universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Rethinking academic conferences – a young scientist's examination"

verfasst von / submitted by

Isabella Caterina Fabarius, BSc

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2022 / Vienna 2022

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	UA 066 915
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Betriebswirtschaft
Betreut von / Supervisor:	Ass.-Prof. Steffen Keck, PhD

“Indeed, the pandemic and associated social distancing measures have halted in-person or spontaneous interactions in science to an extreme degree, drastically reducing chance encounters or other social interactions that might facilitate the flow of new research ideas and collaborations.”

(Gao et al., 2021)

Abstract

Scientific conferences are a co-location with the purpose of knowledge exchange and networking. Due to the COVID-19 pandemic, many conferences have been canceled or held online for safety reasons. Recent literature has yet addressed the deceleration of novel research due to the shortfall of academic conferences during the pandemic. Little attention, however, was paid to the effect on young scientists, which, for the purpose of building new collaborations in the early stage of their career, are much more reliant on conference attendance and its prevailing face-to-face encounters.

This thesis builds on collaboration-building opportunities as one of the major advantages of attending (on-site) conferences (Chai & Freeman, 2019), and on the lacking personal contact as a major disadvantage of virtual conferences (Gao et al., 2021). While previous literature claims young scientists to be restricted in on-site conference participation due to financial barriers, namely search costs (Esterhuysen, 2021; Valenti et al., 2021), this thesis suggests that at online conferences they struggle even more to establish themselves in the scientific community, to interact with other scientists, and to collaboratively publish scientific papers.

Primary data from a survey (n = 98) was used to evaluate to what extent young scientists perceive online, instead of on-site, conferences to have an impact on collaboration formation. In addition, it was assessed whether the awareness about the negative environmental impact of traveling to conferences, or networking activities that enable personal interactions at online conferences, are decisive influencing factors that lead young scientists to consciously choose online over offline conferences.

Results demonstrate that young scientists aim to attend conferences to create new collaborations, however, using a *Mann-Whitney-U-Test* showed that this collaboration building is perceived to be inhibited by online formats. Likewise, results from another Mann-Whitney-U-Test revealed that the offline conference format is perceived as more beneficial. Using *Spearman's Rank Correlation*, the data further indicates the relevance of age and career stage of the scientists. The younger the scientists, the higher the popularity of the online format, and moreover, the more important the environmental aspect within their decision process, even though the awareness about the negative environmental impact of traveling to

conferences does not increase their likelihood to attend online instead of offline. Furthermore, the younger, the stronger their intention to meet scientists from other career stages. While young scientists expect to be less likely to meet more experienced scientists at online conferences, they indicate that they would be more interested in attending virtual conferences if these would offer efficient networking opportunities. Yet, online conferences should not substitute but complement offline conferences.

Thus, future research needs to be conducted to gain a better understanding of the remaining barriers to online networking activities and how to attract more experienced scientists to these collaboration-enhancing activities.

Keywords: young scientists, virtual conferences, collaborations, networking, face-to-face contact, environmental impact, online networking measures

Table of Contents

List of Figures

List of Tables

1. Introduction

This thesis focuses on the change in academic conference formats, triggered by the COVID-19 pandemic, and consequently the influence on the emergence of collaborations among scientists, in particular of younger generations. Evidence has shown that the rate of new collaborations declined by 17% in 2020, comparing it to the pre-pandemic level in 2019 (Gao et al., 2021). Furthermore, it is evident that especially female scientists, scientists with young children, and bench scientists suffered the most as a result of the measures taken during the pandemic (Gao et al., 2021; Myers et al., 2020). Yet, the impact of contact restricting COVID-19 measures on young scientists has not been addressed in more detail. While it is known that young scientists are the ones who benefit most from conference attendance due to lowered information search costs and thus up to 64.4% higher likelihood of building new collaborations than their older colleagues (Chai & Freeman, 2019), it is not known how they perceive their collaboration building at conferences to be affected by remote measures.

Previous research has already addressed the rising popularity of online conferences compared to established, offline formats in science. Both types of conferences come with advantages but also disadvantages. Whereas offline conferences promote mainly personal contact with face-to-face interactions, online conferences have the advantage of granting access to scientists who previously might not have the possibility to participate due to various barriers, including financial and/or mobility restrictions (Chai & Freeman, 2019). In fact, data has shown evidence from a specific conference considered by Esterhuysen (2021), that three times as many young scientists were able to attend a conference when it was held online instead of offline. However, the online format inhibits personal contact.

Thus, this paper aims to look precisely at these young scientists, to understand their needs and intentions of participating in a conference, consequently which format they prefer, and to investigate whether their participation in an online conference instead of a usual offline conference has an impact on the likelihood of building new collaborations. It further investigates whether awareness of the negative impact of traveling to offline conferences on the environment is decisive for young scientists to rather opt for online

conferences. In addition, it is considered whether they perceive to get in contact with more experienced and established scientists online and if this opportunity would increase their likelihood of participating in virtual conferences instead of on-site. For this purpose, it is surveyed whether there are networking activities at online conferences that enable or facilitate getting into personal contact with other, especially more experienced, scientists in a similar way as on-site.

This thesis is structured as follows: In the beginning, the theoretical background is discussed. Chapter three focuses on the methodology and the model to be researched, as well as explaining the survey design. This is followed by a presentation of the results in chapter four. In chapter five a discussion of the results is given, which is followed by limitations and a suggestion for future research in chapter six. Finally, in chapter seven, results are formulated in a conclusion.

2. Literature Review

The literature review upon which this thesis builds is divided into three subchapters. The first focuses on the relevance of teams in science as teams are the origin and the intention of scientific collaborative formations. The second subchapter addresses offline conferences, their advantages, and disadvantages, as well as the value of conferences for young scientists, whereas the last subchapter deals with the format change towards online conferences caused by the COVID-19 crisis and its resulting advantages and disadvantages. The idea behind providing a literature review on these two formats functions to give an overall understanding of the importance of collaborative working, especially for young scientists, and to provide an overview of the advantages and disadvantages of the respective conference formats which also impact the next generation of scientists. Additionally, the literature review functions as a tool to support the findings in the subsequent discussion.

2.1. The Relevance of Teams in Science

The development of scientific collaborations is the fundamental basis of this thesis. Regardless of the scientific field, teamwork is a driving factor to advance research, and it has been investigated that the size of teams in science has increased over time (Adams et al., 2005; Chai & Freeman, 2019). This trend has led to the fact that especially since the 2000s, the shift of knowledge production towards teamwork in science and its relevance has been increasingly studied (Jones et al., 2008).

Teams, i.e., multiple people working together and complementing each other, enable the accumulation of knowledge and skills and have been proven to combine their expertise and produce more knowledge than individuals on their own. In addition, they can use each other's ideas creatively and sift out worse ideas (Chai & Freeman, 2019).

Therefore, in science, collaborations are responsible for increasing the effectiveness of research (Adams et al., 2005; Boudreau et al., 2017; Catalini, 2018; Catalini et al., 2016; Wuchty et al., 2007). If more people work together, there is an increase in labor division, which leads further to an increase in scientific

productivity (Adams et al., 2005). According to Adams et al. (2005) collaborations are the channel of knowledge flows between scientists, and according to Jones (2009) building collaborations is a "rational response to an increase in knowledge complexity" (Catalini et al., 2016, p. 2).

It is further stated that teams do not only bring greater collective knowledge but also produce high-impact research and papers that are cited more frequently (Wuchty et al., 2007). These high citation rates indicate a high quality of scientific work (Adams et al., 2005).

Hence, the trend for teams arises, first, from the awareness that it increases the quality and effectiveness of scientific research. For another, the trend of teams is reinforced by technological progress and the existence of the internet. Coordination and communication, even at a distance, have never been as cheap, easy, fast, and thus efficient, as it is today through which geographic friction can be overcome (Boudreau et al., 2017; Catalini, 2018; Catalini et al., 2016, 2020).

As can be read out, it is thus team size, which plays a decisive role. With team size, output not only increases in quality but also in quantity and influence. This influence further increases with institutional collaborations (Adams et al., 2005).

Overall, it seems that researching in teams has mainly advantages. However, finding team members is costly. There are two key costs: *search costs* and *joint execution costs*. These are influential factors in how scientists and teams of scientists choose their collaborators (Catalini, 2018). In this thesis, a focus is put on the former.

Search costs arise when looking for new team members and collaboration opportunities (Boudreau et al., 2017). This can take place over geographical distance, which is more expensive, but also within companies (Chai & Freeman, 2019; Jones et al., 2008). For example, foreign conferences are a common venue to develop collaborations, where travel costs and registration fees are considered search costs.

If search costs are high, it can result in fewer new collaborations and vice versa. Especially search costs are a major barrier to collaborations, yet such barriers can be countered by social proximity. If scientists have already established a social scientific network, they can use their social ties to reduce search costs since past

collaborations anticipate future collaborations (Boudreau et al., 2017; Catalini, 2018; Chai & Freeman, 2019). Hence, there is no negative effect of separation on collaboration between previously co-located scientists, since they are already aware of each other and can thus overcome distances (Catalini, 2018).

While collaborating, additional costs of *joint execution* arise, including costs "of face-to-face meetings, coordination, monitoring, and transfer of complex information between teams of scientists" (Catalini, 2018, p. 4351). Just as there is an increase in collaborations when there is a decrease in search costs, the number of collaborations increases when joint execution costs are reduced, since preexisting contacts are more likely to be consulted (Catalini, 2018; Chai & Freeman, 2019). Furthermore, joint execution costs decrease with colocation, since in-person contact facilitates communication, coordination, and monitoring. Therefore, after separation, these costs tend to increase (Catalini, 2018; Chai & Freeman, 2019).

Finally, costs of execution have an impact on the overall quality of the output, yet search costs define which scientists are most likely to collaborate (Catalini, 2018). Hence, this thesis focuses on search costs, as these are one of the main influencing factors in finding collaborators (Boudreau et al., 2017).

2.1.1. Personal Interactions

The just mentioned face-to-face contact, or personal interaction, which is closely related to search costs, is an important factor in this thesis since it determines whether to attend conferences and with whom to collaborate.

According to Storper and Venables (2004), face-to-face contact „is a performance, a means to information production and not merely to more efficient exchange. In this performance, speech, intentions, role-playing and a specific context all come together to raise the quantity and quality of information which can be transmitted" (Storper & Venables, 2004, p.9). The authors point out that face-to-face communication is necessary for trust establishment, for the communication of complex ideas, as well as for the monitorization of effort, and that personal contact is an essential part of the modern economic process (Storper & Venables, 2004).

Storper and Venables (2004) further claim that there is an ongoing strong agglomeration, namely a

geographical accumulation of individuals, who still prefer seeing each other in person to communicate by living in an existing concentration of settlements, even though information transmission costs, namely lower transportation and communication costs, are declining (Valenti et al., 2021). However, this statement dates back to 2004 and might be challenged by the technological development within recent decades, especially in terms of digital communication platforms.

Despite this agglomeration, there are studies by Catalini et al. (2016) showing that due to the introduction of cheaper airfares offered by low-cost airlines in the recent years, scientists are increasingly traveling again to meet other scientists in person. This shows as well that scientists are no longer bound to live in the same geographical area to be able to communicate. However, this development might be decreasing because individuals become more conscious about the environment and their own carbon footprint (Milfont et al., 2021; Oester et al., 2017; Saliba, 2020; Viglione, 2020a, 2020b).

In sum, the topic of personal interactions is of significant relevance for the following discussion, since common face-to-face interactions at scientific conferences are eliminated or highly reduced in virtual settings, hence, as learned above, have a strong impact on collaboration building and the search for teams. A closer examination of offline and online conferences in terms of purpose, advantages, disadvantages, and recent developments follows in the upcoming chapters, after a brief elaboration on the fundamentals of collaborations.

2.1.2. Collaborations

Just as the increase of teams in science, Adams et al. (2005) and Jones et al. (2008) elaborated that also distant and multi-institutional collaborations are increasing, which will be examined in more detail below.

Importantly to mention is that knowledge production exceeds university boundaries and that these “multi-university collaborations are the fastest-growing type of authorship structure” (Jones et al., 2008, p. 1259). Even though there are some advantages related to working with other scientists from the same institution, namely having a similar knowledge domain, or using already existing social networks that help to keep search costs down (Boudreau et al., 2017; Catalini, 2018), Adams et al. (2005) find that especially the

number of collaborations with foreign universities is increasing, meaning "that the location of team members is shifting and is becoming more geographically dispersed, perhaps because of funding advantages coupled with telecommunications improvements" (Adams et al., 2005, p. 282). Building collaborations over distance is more difficult and costly (search costs), therefore, the introduction of digital communication technology facilitated or even enabled foreign collaboration, alternatively to domestic collaborations. In short, communication technologies increase the efficiency of the research, which further supports the increase in collaborations (Adams et al., 2005; Boudreau et al., 2017).

2.2. Conferences – The Road to Collaborations

As already pointed out in the previous chapters, there are certain advantages related to writing scientific papers in collaboration with other researchers. Additional benefits include achieving higher added value (overall quality) through the combination and discussion of individual inputs, as well as a higher number of publications and citations, by combining individual networks (Gao et al., 2021).

These collaborations, however, often emerge from conferences, which exist in all scientific fields. The largest conferences host up to tens of thousands of participants – but what are conferences and what is their purpose, who are the main actors, and what are their benefits and drawbacks?

According to Chai and Freeman (2019), a conference is a short-term colocation, which is outside of an organization and where scientists come together from different institutions. In short, conferences are "a subset of temporary colocation events across organizational boundaries" (Chai & Freeman, 2019, p. 2141). Thus, conferences in science are on-site platforms that are creating space to present current results of scientific work, enhance information exchange, explore trends, and speculate on future directions in science. They are "an important venue for brainstorming, networking and making vital connections that can lead to new initiatives, papers and funding" (Oester et al., 2017, p. 1). As stated in the research of Oester et al. (2017), 64% of all conferees reported having led or will lead to new publications as a result of the conference and the contacts, conversations, and ideas generated there. Hence, the fundamentals are relationships, which are created by in-person interactions at conferences (Viglione, 2020b).

2.2.1. Advantages of Offline Conferences

Expectedly scientists will have different intentions to participate in conferences. First and foremost, the acquisition of knowledge and the presentation of findings from their own research area (Chai & Freeman, 2019). Conferences offer the possibility to gain new techniques and skills, and to develop innovative ideas to improve research and the scientists' careers, so-called spillover effects (Oester et al., 2017; Roos et al., 2020). Thus, conferences are also used to create a presence of themselves, promote their research, and advance their career as well as potentially receive funding (Oester et al., 2017).

The beforementioned network effects of joint publications, which are more often cited than papers by a single author, are a major reason for scientists to build scientific collaborations and maintain existing contacts with collaboration partners (Adams et al., 2005; Chai & Freeman, 2019). Thus, at conferences, scientists are not only listening to talks, participating in workshops, and posters are put up to share the latest work and discuss highly current issues, but there are also breaks in between presentations, or evening events that are used by scientists to exchange expertise and to build collaborative links between academics of different institutions to aim long-term knowledge sharing (Chai & Freeman, 2019; Fayard & Weeks, 2007). These network opportunities and the development of collaborative links are major benefits participants are taking away (Chai & Freeman, 2019; Oester et al., 2017). It is therefore the initially mentioned face-to-face interaction at on-site conferences, which is the driving factor for funding, career and research opportunities, new partnerships, and collaborations that support new research projects (Boudreau et al., 2017; Chai & Freeman, 2019; Gao et al., 2021; Oester et al., 2017). Moreover, Boudreau et al. (2017) found evidence, that being in the same room at the same time, makes it more likely to jointly apply for a grant, whilst Chai and Freeman (2019) proved that attending the same conference is related to future collaborations.

Furthermore, when working face-to-face, the interaction becomes more efficient due to the personal presence, because not only the transfer of knowledge is facilitated, but also the thought processes are stimulated. By questioning or commenting on other scientists' ideas, it is easier to get to know them and their research fields than just reading their literature (Chai & Freeman, 2019).

However, it is especially important to consider that there are serendipitous face-to-face interactions that are outside the scheduled presentations that create valuable social scientific networks (Catalini, 2018; Chai & Freeman, 2019). According to Fayard and Weeks (2007), it is chance encounters in archetypal locations, for example in the hallway or cafeteria, around the water-cooler, coffee machine, or elsewhere, where informal social interactions with legitimacy arise and that can further lead to collaborations. Legitimacy, because it is common and thus acceptable to be at these places talking to other people and recruiting other scientists rather than actually getting water or a coffee (Fayard & Weeks, 2007; Pierce, 2014; Saliba, 2020).

Besides academic reasons, such as the acquisition of knowledge and collaborations, there are further reasons why individuals want to attend conferences, namely the opportunity to learn about new places and cultures of the conference venue (Roos et al., 2020). Consequently, conferences have often been criticized for being used by scientists to go sightseeing instead (Pierce, 2014).

