Listen to the Scientists:

**EFFECTS OF EXPOSURE TO SCIENTISTS AND GENERAL MEDIA CONSUMPTION
ON COGNITIVE, AFFECTIVE AND BEHAVIORAL MECHANISMS DURING THE
COVID-19 PANDEMIC**

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Abstract

Throughout the COVID-19 crisis, in an unprecedented amount, scientists around the globe engaged in science communication to provide first-hand epidemiological knowledge and information on preventive measures. Based on the extended parallel process model, the present work aimed to empirically investigate ($N = 698$) the impact of direct exposure to scientists in comparison to a general COVID-19 related media consumption. The results revealed that direct exposure to scientists positively affected recipients' knowledge and self-efficacy. General media consumption on the other hand, positively affected perceived threat as well as fear and uncertainty. Both sources positively affected the adherence to protective measures.

Introduction

By the end of 2019 the World Health Organization (WHO) took note of the first cases of COVID-19, an infectious disease caused by the Coronavirus SARS-CoV-2 (hereafter COVID-19). On March 11th 2020, the coronavirus was declared a global pandemic. Until 07-08-2020 the virus caused at least 11,797,213 infected people in more than 227 countries and more than 543,595 deaths (Johns Hopkins University, 2020).

In times of a pandemic, scientists are key figures as they are capable of understanding, investigating and explaining its cause and to derive suggestions for appropriate actions which may be recommended to governments and citizens (e.g., Schuchat et al., 2011). Scientific Experts on pandemics are affiliated to academic disciplines such as virology, epidemiology, medicine, biology and/or statistics and are therefore trained to understand and reflect data and papers about novel viruses (Morse et al., 2012). This is not only crucial for research on potential treatments and vaccinations, but also to explain basic facts to people who have no professional background (Schuchat et al., 2011). During pandemics, scientists do not only play a crucial role in investigating and developing potential cures against viruses (e.g., the vaccination) but they are also a primary source of information.

Nowadays people can get exposed to this crucial information through various sources. On the one hand, journalists act as gatekeepers by translating the information provided by scientists and health authorities for the general public which is influenced by news values (Briggs & Hallin, 2010). On the other hand, scientists have an increasing amount of possibilities to more directly communicate their information to an interested audience. For example, scientists are part of official press conferences of governments and health authorities (e.g., Dr. Anthony Fauci, Director of the National Institute of Allergy and Infectious Diseases of the National Institutes of Health in the US), are invited to TV talk shows or interviewed in professional news outlets such as newspapers or radio. Even more immediate, some scientists use their own social media channels to directly communicate to the audience (Dudo, 2015). This was also the case within the COVID-19 crisis. Scientists from all over the world used social media platforms (e.g., Twitter account of Dr. Caitlin Rivers, Johns Hopkins Center for Health Security, US; @cmyeaton and podcasts such as the NDR Podcast *Corona Virus Update* (NDR, 2020) with Prof. Dr. Christian Drosten, Charité Berlin, Germany and Science Journalists Korinna Hennig and Anja Martini) to inform the public directly about the virus. This represents an important development of science communication (e.g., Nisbet & Scheufele, 2009).

The effects of communication by scientists can indeed be assumed to be different from information provided by media and journalists in general: While various studies showed that during pandemics, traditional media, such as newspapers or television can emphasize more emotional appeals, meaning messages of hope but also of fear (e.g., Husemann & Fischer, 2015; Klemm et al., 2016, Vasterman & Ruigrok, 2013), scientific experts have the ability to explain crucial epidemiological information and therefore to underline the importance of different measures (e.g., physical distancing, wearing a face mask) as well as substantiate them with facts and the authority of their expertise. Even when the information given might not be understood in every detail by the

general public since their comprehension of virological details might be bounded, especially expertise might provide a helpful cue and rational basis for the decision to believe the information (Bromme & Gierth, in press; Winter & Krämer, 2012).

Believing the information given by scientists and, subsequently, changing corresponding attitudes and behavior is indeed crucial during a pandemic as the behavior of the individual is crucial for the dissemination of the virus. In consequence, in times of pandemics, information can represent “the difference between life and death” (Reynolds & Quinn, 2008, p. 13). This has already been summarized in the widely used extended parallel process model (EPPM) which aims to conceptualize the effect of information, respectively health messages by investigating its interplay with cognitive and affective reactions (Witte, 1992). More specifically, it describes the effect of a health message on self-efficacy, perceived threat and fear, which in consequence, explains preventive behaviors.

Although the EPPM is widely researched in the realm of health campaigns, it has also been extended and applied to the context of crisis situations, for instance during the MERS-CoV (Middle East respiratory syndrome coronavirus) crisis (e.g., Yoo et al., 2016). However, to date the EPPM has not been related to science communication. Especially in a time that some refer to as “post-factual” and in which trust in media but also trust in science is publicly discussed (Iyengar & Massey, 2019), there is a need to investigate how people respond to information provided by scientists as primary source of information compared to crisis related information provided by media and journalists in general.

