, ES*
- Umut Şahin, *Boğaziçi University, TR*
- Sandra Schmid, *Chan Zuckerberg BioHub, US*
- Peter Sebo, *Institute of Microbiology ASCR, CZ*
- Sara Sepe, *IFOM, IT*

- Erdinc Sezgin, *Karolinska Institutet, SE*
- LS Shashidhara, *Indian Institute of Science Education and Research, IN*
- Cole Sitron, *MPI of Biochemistry, DE*
- Agata Starosta, *Maria Curie-Skłodowska University, PL*
- Gisou van der Goot, *EPFL, CH*

Institutional/professional conference organizers

- Treasa Creavin, *Wellcome Connecting Science, UK*
- Jürgen Deka, *EMBL, DE*
- Thale Jarvis, *Keystone Symposia, US*
- Erika Shugart, *ASCB, US*
- David Stewart, *Cold Spring Harbor Laboratory, US*
- Luis Valente, *Collaborative Centre Gulbenkian, PT*

Selected quotes

We are social animals. We need social interactions.

Margarida Araújo, *PhD student, Portugal*

Creativity does not happen in front of a computer screen. You need to talk [in person] about the differences in opinions.

Jürgen Knoblich, *senior researcher, workshop organizer, Austria*

Conferences are a glue that keeps researchers together.

Moisés Mallo, *senior researcher, workshop organizer, Portugal*

I would feel disconnected if I could not go to conferences.

Umut Şahin, *researcher, workshop organizer, Turkey*

You are immersed in science, away from other distractions, and come back totally energized.

Cole Sitron, *post-doctoral researcher, Germany*

The hybrid mode would be good to avoid transatlantic flights and save time.
But science is also a social thing, so we also need in-person conferences.

Jesus Alvarado Valverde, *PhD student, Germany*

We are scientists, we should experiment with virtual formats.

Michael Glotzer, *senior researcher, United States*

A lot is happening [in virtual conferences] that I would never have imagined it would, and the verbal component is key. It does not need to be in person.

Edith Heard, *senior researcher, organization head, conference organizer, Germany*

We are not going back. This is the new normal. There are many advantages, also some disadvantages, but now we can decide what to do. There's a whole new opportunity for communication. Change is a difficult thing, but we need to change. We've reached a tipping point on many things, including scientific communication. We need to take advantage of these disruptive times, and let's adapt our technology before people relax and go back. Carpe diem!

Sandra Schmid, *senior researcher, conference organizer, United States*

Appendix 4:
Questionnaire to EMBO Young Investigator Network

Sent to members of the EMBO Young Investigator Network (648 persons) in August 2021.
Click on the question text to jump directly to the corresponding result.

A:
We would like to know about what you and your lab members expect to gain when attending scientific conferences

1. Before the pandemic, how many conferences per year did you attend?

- ◯ <3
- ◯ 3–5
- ◯ 6–8
- ◯ 9–10
- ◯ >10

2. What do you perceive as the ideal range for the number of participants for a conference in your field of research?

- ◯ 1–50
- ◯ 50–100
- ◯ 100–150
- ◯ 150–200
- ◯ 200–250
- ◯ >250

Comments: _____

3. **How important are the following aspects for you when attending conferences?**
(must have – important – nice to have – small benefit – irrelevant)

- Being able to present my work to my community to get feedback
- Presenting my work to raise my profile in my field
- Learning about the latest advances in my field
- Learning about unpublished results
- Meeting known colleagues
- Meeting new colleagues to me
- Identifying potential students or post docs
- Seeing new perspectives for my research
- Finding new potential collaborators
- Intense discussions and exchange with peers
- Visiting different places
- Being away from the lab

Other aspects important to you that are not listed here: _____

4. **How important are the following aspects to you when sending your students/post docs/ lab members to scientific conferences?**
(must have – important – nice to have – small benefit – irrelevant)

- Presenting their work to the community and getting feedback
- Presenting their work to raise their profile in the field
- Learning about the latest developments in the field
- Meeting the leading scientists in the field
- Identifying potential supervisors or job opportunities
- Strengthening their motivation
- Seeing new perspectives for their research
- Finding new collaborators

Other aspects important to you for your students that are not listed here: _____

5. **How frequently do you present unpublished data at in person scientific conferences in your field?**

- ◯ Always
- ◯ Frequently
- ◯ Sometimes
- ◯ Seldom
- ◯ Never

6. **In your experience, are unpublished data presented during the talks at in-person conferences in your field?**

- ◯ In my experience mostly published data (including preprints) are presented
- ◯ In my experience mostly unpublished data are presented
- ◯ In my experience equal amounts of published and unpublished data are presented
- ◯ Difficult to say

Further comments: _____

7. **How do you value the presentation of unpublished data at scientific conferences?**

- ◯ Essential
- ◯ Important
- ◯ Nice to have
- ◯ Small benefit
- ◯ Irrelevant

B:

We would like to know about your experiences with scientific meetings during the pandemic

8. Did you participate in any virtual conferences during the pandemic?
(we only want to know about scientific conferences in your field of research, NOT seminars, committee meetings, group meetings or informal meetings that you might have attended)

- ◯ Yes
- ◯ No

If yes: How many virtual conferences in your field did you attend during the pandemic?

- ◯ 1
- ◯ 2–4
- ◯ >5

9. What was your role?
(multiple answers possible)

- ☐ Speaker
- ☐ Panelist
- ☐ Poster presenter
- ☐ Participant
- ☐ Organizer
- ☐ Other: _____

10. If you were invited to speak at a conference what would be your reasons to speak remotely rather than attending in person?

- ◯ I would offer/accept to speak remotely at a conference if I were not interested in attending in person
- ◯ I would offer/accept to speak remotely at a conference in my research area if I had already accepted too many other invitations
- ◯ I generally prefer to give remote presentations
- ◯ I would not accept an invitation to speak remotely
- ◯ Other reason (specify): _____

Comments: _____

11. In your experience, does the balance between published (including preprints) and unpublished data presented during the conference talks in your field change when conferences are held virtually?

- ◯ People present less unpublished data at virtual conferences than at in-person conferences.
- ◯ People present the same proportion of unpublished and published data at virtual and in-person conferences.
- ◯ People present more unpublished data at virtual conferences than at in-person conferences.
- ◯ I find this difficult to judge

Comments: _____

12. Are you less likely to present unpublished data at a virtual conference?

- ◯ Yes
- ◯ No

If yes: Why?

_____

Comments: _____

13. **How well do you think the aspects listed below are served when attending a conference virtually rather than in-person?**
(better served – equally well served – sufficiently served – not well served – completely lacking)

- Being able to present my work to my community to get feedback
- Presenting my work to raise my profile in my field
- Learning about the latest developments in my field
- Meeting my colleagues
- Identifying potential students or post docs
- Providing inspiration or new perspectives for my research
- Identifying potential new collaborators
- Discussions with my peers
- Official questions and answer session following a talk
- Meeting new people

Comments: _____

14. **Please rate the importance you attach to some of the aspects of virtual conferences listed below:**
(extremely important – very important – important – nice to have – not important)

- Less environmental impact
- More time-effective due to not having to travel
- Less costly
- Less disruptive
- More inclusive because less well-funded scientists can attend
- More questions are being asked and answered because of the chat functionality

Other aspects that are not listed above: _____

15. Will the frequency of attending conferences in person change for you after the pandemic?

- ◯ No, I expect to travel to attend conferences as before
- ◯ Yes, I plan to attend fewer conferences in person

Comments: _____

If yes: Why?
(multiple choice)

- ☐ For environmental reasons
- ☐ For family reasons
- ☐ For financial reasons
- ☐ Generally more convenient
- ☐ Other: _____

C:

We would like to know your opinion on hybrid conferences, that is, conferences that combine in-person and virtual attendants

16. **Hybrid meetings can take different formats. From the point of view of the in-person participant what do you think about the following possible formats:**
(very desirable – quite desirable – neutral – not very desirable – not at all desirable)

    - Streaming of talks to the virtual participants with no further services provided
    - Combination of streaming and virtual participation via Q+A and chat
    - Combination of streaming, Q+A and chat, virtual participants can apply to give selected talks
    - Streaming, Q+A and chat, giving selected talks and inclusion in poster session
    - Virtual and in-person participants are equal: social networking of virtual and in-person participants is arranged in addition to the above

    Other suggestions: _____

17. **Hybrid meetings can take different formats. From the point of view of the virtual participant what do you think about the following possible formats:**
(very desirable – quite desirable – neutral – not very desirable – not at all desirable)

    - Streaming of talks to the virtual participants with no further services provided
    - Combination of streaming and virtual participation via Q+A and chat
    - Combination of streaming, Q+A and chat, virtual participants can apply to give selected talks
    - Streaming, Q+A and chat, giving selected talks and inclusion in poster session
    - Virtual and in-person participants are equal: social networking of virtual and in-person participants is arranged in addition to the above

    Other suggestions: _____

18. Would you attend a hybrid meeting as a virtual participant?

- ◯ Yes
- ◯ No

If yes: What could be your reasons?
(mark all that apply)

- ☐ Traveling too much already
- ☐ New topic to me
- ☐ Will not attend every meeting of this series in person
- ☐ Budgetary reasons
- ☐ To avoid long-distance travel
- ☐ Family obligations
- ☐ Work obligations
- ☐ Other reasons: _____

19. Would you recommend to your students/post docs to attend as a virtual participant?

- ◯ Yes, always
- ◯ Yes, occasionally
- ◯ No

If yes (also for yes, occasionally): What are your reasons?
(mark all that apply)

- ☐ Saves money
- ☐ Saves time
- ☐ I want my students to be able to participate in more conferences than I have budget for if I had to pay for in-person attendance
- ☐ Other: _____

If no: Why not?

_____

20. In your opinion, what should be the maximum proportion of virtual speakers at a hybrid conference?

- ◯ Max. 10%
- ◯ Max .30%
- ◯ Max. 50%
- ◯ More/unconstrained

Comments: _____

21. In your opinion, what should be the maximum proportion of virtual participants in a hybrid conference?

- ◯ Max. 10%
- ◯ Max. 30%
- ◯ Max. 50%
- ◯ Max. 70%
- ◯ More/unconstrained

Comments: _____

22. As an in-person participant at a hybrid meeting I would/will:
(mark all that apply)

- ☐ Make specific efforts to find out who has joined remotely
- ☐ Try to engage with remote participants
- ☐ Check the platform to see if someone wants to engage with me
- ☐ In my experience I will not have time to deal with virtual participants

Comments: _____

23. **The addition of virtual participants to an in-person conference would create two categories of participants. To what extent do you agree with the following statements?**
(fully agree – agree somewhat – indifferent – disagree somewhat – do not agree at all)

- I am not concerned, as this is a new opportunity for many that has not existed before.
- Virtual participants should be included at conferences.
- Hybrid conferences should be the exception.