2.2.2. Disadvantages of Offline Conferences

So far, the advantages of conferences have been highlighted, which include knowledge exchange among scientists of different institutions and career stages, and especially personal contact.

Nevertheless, offline conferences do not come without limitations. For example, scientists of different career stages have adverse access to conferences. Usually, it is mainly scientists who are already established in their field and career who can attend offline conferences, given the higher available financial resources. Nevertheless, scientists who are most likely to attend a conference, are not the ones that benefit most from it, because they already have existing networks, unlike young scientists (Chai & Freeman, 2019).

Another decisive barrier to participation is the already shortly addressed geographic dispersion and its associated search costs. It has been proven that distance reduces the likelihood of participation, given the time and money related to traveling, hence decreasing the likelihood of forming new collaborations (Boudreau et al., 2017; Catalini et al., 2016, 2020; Chai & Freeman, 2019).

Vice versa, and as already discussed above, geographical proximity, i.e., a temporary colocation, decreases information search costs and intensifies collaborations since increased interactions at conferences strengthen

bonds and enhance information flow (Chai & Freeman, 2019). However, Catalini (2018) claims that "colocation is an expensive way to lower search costs" (p. 4350).

Even if scientists of different career stages come together at conferences, this does not mean that they will interact with each other. According to Chai & Freeman (2019), scientists with similar characteristics such as age, productivity, and research profile tend to interact more with each other. This is accentuated by the fact that more experienced scientists are less interested in making new contacts because they are already established and have formed their networks, and therefore do not need to actively reveal information about themselves. Consequently, young scientists are more likely to remain among themselves, decreasing the possibility to get to know experienced scientists from whom they could benefit.

2.2.3. Conference Value for Young Scientists

Progressing in the discussion about conferences and collaborations and the opportunities and limitations for young scientists, it is important to define certain terms. It is not necessarily the age that defines young scientists, but rather is a category related to the career stage, which is expectedly correlated to age.

This early stage is particularly relevant for the learning process because it is the period where questions dominate answers, while they are supporting experienced older colleagues to improve the existing and to find solutions (Iatsyshyn et al., 2020). Thus again, it is useful for young scientists to attend conferences and establish contacts, learn, and gain knowledge from more experienced scientists (Chai & Freeman, 2019).

Young scientists, who are still at the beginning of their career, usually do not have the financial means to afford search costs, namely expensive (intercontinental) flights, registration fees, and accommodation costs that come along with attending conferences (Catalini et al., 2020; Esterhuysen, 2021). Nevertheless, it is precisely these young scientists who benefit from the knowledge in their early career stage and, above all, the social contacts as an incentive to collaborate after a conference since they are still quite unknown. Being present at a conference gives young scientists the opportunity to show their interests and abilities on-site so that they learn about subject areas they might not have known before (Chai & Freeman, 2019; Saliba, 2020). For this very reason, it is the young scientists who benefit when cost-reducing measures, such as the

introduction of low-cost airlines to counteract geographical friction, are introduced, as it reduces their barrier to participation (Catalini et al., 2016, 2020).

Once young scientists are at on-site conferences, search costs go down (Chai & Freeman, 2019). This, in fact, favors young scientists because lowering search costs due to face-to-face presence, as learned previously, increases the likelihood of new collaborations (Boudreau et al., 2017; Chai & Freeman, 2019). In contrast, younger generations of scientists, especially those of tomorrow, have been growing up with the internet (Antoun, 2015), hence are more affine to the usage of digital tools of communications, which in turn reduces geographic friction (Catalini et al., 2020). Hence, if young scientists cannot attend offline conferences due to financial or other barriers, the online format could be an appropriate alternative to participate at all.

Accordingly, the development of virtual conferences is discussed in the following chapters.

2.3. The Influence of the COVID-19 Pandemic on Science

In 2020, the long-lasting COVID-19 pandemic has slowed the world down. To contain the spread of the SARS-CoV-2 virus, measures were necessary to limit interpersonal contact to the bare minimum and thus minimize the risk of infection. Events were canceled, so did scientific conferences, and major business activities and stores were closed for certain periods.

Accordingly, there is an impact on science, conferences, papers, and articles written since then. Yet, the impact of the COVID-19 pandemic forced a change in scientific activities and varied between scientific fields. Bench science, like biology or chemistry, was more affected as scientific fields that do not have the necessity of using equipment or laboratory, like economics or mathematics, leading to a decrease of 30 - 40% in research time (Myers et al., 2020). Due to their restricted access to labs, bench scientists could no longer run experiments on-site, having made them develop scientific projects further from home, including data analysis, manuscript, and thesis writing, or develop grant applications (Korbel & Stegle, 2020).

Moreover, female scientists, and scientists with young children, face a larger decline in working hours spent on research during the pandemic (Gao et al., 2021; Korbel & Stegle, 2020; Myers et al., 2020). Further not to neglect is the lack of personal contact for young scientists, since their opportunities for mentoring and practical training are restricted, which compromises young scientists as a driving factor in science (Gao et al., 2021).

Furthermore, the pandemic affected the content of research and publications of scientists. Gao et al. (2021) found evidence that fewer papers have been published about non-COVID-19-related topics since then, as research in many areas, including bench science, has come to a halt. However, the proportion of papers with COVID-19-related topics has increased (Gao et al., 2021).

As already touched upon, the COVID-19 pandemic had, and might still have, a significant impact on the movement and colocation of people. Scientific conferences have been canceled or postponed for safety reasons, traveling was no longer possible, or complicated due to border controls and quarantine regulations. In some cases, however, conferences could be held remotely. It was noticeable that it affected collaborations negatively, as scientists could no longer maintain personal contacts on-site or establish new ones. Especially the above-mentioned chance encounters and spontaneous face-to-face interactions were missing, which are essential for the emergence of collaborations. As a consequence, the rate of new submissions, new projects, and new collaborations declined (Gao et al., 2021). Scientists were thus forced to adapt their methods regarding research, and publications, and how to maintain their scientific contacts.

2.3.1. The Emergence of Online Conferences

Online conferences already existed before the COVID-19 pandemic, but it was not until the pandemic that they were used to a greater extent (Roos et al., 2020). During the pandemic, many conferences were held online in order not to cancel them completely, which led to a trend toward so-called ‘e-conferences’ (Iatsyshyn et al., 2020; Korbel & Stegle, 2020; Roos et al., 2020; Saliba, 2020; Valenti et al., 2021; Viglione, 2020a, 2020b). Consequently, online conferences became “an important format for scientific meetings” (Korbel & Stegle, 2020, p. 4), as they ensured that science continued while participants stayed safe.

However, there are advantages and disadvantages of the online conference format, which depend, among other things, on the career stage and geographical position of the conferee. Therefore, there are proponents and opponents of this conference format.

2.3.2. Advantages of Online Conferences

A big advantage is the cost factor: Running an online conference is much cheaper for the organizer, who has less organizational effort and mostly more time to plan (Saliba, 2020; Viglione, 2020b), but especially for the participants, as there are no travel expenses and lower registration costs (Roos et al., 2020; Viglione, 2020b). As previously learned, the financial barrier is one of the biggest reasons for not attending a conference. Consequently, by removing the barrier of cost, the number of participants in online conferences increases significantly (Esterhuysen, 2021; Misa et al., 2020; Valenti et al., 2021). According to Esterhuysen's (2021) consideration of a conference in March 2020, which was held online instead of offline, the largest share of the increasing number of participants after changing the format to online, are postgraduate students: Out of 220 participants, there were 114 instead of 38 young scientist, which corresponds to a threefold increase in the number of young participants. This can be attributed to the fact that they finally have the opportunity to participate in high-level meetings with fewer barriers (Valenti et al., 2021).

This is linked to online tools and platforms that are needed for an online conference, such as 'Zoom' or others, and which are nowadays not only accessible to almost everyone but also have further developed by the COVID-19 pandemic (Korbel & Stegle, 2020). The facilitation of effective communication among scientists thus represents "an unprecedented opportunity to reform methods of organizing academic conferences" (Valenti et al., 2021, p. 3). Likewise, Iatsyshyn et al. (2020) have examined the advantages of online tools for research institutions in addition to obvious advantages such as low costs and the possibility of data exchange. They mention advantages such as user-friendliness, planning, and advertising functions, and the support of synchronous and asynchronous communication between participants (Iatsyshyn et al., 2020).

However, availability, more precisely the access to presentations, is not only a result of lower costs but also a result of the reach to be achieved due to exactly these digital technologies (Roos et al., 2020). Online conferences can reach a wider audience of scientists than usual offline conferences (Price, 2020; Saliba, 2020; Viglione, 2020a). Additionally, it is also beneficial for the speakers to reach a wider audience than at an offline conference and can therefore also provide an incentive to present at an online conference (Price, 2020). Even if the conference takes place at a scheduled time, it can be recorded and viewed afterward to prepare for a follow-up live discussion. This favors participation regardless of time zones and is beneficial for people who cannot travel for financial or physical reasons (Price, 2020; Valenti et al., 2021; Viglione, 2020a). Experience has shown that indeed, virtual sessions had higher attendance than in-person ones since the time barrier has been removed (Viglione, 2020b).

Furthermore, online conferences support fair and equal virtual participation in discussions and conversations after presentations and at question-and-answer sessions. In on-site settings, these sessions are often dominated by the same established scientists sitting in the front rows. Online, howe ver, other participants, such as young scientists, also have the opportunity of being heard. These often lack on-site courage to participate and feel intimidated in front of more experienced scientists (Saliba, 2020; Viglione, 2020b). Experience in online conferences has also shown that more students post questions in the chat (Esterhuysen, 2021). In addition, these written questions at moderated question sessions in the chat, in comparison to questions on-site, have a positive influence on the quality of the sessions since they can be filtered in advance. Furthermore, it is possible to vote for questions, which allows a larger number of audiences to be satisfied. Thus, only prioritized questions will be discussed, and the flow of the discussion can be better controlled, while real-time adjustments to presentations can be made (Esterhuysen, 2021; Price, 2020; Roos et al., 2020; Saliba, 2020; Viglione, 2020b).

Finally, and as previously indicated, the growing environmental awareness within society might further be a relevant determining factor for participants of conferences. By omitted traveling to the conference site, online compared to offline conferences, has a much smaller carbon footprint (Oester et al., 2017; Roos et al., 2020; Saliba, 2020; Valenti et al., 2021; Viglione, 2020a, 2020b; Wynes & Donner, 2018). Thus,

geographical dispersion is not only a financial barrier to attending conferences for less-well-funded chairs, but it is also a risk for the environment if it requires a long journey. For instance, Wynes & Donner (2018) found that only 8 to 11% of conference attendees travel long distances and are thus responsible for more than 50% of emissions created by air traveling to conferences. Moreover, most of these trips are only short in duration (2 to 5 days) (Wynes & Donner, 2018), and furthermore they often travel long distances between 2,400 and 16,000 km (Roos et al. 2020). The same findings emerged from Desiere's (2016) study, considering a conference in Slovenia in 2014. Here, again, only 10% of the attendees accounted for 50% of the emissions caused by air travel to and from the conference. This results in a high per capita emission (average of five European conferences between 0.5 - 1.3 tons CO_2-equivalents in 2019) with reductions already being called for (Jäckle, 2019).

From this variety of advantages, this thesis will mainly focus on the advantage of the created participation opportunity for young scientists (compared to offline conferences), but also on the lower environmental impact.

2.3.3. Disadvantages of Online Conferences

Nevertheless, there are some drawbacks to online conferencing, in particular the lack of personal contact, that will be examined in the following.

To begin with, different time zones can cause problems because for some participants it is particularly early or late at night when presentations take place. If they want to participate in live discussions, they may have to follow the time zones of other countries or even continents (Oester et al., 2017).

In addition, virtual events can involve technical challenges. Not only during the live stream when internet connections are necessary to ensure a smooth conference and to avoid technical problems, but also when it comes to managing the media of recorded sessions in large online repositories, i.e., to create and maintain these (Roos et al., 2020; Saliba, 2020).

Another problem is that participants in online conferences rather attend sessions on topics they want to hear about. If they were on-site, they would automatically hear about other topics, also when talking to other

scientists, which would introduce them to new topics that are outside their own specific research area and interests. Online, however, this coincidental exposure to unknown topics tends to be limited (Oester et al., 2017).

Moreover, the perceived authenticity is negatively affected since, in the spirit of a scientific career, it is obligatory to give presentations at an ordinary offline conference. Thus, online conferences might not achieve the prestige and weight as an actual presentation held offline (Oester et al., 2017).

A major disadvantage, and especially relevant in this thesis, is the missing face-to-face contact and impromptu personal interactions between presentations or at evening events. If these are lacking, knowledge sharing and relevant research collaboration building for publications and consequently career development will be limited (Gao et al., 2021; Price, 2020; Viglione, 2020b). Likewise, the quality of social interactions is worse than on-site (Misa et al., 2020). Humans are considered social beings who communicate through mimics and gestures in addition to speech, which is more difficult to relay in online conferences (Price, 2020). Nevertheless, there are measures at virtual conferences to enable personal contact, which will be discussed in the following chapters.

Literature indicates that many scientists hope that online conferences will not replace physical conferences and instead claim that after the pandemic, usual offline conferences will return (Roos et al., 2020; Viglione, 2020b). There are, nevertheless, also advocates of online conferences (Esterhuysen, 2021; Viglione, 2020b). In an informal survey of the journal 'Nature', 80% of the scientists surveyed stated that they would like to see some meetings continue to be held virtually after the pandemic (Viglione, 2020b).

Nevertheless, opinions in the literature agree that conferences can be held virtually, that the tools used are improving, and that collaborations can also emerge in virtual meetings. However, literature also agrees that the information-rich face-to-face contact between scientists that leads to relevant collaborations cannot be replicated and that interpersonal contact is still the most important influencing factor for the formation of collaborative relationships (Boudreau et al., 2017; Gao et al., 2021; Roos et al., 2020)

Based on the mentioned advantages and disadvantages, some scientists assume future hybrid conferences (Roos et al., 2020; Valenti et al., 2021). Nevertheless, hybrid conferences are not only associated with more effort during organizing, but they can be more expensive because two formats need to be organized, i.e., not only the online platform has to be provided, but also a venue including staff (Roos et al., 2020; Viglione, 2020). On a different note, back in 2013, Denstadli et al. (2013) looked at the relationship between face-to-face contact and virtual conferencing in the business environment and concluded that the formats are not substitutes but rather complements.

3. Methodology

The methodology chapter is structured as follows. After a short summary of the so-far discussed literature and the aim of this thesis, subchapter one explains what has not been researched yet. In the second subchapter, the derivation of the three respective hypotheses is presented. Subsequently, the data collection process is explained in subchapter three, wherein the six parts of the survey and the meaning of the respective questions are explained. Finally, the data analysis techniques of the quantitative study is defined.

The existing literature highlights the importance of teams in science for creating high-quality and frequently cited publications (Adams et al., 2005). However, finding team members incurs search costs and joint execution costs, which pay off due to knowledge dissemination (Catalini, 2018). Most of these costs are related to networking, achieving face-to-face interactions between researchers from different institutions to establish collaborations and to build a social network. In the case of these short-term colocations, travel costs are a major factor, which influences whether scientists can and want to participate.

The focus hereby is on conferences, because it is precisely these that serve to recruit other scientists, but not everyone has the same opportunity to attend them, leading to inequality. Young scientists are particularly affected because of financial barriers (Chai & Freeman, 2019).

However, due to the COVID-19 pandemic, most conferences were digitized, opening the opportunity for those young scientists to attend conferences virtually without much cost.

The existing literature shows opposing opinions on the advantages and disadvantages of developing online conferences, and based on real-life examples, it gives ideas on how to counteract the problem of the lack of personal contact in online conferences, as can be seen in the following subchapters.

The aim of this thesis' survey is to clarify whether there is a change in the number of new collaborations created, whom young scientists meet at online conferences and whether there are online communication measures for young scientists to develop networks.

Depending on whether the young scientists and their participation intentions and needs, with the focus on collaboration building, are satisfied at online conferences, it can be considered whether other influencing

factors such as the environmental impact of on-site participation also have an impact on the decision whether young scientists prefer online over offline. In short, the individual awareness of the young scholars' environmental awareness is weighed against the respondent's perceived potential of building collaborations online.

Thus, it should be answered whether it is relevant for young scientists to spend large sums of money to physically attend a conference or whether online conferences can serve the same purpose. This is of relevance because prior literature has not yet provided data in which specifically young scientists were examined.

3.1. Research Gap

As young scientists have only been mentioned briefly in the existing literature, there is a lack of empirical evidence on how this relevant group, which contributes fundamentally to the development of science (Gao et al., 2021), perceives the influence of the recently introduced online conference format on collaboration building and how the advantages and disadvantages of the respective formats, for example, the environmental impact, change their willingness to participate.