In this regard the present work aimed to investigate how the exposure to media via different channels (e.g., television, newspaper and social media) and information provided by scientists, in particular virologists, contributes to recipients’ knowledge, self-efficacy, perceived threat, fear and uncertainty, and consequently to the adherence to preventive protection measures. The Covid-19 pandemic provides a unique opportunity for this research endeavor as the number of scientists who directly communicate with the public is unprecedented. Furthermore, the role of trust in media and science was analyzed. All in all, the present work contributes to the understanding of central mechanisms of information processing during a health crisis and with an emphasis on science communication.

Theoretical Overview

Importance of Behavioral Change within a Pandemic & The Extended Parallel Process Model

In May 2020 the WHO released a document that contained a comprehensive strategy which aims to slow down the transmission of the coronavirus in order to prevent people from illness and death. The guideline is predominantly composed of behavioral interventions (e.g., physical distancing measures, frequent hand hygiene, respiratory etiquette) that need to be carried out by the individuals of a community. The behavior of each individual is therefore very important in the handling of a pandemic.

Research in the field of communication science showed that behavioral change in the health context is accompanied by complex evaluations and feelings. Witte's (1992) widely used EPPM conceptualizes the effectiveness of persuasive appeals (e.g., health messages) by identifying affective and emotional reactions that can lead to the acceptance or rejection of preventive behaviors. The interplay of threat and self-efficacy lead to the activation of two different processes, fear control or danger control. If perceived threat and self-efficacy are equally high, people start to engage in danger control processes which means they search for ways to efficiently react to the danger and apply strategies such as prevention behaviors. If, however, perceived fear is high but self-efficacy is rather low, fear control processes are activated. People believe they are not able to react to the situation, so they engage in fear control to defend themselves from the fear, for instance by denial. If perceived threat is low, people will not engage in further elaboration of information which underlines the important role of risk perception for (central) message processing.

Affective Component: Fear & Uncertainty as Negative Emotions

The EPPM argues that perceived efficacy and perceived threat, which both can be categorized as cognitive states, are reciprocally affected by the emotion of fear. Fear can be defined as “negatively-valenced emotion, accompanied by a high level of arousal” (Witte, 1992, p. 331). Researchers agree that fear motivates behavioral reactions that can be crucial in survival (e.g., to flee or fight, LeDoux, 2012). While the original EPPM claims fear to be in a feedback loop with efficacy and perceived threat, Popova (2012) published a literature review in which she summed up empirical evidence which shows that fear itself can also affect behavioral changes. In line with this, Harper et al. (2020) conducted an online study in which the authors aimed to investigate predictors of behavioral change (e.g., improved hand hygiene and distancing) within the COVID-19 crisis. The results showed that the only positive predictor of behavioral change was fear of the coronavirus itself.

Further research suggests that uncertainty - which is certainly prevalent in pandemic crises - is related to fear/anxiety and important for behavioral change during a pandemic (e.g., Walter et al., 2012).

Cognitive components: Self-Efficacy & Perceived Threat

Following the EPPM the affective component of fear can both, affect and be affected by the cognitive components of self-efficacy and perceived threat. Witte (1992) defined self-efficacy as a personal evaluation about whether oneself is able to carry out specific recommended responses. In general, the concept of self-efficacy is more open and self-evaluative as it refers to the perceived strength and ability to overcome obstacles (Bandura, 1977). Bandura (2006) highlights that self-efficacy relates to the individual level of stress associated with the effort of overcoming or coping “taxing environmental demands” (p. 309). In line with this, Schwarzer et al. (1997) referred to the COVID-19 related self-efficacy as *optimistic self-beliefs*. This understanding of self-efficacy is, in contrast to the way Witte (1992)

conceptualized self-efficacy, more strongly focused on the ability to overcome negative outcomes (e.g., negative feelings) induced by a stressful event based on their own abilities. In relation to the COVID-19 outbreak, an empirical study with medical professionals showed that COVID-19 related self-efficacy is especially important throughout stressful events as it was shown to be negatively associated with psychological distress (Shacham et al., 2020). Partly, this seems to be taken up by media reports: A content analysis of newspaper articles during the H1N1 influenza pandemic in Germany showed that there were more articles that aimed to strengthen the self-efficacy and therefore the feeling to overcome the difficult time rather than coverage of threats or fear appeals (Husemann & Fischer, 2015). However, it needs to be mentioned that press coverage, depending on the situation, country and source, also was shown to convey messages that could evoke feelings that contradict self-efficacy by highlighting for instance worst case scenarios (e.g., Boberg et al., 2020; Dudo et al. 2007; Klemm et al., 2016).