Comments: _____

24. **EMBO, as a funder of scientific conferences, could make rules about requiring hybrid formats and allocating funds for conferences offering hybrid format. To what extent do you agree with the following statements?**
(fully agree – agree somewhat – indifferent – disagree somewhat – do not agree at all)

- The decision whether to offer a hybrid format should be left to the organizer in every case.
- All conferences are required to offer hybrid format, but there may be exceptional cases where this may be not be the right thing for the type of meeting.
- Hybrid format should not be an option for EMBO Courses and Workshops.

Comments: _____

Appendix 5:
Summary of results of EMBO Young Investigator Network survey

Sent to members of the EMBO Young Investigator Network (648 persons). The summary is based on 206 responses.

The feedback received is based on significant experience attending conferences, both in-person (pre-pandemic) as well as virtual. The vast majority of respondents has experience with virtual conferences, i.e., they have participated in 1 – 5 conferences in the last year.

The most important aspects when attending conferences are the presentation of own work and receiving personal feedback, learning about new advances and discussing these as well as meeting colleagues.

The respondents felt that the virtual format did not serve them well in meeting colleagues (known and new), having intense discussion with peers and identifying potential post docs/ PhD students. Virtual meetings did serve the goal of being able to present one's work and getting some feedback, learning about new developments and providing inspiration for own work.

A majority (>70%) identified as important advantages of the virtual format the reduced environmental impact and their time efficiency (due to not having to travel), and the increased inclusiveness due to allowing scientists to participate who otherwise could not for various reasons.

Respondents think that the presentation of unpublished results during conferences is important, but have mixed experiences regarding the amount of unpublished data presented, presumably depending on the field and the "traditions" of particular conferences. Many feel (56%), or fear, that less unpublished data are presented at virtual conferences due to speakers not knowing who is listening in and the ease of recording the data presented via screen-shots or recordings.

49% of respondents stated that they will travel to fewer in person conferences after the pandemic, due to environmental, family and convenience reasons.

When asked about the desirability of potential hybrid formats, a majority (approx. 70%) felt that virtual participants would be well served by the streaming of talks and participation in the discussions and possibly being selected to give a talk, fewer thought that further engagement, such as participating in poster sessions or social activity would be desirable, both from the perspective of the in-person as well as the virtual participant.

As an in-person participant most would not want to engage extensively with virtual participants. A majority (56%) stated that they would at least check the platform to see if a virtual participant would want to engage with them.

81% responded that they would attend a hybrid meeting as a virtual participant under certain circumstances, i.e., to avoid long-distance travel, to meet family obligations or to cut down on the extent of their travel.

When asked about the maximum percentages of virtual speakers and participants, opinions diverged, but many commented that experience will have to tell and many were concerned about the in-person part of the conference still delivering its aims (see above: feedback and discussion, presentation of unpublished data), possibly making the overall conference experience worse for all.

Most are not overly concerned (75%) that a hybrid format would create two classes of participants, as this brings new opportunities to scientists, and 78% agree that virtual participants should be included in conferences. 34% think that hybrid conferences should be the exception.

80% think that the decision to go hybrid should be left to the organizers, 45% think that hybrid format should be required (44% disagree), and 28% think that hybrid meetings should not be an option for EMBO.

Conclusions:

There is significant support for experimenting with hybrid conferences in the future, but apparently limited support for making a virtual component to conferences a requirement.

The challenge for hybrid conferences will indeed be to maintain the best of both worlds: host a significant number of participants on site, who are representing the right mix of speakers, senior scientists, post docs and students as to make it worth participants' investments, both financial and time, to travel to the event.

It is interesting and important to note that half of the respondents are planning to attend fewer in person meetings. If this were true, conferences in future might have fewer in-person participants, and possibly a few more remote speakers.

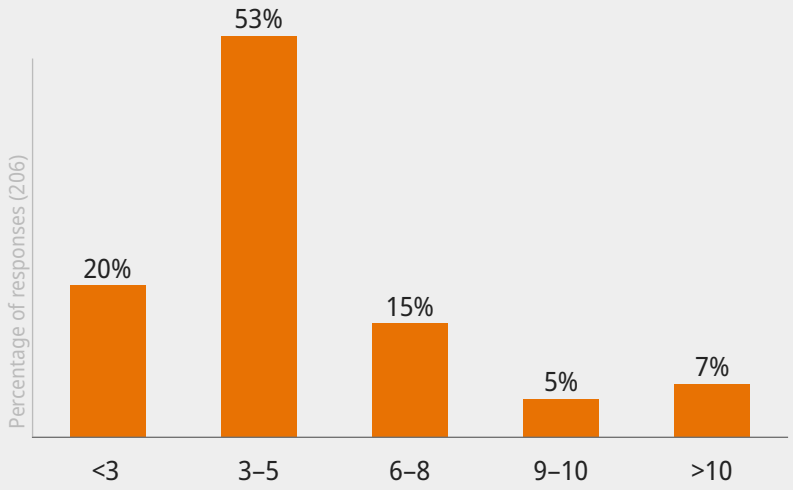
The community we questioned represent mostly well-funded group leaders from Western Europe, hence for most respondents it can be assumed that there is no financial barrier to attending conferences in person. Conference attendance is generally affordable for lab members, but to a more limited extent.

Appendix 6: Questionnaire results

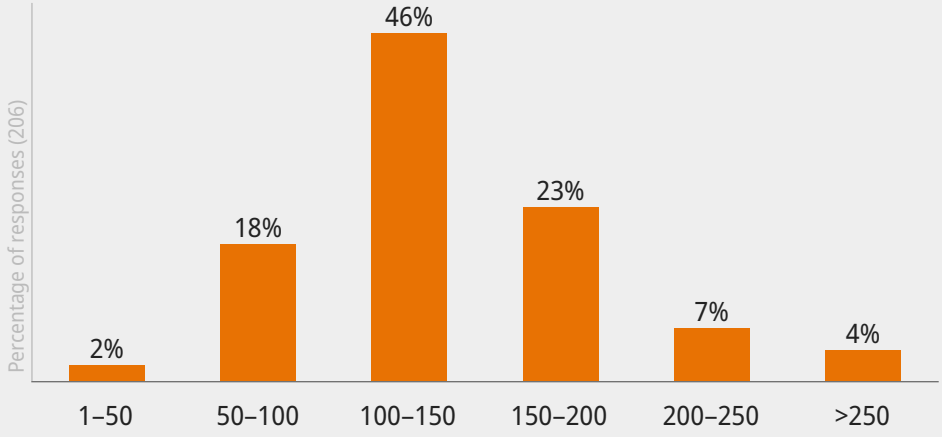
A:

We would like to know about what you and your lab members expect to gain when attending scientific conferences

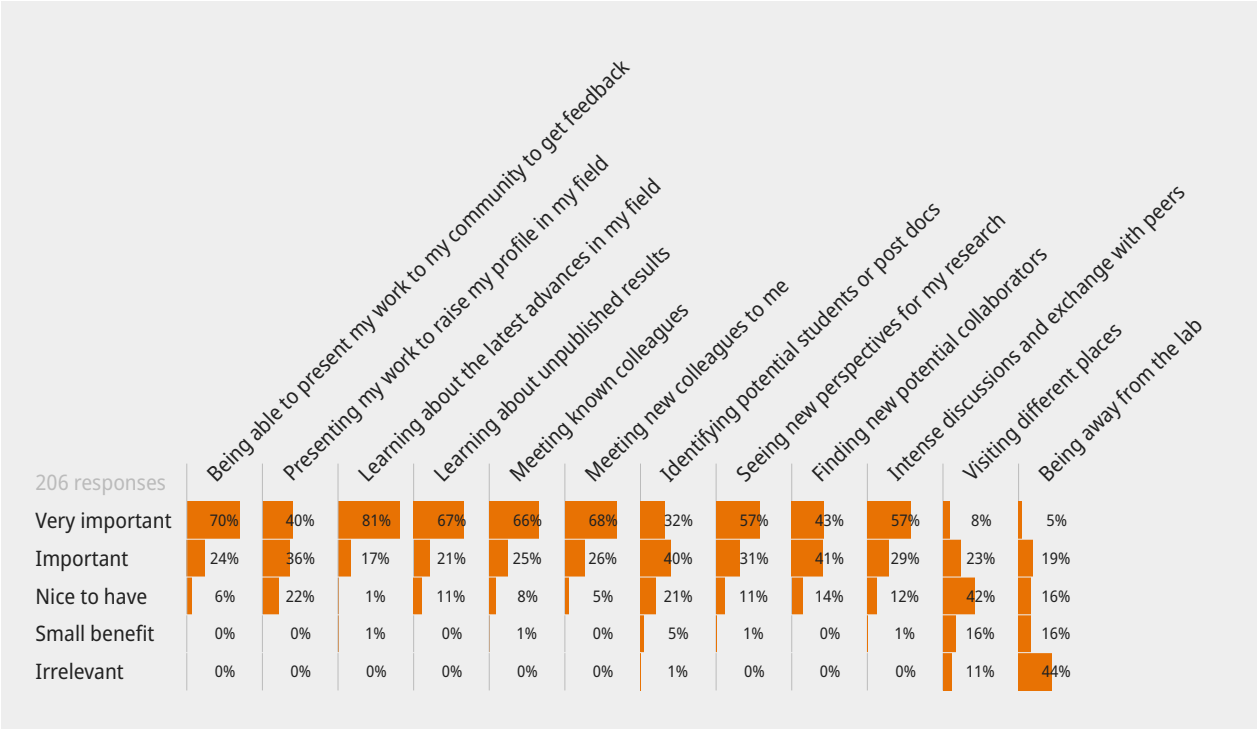
1. Before the pandemic, how many conferences per year did you attend?