So far, prior research has shown that young scientists are the ones who benefit most from conferences and the collaborations created there because they can gain knowledge from more experienced scientists and do not have an established network yet (Chai & Freeman, 2019). On the other hand, they are the ones who (can) participate least because travel costs, i.e., search costs, are high. Even though, in this regard, further research exists on the impact of decreasing travel costs through low-cost airlines on possible participation (Catalini et al., 2016), various research gaps remain open.

First, no specific data has been collected that focuses *solely on young scientists* since the beginning of the pandemic. The collection and consideration of data to date have only referred to samples that included the experiences of participants at any career stage, addressing young scientists rather briefly. Whereas young scientists were mentioned as scientists who suffer from COVID-19 measures and the lack of personal

contact (Gao et al., 2021), their actual participation and opportunities through online conferences were not further highlighted, and they have not been explicitly interviewed about their perceptions in this regard.

Second, previous literature on the change in research since the pandemic has mainly considered scientists from the fields of bench science because these were particularly affected prevention measures, as they could no longer work in laboratories or similar (Gao et al., 2021; Korbel & Stegle, 2020; Myers et al., 2020). Therefore, this thesis treats young scientists from *different scientific fields*.

Third, previous research has only looked at the impact based on the change from an offline to the online format of *a specific single conference*. For example, Misa et al. (2020) considered panel data on pre-conference expectations and post-conference experiences. However, surveying scientists at a single conference that has moved from offline to online cannot represent the general experience of young scientists that results from an *overall* format change in science, including the fact that it was considered during the exceptional time of the pandemic. Above all, the result from a single conference cannot be generalized since conferences proceed differently, and each online conference takes different measures and opportunities to present and discuss. Moreover, this specific conference was studied for the very reason that networking measures were taken there. However, it cannot be assumed that such measures are always provided at online conferences, hence need to be addressed as well.

Moreover, previous literature on collaborations has mainly focused on publication and citation rates comparing the years before and since the pandemic (Gao et al., 2021), while surveys have rarely been done. Thus, in this thesis, the perceptions, experiences, and expectations of young scientists about the emergence of collaborations through online rather than offline conferencing will be directly queried. In addition, the question what would make them decide to attend online rather than offline needs to be addressed, as it is assumed that also among young scientists, the online format harms networking. This will help to explore the intentions for online conference participation and more specifically how effective the opportunities for personal exchange and network creation through networking activities are. Furthermore, the awareness of young scientists about the negative environmental impact of long travel distances to offline conferences,

which has already been strongly criticized in the literature, will be assessed. The reason is that there is still no research on whether young scientists could be an influential factor in reducing the drastic negative environmental impact because their generation is more aware of emissions.

Summing up, the existing data represents only a part of the whole and is thus not representative of the *impact on young scientists* in *different research fields* since the outbreak of the COVID-19 pandemic and the resulting remote measures, which accelerated the change in the conference formats used and therefore the young scientists' participation opportunities.

Consequently, it needs to be empirically assessed whether collaboration opportunities of young scientists, depending on their *Age* and *Career Stage* and regardless of their scientific *Research Field*, have changed due to the format change from offline to online conferences and whether they change their attitude towards participating online rather than offline conferences, either because of the awareness about the environmental impact or because of the introduction of networking activities. For this purpose, the young scientists' perception of online conferences, also in comparison to offline conferences, will be surveyed. Based on their perception of the benefits and drawbacks of online conferences, it becomes apparent whether online conferences serve the same purpose as offline conferences for young scientists, and whether it will remain a relevant format for them in the future.

3.2. Research Model

In the following, the derivations to the three hypotheses are explained.

Within science, there is broad agreement that, in the future, not only offline conferences will be held, but also online conferences will somehow remain, and even hybrid formats will establish.

Advantages, such as lower costs, to act better with family commitments, or the possibility for physically restricted people (physical mobility) to participate in conferences, but also the associated time efficiency and the convenient format of online participation in today's acceleration of the world, might be reasons for online conferences being a common format even after the pandemic.

Prior literature has shown that young scientists benefit from participating in conferences, either it is offline or online. Attending online conferences, particularly, reduces the main barrier to participation, namely the costs, and thus offers especially young scientists the opportunity to increasingly participate in conferences, possibly even for the first time (Esterhuysen, 2021; Valenti et al., 2021). Thus, it enables scientists of an early career stage to not only gain the latest knowledge, but also to get in contact with other scientists, through which collaborations can emerge, and careers and visibility can be improved.

Nevertheless, and as already discussed, at online conferences, there is an issue of mainly listening to presentations, whereas discussions are rather hardly initiated. Thus, there is a lack of personal face-to-face contact and physical chance encounters, which are the basis for meeting new researchers and consequently building new collaborations (Gao et al., 2021). This suggests that online conferences do not offer the same personal networking opportunities to generate collaboration as on-site conferences.

This development gives rise to the first hypothesis, which considers the young scientists' perceived opportunity for collaborations creation at online conferences in relation to the collaborations that would arise on-site due to the lack of interpersonal exchange between scientists.

> ***Hypothesis 1:*** *Young scientists perceive that their participation in online conferences leads to fewer new collaborations than when participating in offline conferences.*

Accordingly, if one of the main motives for participating at a conference, namely networking and collaboration building, is limited, young scientists might question to attend online conferences. However, there are other factors, which are not career-related, that might motivate young scientists to participate in online conferences, for example, environmental awareness.

Young individuals and the following generations have grown up with social norms, such as the expectation of a conscious approach to the environment. In this respect, there is evidence that there is a movement among younger people to be more environmentally conscious (Milfont et al., 2021), hence making them possibly question their actions towards causing additional emissions by traveling to an on-site conference. These could lead to young scientists preferring to participate online rather than offline in the future, even if the possibility of on-site conferences would exist.

As mentioned in the literature review, traveling to conferences has a particularly large negative impact on the environment whereby it is evident that, compared to trips for other scientific purposes, most emissions arise from participation in conferences (55%), with only short durations (Wynes & Donner, 2018). Thus, online conferences might become more relevant because of the growing awareness about the negative environmental impact. Especially in today's younger 'Fridays-for-Future-Generation', this awareness could lead to a rethinking process of participation decisions between the two formats.

In this respect, it cannot be ruled out that there might be increasingly environmental restrictions in the future, whereby, e.g., university chairs are required by their universities or the government not to exceed certain CO_2 values per year, the introduction of carbon offset programs or similar (Wynes & Donner, 2018).

Particularly the COVID-19 pandemic, i.e., the forced online formats, might have improved the awareness or at least the perception that online conferencing might be a solid way to participate in conferences from a distance because the digital tools and digital communication possibilities have been not only improved but also increasingly recognized and appreciated in research (Korbel & Stegle, 2020). There may therefore be an awareness that it is an appropriate opportunity to participate in online conferences, which was rather not considered before the crisis.

In sum, young scientists, if they have a choice, may be more likely to attend online conferences in the future because of their awareness of the negative environmental impact and the given possibilities of online participation through the improved online tools.

> ***Hypothesis 2****: The environmental awareness of young scientists increases the likelihood of participating in conferences online rather than offline.*

However, previous literature has shown that there are some reasons why scientists do *not want* to participate in online conferences. These include, again, mainly the lack of face-to-face contact and the resulting lack of new collaborations (Hypothesis 1). Consequently, after the removal of the pandemic measures, such as contact restrictions, which have 'forced' an online format, online conferences might not be interesting for scientists anymore but could rather be seen as a temporary solution.

Especially for experienced and established scientists, online conferences do not seem to be a fitting format, as they have always been used to offline conferences and have no financial constraints. Moreover, they have less affinity for the internet (Antoun, 2015), and possibly therefore also for digital tools that are used for online conferences, than their younger colleagues. Furthermore, and according to existing literature, the lack of face-to-face contact online means that they cannot maintain their existing contacts as they would usually do at offline conferences (Chai & Freeman, 2019). These factors could lead to more experienced scientists from higher career stages being less likely to attend online conferences in the future, especially if hybrid conferences allow them to choose between the two formats.

Hence, the problem might be that in the future, online conferences rather appeal to scientists who cannot afford or cannot permit them to go to offline conferences, i.e., young scientists.

These opposing expectations, needs, and available resources of young and experienced scientists might lead to the problem that young scientists are more likely to meet scientists of the same career stage at online conferences and thus do not meet the experienced and established scientists they are hoping to meet for knowledge exchange, career development and collaboration building. This is because, as already learned, young scientists attend conferences to make new contacts, draw attention to themselves, and consequently

advance their careers – but this is mainly beneficial if they meet more experienced scientists online. A major initial motivation for making contacts could thus not be fulfilled by future online conferences.

How could this problem be solved? It is assumed that online conferences will be a conference format that will persist to some extent after the pandemic for various reasons (opportunities for scientists to participate, reach, availability, internationality, environmental impact, etc.). Presumably, it will also evolve even further with tools such as Virtual Reality (VR), apps, the use of machine learning algorithms, etc. (Valenti et al., 2021). Considering previous virtual conferences, organizers already tried to recreate especially the missing serendipitous interactions at break time, in the hallway, and while getting coffee. For this purpose, synchronous break-out rooms, or so-called 'digital water-coolers' (Gao et al., 2021) or 'virtual tea breaks' (Roos et al., 2020) were set up in the online tools so that participants could enter independently from the actual presentations to reproduce social interactions. Additionally, participant lists can be viewed in advance. This enables unofficial chats during conferences, which allows scientists to exchange knowledge (Viglione, 2020b). Other approaches to simulate personal get-to-know contact, like offering biographies of the participants, connecting participants through a matchmaking app (Roos et al., 2020; Viglione, 2020b), 'speed greetings', in which people are attending randomly or by a wish list, while chatting in a virtual room and while participants are steadily rotating, were introduced. In some cases, rooms are divided into specific groups, such as young scientists (Esterhuysen, 2021). Nevertheless, Gao et al. (2021) point out, that although these measures existed, there was hardly any virtual contact between colleagues. Thus, and although there are already various approaches to interacting online, it should be discussed how online conferences could be made more attractive in the future, so that they can overcome the existing difficulties, especially for young scientists, e.g., through networking activities, resulting in more personal contact between experienced and young scientists online.

Interviewed scientists who have already participated in online conferences said in the article "Navigating Virtual Conferences as a Junior Researcher" (2020) that it is of relevance that established scientists take responsibility to participate in networking events (i.e., chats or breakout rooms) that are intended for young

scientists to bring scientists of different career stages together and thus invest in the new generation of scientists. It seems that in the existing online networking methods, like breakout rooms, young scientists are rather among themselves and that synthetic attempts must be made to integrate other, especially more experienced, scientists. Therefore, it should be evaluated whether the networking activities in online conferences are perceived to lead to an increase in interaction between scientists of different age and career stage, independent of their research field. Thus, these interpersonal interactions with more advanced scientists might lead young scientists to be more likely to attend online conferences than offline conferences.

> ***Hypothesis 3:*** *Young scientists perceive that networking activities at online conferences positively affect interactions between scientists of different career stages, and therefore increases their likelihood to participate in online conferences.*

In summary, online networking methods would be an effective way for young scientists to meet the needs mentioned in Hypotheses 1 and 2: If young scientists were to meet more experienced scientists in online networking activities (Hypothesis 3), they would (1) be able to form new collaborations and (2) fulfill their individual need to protect the environment.

Thus, in the future, it can lead them to want to attend online conferences rather than offline conferences even after the pandemic and even if they would have the opportunity to choose between both formats.

3.3. Data Collection Method

So far, the methods used in prior literature to look at the change of teams in science or the influence of COVID-19 on science were mostly data analysis of publications and citations. Surveys are, however, only rarely done, being conducted only at a single conference. Additionally, so-far existing surveys have yet not focused on young scientists and have only focused on specific scientific groups.

This thesis, on the contrary, uses a quantitative technique (survey) to collect primary data, namely a self-completion online questionnaire that was conducted in February and March 2022 to examine the scientific evolution of young scientists about the change in conference formats and the related collaboration opportunities since the outbreak of the COVID-19 pandemic, as well as their general assessment of online conferences. It is therefore cross-sectional data with the survey taking place at a certain point in time, with the scientists interviewed being randomly sampled.

The participant recruitment was conducted via email. For this purpose, email addresses of chair members which are available on the websites of different universities in Austria and Germany were gathered. Together with their name, their current position, research field, and university city, a database was created, and the questionnaire was sent out. Thereby, mainly scientists of early career stages were chosen for this purpose, i.e., Research Assistants, Prae Docs, Post Docs, Assistant Professors, but also Associate Professors. To ensure their currentness of data, their position was queried again in the demographic part of the questionnaire.

Presumably, *Prae Docs* and *Post Docs* were assumed to be the 'best fitting' respondent group for this thesis, as they are considered young scientists not only by career stage but also by age. At the same time, *Prae Docs* usually attend conferences after a few years of apprenticeship, thus, they might not have experienced both conference formats, as the pandemic and the related remote measures were at the time of the survey only in place for two years. Certainly, if participants had the necessary conference experience, they fell into the sample, however, they were also asked about their expectations if they had not yet participated. Scientists from higher career stages such as *Associate Professors*, on the other hand, might be too experienced to

qualify as early career stagers. Nevertheless, they were included in the data collection process because there could be younger scientists, in terms of age, among them.

After the email addresses had been compiled into a sample, survey invitations were sent to these randomly sampled email addresses. To achieve a higher response rate, personalized emails were used. To reach even more people, respondents were asked to forward the survey to other young scientists in their network.

A total of 850 scientists from European universities were contacted during the data collection process. Of these, 73 were not available for reasons such as maternity leave, because their e-mail addresses had changed, or because they were on semester break. Of the remaining, 112 fully completed the questionnaire (48 male, 61 women, 3 diverse, M_{Age} = 33 years), resulting in a response rate of 14.41%. Participants spent an average of 6.07 minutes completing the online questionnaire.

3.3.1. Survey Design

In the following, the composition of the survey is explained. The full survey is accessible in Appendix.

The hyperlink contained in the email that was send to the 850 scientists led to a questionnaire uploaded on the survey tool 'SoSci Survey', which contained five parts and consisted of a total of 17 questions, which were mainly Likert scale questions, as well as a few open-ended and close-ended (fixed choice) questions.

After a short introductory text, Part 1 surveyed the scientists' previous *experiences*.

First, they were asked how many conferences, offline or online, they have already attended to see whether the respondents have already participated in both formats so that they can draw comparisons (Q1).

In addition, they were asked how beneficial they perceive the respective format on a 7-point Likert scale ranging from '1 – very beneficial' to '7 – not beneficial at all' (Q2).

Moreover, different intentions to attend a conference were given to be evaluated on a 7-point Likert scale ranging from '1 – strongly agree' to '7 – strongly disagree' (Q3). Here, only intentions were provided that were related to the topic of this thesis. Namely, intentions that aim to advance the individual's career, such as networking and collaboration-building intentions. Other intentions, such as family commitments, were

excluded because they had already been researched in previous literature and are not related to this thesis' topic of networking, collaboration building, or personal participation possibilities.
Lastly, their perceived effectiveness of new collaboration formation (either online, offline, or in comparison) was surveyed using the same Likert scale (Q4). Thus, the differences in the effectiveness of collaboration formation could be differentiated by the respective formats.

Part 2 dealt with the scientists' overall *preferences* and *possibilities to attend* conferences.
First, their general preference was assessed, more specifically whether participants prefer to attend online or offline conferences (Q5). In this way, a first, uninfluenced impression could be gained about the individual preference. Then, again, a 7-point Likert scale was used to find out whether young scientists perceive to rather have the opportunity to attend a conference if it is held online (Q6). This is because previous literature often argues that it is the online format that enables young scientists to attend conferences (Esterhuysen, 2021; Valenti et al., 2021). Here, examples were given of reduced costs and travel times.
Afterward, it was explained that online conferences were a forced format due to the COVID-19 pandemic. With this in mind, it was explored whether young scientists would like to attend online conferences in the future, even if they could choose from different formats (Q7), and whether they think that online conferences in general will be a relevant format in the future (Q8).

Part 3 asked about some specific *advantages and disadvantages* of online conferences which are relevant for this thesis. Again, only advantages related to the possibility of participating in a conference were given, as well as disadvantages, which are related to the lack of personal face-to-face contacts discussed in the previous literature. These factors were then specifically surveyed among young scientists. Accordingly, and due to the perceived advantages (Q9) and disadvantages (Q10) ranked on a 7-point Likert scale, it became apparent what needs to be changed in the future so that young scientists value online conferences more than they do now. The focus here is on (1) the opportunity for young scientists to participate in conferences and (2) whom young scientists meet online, or do not meet, online.

Part 4 and Part 5 were specific to Hypotheses 2 and 3.