The other cognitive concept in the EPPM is perceived threat. In Witte's (1992) original work, perceived threat was composed of the perceived severity, which is the subjective belief about the threat's seriousness and the perceived susceptibility, which represents the estimated probability of experiencing the threat. Not only is the concept used to evaluate the perceived threat of specific health messages, but to evaluate the threat of specific diseases (Popova, 2012). Different empirical studies have shown that, during pandemics, perceived threat is an important predictor of adhering to preventive measures (e.g., handwashing or cough etiquette, Yoo et al., 2016). It is important to note that this behavioral effect is frequently affected by the interactions with self-efficacy (e.g., Brug et al., 2009). Leppin and Aro (2009) conducted a review on risk perception in the context of SARS-CoV and highlighted that most studies and models conceptualized perceived threat as a cognitive measure while it can also be categorized as an emotional phenomenon. The authors argue that in situations of acute threat in combination with a lack of evidence-based information might highlight the importance of emotions in the process of risk perception. This directly leads to another important aspect that influences adherence to preventive measures within pandemic situations; the knowledge.

Knowledge

Within the EPPM, Witte (1992) conceptualized a health message as an external source that initiates the affective, cognitive and behavioral processes mentioned above. In different adaptations of the model, the message was converted to a general knowledge about a certain disease (e.g., Seo, 2019). Within a pandemic, being informed is associated with complicated epidemiological facts (e.g., transmission of the virus), information on the virus' prevalence and its clinical manifestation (Bawazir et al., 2018), which are not always evidence-based or even wrong (Boberg et al., 2020). Empirical research indicates that knowledge is an essential part of preventing infections during a pandemic (Tooher et al., 2013). Identifying knowledge as key variable for individuals to adopt preventive protection measures such as quarantine during the Ebola outbreak or H1N1, Webster et al. (2020) found that persons who understand what they had to do exactly (e.g. isolate themselves from others) and why they had to do it (e.g. to interrupt

the infection transmission via droplets) adhere more likely to the preventive behaviors. In sum, it therefore seems to be crucial to provide information to the general public. In line with the EPPM the following Hypothesis was formulated:

Hypothesis 1: The knowledge about the coronavirus has an effect on the cognitive components of self-efficacy and perceived threat.

The role of media and trust in media

During pandemics, there are different stakeholders (e.g., health authorities, mass media or scientists) who try to inform the public and work together to reach this goal (Coombs, 2014). Still, these stakeholders differ in the way they communicate their information (Holland et al., 2014) and use different channels to disseminate their information ranging from traditional media like newspapers or television to the usage of new media platforms such as social networking sites or podcasts. Surprisingly, old and new forms of media do not seem to differ much regarding their framing to report about the crises. With regard to newspapers, Dudo et al. (2007) scrutinized that coverage about avian flu was dominated by high sensationalism, episodic frames and high-risk magnitude as well as risk comparison information. Also, there was minimal information promoting self-efficacy. Further evidence suggests that media reporting during the swine flu in 2009 was found to often work with emotional appeals (Klemm et al., 2016).

Similarly, Twitter analyses suggest that information disseminated in social media includes emotional utterances (Chew & Eysenbach, 2010) that have predominantly been identified as negative emotions, for example, during the MERS outbreak (Choi et al., 2017). With regard to the effects, Choi et al. (2017), demonstrated that social media exposure was positively related to forming risk perceptions. In longitude, polls show that news coverage peaks when a new infectious disease starts and that parallel to this, perceptions of threat were highest in those early stages of an outbreak (Ho et al., 2007).

One of the most comprehensive studies on media use and its effects on health behavior has been presented by Zhang et al. (2015). They demonstrate for the H1N1 flu pandemic that media use increased the likelihood of adopting preventive measures. The effect was mediated by higher levels of perceived knowledge and fear resulting from increased media usage.

Taken together, previous research allows to hypothesize that media usage will affect the basic components of the EPPM, meaning cognitive and affective variables as well as behavioral intentions:

Hypothesis 2: COVID-19 related media consumption is positively associated with a) laypeople's knowledge about COVID-19, b) their COVID-19 related self-efficacy, c) perceived threat d) negative emotions, and e) their intention to adhere to the measures.

Given that professional media coverage is met with more and more skepticism, it is important to scrutinize the influence of individual trust in media (i.e., trust in journalism, Kohring & Matthes, 2007). As can nowadays be seen in attempts to devalue professional journalism, trust in media can indeed vary interindividually (Lee, 2010). Kohring and Matthes (2007) argue that trust in media consists of four factors which include trust in the selectivity of topics, trust in the selectivity of facts, trust in the accuracy of depictions, and trust in journalistic assessment. They further summarize that “media enables their public to fulfill their need for orientation to their social environment and to adjust their expectations regarding other social actors (e.g., politicians). Trust in news media is therefore a necessary condition for trust in other social actors” (p. 238; see also Tsfaty, 2003).

As this seems to be true not only with regard to politicians depicted in the media but also with regard to scientists, an important implication for our study is that trust in media will moderate the effects of scientific communication. Therefore, the amount of media reception will only be influential in case recipients have a minimum trust in media and professional journalism. Therefore, the following hypothesis emphasizes the role of trust in media:

Hypothesis 3: The relation between amount of media use and a) laypeople's knowledge about COVID-19, b) their COVID-19 related self-efficacy, c) perceived threat d) negative emotions, and e) their intention to adhere to the measures is moderated by people's individual trust in media.