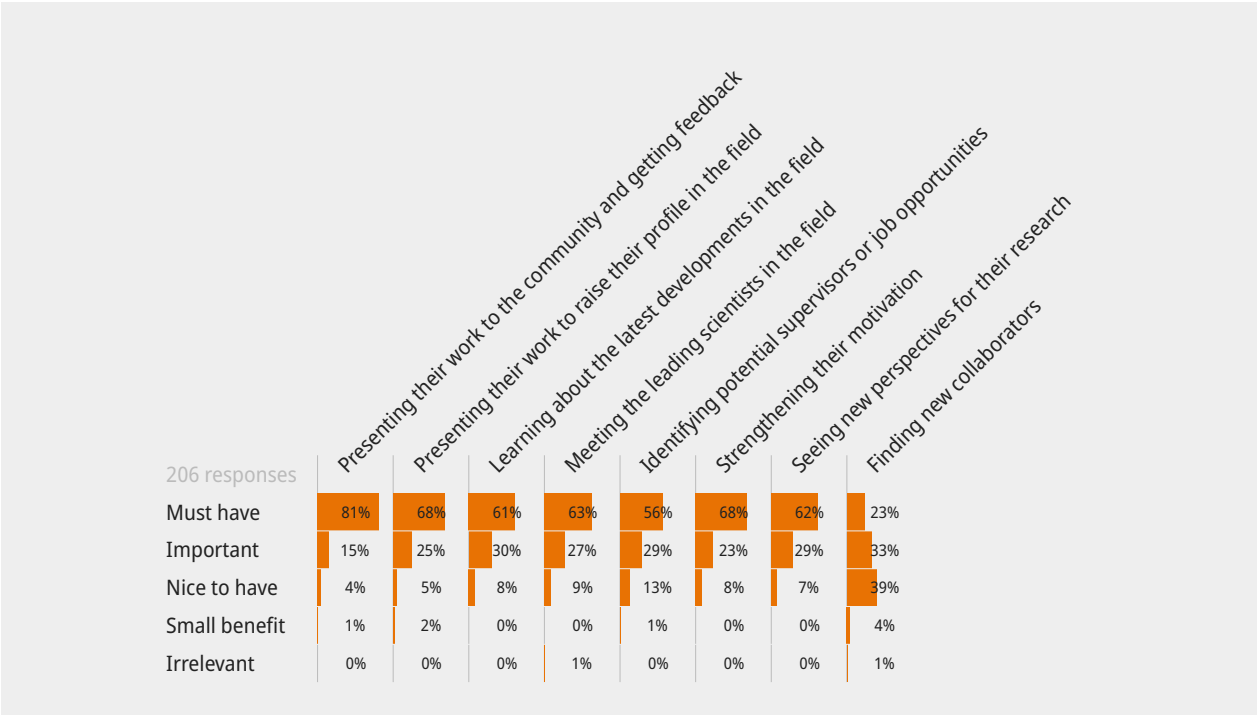
2. What do you perceive as the ideal range for the number of participants for a conference in your field of research?



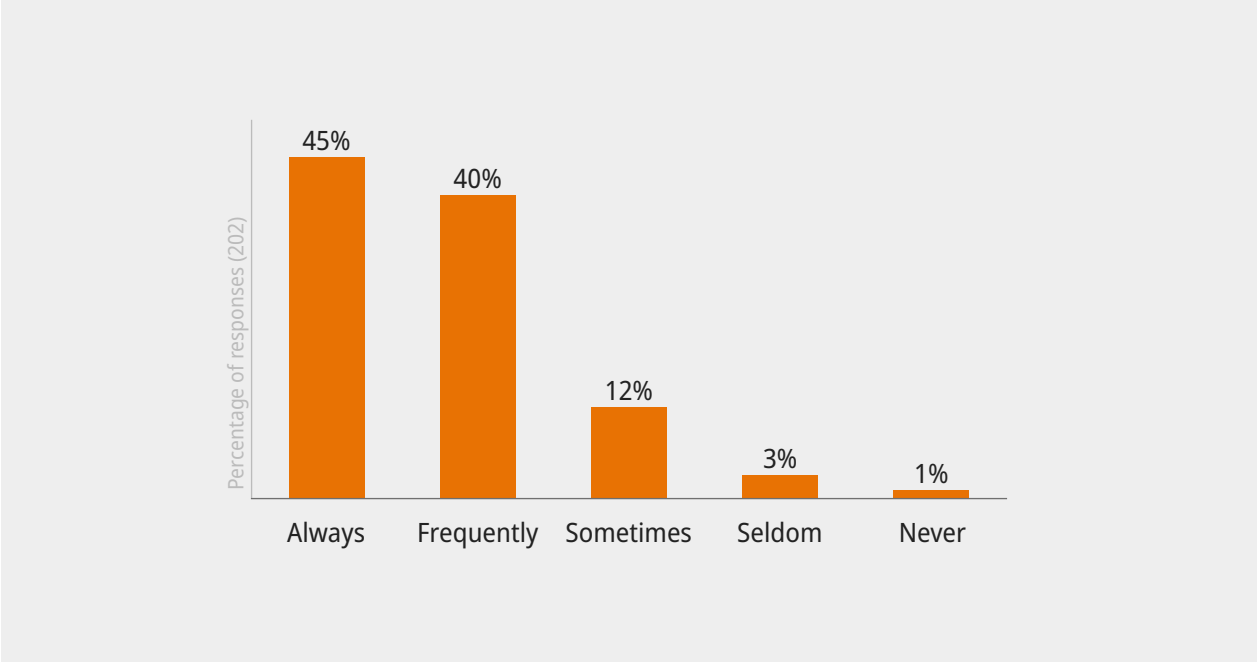
3. How important are the following aspects for you when attending conferences?



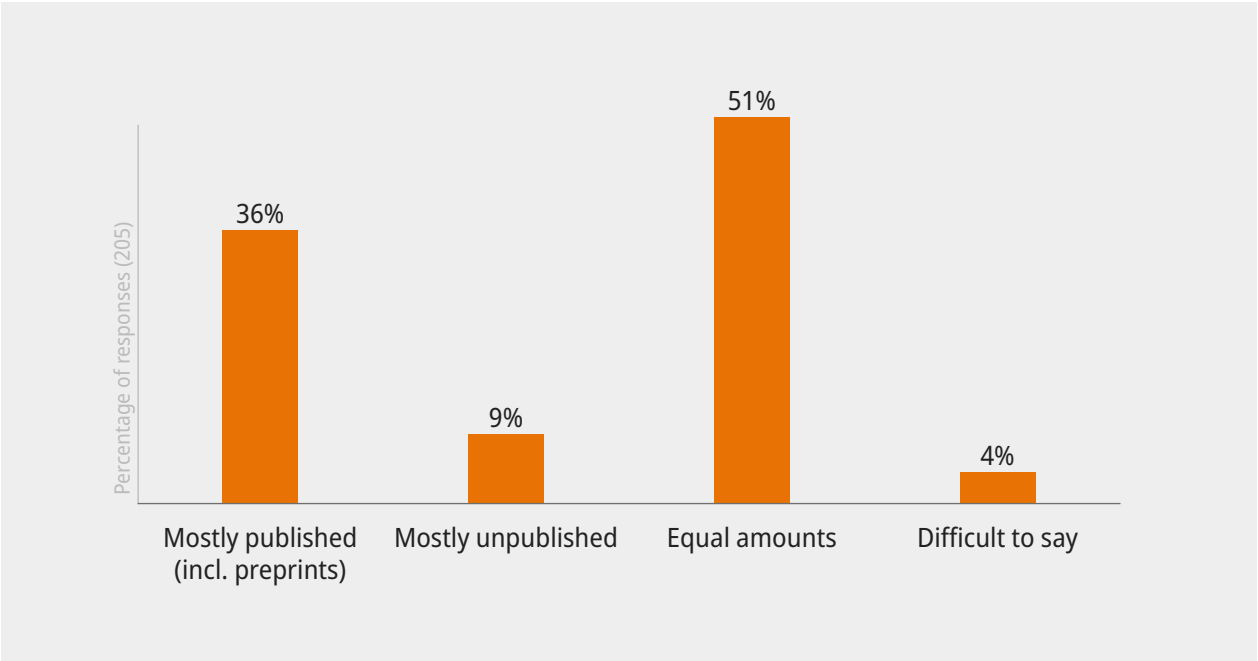
4. How important are the following aspects to you when sending your students/post docs/ lab members to scientific conferences?



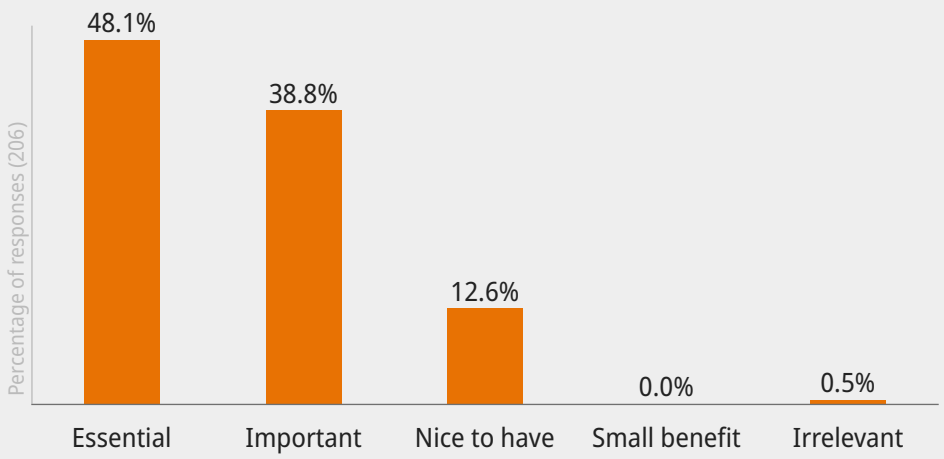
5. How frequently do you present unpublished data at in person scientific conferences in your field?



6. In your experience, are unpublished data presented during the talks at in-person conferences in your field?



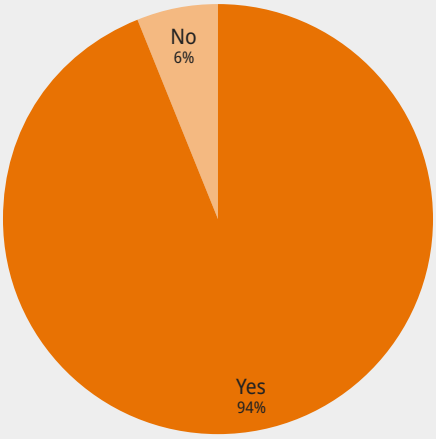
7. **How do you value the presentation of unpublished data at scientific conferences?**



B:

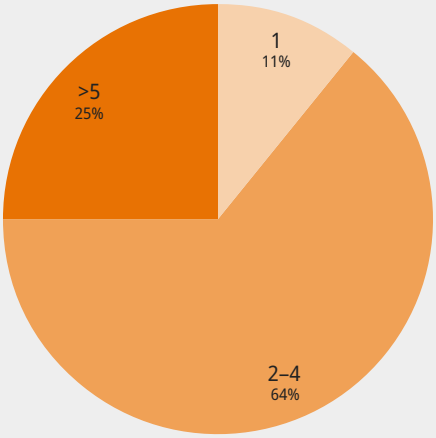
We would like to know about your experiences with scientific meetings during the pandemic