Part 4 addressed the participants personal experiences regarding *networking activities* at online conferences. Since the previous literature indicates the lack of personal contact as the main reason for the dissatisfaction with online conferences, young scientists were asked whether they have already experienced networking activities at previous online conferences (Q11) which are intended to counteract, among other things, the lacking on-site chance encounters. In addition, it was queried how well these activities are able to recreate the personal contact between scientists (Q12) to see how these measures are perceived to replicate face-to-face contact. Furthermore, they were asked whether they perceive that these measures have led them to get to know scientists from other career stages whom they would not necessarily have met on-site (Q13). In the same context, they had to indicate how many new collaborations have resulted from these online networking activities (Q14).

Lastly, and most importantly, respondents had to evaluate if they would be more likely to participate in online conferences if online networking activities would make it possible to replicate the desired face-to-face contact and thus to meet more experienced scientists from higher career stages than their own (Q15). By asking these questions, it is possible to get an idea of whether these online networking methods already exist, if so, how well they work, and whether it would change the young scholars' decision to participate in online conferences if these online networking activities could efficiently generate networks.

Part 5 dealt with the young scientists' attitude regarding the *environmental impact*.

On the one hand, they were asked if they are aware of the negative environmental impact of traveling to offline conferences (Q17.1). On the other hand, they were asked if the negative environmental impact is a decisive reason for them to participate online instead of traveling to the on-site conferences (Q17.2). However, before the young scientists were made aware of the environmental damage, they were asked beforehand to answer independently what other reasons they have that would make them want to participate online rather than offline (Q16). This is deliberately asked before the environment-related questions to prevent them from being biased in Q17.

Finally, Part 6 asked for the respondents' demographic data.

3.3.2. Data Analysis

Starting with descriptive statistics, mainly the mean values of Likert scale questions were evaluated. Since a 7-point Likert scale was used, the mean values of the results were classified into the following intervals:

Interval	Mean Value
1 – strongly agree	1 – 1.857
2 – agree	1.858 – 2.714
3 – rather agree	2.715 – 3.571
4 – neutral	3.572 – 4.429
5 – rather disagree	4.430 – 5.286
6 – disagree	5.287 – 6.143
7 – strongly disagree	6.144 – 7

Table 1: Intervals of the 7-point Likert scale

Further evaluation was carried out using two non-parametric statistical tests. First, a *Mann-Whitney-U-Test* was used to determine differences in the mean values of two samples, namely between offline and online conferences. Second, an inferential statistical technique, namely *Spearman's Rank Correlation*, was used to assess the correlation between two surveyed variables, especially between the demographic data variables *Age* and *Career Stage* and questions asked in the questionnaire which were treated in the respective hypothesis. These were chosen to overcome the non-existence of a normal distribution of certain variables. Complementary, in few cases, direct statements of respondents from open-ended questions were used.

STATA was used for the analyses, and the level of significance was set at 0.05 for all comparisons. Prior to the data analysis, all incomplete responses were removed.

4. Results

In this chapter, the findings of this research, stemming from the quantitative survey data, are outlined. First, general findings such as the demographic data of the young scientists surveyed, their previous number of participations in conferences, and general preferences and experiences at both conference formats are statistically compiled. The following subchapters are then dedicated to the respective Hypotheses 1 to 3 (collaboration building, environmental impact, and online networking activities) and the data collected/questions that are relevant to each hypothesis.

Respondents' age ranged from 20 to 62 years, including a few outliers. Given the focus of this thesis is on young scientists, only the respondents between 20 and 41 years were considered since it can be seen from the variables *Age* and *Career Stage* that the upper quartile of the *Assistant Professors'* boxplot, and thus the highest career stage that was still under consideration, lied at 41 (*Figure 1)*. Moreover, *Prae Doc* or *Post Doc* in the surveyed data set were included anyway since they are, based on their *Career Stage*, considered early career stagers. In addition, *Research Staff and Assistants* were included in case they participated in conferences, too. Nevertheless, these were not emphasized as much as the other career stages in the respective analyses.

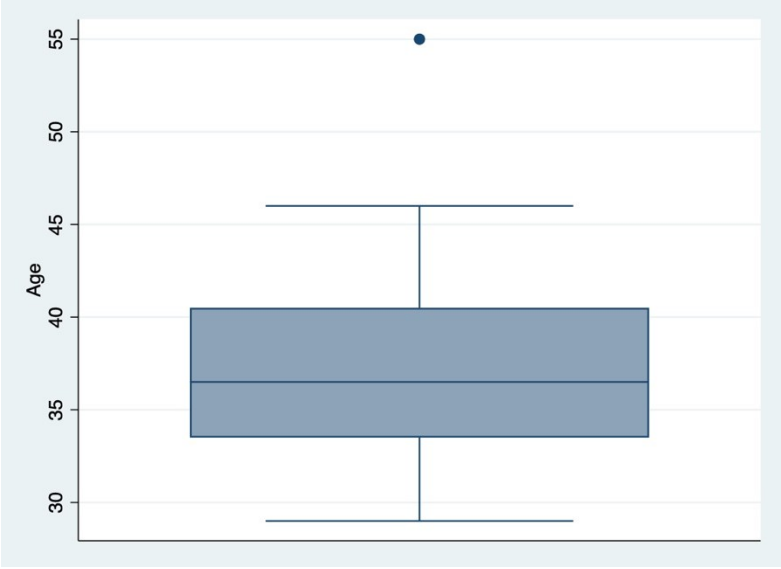

Figure 1: Age of Assistant Professors interviewed, n = 17

Thus, as young scientists, *Research Staff or Assistants* (9 participants), *Prae Docs* (47 participants), *Post Docs* (25 participants), and *Assistant Professors* (17 participants) were considered. Higher career stages were not included in this research since they are not considered early career stagers, while scientists from a higher age were accordingly omitted from the data set.

According to their demographics, there was a statistically highly significant moderate positive correlation between the variables *Age* and *Career Stage* ($r(98) = 0.56$, $p = 0.000$), which makes sense since the career is a long-term process, and thus the *Career Stage* increases with *Age* (*Figure 2*). In the analysis, both of these variables will be specifically considered.

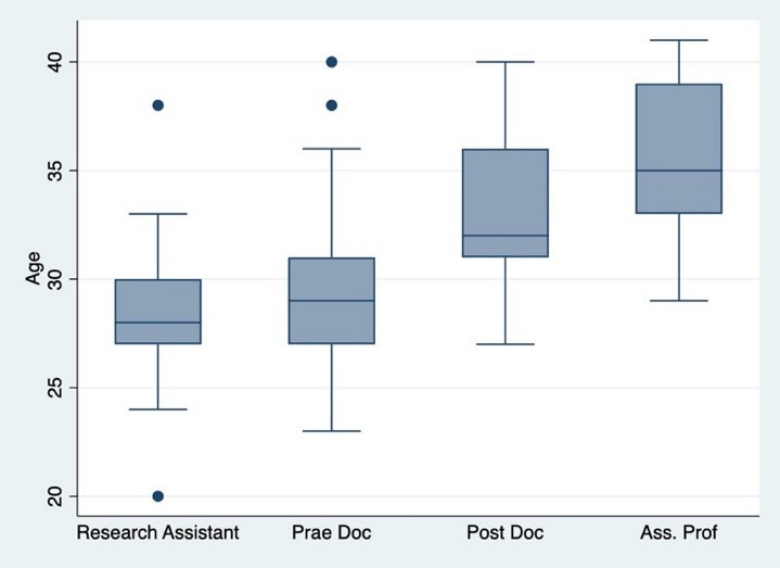

Figure 2: Age of Career Stagers interviewed, n = 98

This selection resulted in 98 young scientists (40 male, 56 women, 2 diverse, $M_{Age} = 31$ years), whose data is considered in the following. The research fields of these participants were strongly diverse, with most subjects coming from the field of 'Other Social Science & Humanities' (27.57%), 'Psychology & Sociology' (19.39%), 'Humanities & Art' (13.27%), 'Education' (12.24%), and 'Business Management & Economics' (10.2%). In total, a range of 13 different research fields was represented, which, contrary to previous literature that focused on bench science, provided evidence that the results apply to multiple fields rather than just one specific research field.

Overall, the respondents participated in more offline than online conferences (Q1). On average, the 98 scientists surveyed have attended 6 to 10 *offline* conferences ($M_{Q1.1.} = 3.0$), but only 1 to 5 *online* conferences ($M_{Q1.2.} = 2.49$).

It was found that more experienced scientists have participated in more offline conferences than early career stagers. While *Prae Docs* and *Post Docs* attended 1 to 5 ($M_{Prae} = 2.3$) and 6 to 10 ($M_{Post} = 3.44$) *offline* conferences, *Assistant Professors* have attended more offline conferences during their academic career, namely 11 to 15 ($M_{Ass.Prof} = 4.47$).

Accordingly, *Spearman's Rank Correlation* showed that there is a significant moderate positive correlation between *Career Stage* and the number of participations in *offline* conferences (Q1.1.) ($r(98) = 0.42$, $p = <0.001$). Likewise, there is a significant weak positive correlation between the *Age* and the number of participations in *offline* conferences (Q1.1.) ($r(98) = 0.31$, $p = 0.002$).

In contrast, the number of participations in *online* conferences was very similar between all career stagers, namely on average 1 to 5 online conferences ($M_{Res.Ass.} = 3.11$, $M_{Prae} = 2.47$, $M_{Post} = 2.36$, $M_{Ass.Prof} = 2.41$).

In line with these findings, the young scientists interviewed '3 – rather agree' in their perception that they rather have the opportunity to participate in an online conference than in a usual offline conference (Q6) ($M_{Q6} = 3.48$; $Mdn_{Q6} = 3$; $SD_{Q6} = 1.71$), with a significant weak positive correlation ($r(98) = 0.22$, $p = 0.026$) between *Career Stage* and this statement ($M_{Res.Ass.} = 2.67$, $M_{Prae} = 3.34$, $M_{Post} = 3.44$, $M_{Ass.Prof} = 4.35$)

Contrary, however, offline conferences were considered much more beneficial than online conferences (Q2). Asking young scientists on a 7-point Likert scale how beneficial they perceive the respective format, *offline* is perceived as more beneficial ($M_{Q2.1.} = 2.0$; $Mdn_{Q2.1.} = 2$; $SD_{Q2.1.} = 1.14$) than *online* ($M_{Q2.2.} = 3.79$; $Mdn_{Q2.2.} = 4$; $SD_{Q2.2.} = 1.53$). Thus, with a mean value of almost 4, the online format is rather evaluated as neither beneficial nor not beneficial.

When it comes to *offline* conferences, however, none of the respondents perceived this format as '6 – not beneficial' or '7 – not beneficial at all', and only 6.12% of the respondents clicked '5 – rather not beneficial', which resulted in a general agreement of the offline format being beneficial.

Using a *Mann-Whitney-U-Test*, there was a significant difference between these two conference formats and their perceived benefits (U = 1743.5, p = <0,001, r = 0.56). The null hypothesis, that there is no difference between the perceived benefits of online and offline formats, could thus be rejected. Therefore, when directly asked which of the two formats they prefer to attend if they have the choice, the offline format was overall preferred (Q5) (M_{Q5} = 1.14; Mdn_{Q5} = 1; SD_{Q5} = 0.35), independent of their *Age* or *Career Stage*.

4.1. Results of Hypothesis 1 – Collaboration Building Opportunities

Starting with Hypothesis 1, it was considered whether

> *young scientists perceive that their participation in online conferences leads to fewer new collaborations than when participating in offline conferences.*

Regardless of the conference format, the first part of the survey asked about some specific intentions that could be a personal reason for attending a conference, including building new collaborations. Among these pre-selected intentions, there was a general agreement on certain items and quite similar mean values, also when considered in relation to *Career Stage*: Each proposed intention had a mean value between 1.82 and 2.81, representing '1' or '2' on the Likert Scale. Only to 'become more visible' was rated '3 – rather agree'.

Interesting for Hypothesis 1, however, was the intention to attend a conference to build new collaborations. Here, a general agreement could be seen that building new collaborations is an intention for this sample's young scientists to participate in conferences, regardless of being held offline or online (Q3.5.) ($M_{Q3.5.}$ = 2.63; $Mdn_{Q3.5.}$ = 2; $SD_{Q3.5.}$ = 1.56).

Especially their intention to meet scientists from other career stages than their own (Q3.8.) became apparent, which is an important factor for collaboration formation ($M_{Q3.8.}$ = 2.81; $Mdn_{Q3.8.}$ = 3; $SD_{Q3.8.}$ = 1.46). Here, a distinct disparity among *Assistant Professors* was found: Particularly young scientists (*Research Assistants*, *Prae Docs*, and *Post Docs*) seem to have a greater interest in getting to know scientists from other career stages than their own ($M_{Res.Ass.}$ = 1.78; M_{Prae} = 2.72; M_{Post} = 2.88). *Assistant Professors*, however,

did not have as much of a need ($M_{Ass.Prof}$ = 3.47). Consequently, there was a significant weak positive correlation between this intention and the scientist's *Career Stage* (r(98) = 0.25, p = 0.012).

Next to the *intention* to build collaborations, it was further assessed how conferees perceive the actual potential of forming collaborations at conferences.

When young scientists were asked on a Likert scale ranging from 1 to 7 whether they perceive that *online* conferences lead to new collaboration building (Q4.1.), they '5 – disagreed' ($M_{Q4.1.}$ = 5.01; $Mdn_{Q4.1.}$ = 5; $SD_{Q4.1.}$ = 1.5). In contrast, they perceive that *offline* conferences are more likely to lead to new collaborations (Q4.2) ($M_{Q4.2.}$ = 3.19; $Mdn_{Q4.2.}$ = 3; $SD_{Q4.2.}$ = 1.48).

Using a *Mann-Whitney-U-Test*, a statistically significant difference between the means of these two formats and their perceived ability for new collaboration building was be found, as the null hypothesis, stating that there is no difference between the perceived collaboration building opportunities of the online and offline format, could be rejected (U = 1842.5, p = <0.001, r = 0.54).

Asking for a direct comparison of whether online conferences lead to less collaboration than offline conferences (Q4.3.) also resulted in an agreement ($M_{Q4.3.}$ = 2.57) and thus emphasizes the results of the Mann-Whitney-U-Test from above.

4.2. Results of Hypothesis 2 – Environmental Awareness

Directing the focus on Hypothesis 2, it was researched whether

> *the environmental awareness of young scientists increases the likelihood of participating in conferences online rather than offline.*

The data indeed showed that young scientists are aware that traveling to on-site conferences causes damage to the environment ($M_{Q17.1.}$ = 2.01; $Mdn_{Q17.1.}$ = 2; $SD_{Q17.1.}$ = 1.44). Yet, it is no decisive reason for them to attend online rather than offline at a conference ($M_{Q17.2.}$ = 4.33; $Mdn_{Q17.2.}$ = 4; $SD_{Q17.2.}$ = 1.93), with most participants choosing the middle option '4' (19.39%).

However, the latter value showed that the respondents are ambivalent about this decision since the mean value was at the tipping point to '5 – disagreement'. The values of the surveyed 7-point Likert scale options visibly fluctuate around the mean, providing reasons for the standard deviation to be the highest compared to the other results obtained in this thesis ($SD_{Q17.2.} = 1.93$). Nevertheless, the slightly left-skewed histogram below (*Figure 3)* showed that the decision to participate in online conferences for environmental protection is barely perceived to be '5 – rather disagreed' by only a few decimal places ($M_{Q17.2.} = 4.33$).

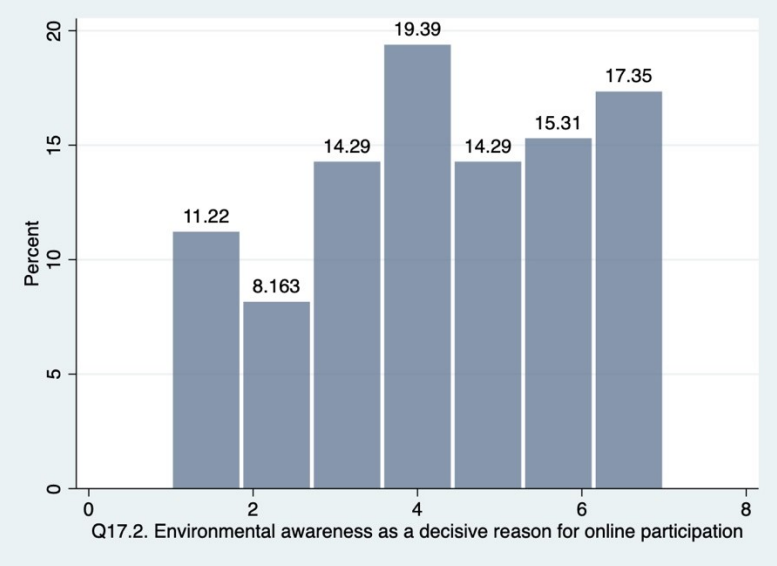

Figure 3: Environmental awareness as a decisive reason to switch to online conferences (Q17.2.), n = 98

Since environmental awareness is related to age rather than career stage, a possible correlation between the subjects' ages and awareness of the negative environmental impact of traveling to on-site conferences was examined (Q17.1.). Testing results showed a weak positive, yet not significant, correlation between the variables ($r(98) = 0.11$, $p = 0.265$).