Scientists in the media and the role of trust in science

Increasingly, scientists themselves appear in the media and thereby become the primary source of information. They can either be featured in newspaper articles or tv news programs (Vasterman & Ruigrok, 2013), but they can also function as a primary source of information by communicating science via their own channels (e.g., social media or podcasts). This form of direct communication can indeed foster public understanding of science as scientists can establish a connection with individuals (Su et al., 2017). The notion of “science of science communication” entails that in order to be effective, science communication needs to inform people about potential benefits and risks which enables people to make sound decisions (Fischhoff, 2013). One of the basic prerequisites is trust – which needs to be fueled on the one hand by a basic understanding of the processes of science by the recipient (in the sense of science literacy) so that a feeling of self-efficacy results (Lupia, 2013; Reyna, 2012). On the other hand, epistemic trust in the scientist as a source of trustworthy messages needs to be present (Bromme & Gierth, in press; Hendriks et al., 2016). Bromme and Gierth (in press) have compellingly argued that non-scientists have a bounded understanding of scientific issues. The sheer complexity of scientific knowledge, the potentially unlimited depth of scientific explanations and the disciplinary structure of science results in the fact that no one can know and critically reflect everything. This makes it particularly difficult to evaluate conflicting scientific knowledge claims: In this regard, laypeople might even lack the capacity to decide on the basis

of the evaluation of the claims whether a plausible sounding statement of a conspiracy theorist should be adopted as a true belief (Ball & Maxmen, 2020). Therefore, Bromme and Gierth (in press) carve out that when encountering competing knowledge claims, a way of coping could be to shift from the question of plausibility (*What to believe?*) to the question of trustworthiness of the source (*Whom to believe?*). Although this seems to contradict with scientific reasoning which builds on the principle of knowing the truth instead of trusting what one is told, this kind of epistemic trust (Sperber et al., 2010) is the best available rational way for citizens to decide about the truth of scientific knowledge claims. As the public's ability to judge trustworthiness of the source is less bounded than the ability to judge which of the competing claims is true, trust in science and scientists is an important factor in science communication. Nadelson et al. (2014) demonstrated that trust in science increases with increasing number of science courses and number of years in college. In addition, it was frequently shown that the majority of people hold very positive attitudes towards science and that they trust scientists to produce reliable knowledge (e.g., European Commission, 2013; Hendriks et al., 2016).

Against this background, two hypotheses were derived:

Hypothesis 4: Scientists as a primary source of information are positively associated with a) laypeople's knowledge about COVID-19, b) their COVID-19 related self-efficacy, c) perceived threat d) negative emotions, and e) their intention to adhere to the measures.

Hypothesis 5: The relation between listening to scientists and a) laypeople's knowledge about COVID-19, b) their COVID-19 related self-efficacy, c) perceived threat d) negative emotions, and e) their intention to adhere to the measures is moderated by their individual trust in science.

Differential effects of general media consumption and exposure to scientists

As described above, the COVID-19 crisis is especially characterized by a high number of scientific experts who are directly accessible in the media. Virologists and epidemiologists appear in governmental press conferences, are guests in talk-shows, are interviewed in podcasts or use social media formats such as Twitter.

For the recipient, who selectively exposes him/herself to the media (Knobloch-Westerwick, 2014), this means that when using media in a crisis situation, it is possible to encounter more or less scientific experts. The spectrum might vary between avoiding all crisis-related information (e.g., by selecting entertainment program), consuming predominantly journalistic formats which summarize scientific information and choosing media contributions in which scientists themselves provide explanations. Given previous results on the effects of media usage in crisis situations, we propose that effects will be different depending on the amount of media formats consumed which feature direct communication of scientists. As general media coverage in pandemics has been shown to be characterized by emotional content and appeals (Chew & Eysenbach, 2010; Choi et al., 2017;

Holland et al., 2014), it is not surprising that effects encompass negative emotional reactions such as fear as well as perceived threat (e.g., Choi et al., 2017; Ho et al., 2007; Husemann & Fischer, 2015). The increased exposure to scientists, however, should rather lead to differences in knowledge and increase people's self-efficacy of what own options they have to protect themselves, especially when the scientist yields trust (Bromme & Gierth, in press). Therefore, the following hypothesis was derived:

Hypothesis 6: General media usage and exposure to scientists will have different effects: While general media usage will predominantly affect a) perceived threat and b) negative emotions, exposure to scientists will have greater impact on c) laypeople's knowledge about COVID-19, and d) their COVID-19 related self-efficacy.