8. Did you participate in any virtual conferences during the pandemic?



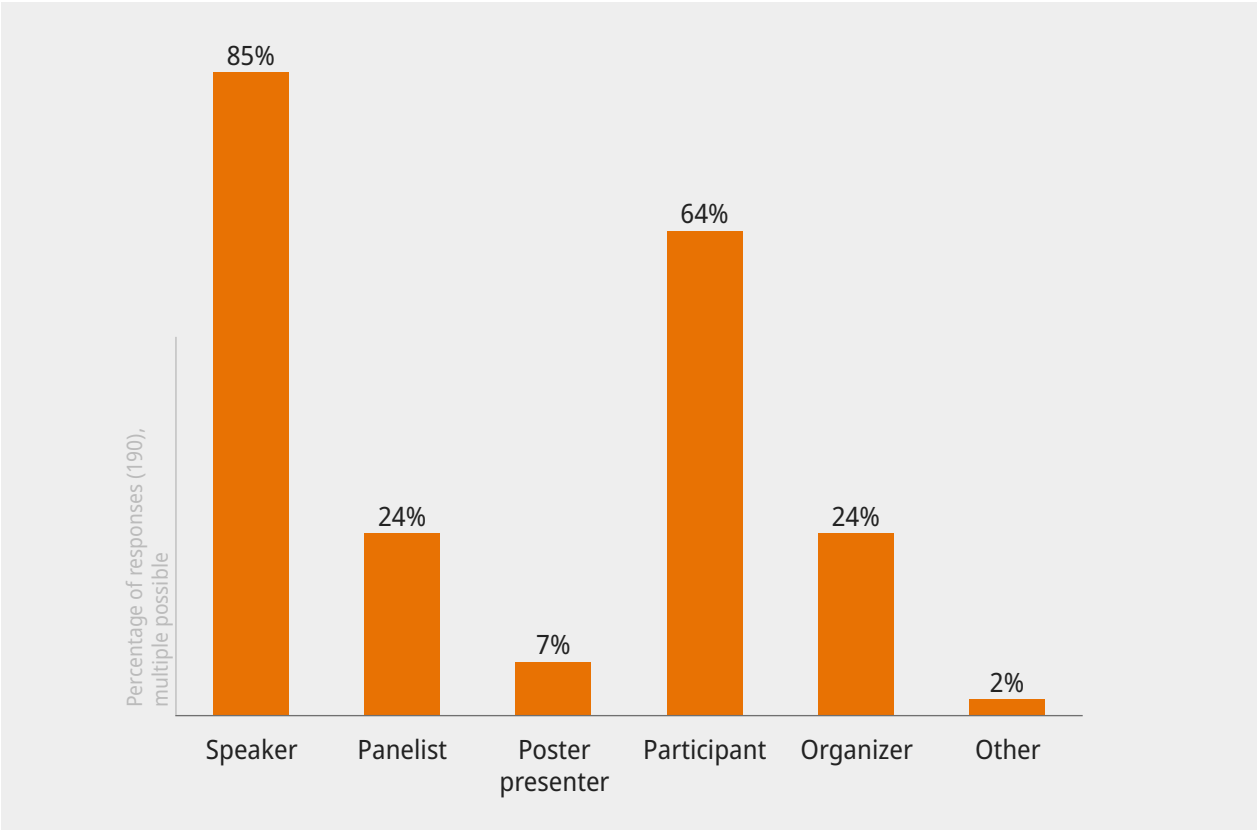
199 responses

If yes: How many virtual conferences in your field did you attend during the pandemic?

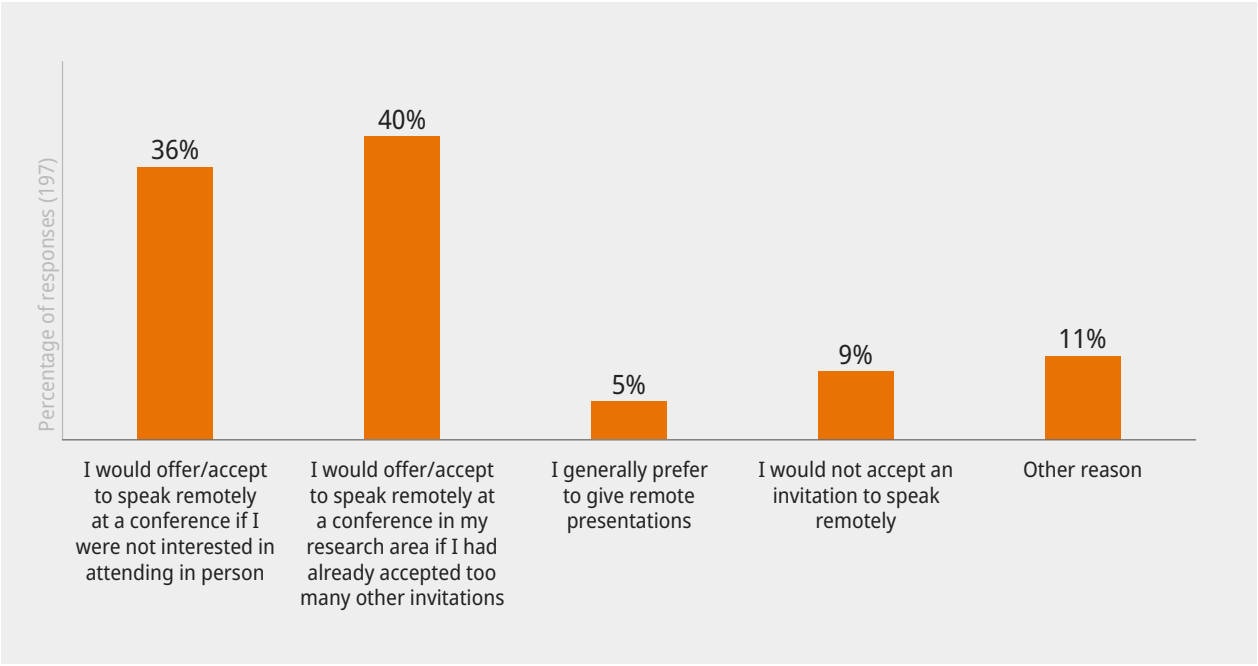


190 responses

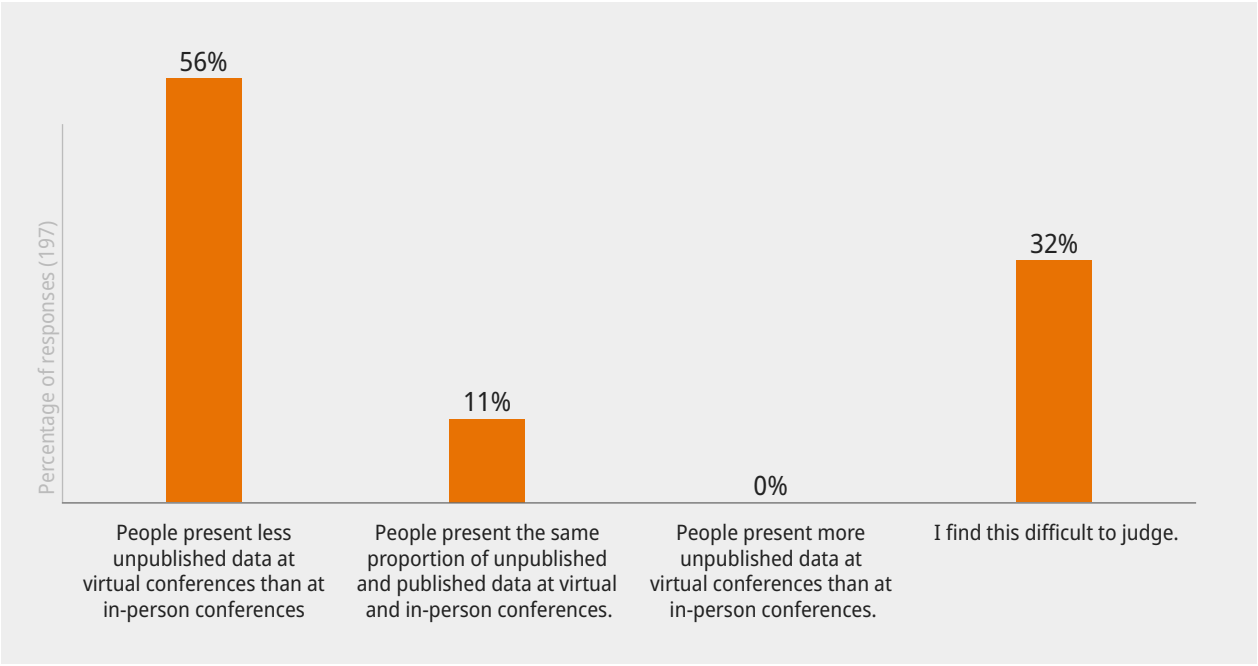
9. What was your role?



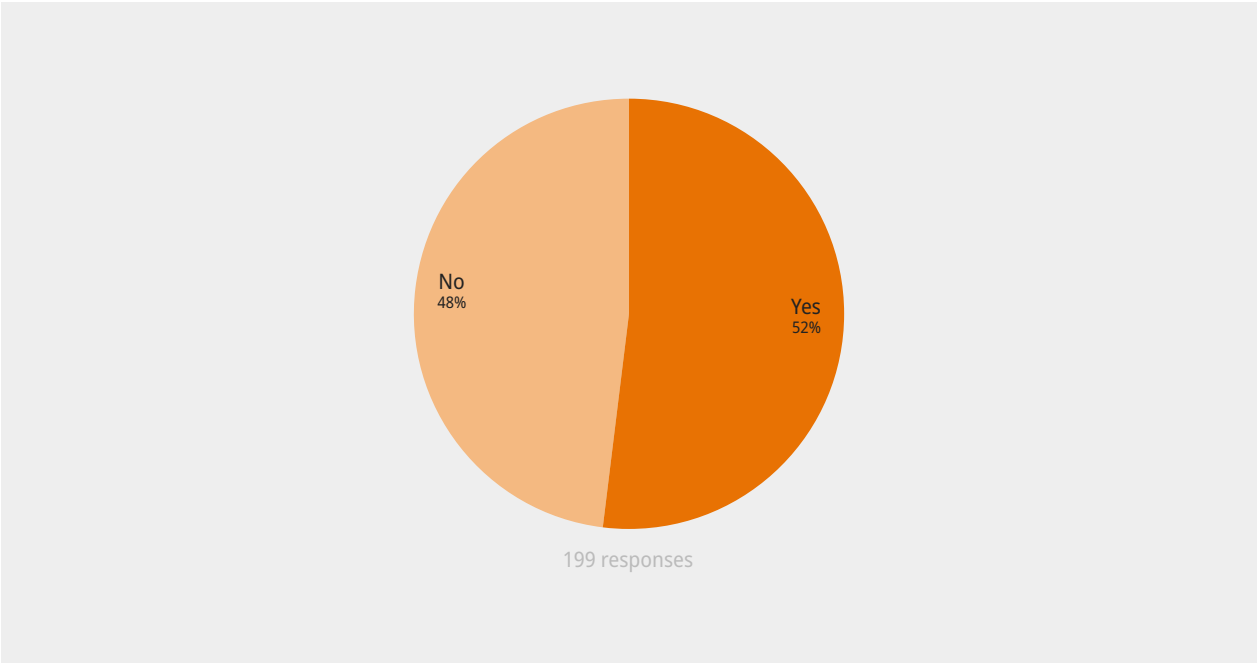
10. If you were invited to speak at a conference what would be your reasons to speak remotely rather than attending in person?