4.3. Results of Hypothesis 3 – Online Networking Activities

Investigating Hypothesis 3, namely whether

> *young scientists perceive that networking activities at online conferences positively affect interactions between scientists of different career stages, and therefore increases their likelihood to participate in online conferences,*

showed that only 29.59% of the respondents had experienced such networking measures at online conferences (Q11), and perceive or expect that these measures poorly replicate face-to-face contact (Q12) ($M_{Q12} = 5.33$; $Mdn_{Q12} = 5$; $SD_{Q12} = 1.27$). Here, no respondent had chosen '1 – strongly agree'.

Moreover, it was found that they perceive or expect not to meet scientists of other career stages than their own from these networking activities either (Q13) ($M_{Q13} = 5.08$; $Mdn_{Q13} = 5$; $SD_{Q13} = 1.5$). Here, a significant weak positive correlation between this expectation and the *Career Stage* could be seen ($r(98) = 0.34$, $p = 0.005$). Nevertheless, new collaborations are emerging to a certain extent because of these activities (Q14) ($M_{Q14} = 2.62$; $Mdn_{Q14} = 2$; $SD_{Q14} = 1.83$).

Lastly, and particularly relevant, is the directly asked question of whether the respondents would be more likely to participate in online conferences if there would be online networking activities that replicate face-to-face contact and that would enable them to meet more experienced scientists from higher career stages than their own (Q15). This statement was largely agreed ($M_{Q15} = 2.57$; $Mdn_{Q15} = 2$; $SD_{Q15} = 1.55$).

5. Discussion

In the following, the findings from the previous chapter are reflected and put into context with the existing literature. In particular, correlations mainly between respondent career stage and age are considered in relation to the surveyed questions. The discussion is introduced by analyzing striking findings in the demographic data in relation to previous conference attendance experiences of young participants. In this way, differences between conference formats can be identified.

Subchapter one to three are devoted to each of the three hypotheses. It is analyzed by looking at correlations between demographic data and surveyed questions about whether each hypothesis (collaboration building, environmental impact, and online networking activities) can be confirmed or rejected. Besides revealing results, a few non-significant results are also considered if they appear to be conspicuous. Assumptions are formulated to best explain given findings. Finally, in the last subchapter, it will be discussed whether conferees expect online conferences to be relevant in the future (both, subjectively and objectively) and what needs to be changed in order to achieve participant satisfaction.

As can be seen in the results, most of the interviewed scientists participated in fewer online than offline conferences (Q1), which can be explained by the fact that the use of the online format has just recently increased due to the COVID-19 pandemic. By then, conferences were usually arranged on-site.

Also, the fact that more experienced scientists have participated in more *offline* conferences than early career stagers is quite straight forward due to their longer tenure in the profession.

In short, the higher the *Age* and the *Career Stage*, the higher the number of *offline* conferences attended. Besides the temporal aspect, the results found by Chai and Freeman (2019) additionally state that “older researchers are more likely to participate” (p. 2140), whereas the authors refer to financial resources. Thus, there are two factors that may influence the higher likelihood of more experienced researchers attending offline conferences.

As it was also evident in the results, the number of participations in *online* conferences is almost identical, regardless of their *Career Stage* and *Age*, which, again, can be explained by the online format only being

recently established. In addition, during the years of the pandemic, it was the only opportunity for scientists of any age and career stage to attend conferences.

In the future, however, it could evolve towards a greater proportion of young scientists participating in online conferences because the results showed that they perceive to be more likely to get the opportunity to participate in conferences through the online format (Q6), i.e., the lower the *Career Stage*, the more likely young scientists perceive to get the opportunity to attend a conference. On the supply side, the by the COVID-19 pandemic accelerated development of online conferencing and its tools might further increase and provide additional opportunities for young scientists to participate in the future.

These results are consistent with previous research. For example, and as mentioned in the literature review, the conference observed by Esterhuysen (2021) revealed that three times as many young scientists participated in the online conference they were considering than when it was held on-site. Likewise, Roos et al. (2020) proved that considerably more young scientists participated in the online format than when the conference was held offline. More specifically, their data showed that Ph.D. students, with their career stage equivalent to *Prae Docs*, are most likely to attend a conference online. This is made possible mainly by decreasing financial barriers (Esterhuysen, 2021; Gao et al., 2021; Roos et al., 2020) which is the case at online conferences, but also by organizers being able to offer the capacity online to increase the number of participants (Valenti et al., 2021). The young scientists surveyed in this thesis also indicated that the cheaper participation is an advantage of online over offline conferences that would lead them to choose to participate online rather than offline ($M_{Q9.1.} = 1.99$; $Mdn_{Q9.1.} = 2$; $SD_{Q9.1.} = 1.33$).

In sum, it can be said that scientists at *particularly low* career stages, perceive to get the opportunity to participate in conferences due to the online format. It can be seen in *Figure 4* below that the perception receives less agreement with increasing career stage. Hence, these findings are in accordance with findings reported by papers such as Esterhuysen (2021), Valenti et al. (2021), and Roos et al. (2020) stating that young scientists benefit from the online format, giving them the opportunity to participate in high-level meetings, due to the decreasing financial barriers and accordingly search costs. Only the *Assistant Professors* are indecisive ($M_{Ass.Prof.} = 4.35$), even almost tend to disagree. This is probably because their

mean age, which in these data is at 35 (see *Figure 2*), suggests that they have been able to attend conferences more often because they have been in the profession for a longer period of time.

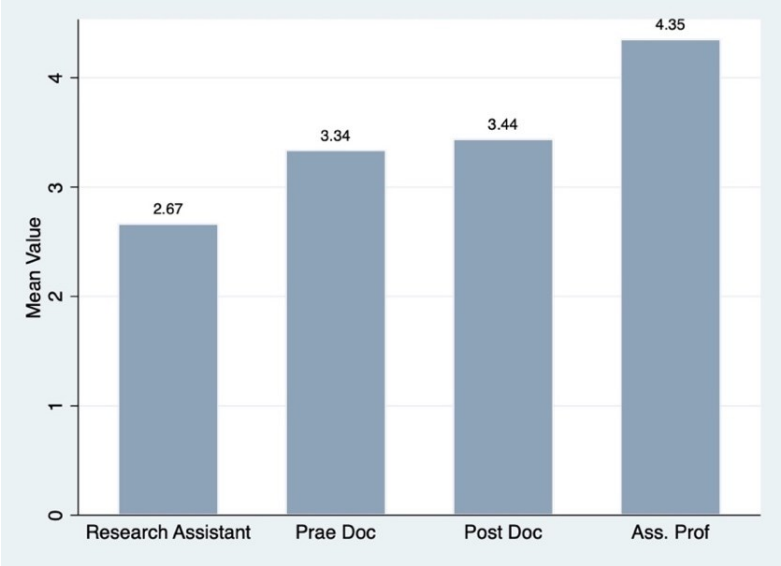

Figure 4: Mean values of the perceived opportunity to attend in conferences due to the online format, for each Career Stage (Q6), n = 98

Since only young career stagers are observed, it can be assumed that the difference in mean values would probably be even more evident if additionally, scientists from even higher career stages than *Assistant Professors* would be observed. This would, however, require a study of precisely these, and could be used to determine whether the difference between the career stages is even more distinct than it is evident here.

When it comes to the question of how beneficial online and offline conferences are perceived, it becomes apparent that offline conferences are nevertheless considered more beneficial ($M_{offline} = 2.0$; $M_{online} = 3.79$). In the context of the just discussed result, namely that online conferences enable young scientists to participate in conferences, it seemed like they attend online conferences because they have the opportunity, but they would actually rather want to attend conferences on-site. Previous literature has not yet discussed this trade-off between participation opportunity and format preference, which probably in most cases results in young scientists preferring to attend online with decreased networking opportunities than not at all.

Looking at the relationship between the variable *Career Stage* and the perceived benefits of online conferences, a weak positive, yet not significant, correlation can be observed (Q2.2.) ($r(98) = 0.11$, $p = 0.26$). In other words, the lower the career stage, the more beneficial the online format is perceived. Presumably, this correlation is due to the fact that young scientists are less likely to be able to attend offline conferences and thus attend online conferences with gratitude. If, however, they are already further advanced in their career and have participated more often in offline conferences and thus also can draw a comparison, they perceive online as less beneficial. Influencing factors, such as an unequal number of participations in offline and online conferences (as could be seen in the results of Q1, that young scientists have less experience with offline than with online conferences), may also cause them to be biased in their perception of how beneficial each conference format is.

An alternative or additional explanation for the fact that younger scientists perceive the online format to be more beneficial is that young generations are more affine to the use of the internet and digital tools of communication (the so-called 'digital natives') than their older, more experienced colleagues (Antoun, 2015) and are thus potentially also more attracted by them. Whether this is indeed the decisive reason for the positive correlation cannot be confirmed with the collected data. However, the effect likely becomes stronger with increasing age and career stage, but, again, this would need to be tested using data from even older scientists and accordingly higher career stages.

Numerically the preference towards the on-site format is obvious with 85.71% of the respondents seeing the offline format as more beneficial, independent of the *Age* and *Career Stage*.

Shortly addressed on a side note here, a slight difference can be found by *Gender*: While 10% of men indicate a preference for online, 14.3% of women prefer the online format. It can be assumed that this slightly higher value might be influenced by the care work discussed in the existing literature, saying that women are part of the underrepresented group of scientists at offline conferences (Roos et al., 2020; Valenti et al., 2021).

Both variables, namely how beneficial the respective conference format is perceived, and which one is preferred, are influenced by various factors. Given the large availability of factors that would exceed the

scope of this thesis, three influencing variables have been identified. In the following subchapters the effect of collaboration building, environmental impact, and online networking activities to meet more experienced scientists on the decision to participate in online conferences is examined along the three hypotheses from above.

5.1. Discussion of Hypothesis 1 – Collaboration Building Opportunities

Chai and Freeman (2019) already discussed that attending the same conference leads to future collaborations – but does that hold true for attending an online conference and for the specific group of young scientists?

The results indeed show that the young scientists surveyed want to attend conferences to create new collaborations. However, they perceive to do so better at offline conferences than at online conferences. While offline conferences are often too expensive (search costs), online conferences are affordable but hardly enable face-to-face exchange and therefore promote fewer new collaborations.

Even though the data shows that young scientists have the *intention* to attend conferences to build new collaborations ($M_{Q3.5.} = 2.63$), which ties in well with previous literature (Gao et al., 2021), the mean value close to '3 – rather agree' is surprising.

On the one hand, conferences are frequently described as 'the way' to create collaborations. On the other hand, the very fact that there are many papers that are investigating either the difficulty for young scientists to attend on-site conferences due to high search costs as a major barrier to participating (Boudreau et al., 2017; Catalini et al., 2020; Gao et al., 2021), or discussing the impact of conference format changes and the resulting lack of personal contact due to the COVID-19 measures on collaboration building (Gao et al., 2021), suggests that (offline) conferences make a substantial contribution to collaboration formation. Thus, a lower value than '3' was expected, indicating a stronger agreement that young scientists attend conferences to gain new collaborators.

A possible explanation for this rather low agreement is that the surveyed scientists in this thesis have not yet participated in many offline conferences and therefore are not aware of its effectiveness for collaboration building, especially compared to online conferences.

Furthermore, if they experienced that at online conferences collaborations do not develop that well, their experience of collaboration formation in online conferences might bias the value towards a lower agreement. Since the queried intention (Q3.5.) refers to both formats, online *and* offline, it might reduce the value of the intention for offline conferences, which would probably be a stronger agreement if it had been queried by itself.

However, this assumption is contradicted by the following result from Q4.2, since it is also surprising that the mean value of Q4.2., namely that *offline* conferences lead to new collaborations, is only evaluated with '3 – rather agree' ($M_{Q4.2.} = 3.19$). Again, a lower value than '3' was expected, in line with the assumption that young scientists want to attend *offline* conferences to gain new collaborators.

Especially since there is a lot of research on how search costs can potentially be reduced, e.g., by introducing low-cost airlines (Catalini et al., 2016), so that also people from less-well financed chairs can participate in offline conferences (Roos et al., 2020), the urgency to participate in on-site conferences to form collaborations has been highlighted. Again, this weak agreement could be caused by the fact that young scientists have only attended a few on-site conferences so far due to the pandemic, which can distort their perception of offline conferencing and its collaborative nature.

Nevertheless, these mean values imply an agreement that young scientists perceive or expect conferences to lead to new collaborations, especially when these are offline. Thus, these results are in line with the findings that young scientists benefit from using offline conferences to build new collaborations (Boudreau et al., 2017; Catalini et al., 2020; Chai & Freeman, 2019; Gao et al., 2021), even if the mean values found are not particularly high in agreement.

Hence, and in line with findings from Boudreau et al. (2017) and Gao et al. (2021), the extent of how well new collaborations can be established is dependent on the conference format.

While respondents '3 – rather agree' that *offline* conferences lead to new collaborations ($M_{Q4.2.} = 3.19$), they '5 – rather disagree' that *online* conferences lead to new collaborations ($M_{Q4.1.} = 5.01$).

As already mentioned in chapter 2.3.3., and as it can be seen from the young scientists' perceptions, this is because the online format does not allow for interactive face-to-face contact. There is broad agreement in the literature (Boudreau et al., 2017; Catalini et al., 2020; Chai & Freeman, 2019), that personal contact is particularly important for building relationships and networks. Not only does the Mann-Whitney-U-Test confirm a significant difference between the online and offline format in creating new collaborations, but also when asked in a direct comparison between these two formats, the data reveals that young scientists indeed perceive online conferences to be less useful than offline conferences for collaboration building ($M_{4.3.} = 2.57$).

Even if the lack of contact was not asked in direct relation to collaboration building, it is on the one hand clear from the existing literature that the lack of face-to-face contact is the reason why online conferences lead to significantly fewer new collaborations. In this thesis' data, however, it can also be detected from the survey: When respondents are asked what disadvantages online conferences have in contrast to offline conferences, the 'lack of personal contact' was the main reason, being evaluated with '1 – strongly agree' ($M_{Q10.1.} = 1.59$). Gao et al. (2021) in particular mentioned the fact that hardly any virtual contact is established online. Likewise, not only the personal contact as such is missing, which in theory can be recreated to a certain extent online, but participants also expressed the lack of serendipitous encounters on-site ($M_{Q10.2.} = 1.69$), that occur, e.g., during coffee breaks or around the water-cooler in between presentations and which have also been highlighted in previous literature as particularly relevant for collaboration building (Viglione, 2020b).

Summing up, the data collected for this thesis supports the assumption that young scientists perceive online conferences to lead to fewer new collaborations than offline conferences, hence **Hypothesis 1 can be confirmed**. These results go beyond previous findings, as they directly address the group of 'young scientists', apply across various research fields, and as they focus not only on a specific conference.

In practice, the findings highlight why online conferences still face barriers to asserting themselves and why the offline format is still preferred. Thus, attending online conferences does not meet the young scientists' *intentions*, namely, to broaden career opportunities ($M_{Q3.3.}$ = 2.73) by interacting face-to-face at chance encounters ($M_{Q3.4.}$ = 1.87) and by meeting new scientists ($M_{Q3.7.}$ = 2.07) to finally build new collaborations ($M_{Q3.5.}$ = 2.63) (*Figure 5*).

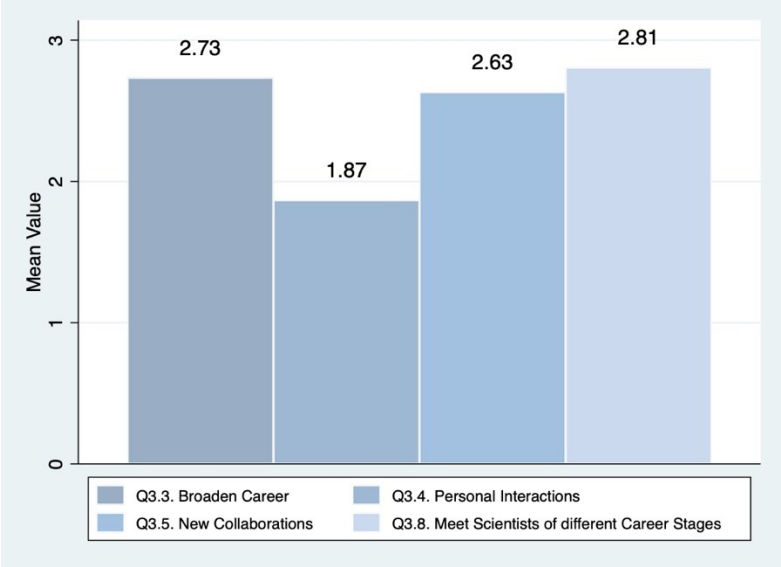

Figure 5: Mean value of agreement of intentions to attend a conference, n = 98

The fact that young scientists are less likely to be able to form new collaborations at online conferences is especially problematic because it is precisely these young scientists who '3 – rather agree' to perceive to get the opportunity to participate in conferences online rather than offline (M_{Q6} = 3.48), e.g., due to lower search costs caused by traveling. Therefore, initiatives need to be established that online conferences offer the possibility for young scientists to get in personal contact with others, establish a network and build future collaborations.