Method

Sample & procedure

Overall 876 persons participated in the online survey from March, 28 to April, 6 2020. Participants were recruited via an online panel, social media and mail. 178 participants were excluded from further analyzes since they passed the survey too fast or failed the quality check questions. The remaining sample of 698 persons had a mean age of 36.34 (range: 16–78, $SD = 15.14$); 493 participants were female, 202 were male and 3 diverse. The sample was rather highly educated with 294 participants holding a university degree and 211 with high school graduation. After providing consent participants were instructed that the study investigates media consumption behavior during the coronavirus pandemic and resulting perceptions of the situation. First, they stated their sociodemographic data, followed by exposure to scientists and media consumption. The next part of the survey consisted of questionnaires concerning trust in media and science. Afterwards respondents' knowledge about the coronavirus was asked. In the following, participants indicated their adherence to prevention measures, their negative emotions about the situation, their perceived COVID-19 related self-efficacy and their perceived threat and fatality. Beyond that, further questionnaires were part of the study which, however, will not be described here as they are not part of the evaluation. The procedure of the study was approved by the local ethics committee.

Contextual information about the recruiting time

At the time of recruiting, in Germany, schools and day nurseries were closed as well as all shops except for grocery stores. Moreover, citizens were advised to heavily restrict their contacts. However, there was no obligation to wear a mask in public spheres. Shortly before, the German chancellor Angela Merkel gave her first TV speech to inform and warn the people about the risk coming along with the COVID-19 pandemic. Communication activities by official sources were the daily press conference of the Robert Koch Institute (the German government's central scientific institution in the field of biomedicine and infectious diseases) and the public had the opportunity to be informed by scientists via different media formats, such as the daily NDR podcast with Professor

Dr. Christian Drosten (Charité Berlin, German) and science journalists Korinna Hennig and Anja Martini (NDR, 2020). Both sources aimed to inform about current numbers of infections, deaths and heals, new findings from recent studies and guidance and measures on how to deal with the pandemic. In these days, it was considered as most important to flatten the infection curve to avoid overloading the health care system.

Measures

Sociodemographic characteristics

Besides the assessment of age, gender, occupation and education, respondents were instructed to provide their field of occupation.

General media consumption

We assessed participants' general media usage by asking them on a five-point Likert scale (1 = *never* to 5 = *very frequent*) how often they inform themselves about the coronavirus by using the following media types: TV, newspapers and magazines, social media, radio, the homepage of the Robert Koch Institute, the homepage of the German Federal Government, podcasts, web pages of politicians, parties or governmental institutions, and the homepage of the Johns Hopkins University or independent web blogs. Based on the answers, we conducted a media index indicating diversity and frequency of media consumption ($M = 13.79$, $SD = 5.92$, range: 0–40). Therefore, for all ten media types answers concerning the frequency of use were coded according to their point on the scale (0 = *never* to 4 = *very frequently*) and summed so that every participant has been assigned a value for every media type.

Exposure to scientists

Respondents were asked if they have ever seen, read or listened to media contributions by scientists which at the time of data collection were those most frequently represented in German media. We asked for Prof. Dr. Christian Drosten, head of the institution for virology at the Charité Berlin, for Prof. Dr. Lothar Wieler, president of the Robert Koch Institute and Prof. Dr. Alexander Kekulé who holds the chair of Medical Microbiology and Virology at the Martin-Luther-University Halle-Wittenberg. Furthermore, participants were provided with a five-point Likert scale (1 = *never* to 5 = *very frequent*) to indicate the frequency of exposure. Based on their answers, we calculated an index which higher values indicated more and more frequent exposure to scientists ($M = 3.47$, $SD = 3.12$, range: 0–12). Participants' answers for the three scientists were coded (0 = *never* to 4 = *very frequently*) and totaled so that a maximum value of 12 could be reached.

Epidemiological and clinical COVID-19 Knowledge

According to the procedure applied by Manika and Golden (2011) participants had to answer ten statements which were either false or right (with the answering options wrong, right or I do not know) concerning the coronavirus infection. Statements were adapted from WHO reports and covered both epidemiological (e.g. 'The coronavirus is transmitted via droplet infection') and

clinical knowledge (e.g. ‘The incubation period of COVID-19 is one to two weeks’). Based on the correct answers a sum score was conducted with higher values indicating a higher level of knowledge ($M = 5.66$, $SD = 0.93$, range: 0–9, maximum: 10).

COVID-19 related self-efficacy

For measuring respondents self-efficacy regarding the COVID-19 pandemic, we adopted items from the study by Yoo et al. (2016) such as ‘Against the background of what I have managed to do in the past, I am not going to let myself panic because of the COVID-19 pandemic’ which had to be answered on a five-point Likert scale (1 = *I do not agree at all* to 5 = *I totally agree*). A factor analysis yielded a three-factor solution from which we only used one factor for further calculations ($M = 4.09$, $SD = 0.59$, $\alpha = .79$).

Perceived threat and fatality

Perceived threat was conducted by items that are influenced by Witte’s (1992) description of perceived susceptibility, such as ‘I expect to become infected with the coronavirus (COVID-19) within the next three months’. To also cover the subdimension of perceived severity, a question about the fatality of the virus was included: ‘The coronavirus (COVID-19) is a fatal virus’ ($M = 3.41$, $SD = 0.65$, $\alpha = .62$).