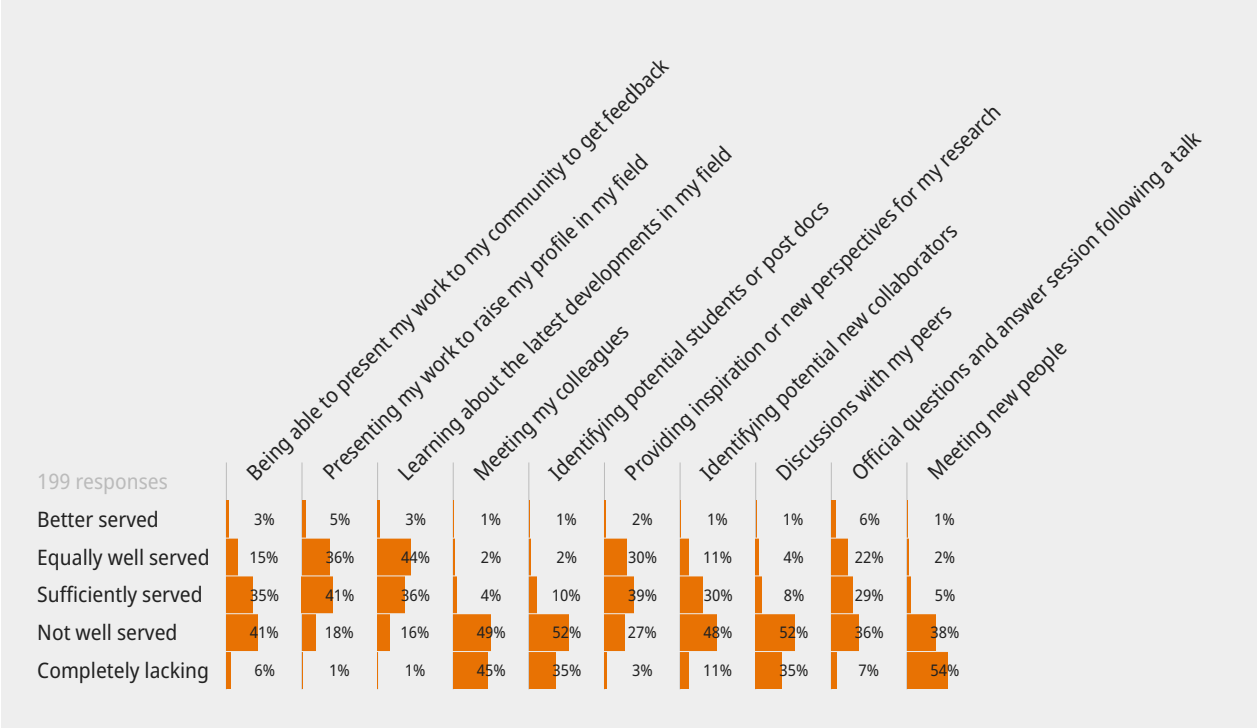
11. In your experience, does the balance between published (including preprints) and unpublished data presented during the conference talks in your field change when conferences are held virtually?



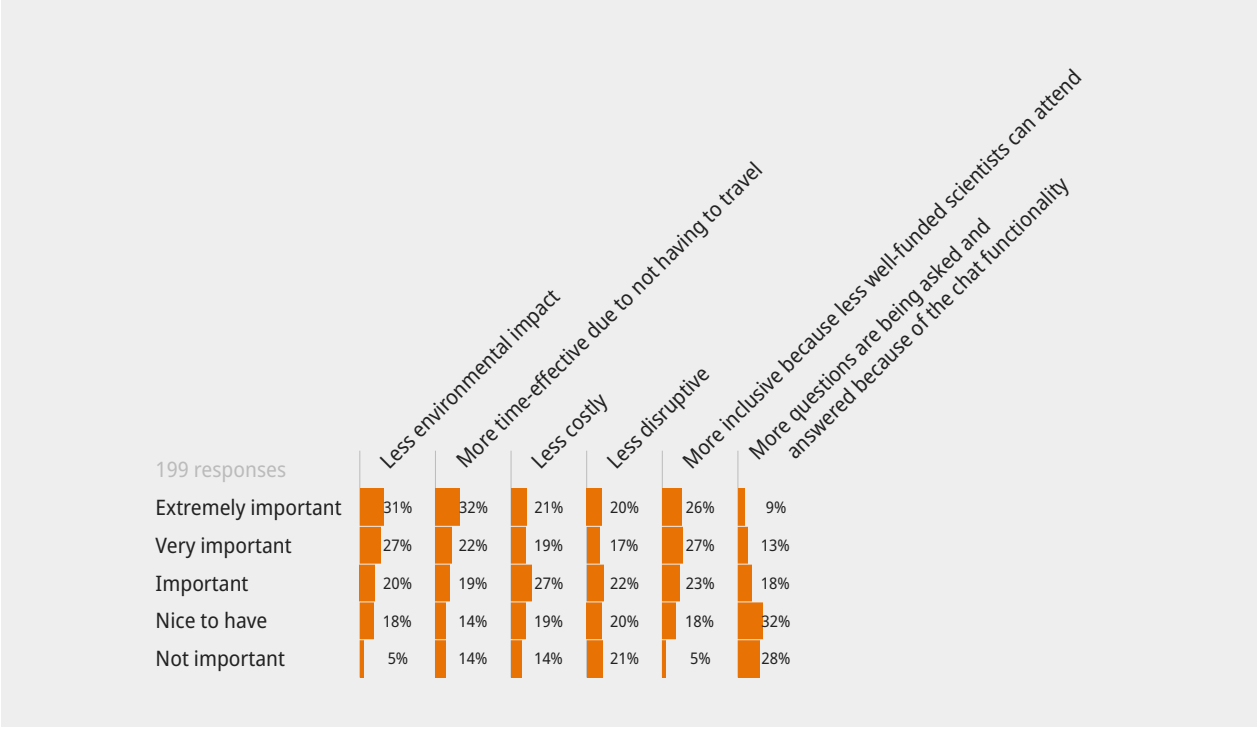
12. Are you less likely to present unpublished data at a virtual conference?



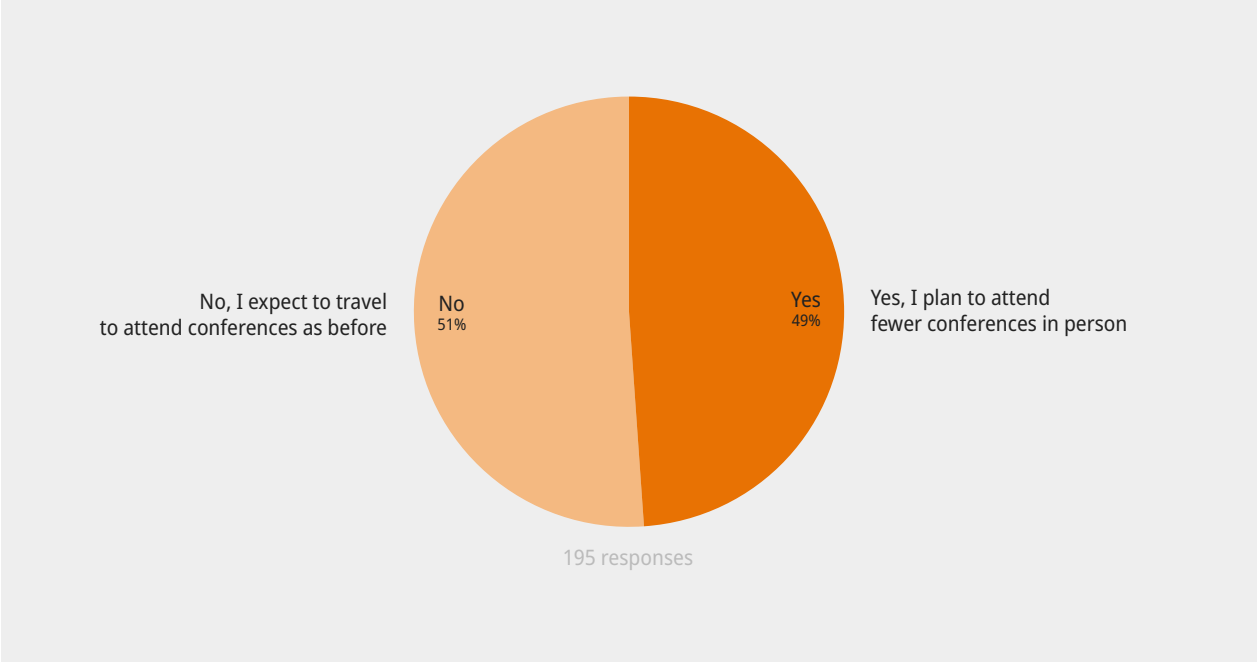
13. How well do you think the aspects listed below are served when attending a conference virtually rather than in-person?



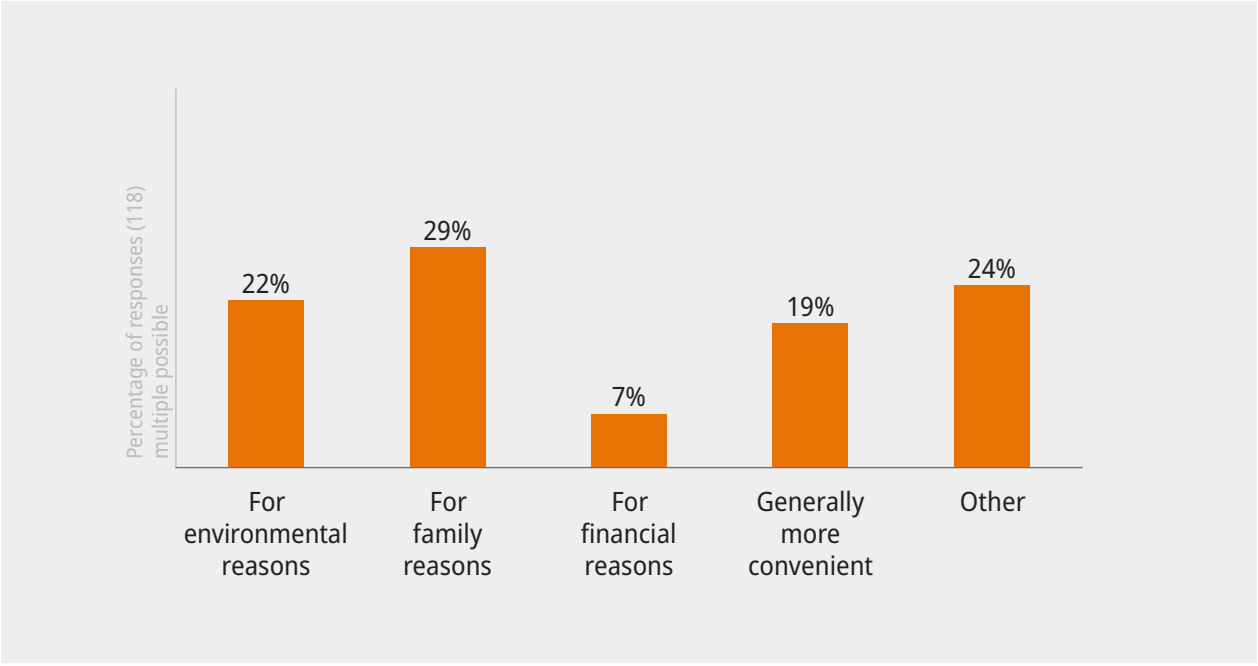
14. Please rate the importance you attach to some of the aspects of virtual conferences listed below:



15. Will the frequency of attending conferences in person change for you after the pandemic?



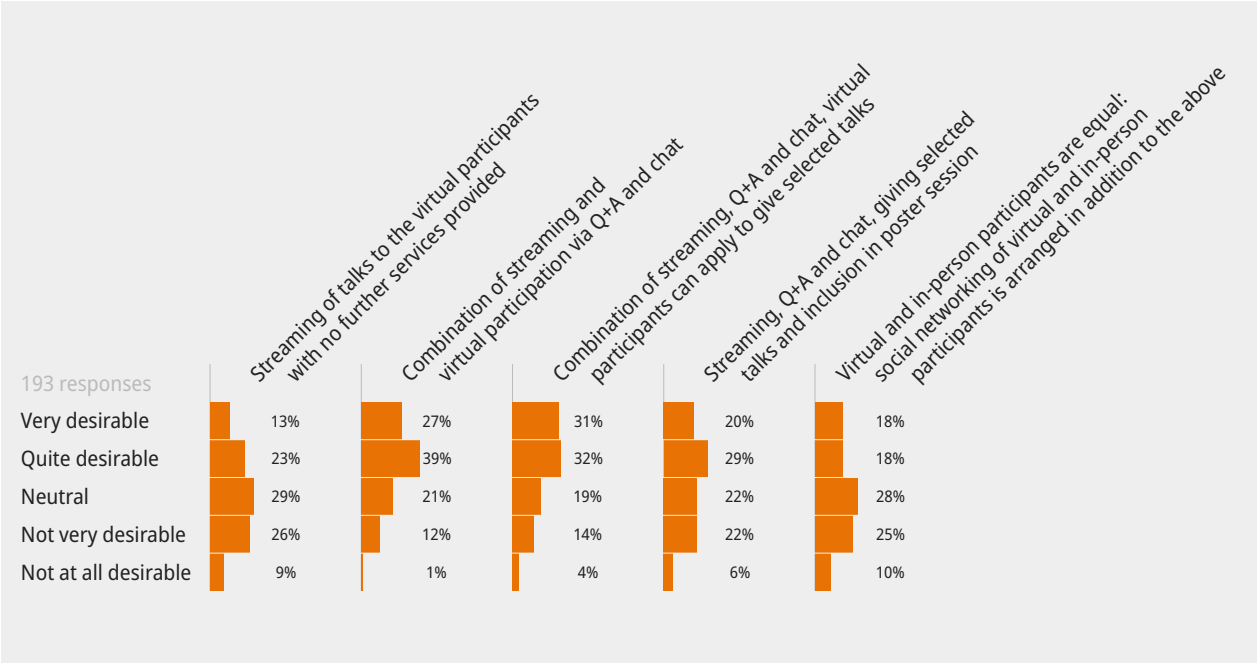
If yes: Why?



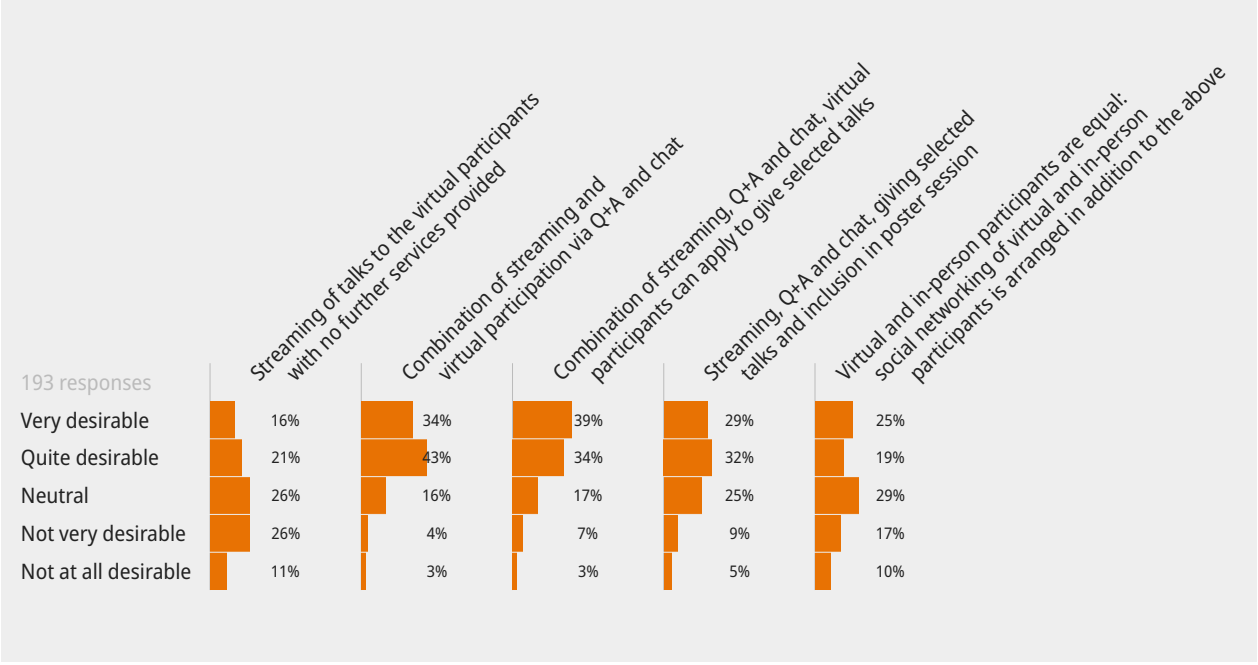
C:

We would like to know your opinion on hybrid conferences, that is, conferences that combine in-person and virtual attendants

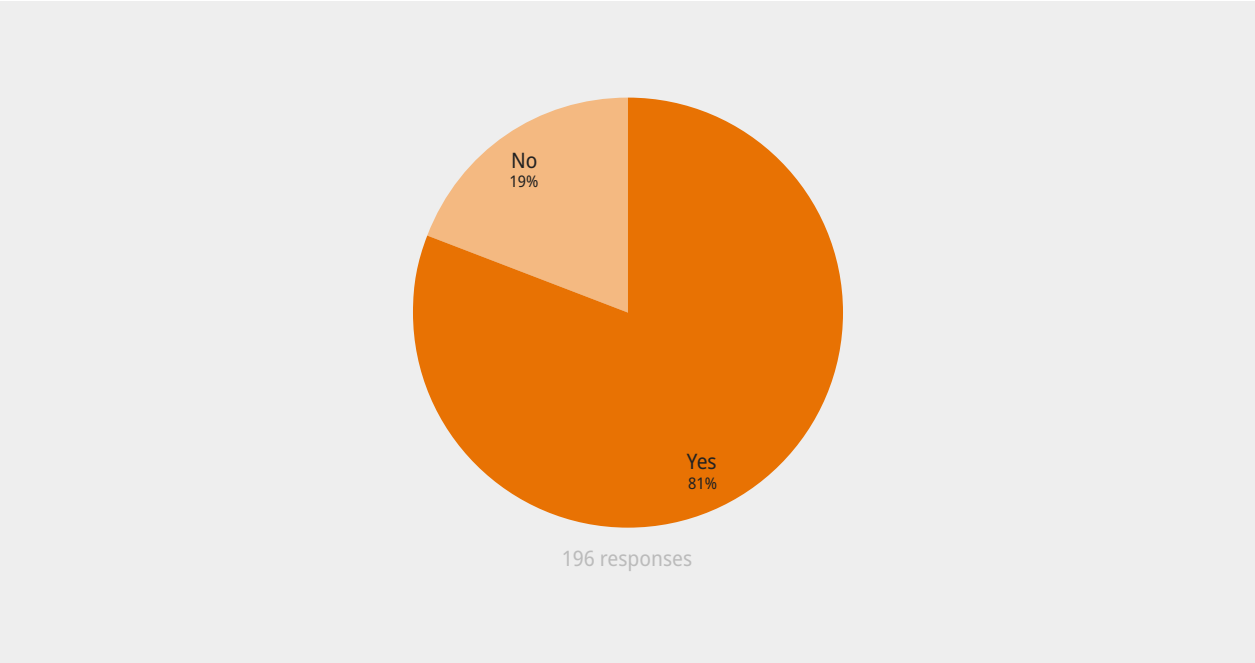
16. Hybrid meetings can take different formats. From the point of view of the *in-person* participant what do you think about the following possible formats:



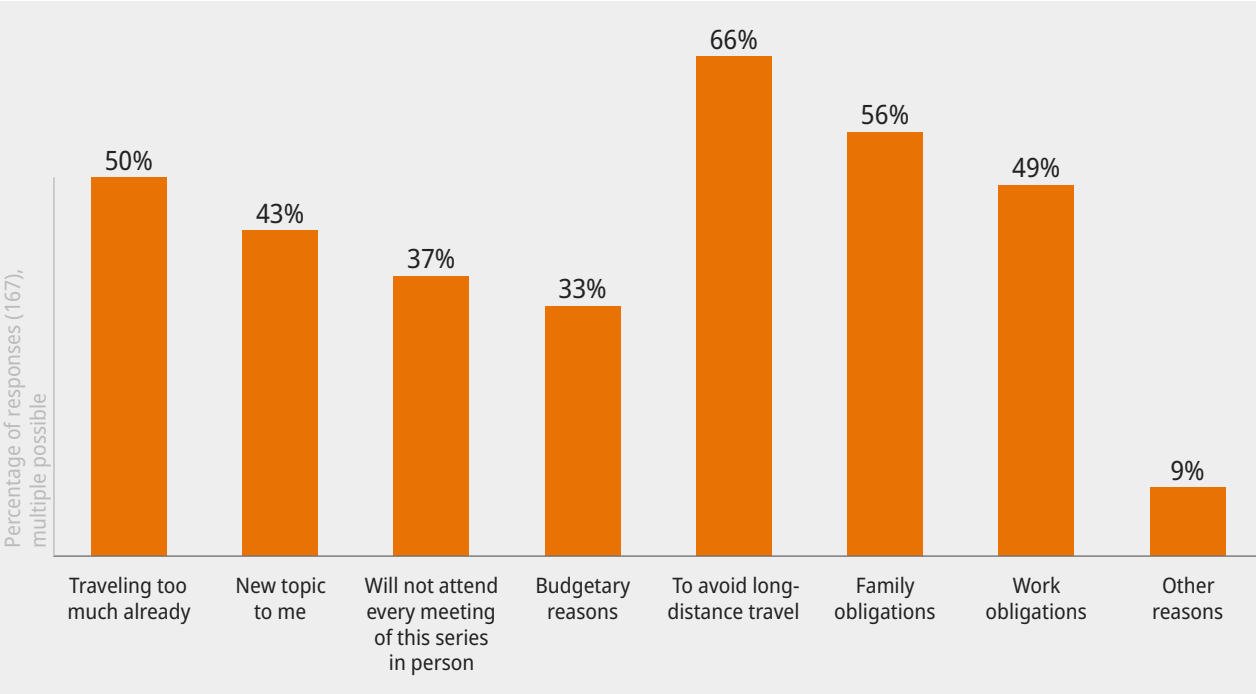
17. Hybrid meetings can take different formats. From the point of view of the *virtual* participant what do you think about the following possible formats:



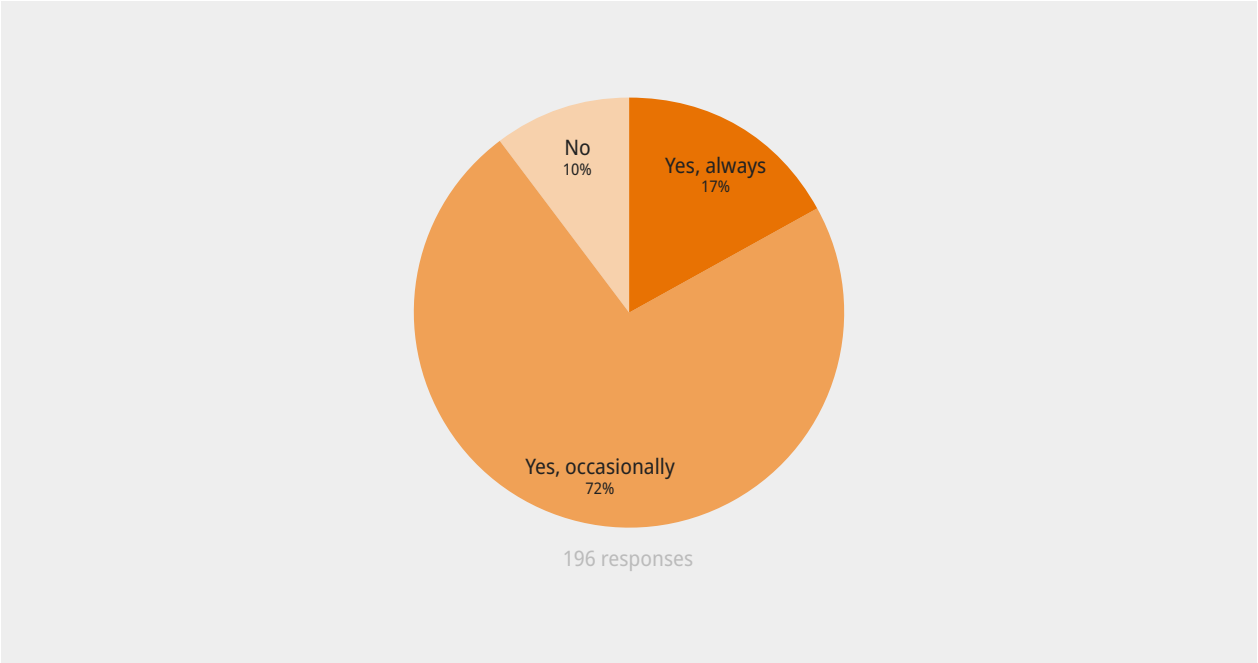
18. Would you attend a hybrid meeting as a virtual participant?



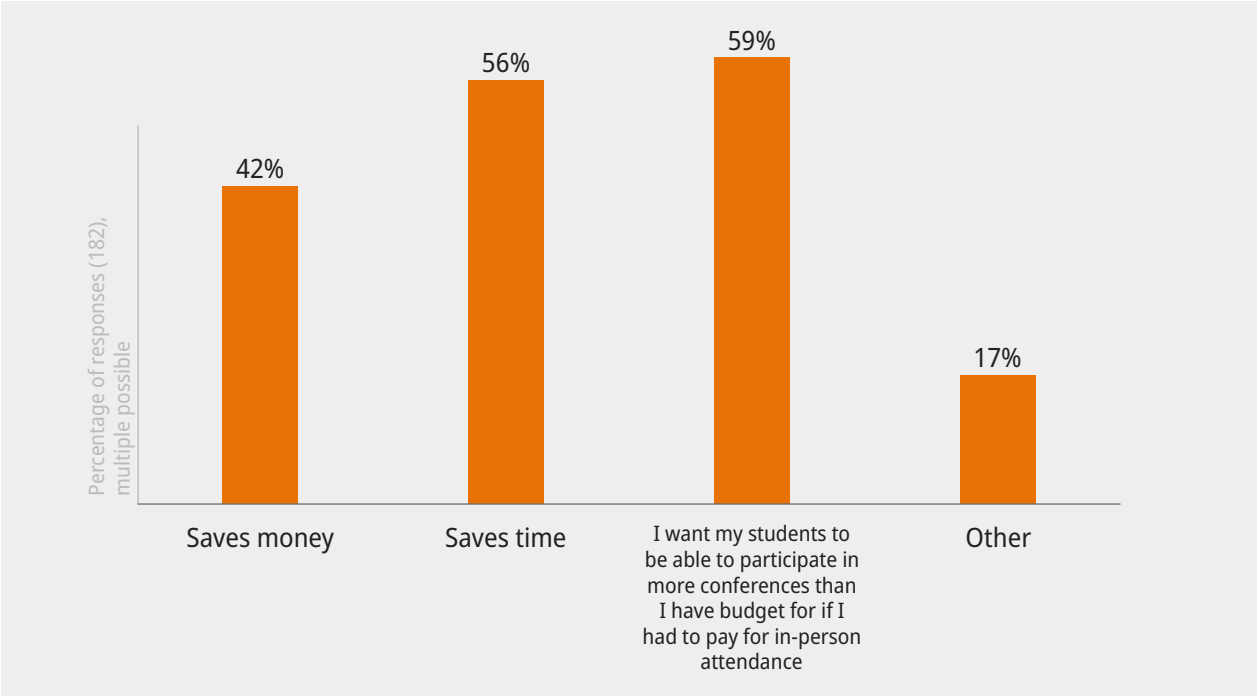
If yes: What could be your reasons?



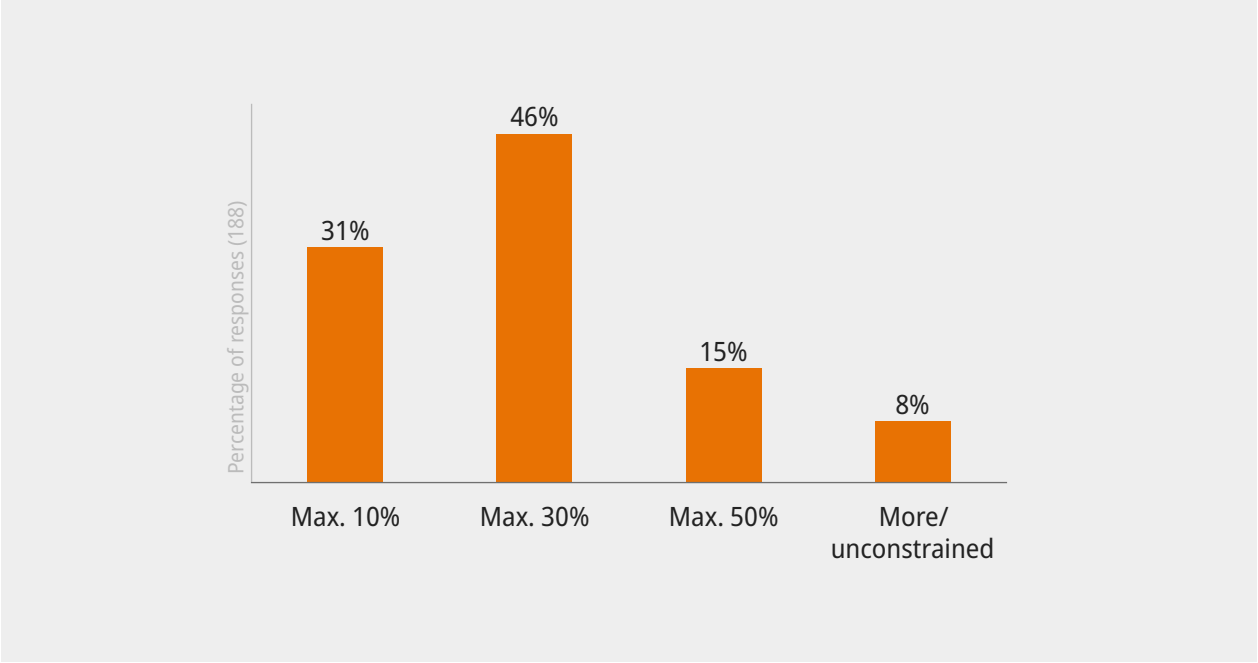
19. Would you recommend to your students/post docs to attend as a virtual participant?



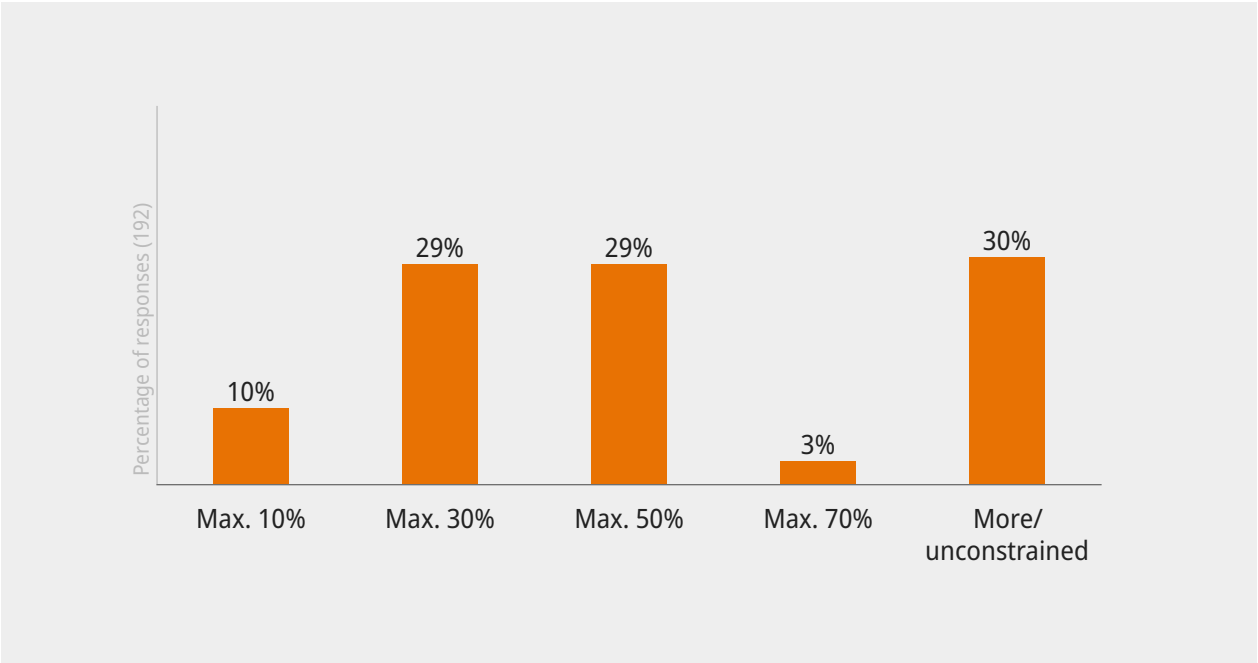
If yes (also for yes, occasionally): **What are your reasons?**