5.2. Discussion of Hypothesis 2 – Environmental Awareness

Besides the young scientists' intrinsic interests, such as career development, they might additionally be influenced by extrinsic motivations, such as sustainability and environmental impact. Thus, emissions saved by not traveling could be another incentive for young scientists to still attend the conference online.

In line with this thought, the goal of the second hypothesis was to investigate whether young scientists consciously decide to attend online conferences rather than on-site conferences due to their awareness of environmental degradation caused by traveling to on-site conferences.

To evaluate if the young scientists' environmental awareness is a sufficient criterion to forego offline conferences and instead participate in online conferences, this thesis builds on two conditions being necessary. Namely, that (1) they are aware that there is a negative impact and that (2) this negative environmental impact is important enough for them to put aside their interests in attending a conference personally on-site and attend online instead.

Analyzing the collected data revealed that the young scientists are indeed aware that traveling to on-site conferences has a negative environmental impact ($M_{Q17.1.} = 2.01$) but that it is not a reason for them to switch to the online format instead to reduce their impact on the environment ($M_{Q17.2.} = 4.33$).

Taking a closer look at the data using *Spearman's Rank Correlation*, it can be observed that there is a weak positive, yet not significant, correlation between the variables *Age* and environmental awareness (Q17.1.) ($r(98) = 0.11$, $p = 0.265$). In other words, there is a tendency that the younger the individuals, the higher their awareness of the negative environmental impact. To prove this tendency, the data would have to be compared to an older and a younger control group. Especially younger individuals might even have a significantly stronger pronounced environmental awareness, as seen in various climate activities like 'Fridays For Future'. According to Milfont's et al. (2021), young individuals care more about climate change than older ones. Thus, despite the lack of significance, it can be assumed that there is indeed a relevant relationship between age and environmental awareness that should be considered for future conference location and organizational planning. Those who prefer not to travel could be offered to attend

live webcam sessions or watch recorded presentations from the online repository (Roos et al., 2020; Viglione, 2020a).

Despite this growing awareness among younger generations, it remains unclear what the carbon footprint of scientific conferences will look like in the near future. As Wynes & Donner (2018) and Desiere (2016) discussed, only a small percentage of 8-11% of fliers account for half of the emissions due to their destination distance. The authors, however, did not clarify which individuals count into these percentages, but as already mentioned earlier, it is mainly more experienced scientists that attend on-site conferences (Chai & Freeman, 2019). Since these are the ones most likely to attend offline conferences, but also are the ones who by evidence do not have such a strong environmental awareness (Milfont et al., 2021), there will probably be no or only a slight change in behaviors (i.e., attend offline instead of online) of those who would make the biggest difference in carbon emissions to protect the environment. Nonetheless, since Milfont et al. (2021) report that there is a growing belief in climate change among all age groups in the last decade, it remains open to question whether older scientists are also gaining an awareness of attending offline rather than online to decrease their carbon footprint. Additionally, the COVID-19 pandemic might have stimulated this thought process further.

Finally, to briefly summarize, it becomes apparent that if these participants were willing to take part online instead of offline, emissions could drastically be reduced.

In general, literature so far has yet discussed the relationship between scientific conference settings and possibilities to reduce emissions in an insufficient manner. In particular, the attitude of young scientists towards carbon emissions in relation to their attendance online instead of offline has not yet been empirically studied.

Existing literature already discusses measures to reduce emissions, but these do not address young scientists. While Roos et al. (2020) suggested that pooling on-site conferences would be a way to reduce emissions, younger scientists would not benefit from this measure, since they would still be constrained by the financial hurdle of travel. Also, Jäckle (2019) said, and regardless of the remote measures introduced since the COVID-19 pandemic thereafter, that choosing more central conference venues, more environmentally

friendly means of transport, and introducing online participation for researchers from far away, can reduce emissions remarkably. However, young scientists benefit mainly from the latter measure, because the other approaches still include search costs, even though these might be reduced (due to more central venues). Thus, online conferences would be the most appropriate format and solution that also serves young scientists, and the environment. In combination with the young scientists' statement that they are indecisive, but would rather *not*, switch to the online format because of the emissions ($M_{Q17.2.}$ = 4.33), effective networking activities must be implemented to make virtual conferences more attractive for scientists, which is going to be discussed in the next subchapter. However, the fact that the values of this statement vary (see *Figure 3*), i.e., that there are already some advocates of switching the format for environmental reasons, means that it is likely that the scientists who experienced efficient networking activity solutions will strengthen their opinion and, above all, those who are still ambivalent (19.39%) can be convinced to increasingly consider the online format. In this way, the current perception, which is still at the tipping point toward disagreement, can be altered.

To get another and more detailed perspective, the respondents were asked in an open-ended question what other factors would make them decide to attend a conference online rather than offline (Q16). There are main reasons mentioned related to the arising effort when traveling to the destination of the conference and how expensive and time-consuming it is to get there, including disadvantages like jet lag or visa requirements, especially if it is only for a short conference duration ("distance", "avoiding extremely long & expensive travel (e.g., transatlantic)", "location, cost, time", …). Close to 40% of respondents indicated this in various ways. Others report their flexibility when attending online, namely the compatibility with work, to watch recorded sessions, the option to switch between sessions, or to leave whenever they want to (12%). They have further mentioned family responsibilities (5%), again being in line with existing literature (Roos et al., 2020; Valenti et al., 2021).

The environment, however, was mentioned by only a few respondents. Without being directly asked for it, 7% mentioned emissions from aviation as a reason to decide not to attend offline but rather online, as the following exemplary quotes illustrate:

"ecological impact of travel (carbon emissions)" – 28-year-old Prae Doc, Vienna

"environmental impact" – 24-year-old Research Assistant, Frankfurt

"reduce carbon footprint" – 30-year-old Prae Doc, Vienna

"no air travel (environment)" – 25-year-old Prae Doc, Vienna

"avoid airtravel" – 36-year-old Post Doc, Vienna

The 7% are only a diminishing proportion of people that would switch to the online format, however since multiple answers were possible as well, in combination with other factors, the number of people that are willing to change the format might get larger.

Nevertheless, 26% mentioned that there is no reason for them to change the format, or at least they could not think of any. Lastly, 10% of respondents gave further reasons that do not belong to the categories already mentioned ("establish an online identity", COVID-19, etc.) (*Figure 6*).

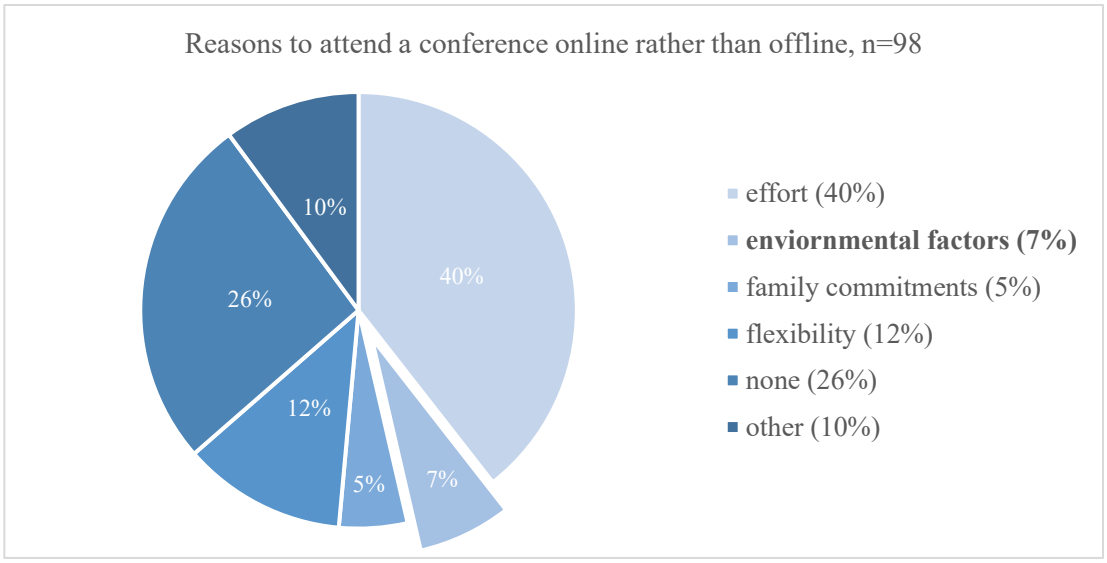

Figure 6: Reasons to attend a conference online rather than offline (Q16), n = 98

In conclusion, **Hypothesis 2 cannot be confirmed**. Even though the awareness of the negative environmental impact when traveling to on-site conferences exists, this negative impact seems to be perceived as either not strong or conscious enough to put the young scientists' own needs aside to protect the environment. Alternatively, the lack of opportunities to connect with other scientists is a decisive reason

for young scientists to not see online conferences as an adequate substitute, and thus could not effectively contribute to reducing air travel and consequently emissions caused by the attendance of on-site conferences.

5.3. Discussion of Hypothesis 3 – Online Networking Activities

The introduction of networking activities at online conferences, however, could be a way to satisfy the needs of collaboration building, hence making more people willing to attend online conferences, and thus address the issue of environmental protection. So far, the results have shown that online conferences are not that attractive to young scientists because the lack of personal contact hardly leads to new collaborations. However, the data shows that online conferences might be more preferred if they would bring the necessary measures, namely networking activities, so that collaborations could emerge easier online ($M_{Q15} = 2.57$). In this way, both needs, namely collaboration formation (Hypothesis 1) and, at the same time, the decrease in negative environmental impact by attending online (Hypothesis 2), could be satisfied.

The results show that networking activities indeed exist at online conferences to a certain extent, resulting in almost 30% of respondents saying that they had experienced such activities (Q11). However, these do not seem to recreate face-to-face contact and on-site chance encounters ($M_{Q12} = 5.33$) that enable interactive discussion, and especially not the way it exists at offline conferences. Above all, the respondents '5 – rather disagree' to perceive meeting scientists of other career stages by attending these networking activities ($M_{Q13} = 5.08$). However, they indicate that their likelihood of attending online rather than offline conferences would increase if these online contact-building measures would replicate face-to-face contact so that they could meet more experienced scientists from other career stages than their own ($M_{Q15} = 2.57$).

These findings tie in well with the papers mentioned in the literature review of this thesis (Gao et al., 2021; Price, 2020; Roos et al., 2020; Viglione, 2020b), emphasizing that networking does not work online as well as offline, especially because chance encounters hardly ever occur, so that discussions are rather difficult initiated (Boudreau et al., 2017; Gao et al., 2021). The only encounters that can occur online are most likely to be provided by deliberately introduced activities such as the already mentioned 'speed greetings', through

a matchmaking app, or similar, in which the scientists can participate voluntarily (Esterhuysen, 2021; Roos et al., 2020; Viglione, 2020b). Nevertheless, possibilities are limited, offering no real chance encounters as these will never exist online.

Additionally, to build collaborations, not only a personal exchange itself is advantageous, but also that this exchange takes place with potential future collaborators that can lead to high-quality scientific papers and increase the effectiveness of research.

When being asked about the disadvantages of online conferencing, the respondents clearly agree upon the lack of contact with more experienced and established scientists online compared to offline conferences ($M_{Q10.3.} = 2.39$). Even if there are especially for this purpose introduced networking activities, the data shows that scientists perceive or expect *not* to meet scientists of other career stages than their own at these online conference measures ($M_{Q13} = 5.08$). Yet, as previously discussed, it is precisely these contacts with more experienced and established researchers that would benefit the career of young scientists (Chai & Freeman, 2019). Since the statement was overall disagreed, it can be concluded that to this date networking activities, such as breakout rooms, at online conferences do not seem to address this issue.

This result is in accordance with prior research stating that at conferences, scientists with similar backgrounds and characteristics, like age or research field, tend to interact more with each other (Chai & Freeman, 2019; "Navigating Virtual Conferences as a Junior Researcher," 2020). Furthermore, combined with the fact that "senior researchers may have less need to create connections […] at a conference" (Chai & Freeman 2019, p. 2142), it provides additional reasoning for the results of this thesis sample that young scientists perceive to remain among themselves in those online networking activities. This represents a fundamental problem because the benefits of making contacts and career development for young scientists when participating in an online conference will not be given if they do not meet experienced scientists for collaboration building and career improvement. As could be seen in the results of Hypothesis 1, it is the scientists of particularly low career stages that seem to have the greatest interest in getting to know scientists from other (namely higher) career stages than their own ($M_{Q3.8.} = 2.81$). Hence, *Assistant Professors*, i.e., scientists at a somewhat higher career stage, tend to be less interested in meeting scientists from other career

stages ($M_{Ass.Prof.}$ = 3.47). This might be caused by them already being more established in their field and further advanced in their careers, including an existing network and knowledge of other scientists' work (Chai & Freeman, 2019). This reasoning is also reflected in the significant positive correlation between this statement (Q3.8.) and the variable *Career Stage* ($r(98) = 0.25$, $p = 0.012$) (see chapter 4.1. – Results of Hypothesis 1). In other words, the lower the career stage, the stronger the intention to meet scientists from other career stages.

In summary, young scientists participate in conferences, also online, with the intention of meeting scientists of higher career stages. However, they reported that this barely happens because of missing or inefficient online networking activities. These findings are consistent with what has been stated in previous studies, emphasizing that online conferences do not have the potential to substitute offline conferences (Roos et al., 2020), specifically in terms of collaboration formation.

It is therefore interesting that the respondents nevertheless state, according to their experience, that new collaborations emerged through precisely these networking activities (M_{Q14} = 2.62), namely 6 to 10 new collaborations. Moreover, this is in contrast to what the authors Boudreau et al. (2017) and Gao et al. (2021) have considered before, saying that collaboration formation suffers from the lack of personal contact online, and also in contrast to the results of this thesis that young scientists struggle to meet older, more experienced scientists. From this, it can be concluded that young scientists rather built collaborations with scientists of a similar age and career stage as their own. This can be valuable as well, but as previously discussed, less valuable than with advanced researchers and, as found in the results, not the actual interest of the young scientists.

In order to answer Hypothesis 3, however, it was directly asked whether the respondents would be more likely to participate in online conferences if there would be online networking activities that replicate face-to-face contact and that would enable them to meet more experienced scientists from higher career stages than their own (Q15). This statement is predominantly agreed (M_{Q15} = 2.57) and thus points out that actions need to be taken to either introduce other or improve existing online networking measures.

Thus, **Hypothesis 3 can be confirmed**. The data provides empirical evidence that if networking activities work effectively online, it would increase the likelihood of participating online instead of offline. Scientists would consequently be aware that they could also create new contacts through online conferences and networking activities and would know that they do not necessarily have to be physically present. This would not only be an opportunity to reduce the environmental impact discussed in Hypothesis 2 but at the same time would satisfy the scientists' needs to meet other scientists and form collaborations as discussed in Hypothesis 1.

Translated into practice, the results reveal that there are indeed networking activities at online conferences to connect scientists and get them to exchange knowledge and interests (see results Q11, where almost 30% experienced networking measures at online conferences), however, the poor contact opportunities of these activities so far also suggest that either (1) these activities are not yet sufficiently established, i.e., there need to be more of them, or (2) they need to be improved in their implementation and their possibilities. It thus requires creative ideas and better execution to meet the needs of young scientists.

Yet, it remains to be clarified to what extent the intention of meeting scientists of other career stages than their own through online networking activities cannot be fulfilled because either older, more experienced scientists are not interested in building new connections, or basically because networking conditions are not existent. Thus, a more detailed analysis of these discrepancies needs to be done in future research to develop precise measures that bring together scientists from different career stages.

Interestingly, when asked in Q16 what would make young scientists switch from attending offline to online conferences, a respondent said that

> *„Instead of replicating face to face (which can't be done entirely online) we should work and find appropriates and stimulating online formats - exploring new ways of doing conferences etc."*
> – 28 year-old Prae Doc, Paris

This statement supports the in the derivation to Hypothesis 3 (see chapter 'Research Model') mentioned idea which had already been highlighted by Valenti et al. (2021), namely of how the online conference

format could be developed in the future through extensions such as pre-recorded presentations, usage of modern apps or technology like VR, the use of machine learning algorithms, or similar, to appeal to more scientists. Thus, it is not about 'replicating' offline conferences, but about designing online conferences in such a way that they even bring additional and differentiable value to participants (USP) that they would not experience in an on-site format.