Negative emotions

Participants negative emotions concerning the COVID-19 pandemic were measured with the items such as ‘anxious’ or ‘uncertain’ taken from the Positive and Negative Affect Schedule (PANAS, Krohne et al., 1996) on a five-point Likert scale (1 = *not at all* to 5 = *very largely*). Based on a Horn’s parallel analysis, a factor with six items emphasizing fear and uncertainty was computed ($M = 3.02$, $SD = 0.96$; $\alpha = .88$).

Adherence to preventive measures

In accordance to Yoo et al. (2016) we measured participants’ adherence of preventive protective measures by asking them ‘to what extent do you adhere to the following preventive measures?’. In this regard they evaluated measures such as social distancing and hand washing on a five-point Likert scale (1 = *not at all* to 5 = *very largely*). Mean values were calculated for the adherence to prevention measures ($M = 4.48$, $SD = 0.43$, $\alpha = .57$).

Trust in media

To captured participants trust in media, we used the scale by Matthes and Kohring (2003) asking participants on a five-point Likert scale (1 = *I do not agree at all* to 5 = *I totally agree*) how they evaluate the media coverage concerning the coronavirus (e.g. ‘I can trust the information I receive’ or ‘Through the reporting I can get a complete picture of what is happening’). Mean score was calculated ($M = 3.40$, $SD = 0.63$, $\alpha = .91$), with higher values indicating higher trust in media.

Trust in science

For the assessment trust in science, we adapted the scale by Nadelson et al. (2014) where respondents had to answer on a five-point Likert scale (1 = *I do not agree at all* to 5 = *I totally agree*) how much they agree with statements such as ‘Scientist don’t care whether laymen understand their work’ or ‘I have faith that scientists will find a solution to our problems’ ($M = 3.56$, $SD = 0.50$, $\alpha = .72$).

Results

Structural Equation Model

To test which mechanisms were affected by information provided by scientists in comparison to the general COVID-19 related media consumption (H1, H2, H4 & H6), a structural equation model (SEM) with observed variables was computed. Maximum Likelihood method has been used to evaluate the model. Its goodness-of-fit was estimated based on parameters recommended by Schermelleh-Engel and Moosbrugger (2003), Marsh and Hocevar (1985) and Hu and Bentler (1999). To test the model’s appropriateness, a ratio of $c^2/df < 3$ was chosen. The cut-off criteria for the Nonnormed Fit Index (NNFI; also known as Tucker-Lewis Index TLI) and comparative fit index (CFI) was .95. The root mean square of error approximation (RMSEA) value should not exceed .08, while the standardized root mean squared residual (SRMR) is defined to be under .05. The results revealed a good model fit as all important parameters showed to be in accordance with the literature: $c^2(1) = 3.12$, $p = .211$, $c^2/df = 1.556$, CFI = .99, NNFI/TLI = .98, RMSEA = .03, SRMR = .01. Figure 1 shows the model.

Figure 1. The Effect of Exposure to Scientists and General Media Consumption (Yellow) on Knowledge (Light Blue), Cognitive (Dark Blue), Affective (Green) and Behavioural (Red) Components during the COVID-19 Pandemic

Effects of epidemiological and clinical COVID-19 Knowledge (H1)

The first hypothesis assumed that the epidemiological and clinical COVID-19 knowledge influenced the cognitive processes of COVID-19 related self-efficacy and perceived threat and fatality. The results revealed that knowledge had no significant effect on the COVID-19 related self-efficacy ($\beta = -.035$, $S.E. = .022$, $p = .299$). However, it did have a marginally significant effect on perceived threat and fatality ($\beta = .066$, $S.E. = .026$, $p = .074$). Due to missing relations between the concepts, H1 needs to be rejected.

Effects of general media consumption and exposure to scientists (H2 & H4)

Hypothesis 2 and 4 assumed that scientists as source of information and the general media consumption via different channels (e.g., social media, television or online and offline newspaper) affect knowledge, self-efficacy, perceived threat, negative emotions and preventive behavior intention. In the following the model paths of the general media consumption and scientists as source will be explained separately.

Regarding the general media consumption via different channels (e.g., social media, television or online and offline newspaper; H2), the results revealed that it had no significant effect on the knowledge about COVID-19 ($\beta = .005$, $S.E. = .007$, $p = .898$; H2a). In terms of the cognitive component of COVID-19 related self-efficacy, a negative relation was found ($\beta = -.096$, $S.E. = .004$, $p = .021$; H2b). The results moreover revealed a direct significant effect of general media consumption on the other cognitive component of perceived threat and fatality ($\beta = .200$, $S.E. = .004$, $p < .001$; H2c). General media consumption did have a significant positive relation to the negative emotions of fear and uncertainty felt during the COVID-19 crisis ($\beta = .291$, $S.E. = .007$, $p < .001$; H2d). In terms of the behavioral component of sticking to preventive behaviors, the general media consumption had a marginally significant influence ($\beta = .081$, $S.E. = .003$, $p = .058$; H2e). The results of the SEM do support H2 b), c), d) and e), while the hypothesis claiming a link to knowledge (H2a) needs to be rejected.