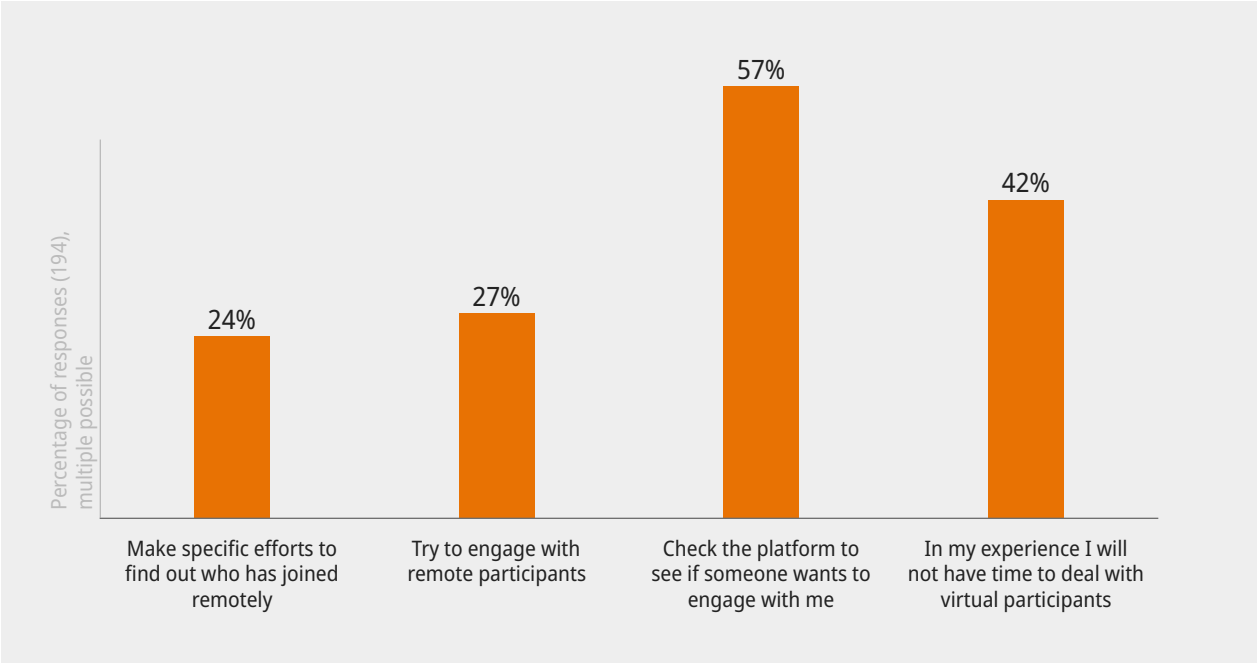
20. In your opinion, what should be the maximum proportion of virtual speakers at a hybrid conference?



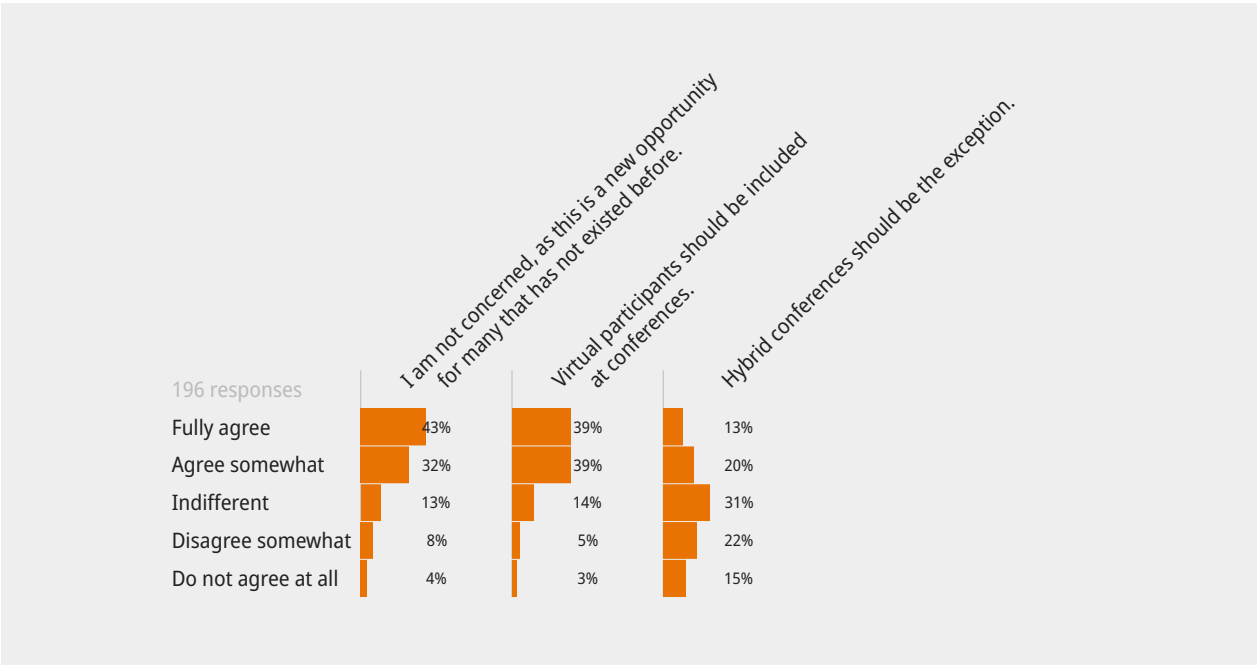
21. In your opinion, what should be the maximum proportion of virtual participants in a hybrid conference?



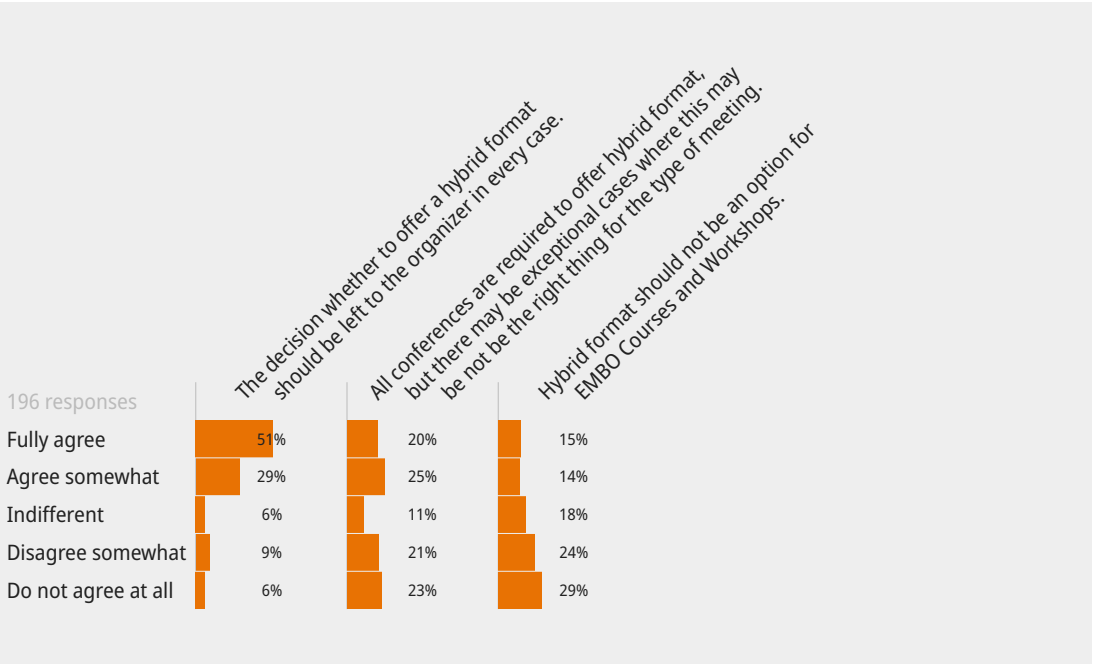
22. As an in-person participant at a hybrid meeting I would/will:



23. The addition of virtual participants to an in-person conference would create two categories of participants. To what extent do you agree with the following statements?



24. EMBO, as a funder of scientific conferences, could make rules about requiring hybrid formats and allocating funds for conferences offering hybrid format. To what extent do you agree with the following statements?



Appendix 7:
Virtual platforms

The virtual platform market is currently developing at high speed. What started with a handful of known companies providing video call support has turned into an online events solution industry.

Despite a wide range of offers on the market, there seems to be no one single perfect solution for all virtual or hybrid conferences. The ideal virtual event would have an easily navigable interactive agenda; a list of speakers and participants, preferably with an option to see who is currently online; and an integrated abstract book, together with easy access to the posters and a repository of recorded videos. Moreover, it would have a well-structured chat with an option for one-on-one video calls and private messages, and a solution for live poster sessions, meet the speaker events, and social gatherings.

Most online conferences make use of separate virtual networking platforms to run their real-time interaction functions as these are currently not integrated into commercial virtual platforms.

The EMBO Courses & Workshops team has worked with a platform provider in solving some of the challenges reported above. Further information can be provided on request.

An important consideration for a conference organizer is how difficult or time consuming it is to set up the virtual platform. While user interfaces function well and are easy to use on most platforms, the back-end can require a significant time investment by the organizers.

Pricing varies widely. Some platforms charge fees for a license with video conferencing providers, video repositories, or streaming services. Extra technical support hours from the platform providers on the conference days usually are not included and also result in extra costs. Networking platforms are usually free up to a defined number of users but charge for larger numbers of participants.

Appendix 8:
Further reading

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The values of scientific conferences in a virtual framework:
analysis and practical options

17 December 2021

EMBO
European Molecular Biology Organization
Meyerhofstrasse 1
69117 Heidelberg, Germany

Telephone: +49 6221 8891 0
Fax: +49 6221 8891 200
Email: communications@embo.org

www.embo.org