This finding is therefore in line with the existing literature by Roos et al. (2020), saying that "virtual meetings do not have to recreate the same types of events" (p. 5).

Moreover, besides the introduction of novel networking activities, breakout rooms at online conferences provide another value to participants with little effort. As one respondent stated,

> *"Usually there are less people attending online, a factor that help in the discussion. Only the people really interested in the talk attend, favoring the discussion and the possibility to meet other scholars in the field for collaborations"* – 36-year-old Post Doc, Vienna

Thus, with today's already used technology, larger discussion panels can be broken down to smaller scale virtual rooms, to create a more personal space and engages participants to share more of their thoughts, which in turn facilitates finding potential collaborators to work with. By simple means of current technology, a synthetically initiated grouping of scientists of different career stages could therefore help bringing together younger and more experienced scientists who potentially would not have come into conversation on-site.

To implement this, a focus must be placed on ensuring that more experienced scientists continue to participate in online conferences in the future and thus under normal circumstances. Incentives can be set to attract them, e.g., benefits for experienced scientists and their research field, the possibility to supervise breakout rooms and have discussion rooms for their own research topics, etc. Additionally, more experienced scientists must be made aware of the environmental challenges, since their awareness is not as strong as that of their younger colleagues.

However, how to encourage more experienced scientists is not the goal of this thesis, but only a thought process, which should provide an incentive for further research.

5.4. The Future of Online Conferences

These developments give reason to empirically evaluate, independent of the previous hypotheses, whether young scientists would continue to use online conferences under normal circumstances, i.e., independent of pandemic measures (Q7), and whether they generally think that online conferences will be a relevant format in the future (Q8). When asked directly whether the young scientists surveyed would want to continue attending online conferences in the future after the COVID-19 pandemic (Q7), the answers were widely distributed ($M_{Q7} = 3.65$; $Mdn_{Q7} = 3$; $SD_{Q7} = 1.75$). While slightly more than a quarter (27.55%) '3 – rather agree', the evaluation results of the 7-point Likert scale strongly vary, ranging from about 7.14% to 17.35% (*Figure 7*). Here, no correlation to the variable *Age* or *Career Stage* could be observed.

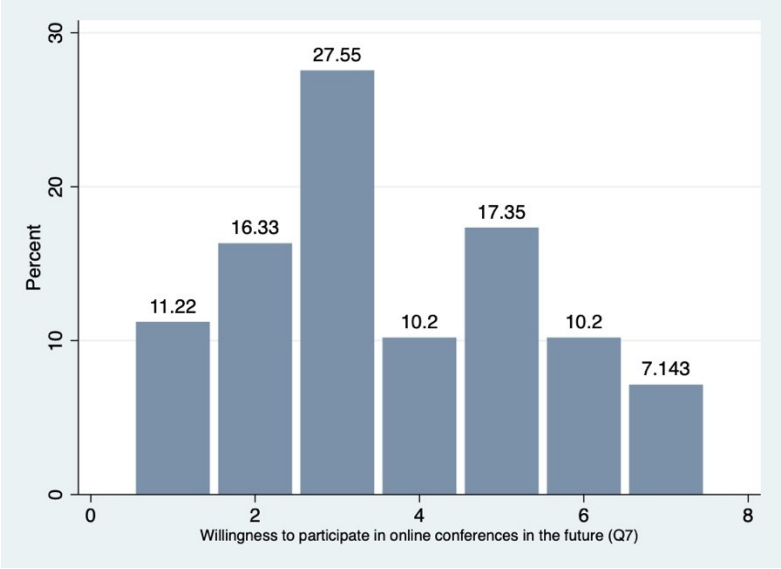

Figure 7: Distribution of willingness to participate in online conferences (Q7), n = 98

In the future, it could be assumed that young scientists would like to participate in online conferences if they perceive the online format as beneficial and effective for collaboration building. However, since this is not the case so far, no correlation can be found in these data.

It can further be assumed that these different responses are caused by the trade-off mentioned in the discussion of Hypothesis 1: While the online format allows young scientists to participate in conferences, it

is not as good as offline conferences for networking and collaboration building. This conflict may be the reason why responses to future participation in online conferences are very diverse.

Lastly, the result might be explained by the fact that each individual has different subjective expectations and criteria such as personal preferences, interests, or factors such as their current life situation, why they would want to continue to participate in online conferences in the future, or why it would not be an appropriate format for them, which are, among other things, based on their previous experiences.

In any case, more than half (55.01%) of the respondents indicate that they would want to continue using online conferences under normal circumstances after the COVID-19 pandemic, which can also be seen in the right-skewed histogram.

Presumably, this tendency depends on a factor that a respondent indicated when asked under which circumstances, she would rather participate online than offline (Q16):

> *"If the usefulness and experience would be the same."* – 26-years old Prae Doc, Vienna

This sums up two key characteristics. To achieve *usefulness*, the personal goals of the conference participants must be fulfilled, which include the intentions listed in chapter 2.2.1. (Advantages of Offline Conferences) such as the acquisition of knowledge, getting more visible to broaden career opportunities, and including networking and collaboration building. Furthermore, the *experience* itself, getting to know other scientists and research fields, and all the surroundings, including the journey, should be experiential. Even though it is not possible to do the in the literature review mentioned sight-seeing tours, or to have a coffee with other scientists on-site, there might be other activities and possibilities, such as VR, 'digital watercoolers' sessions, etc., that could bring similarly, or even novel, experiences.

Regardless of their own preference, the respondents overall believe that online conferences will be a relevant format in the future (Q8) ($M_{Q8} = 2.43$; $Mdn_{Q8} = 2$; $SD_{Q8} = 1.25$).

There is a weak positive correlation between the *Career Stage* and this statement ($r(98) = 0.17$, $p = 0.09$), which is, however, barely not significant. The further the scientists are in their careers, the less they expect

online conferences as being relevant in the future. This result is in line with the previous findings and literature that the online format is especially relevant for young scientists.

This relation might be caused due to different reasons. On the one hand, it can be assumed that more established scientists are more likely to be used to offline conferences and are aware of the advantages that offline conferences have over online conferences and thus can compare the respective advantages and disadvantages. On the other hand, and as already discussed in detail, younger scientists (1) perceive the online format as a possibility to participate in conferences, and (2) are more habituated to researching, communicating, and teaching using digital tools (Korbel & Stegle, 2020).

Lastly, and since it was previously observed that personal contact is a major influencing factor why online conferences have been perceived as not being an appropriate format so far, online conferences could be seen as a useful format among young scientists in the future if the previously mentioned introduced online networking measures (Hypothesis 3) would work effectively by being able to replicate face-to-face-similar contact and thus lead to new collaborations.

There might also be other reasons why young scientists agree with the future relevance of online conferences. For instance, since the pandemic, remote measures have become established in other areas of life such as at the workplace (Home Office), and therefore exemplify certain normality of digital tools.

However, there are additionally hybrid conferences, giving scientists the option to choose which conference format they will attend. This format gives some scientists the opportunity to attend a conference on-site if they are close to the venue, while others can join the same conference online if they live in a different area (Roos et al., 2020). Given the flexibility, scientists will probably be able to participate in more conferences than they would have been able to before and can also choose the format that best fits their needs. One participant stated that

> *"I can participate in more conferences in total. I can attend 2 offline plus an additional conference if it is online."* – 27 years-old Prae Doc, Vienna

In other words, scientists that use on-site conferences for face-to-face contact can also use virtual conferences. This is consistent with what has been mentioned in the literature review by Denstadli et al., (2013), although the authors were referring to the business environment, saying that it is therefore not a matter of substitution, but rather of complementing. Online conferences may rather be seen as a supplement to offline conferences in the future. As was seen in the case of the environmental impact, even a small number of scientists who no longer travel to conferences and instead participate online can have a big impact.

Scientists can therefore decide in their current setting why they would rather want to participate in an online or offline conference. E.g., at an online conference to efficiently (cost, time) gain knowledge, and at an offline conference to personally interact with other scientists. Hybrid conferences are thus able to meet the needs of the individuals even better. In other words, people are free to choose which needs they are currently pursuing and can therefore participate in the respective format. Consequently, there will be more people on-site who attend to network, and online there will be more people who participate in content-related discussions.

6. Limitations & Future Research

The limitations of this thesis result from the data collection and the questions asked in the questionnaire.

Addressing the method used, there might be an imbalance of individuals responding to the questionnaire. More experienced or successful scientists might have been too busy to answer. The other way around, there might be scientists who are not well established and who are therefore pleased to receive such a request for participation. There might also be a bias in gender since some women were on maternity leave when they received the invitation to the questionnaire.

However, since it was not possible to track who exactly responded, no conclusions can be drawn about whether there is a disparity between the individuals who completed the questionnaire. Nevertheless, there might be patterns among individuals who respond or are more likely not to respond.

Likely, scientists who have had particularly positive or particularly negative experiences with conferences have a particularly strong urge to share their experiences and are therefore more likely to participate in the questionnaire, resulting in a response profile of more extreme positions.

A further limitation is that the data might be biased towards framing conference attendance as a pure matter of networking or career opportunities by giving them only a few selected options of intentions (Q3), or advantages and disadvantages (Q9 and Q10). However, there are other factors like mental health, socioeconomics, or caretaking obligations that make a difference and are not mentioned as options in the questionnaire. This was, however, intended, as the topic would otherwise go beyond the scope of this thesis. As already mentioned in the model description, the focus is on collaboration formation, and thus on career development, as the focus is on young scientists.

Moreover, the just mentioned other influencing factors, such as family responsibilities, have already been discussed in the literature (Gao et al., 2021; Myers et al., 2020; Valenti et al., 2021) and do not belong to the focus of this thesis. Nevertheless, it is relevant to keep these in mind, as they are relevant participation intentions and can have an influence on the decision-making process between conferences, in addition to the intentions asked here. Therefore, they have been briefly mentioned in this thesis, since it is an interaction

of various factors that lead to decisions and actions, such as whether to participate in an online or offline conference.

An obvious direction for future research is to investigate other criteria that possibly influence the decision-making of young scientists with regard to picking a conference format. The just mentioned motives like socioeconomics, or caretaking obligations, but also not yet mentioned reasons like the 'zoom fatigue' phenomenon can be potential influencing factors that are worth to be explored in future research.

Furthermore, it could make sense to harden or challenge the results of this thesis regarding the environmental motives by running another study with a counter sample of more experienced scientists.

In addition, it has already been suggested in the discussion that not only creative ideas should be developed to design online conferences and networking activities in such a way that the young scientists' needs are fulfilled, but also that incentives that motivate older, more advanced scientists will be set (including the reduction of digital barriers and the improvement of environmental awareness). Thus, it should be analyzed what particular benefits exist for more advanced scientists at online conferences, so these can be communicated and thus encourage them to participate online.

As was also pointed out in the discussion of Hypothesis 3, it should be explored whether it is due to the ineffective implementation of online networking activities, or due to the absence of experienced scientists in these online networking activities, that these activities do not serve the purpose of bringing together scientists of different career stages. Thus, future research should provide additional practical answers to the question of the right measures to improve these networking activities.

Lastly, just as Catalini et al. (2020) explored that the introduction of low-cost airlines affects the quality of the resulting paper through the collaborations that emerge, future research should investigate whether the quality of publications changes as a result of the different types of the conference (online) and the different methods used there (networking) instead of direct face-to-face contact. This should be further investigated, i.e., not only whether collaborations and publications occur, but also whether the further process after their collaboration formation, e.g., the quality of the publications, changes.

7. Conclusion

Scientists are known to benefit from writing scientific papers in teams, which often arise from attending conferences. The COVID-19 pandemic has increased the use of the online format, which on the one hand, has benefited young scientists who are constrained to attend offline conferences by financial barriers, but on the other hand, also brings disadvantages in terms of collaborative opportunities.

The thesis aimed to empirically prove by collecting data using a quantitative method (survey), that especially young scientists, depending on their *Age* and *Career Stage* and regardless of their scientific *Research Field*, perceive to be influenced by participation in online conferences in their search for collaborators and consequently in the development of their careers. In addition, two specific motives – environmental impact, and improvement of online networking activities were explored that could continue to influence young scientists' decision to attend online rather than offline conferences in the future.

The findings obtained provide valuable and consistent results, even if these have mostly been found to be weakly correlated and not all of them to a significant amount. The collected data found evidence that young scientists perceive online conferences to lead to significantly fewer collaborations than offline conferences (Hypothesis 1), but that they perceive to get the opportunity to participate in conferences more or at all. In sum, young scientists overall prefer to attend offline conferences to push their careers and to get into personal contact with older, more experienced scientists from higher career stages to build new collaborations.

While intentions related to networking and collaboration building turn out to be the decisive factor influencing young scientists' preference for online rather than offline participation, the criterion of negative environmental impact, which is often criticized in the literature, turns out to be less influential (Hypothesis 2). Although young scientists are aware of the negative environmental impact of traveling to on-site conferences, they are not willing to switch to the online format for this reason, if they would have the choice between the two formats. They would be more willing to switch to online if there were networking activities at online conferences that would stimulate personal interaction with other, namely more experienced,

scientists and thus would fulfill their intentions of collaboration building and career development (Hypothesis 3). Moreover, the data showed that these perceptions are amplified with decreasing age and career stage.

More generally, the results appear consistent with what is known from the literature, namely that virtual conferences cannot substitute the offline format. Besides this existing knowledge, however, the findings provide additional information about online conferences being a format that will be established in the scientific world in the future through differentiable and efficient networking methods that target the needs of the participants. Looking at the future, it is expected that both formats will remain with individual use cases that rather complement than substitute each other. Hence, it will even be a more distinct decision on how many financial and time resources one should commit in order to fulfill a specific purpose. To be more precise, those scientists who can choose, need to evaluate whether the extra cost of attending on-site is worth the investment, in terms of pushing their careers by forming collaborations.

For the other group, young researchers and/or researchers of financially less equipped chairs, the online format represents an opportunity to participate in conferences more frequently or even at all. Yet, the data collected as well as the direct statements of the respondents show that online conferences do not only need to close the gap in collaboration building compared to offline conferences but very much should find their own USPs for people wanting to participate.

Finding that USP, however, will require providing outside-the-box ideas and innovative ways of organizing online conferences, that provide additional value to participants that would not obtain in offline settings.

Nevertheless, the shortfall in networking opportunities needs to be addressed as well. Those measures taken today to close the gap, already comprise certain technology-based tools that have advantages over offline settings, like scalable breakout rooms, and digital business cards, or machine learning algorithms, to only name a few. As the respondents indicated their willingness to participate in online conferences in the future, very much depends on the possibility to meet other researchers. To date, these options are scarce, either because there are no online networking activities, or because they are implemented poorly, which also needs to be explored in more detail in the future. In the end, incentives for participation have to be in place

for both sides, i.e., for young as well as for more experienced scientists, so that these counterparts can get into an active exchange online.

Whether online can establish itself as a format in the future thus hinges to a large extent on the existence of interactive personal contact. If young scientists were to get into contact with more experienced scientists online and if more online networking activities were to take place, the online format would probably gain a different reputation and establish a different position itself in the scientific world. For this to happen, however, action must be taken because, as was evident before, attitudes towards online conferences appear to be right at the tipping point between being perceived beneficial or not.

Furthermore, according to the results, the awareness of the negative environmental impact is a minor reason for young scientists to participate in a conference online rather than offline. Again, the trade-off between protecting the environment for the cost of missing opportunities to develop the own career is bearing a relatable answer that was also evident in the results. However, the environmental awareness of people is increasing and so does the willingness to give up certain privileges prior generations had.
Thus, making scientists more aware of the negative impact of these trips could help to motivate more people to see the upsides of online conferences, to actively engage in this format, and thus stimulate a rethinking process.

In this respect, hybrid conferences could potentially also contribute to finding a solution to this dilemma. If for the reason of gaining knowledge and engaging in discussion to enlarge one perspective a scientist would want to participate in a certain conference, the option to dial in online is the optimal fitting. At the same time, other scientists with the main intent of meeting other people can attend the very same conference, with having their respective different needs met.

Hence, if there are dual-track formats such as hybrid conferences that satisfy individual needs, and valuable networking activities for those who want to participate online, even if they work differently than on-site, there is not necessarily the need to spend large sums of money to travel to a, probably faraway, conference venue.