The same relations were tested in terms of scientists as a primary source of information (H4). In contrast to the general consumption of COVID-19 related information, the computed structural equation model revealed that the consumption of information provided by scientists had a positive direct effect on the epidemiological and clinical knowledge about COVID-19 ($\beta = .139$, $S.E. = .012$, $p < .001$; H4a). Moreover, the information provided directly by scientists is positively related to the feeling that one can conquer the crisis, meaning the COVID-19 related self-efficacy ($\beta = .114$, $S.E. = .008$, $p = .007$; H4b). The data showed that in contrast to the general media consumption, perceived threat and fatality is not affected by information provided by scientists ($\beta = .037$, $S.E. = .009$, $p = .369$; H4c). The affective component of negative emotion and uncertainty is significantly negatively connected to information provided by scientists ($\beta = -.096$, $S.E. = .012$, $p = .018$; H4d). Regarding the behavioral component of preventive behaviors, the information provided by scientists had a direct significant effect ($\beta = .111$, $S.E. = .006$, $p = .007$; H4e). H4c concerning perceived threat needs to be rejected, while all others are accepted.

Differences between general media consumption and exposure to scientists (H6)

The calculations of the SEM demonstrate how the individual variables affect each other in the context of the model as a whole. What cannot be derived is to what degree the reception of scientists makes a specific, incremental contribution to the explanation of the dependent variables. Certainly, scientists are part of the crisis-related press and media coverage (Vasterman & Ruigrok, 2013) but do they add more to the variance of resulting cognitions, affect and behavioral intentions as general media usage does? In order to fully discuss which influence scientists as a primary information source have in comparison to a COVID-19 related general media consumption (Hypothesis 6) the incremental variance of the perception of scientists needs to be analyzed in a separate calculation. In order to achieve this, multiple regressions with block-wise entry have been conducted with the different cognitive, affective, emotional and behavioral components as dependent variables while general media coverage was entered as a predictor in the first block, and exposure to scientists in the second step.

Table 1 shows the results of the regression testing the effect of exposure to scientists and general media consumption on perceived threat. As general COVID-19 related media consumption does serve as a predictor for perceived threat, while exposure to scientists does not, H6a is supported.

Table 2 displays the regression analysis that revealed that scientists are negative predictors of fear and uncertainty. H6b is therefore supported.

Table 3 presents the statistical terms that allow for an acceptance of H6c as it shows that exposure to scientists serves as a significant predictor for knowledge, while exposure to general COVID-19 related media does not.

In table 4 the results of the analysis concerning self-efficacy are presented. The data shows that once scientists are added to the regression, general media consumption turns into a negative predictor, while exposure to scientists serves as a positive one. H6c is therefore supported.

Moderating effects of trust in media and trust in science

Trust in media (H3)

For examining a moderating effect of recipients' trust in media on the relation between media use (H3) and a) laypeople's knowledge, b) their COVID-19 related self-efficacy, c) perceived threat, d) their negative emotions, and e) their intention to adhere to the measures, moderation analyses (PROCESS) were conducted.

As can be derived from the results in table 5, solely the effect of media usage on negative emotions was moderated by recipients' trust in media. For low levels of trust, media consumption results in higher fear and uncertainty ($b = .05$, $t(694) = 6.48$, $p < .001$) compared to the effect of higher levels of trust which reduced the negative emotions ($b = .03$, $t(694) = 3.36$, $p = .008$; adjusted $R^2 = .005$). Therefore, hypothesis 3 can only be partly confirmed for the impact of media consumption on fear and uncertainty to be influenced by respondents' trust (H3d).

Trust in science (H5)

To address Hypothesis 5, which proposes a moderating influence of recipients' trust in science on the impact of listening to scientists on a) laypeople's knowledge about COVID-19, b) their COVID-19 related self-efficacy, c) perceived threat d) negative emotions, and e) their intention to adhere to the measures is moderated, moderation analyses (PROCESS) were performed.

The connection between media consumption and negative emotions, meaning fear and uncertainty, was (again) the only to be moderated by trust of science (H5d). The effect of exposure to scientists on fear and uncertainty is increased with lower levels of trust in science, whereby higher levels of trust in scientists reduces perceived negative emotions after the exposure to scientists. Therefore, for individuals with lower levels of trust in science the exposure to scientists results in higher uncertainty ($b = .03$, $t(694) = 2.20$, $p = .028$). However, higher levels of trust in science did not impact the relation between exposure to scientists on fear and uncertainty ($b = -.01$, $t(694) = -.72$, $p = .472$; adjusted $R^2 = .007$). Due to missing moderating effects, H5 can only be partly confirmed. See table 6 for results.

Discussion

The most important goal of the current study was to analyze the impact of a direct exposure to scientists in comparison to a general COVID-19 related media consumption on knowledge, self-efficacy, perceived threat, negative emotions and intention to adhere to the measures. The results are largely in accordance with the theoretically derived hypotheses and are discussed in the following with a specific focus on the differential influence of scientists and general media consumption on the single dependent variables. Subsequently, we discuss the role of trust in science and media. The discussion is structured based on the model path, that is starting from knowledge to self-efficacy, perceived threat, fear and, finally, to the adherence to preventive measures.