References

Adams, J. D., Black, G. C., Clemmons, J. R., & Stephan, P. E. (2005). Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981-1999. *Research Policy*, *34*(3), 259–285. https://doi.org/10.1016/j.respol.2005.01.014

Antoun, C. (2015). Who Are the Internet Users, Mobile Internet Users, and Mobile-Mostly Internet Users?: Demographic Differences across Internet-Use Subgroups in the U.S. In *Mobile Research Methods: Opportunities and challenges of mobile research methodologies*. Ubiquity Press. https://doi.org/10.5334/bar.g

Boudreau, K. J., Brady, T., Ganguli, I., Gaule, P., Guinan, E., Hollenberg, A., & Lakhani, K. R. (2017). A field experiment on search costs and the formation of scientific collaborations. *Review of Economics and Statistics*, *99*(4), 565–576. https://doi.org/10.1162/REST_a_00676

Catalini, C. (2018). Microgeography and the direction of inventive activity. *Management Science*, *64*(9), 4348–4364. https://doi.org/10.1287/mnsc.2017.2798

Catalini, C., Fons-Rosen, C., & Gaulé, P. (2016). *Did Cheaper Flights Change the Direction of Science? Did Cheaper Flights Change the Direction of Science? **.

Catalini, C., Fons-Rosen, C., & Gaulé, P. (2020). How do travel costs shape collaboration. *Management Science*, *66*(8), 3340–3360. https://doi.org/10.1287/mnsc.2019.3381

Chai, S., & Freeman, R. B. (2019). Temporary colocation and collaborative discovery: Who confers at conferences. *Strategic Management Journal*, *40*(13), 2138–2164. https://doi.org/10.1002/smj.3062

Denstadli, J. M., Gripsrud, M., Hjorthol, R., & Julsrud, T. E. (2013). Videoconferencing and business air travel: Do new technologies produce new interaction patterns? *Transportation Research Part C: Emerging Technologies*, *29*, 1–13. https://doi.org/10.1016/j.trc.2012.12.009

Desiere, S. (2016). The Carbon Footprint of Academic Conferences: Evidence from the 14th EAAE Congress in Slovenia. *EuroChoices*, *15*(2), 56–61. https://doi.org/10.1111/1746-692X.12106

Esterhuysen, C. (2021). Conferences in the time of COVID: Perspectives on organising ISXB-4 Virtual. In *CrystEngComm* (Vol. 23, Issue 28, pp. 4889–4895). Royal Society of Chemistry. https://doi.org/10.1039/d1ce90069b

Fayard, A. L., & Weeks, J. (2007). Photocopiers and water-coolers: The affordances of informal interaction. In *Organization Studies* (Vol. 28, Issue 5, pp. 605–632). https://doi.org/10.1177/0170840606068310

Gao, J., Yin, Y., Myers, K. R., Lakhani, K. R., & Wang, D. (2021). *Loss of New Ideas: Potentially Long-lasting Effects of the Pandemic on Scientists*.

Iatsyshyn, A. v, Hubeladze, I. H., Kovach, V. O., Kovalenko, V. v, Artemchuk, V. O., Dvornyk, M. S., Popov, O. O., Iatsyshyn, A. v, & Kiv, A. E. (2020). *Applying digital technologies for work management of young scientists' councils*. http://ceur-ws.org

Jäckle, S. (2019). WE have to change! The carbon footprint of ECPR general conferences and ways to reduce it. *European Political Science*, *18*(4), 630–650. https://doi.org/10.1057/s41304-019-00220-6

Jones, B. F. (2009). The Burden of Knowledge and the "Death of the Renaissance Man": Is Innovation Getting Harder? In *Review of Economic Studies* (Vol. 76). https://academic.oup.com/restud/article/76/1/283/1577537

Jones, B. F., Uzzi, B., & Wuchty, S. (2008). Multi-University Research Teams: Shifting Impact, Geography, and Stratification in Science. *Science*, *1259*(1263), 1257–1259. https://doi.org/10.1126/science.1158357

Korbel, J. O., & Stegle, O. (2020). Effects of the COVID-19 pandemic on life scientists. In *Genome Biology* (Vol. 21, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s13059-020-02031-1

Milfont, T. L., Zubielevitch, E., Milojev, P., & Sibley, C. G. (2021). Ten-year panel data confirm generation gap but climate beliefs increase at similar rates across ages. *Nature Communications*, *12*(1). https://doi.org/10.1038/s41467-021-24245-y

Misa, C., Guse, D., Hohlfeld, O., Durairajan, R., Sperotto, A., Dainotti, A., & Rejaie, R. (2020). *Lessons Learned Organizing the PAM 2020 Virtual Conference*. https://pam2020.cs.uoregon.edu/Program.html

Myers, K. R., Tham, W. Y., Yin, Y., Cohodes, N., Thursby, J. G., Thursby, M. C., Schiffer, P., Walsh, J. T., Lakhani, K. R., & Wang, D. (2020). Unequal effects of the COVID-19 pandemic on scientists. In *Nature Human Behaviour* (Vol. 4, Issue 9, pp. 880–883). Nature Research. https://doi.org/10.1038/s41562-020-0921-y

Navigating virtual conferences as a junior researcher. (2020). *Nature Communications*, *11*(1), 5019. https://doi.org/10.1038/s41467-020-18656-6

Oester, S., Cigliano, J. A., Hind-Ozan, E. J., & Parsons, E. C. M. (2017). Why conferences matter—an illustration from the international marine conservation congress. *Frontiers in Marine Science*, *4*(AUG). https://doi.org/10.3389/fmars.2017.00257

Pierce, G. (2014). The dilemma of attending (or not) scientific conferences. In *Canadian Journal of Physiology and Pharmacology* (Vol. 92, Issue 1). https://doi.org/10.1139/cjpp-2013-0412

Price, M. (2020). As COVID-19 forces conferences online, scientists discover upsides of virtual format. *Science*.

Roos, G., Oláh, J., Ingle, R., Kobayashi, R., & Feldt, M. (2020). Online conferences – Towards a new (virtual) reality. *Computational and Theoretical Chemistry*, *1189*. https://doi.org/10.1016/j.comptc.2020.112975

Saliba, M. (2020). Getting to grips with online conferences. In *Nature Energy* (Vol. 5, Issue 7, pp. 488–490). Nature Research. https://doi.org/10.1038/s41560-020-0656-z

Storper, M., & Venables, A. J. (2004). Buzz: Face-to-face contact and the urban economy. *Journal of Economic Geography*, *4*(4), 351–370. https://doi.org/10.1093/jnlecg/lbh027

Valenti, A., Fortuna, G., Barillari, C., Cannone, E., Boccuni, V., & Iavicoli, S. (2021). *The future of scientific conferences in the era of the COVID-19 pandemic: critical analysis and future perspectives RUNNING TITLE: COVID-19 pandemic and scientific conferences*.

Viglione, G. (2020a). A year without conferences? How the coronavirus pandemic could change research. In *Nature* (Vol. 579, Issue 7799, pp. 327–328). NLM (Medline). https://doi.org/10.1038/d41586-020-00786-y

Viglione, G. (2020b). *How conferences will survive the coronavirus shock*. http://doi.org/dw3f;

Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science*, *316*(5827), 1036–1039. https://doi.org/10.1126/science.1136099

Wynes, S., & Donner, S. D. (2018). Addressing Greenhouse Gas Emissions from Business-Related Air Travel at Public Institutions - A Case Study of the University of British Columbia. *Pacific Institute for Climate Solutions*.

Appendix

Questionnaire

PART 1 – General information & Experiences

Q1 How many scientific conferences did you attend so far? Please write a number.

1. **Offline (on-site):**	2. **Online (virtual):**
o 0	o 0
o 1-5	o 1-5
o 6-10	o 6-10
o 11-15	o 11-15
o 16-20	o 16-20
o 21-25	o 21-25
o >25	o >25

Q2 Overall, how **beneficial** do you think it is (for you and your professional development) to attend an …

1. … **offline** conference?

   very beneficial o1 o2 o3 o4 o5 o6 o7 not beneficial at all

2. … **online** conference?

   very beneficial o1 o2 o3 o4 o5 o6 o7 not beneficial at all

Q3 Please evaluate the following **intentions to participate** in a conference (both, online and offline).

1. Acquire **new knowledge**, ideas, and information by following presentations and discussions
2. Present the own work and **become more visible** in the respective research area
3. Broaden **career opportunities**
4. Meet other scientists face-to-face at **chance encounters**, breaks or evening events (social interactions)
5. Build new **collaborations** (co-authorships)
6. Interact with researchers **I already know**
7. Meet **new** researchers
8. Meet researchers of **different career stages** or research fields **than my own**

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

Q4 In your opinion and experience …

1. … do **online** conferences lead to an increase in **new collaborations** (co-authorships)?

   strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

2. … do **offline** conferences lead to an increase in **new collaborations** (co-authorships)?

   strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

3. … do **online** conferences lead to fewer **new collaborations** than **offline** conferences (co-authorships)?

   strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

PART 2 – Preferences & Possibilities to attend in conferences

Q5 When you have the choice between attending a conference online **or** offline, what would you **prefer**?

o Offline (on-site)

o Online (virtual)

Q6 If a conference takes place **online** (virtual), would you rather have the opportunity to attend the conference, than in an offline (on-site) setting (due to cost, travels, etc.)?

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

Q7 During the COVID-19 pandemic many conferences took place online for safety reasons. Would you want to participate in **online** conferences **under normal circumstances** (in the future)?

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

Q8 Do you think **online** conferences will be **relevant in the future**?

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

PART 3 – Advantages & Disadvantages

Q9 In your experience or opinion, which **advantages** of **online** (virtual) conferences **compared to offline** (on-site) conferences have a **relevant impact** on your **decision to participate online** (virtual)?

1. **cheaper** to participate
2. lower **geographic distance**
3. possibility to **participate more actively in discussions** than at offline conferences, where it is always the same dominant people speaking
4. more **efficient** use of time

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

Q10 In your experience or opinion, what **disadvantages** do **online** (virtual) conferences have **compared to offline** (on-site) conferences that cause you **not to participate online** (virtual)?

1. the overall **lack in personal contact**
2. getting to know **fewer new scientists**, since there is a lack of informal events (coffee breaks, etc.) where scientists meet each other through chance **encounters**
3. lack in contact with **more experienced** and **established scientists**
4. more difficult to **maintain contact** with scientists **I already know**
5. more difficult to **advance the own career**

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

PART 4 – Online networking activities

Q11 In your experience or opinion, do **online** conferences provide appropriate means (so-called online networking activities, like breakout rooms, 'speed-greetings', etc.) to replicate relevant advantages of offline conferences (face-to-face contact, coffee breaks, etc.)?

o Yes

o No

Q12 In your experience or opinion, **how well** can **online networking activities** recreate face-to-face contact and **on-site chance encounters**?

very good o1 o2 o3 o4 o5 o6 o7 very bad

Q13 Please evaluate the following statement.

Through **online networking activities**, I got to know scientists **of a different career stage** than mine that I would not necessarily have come into contact with on-site.

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

Q14 In your experience or opinion, how many **new collaborations** (co-authorships) have been created through **online networking activities**?

o 0

o 1-5

o 6-10

o 11-15

o 16-20

o 21-25

o >25

Q15 Please evaluate the following statements.

If there would be **online networking activities** that **replicate face-to-face contact** and that would enable me to meet more experienced scientists from higher career stages than mine, this would **increase my likelihood of participating** in **online** conferences.

strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

PART 5 – Future reasons to participate in online conferences

Q16 Which other factors would make you decide to attend a conference **online rather than offline**?

[open]

Q17 Please evaluate the following statements.

1. I am aware that traveling to on-site conferences has a **negative environmental impact**.

   strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

2. The **environmental impact** is a decisive reason for me to attend a conference **online rather than offline**.

   strongly agree o1 o2 o3 o4 o5 o6 o7 strongly disagree

PART 6 – Demographics

Q18 Gender

o m

o f

o d

Q19 Age

I am ___ years old

Q20 City of your university

[open]

Q21 Which of the following best describes your current position?

o Research staff or assistant

o Graduate student in a doctoral program (Prae Doc)

o Post-doctoral researcher (Post Doc)

o Assistant Prof.

o Associate Prof.

o Faculty or principal investigator

o Other [open]

Q22 Which of the following best describes your field of study?

o Biochemistry, Cellular & Molecular Biology

o Other Biological Sciences

o Astronomy & Astrophysics

o Computer Sciences

o Agriculture & Natural Resources

o Chemistry & Chemical Engineering

o Clinical Sciences

o Education

o Atmospheric, Earth, & Ocean Sciences Physics

o Other Engineering

o Psychology & Sociology

o Health Sciences

o Mathematics & Statistics

o Other Social Sciences & Humanities

o Business Management & Economics

o Legal Studies

o Humanities & Art

o Physics

o Political Science

o Other [open]

Zusammenfassung

Wissenschaftliche Konferenzen werden zum Zwecke des Wissensaustauschs und der Vernetzung abgehalten. Während der COVID-19-Pandemie wurden viele Konferenzen aus Sicherheitsgründen abgesagt oder online abgehalten. Die bestehende Literatur hat bereits den Rückgang neu veröffentlichter Forschungsarbeiten aufgrund des Mangels an akademischen Konferenzen während der Pandemie thematisiert. Wenig Aufmerksamkeit wurde jedoch den Auswirkungen auf junge Wissenschaftler gewidmet, die für die Bildung neuer Kooperationen in der Anfangsphase ihrer Karriere besonders stark auf die Teilnahme an Konferenzen und die dort vorherrschenden persönlichen Begegnungen mit anderen Wissenschaftlern angewiesen sind.

Die vorliegende Arbeit stützt sich auf die Möglichkeiten der Entstehung von Kollaborationen als einen der wichtigsten Vorteile der Teilnahme an (offline) Konferenzen (Chai & Freeman, 2019) und auf den fehlenden persönlichen Kontakt als einen der größten Nachteile virtueller Konferenzen (Gao et al., 2021). Während die bisherige Literatur behauptet, dass junge Wissenschaftler bei der Teilnahme an Vor-Ort-Konferenzen aufgrund finanzieller Barrieren, genauer gesagt Suchkosten, eingeschränkt sind (Esterhuysen, 2021; Valenti et al., 2021), legt diese Arbeit nahe, dass sie durch das online Format und die dort wegfallenden persönlichen Interaktionen noch größere Schwierigkeiten haben, sich in der Forschungswelt zu etablieren und gemeinsam wissenschaftliche Arbeiten zu veröffentlichen.

Anhand von Primärdaten einer Erhebung (n = 98) wurde untersucht, inwieweit junge Wissenschaftler der Meinung sind, dass Online-Konferenzen anstelle von Vor-Ort-Konferenzen einen Einfluss auf die Entstehung von Kooperationen haben. Außerdem wurde untersucht, ob das Bewusstsein über die negativen Umweltauswirkungen von Reisen zu Konferenzen, oder Networking-Aktivitäten, die persönliche Interaktionen auf Online-Konferenzen ermöglichen, entscheidende Einflussfaktoren sind, die junge Wissenschaftler dazu bewegen, sich bewusst für Online- statt Offline-Konferenzen zu entscheiden.

Die Ergebnisse zeigen, dass junge Wissenschaftler Konferenzen besuchen wollen, um neue Kooperationen zu knüpfen. Ein durchgeführter *Mann-Whitney-U-Test* hat jedoch gezeigt, dass dieser

Aufbau von Kooperationen durch Online-Formate als gehemmt empfunden wird. Ebenso zeigten die Ergebnisse eines weiteren *Mann-Whitney-U-Tests*, dass das Offline-Konferenzformat als vorteilhafter wahrgenommen wird. Anhand der *Spearman's Rank Correlation* zeigen die Daten außerdem die Relevanz von Alter und Karrierestufe der Wissenschaftler. Je jünger die Wissenschaftler sind, desto beliebter ist das Online-Format und desto wichtiger ist ihnen der Umweltaspekt in ihrem Entscheidungsprozess, ob sie online oder offline teilnehmen, auch wenn das Bewusstsein über die negativen Umweltauswirkungen von Reisen zu Konferenzen die Wahrscheinlichkeit einer Online- statt einer Offline-Teilnahme nicht erhöht. Je jünger sie sind, desto stärker ist zudem ihre Absicht, Wissenschaftler andere Karrierestufen kennenzulernen. Während junge Wissenschaftler davon ausgehen, dass sie auf Online-Konferenzen seltener mit erfahreneren Wissenschaftlern zusammentreffen, geben sie an, dass sie eher an der Teilnahme an virtuellen Konferenzen interessiert wären, wenn diese effiziente Vernetzungsmöglichkeiten zu diesen bieten würden. Online-Konferenzen sollten jedoch Offline-Konferenzen nicht ersetzen, sondern ergänzen.

Daher müssen zukünftige Forschungsarbeiten durchgeführt werden, um ein besseres Verständnis der verbleibenden Hürden für Online-Networking-Aktivitäten zu erlangen und herauszufinden, wie erfahrenere Wissenschaftler für diese kollaborationsfördernden Aktivitäten gewonnen werden können.