General media consumption and exposure to scientists: Effects on and from epidemiological and clinical knowledge about COVID-19 (H1, H2a, H4a, H6c)

H2a, H4a and H6c all addressed the epidemiological and clinical knowledge about COVID-19. Both the SEM and the regression analysis showed that general media consumption does not contribute to the knowledge about the virus, but instead the exposure to experts does. This seems plausible as scientists are trained to understand epidemiological and clinical details about the virus (Morse et al., 2012) while mass media also cover different other aspects of a crisis ranging from emotional appeals, case reports to (political) discussions about recommended behaviors (e.g. Holland et al., 2014; Vasterman & Ruigrok, 2013). Here, the results of the regression analysis need to be highlighted as it showed that if looking at general media and exposure to scientists separately, the exposure to scientists in the mass media seems to be the crucial factor to make general media at least a marginally significant predictor to knowledge. A higher percentage of direct communication of scientists in the media could therefore be beneficial to educate the public about the virus.

However, journalists are experts in their own field of work and without any doubt, it is important to also report aspects that are connected to the pandemic but do not center around epidemiological facts. Also, it needs to be acknowledged that science journalists are trained to frame and explain scientific information, which for some people is an essential connection to science. Nelkin (1995) concluded on this: “For most people, the reality of science is what they read in the press. They understand science less through direct experience or past education than through the filter of journalistic language and imagery” (p. 2). In consequence, cooperation between journalists and scientists could be especially beneficial in times in which scientific information is crucial. In Germany, the NDR Podcast *Corona-Virus Update* (NDR, 2020) with the science journalists Korinna Hennig and Anja Martini and Prof. Dr. Christian Drosten (Charité Berlin, German) gained huge popularity (41 million clicks for 40 episodes) as the journalists managed to navigate through relevant topics by asking the right questions to the expert.

The fact that knowledge had no significant effect on self-efficacy and only a marginally significant effect on perceived threat (Hypothesis 1) might be due to the fact that both cognitive variables are affected by personal evaluations and are also assumed to be affiliated with affectional reactions (see for instance Bandura, 2006 on self-efficacy and Leppin & Aro, 2009 for work on perceived threat). The results indicate that epidemiological knowledge on its own does not mean that people believe that they can overcome the crisis and that this knowledge affects how fatal they perceive the crisis (see below).

General media consumption and exposure to scientists: Effects on COVID-19 related self-efficacy (H2b, H4b, H6d)

The results of the SEM and regression analyses show that both, the general media consumption and the exposure to scientists are significantly related to self-efficacy (H2b & H4b). Interestingly, the regression demonstrated that general media consumption turns into a significant predictor once entered together with the variable exposure to scientists - underlining the relevance of both variables. There is, however, an important difference between both variables; while scientists are positively related to self-efficacy (meaning higher levels of exposure to scientists explains why people have the feeling to concur the crisis), the general media consumption decreases self-efficacy (H6d). Studies on previous pandemics have shown that mass media cover both: stories that facilitate self-efficacy rather than messages that promote fear (Husemann & Fisher, 2015), as well as stories that highlight worst case scenarios (Boberg et al., 2020). Our data suggest that effects of general media consumption are marginalized when being opposed with direct communication from scientists which might be more successful in “guiding” societies through a crisis.

It is, however, surprising to see that exposure to experts influences both knowledge and self-efficacy, but that they are not connected to each other. The obvious explanation that via communicating knowledge, experts help increase people’s self-efficacy therefore does not hold. The scientists seem to provide something other than knowledge which supports people’s self-efficacy. Whether this potentially results from their own example as comparable individuals also mastering the crisis (vicarious self-efficacy, Bandura, 1977) needs to be addressed in future studies.

The negative relation between general media consumption of COVID-19 related information and self-efficacy during the crisis should be carefully reflected. As mentioned above, media analyses of earlier pandemics indicate that the media also try to convey messages of self-efficacy (Huseman & Fisher, 2015). However, part of our general media consumption index was also the usage of social media. Here, an analysis of Facebook during the beginning of the Covid-19 pandemic showed that social media enhanced the spread of what the authors call pandemic populism (Boberg et al., 2020). The results showed that many articles shared on social media emphasized how governments, political leaders or individuals failed to deal with the dangers of pandemics which could be one of the factors that contributes to the negative relation between general media consumption and self-efficacy within the pandemic. An additional regression analysis of the present data indeed indicated that especially social media consumption seems to be responsible for recipients' decreased self-efficacy ($b = -.141$, $t(696) = -3.75$, $p > .001$) and not traditional media ($b = .001$, $t(696) = 0.25$, $p = .980$). The role of social media as a frequently used information source should therefore be carefully reflected within pandemic situations.

General media consumption and exposure to scientists: Effects on Perceived Threat and Fatality of the Coronavirus (H2c, H4c, H6a)

The results of both, the SEM and the regression analyses showed that general media consumption, in contrast to the exposure to scientists, is significantly positively related to the perceived threat and fatality of the coronavirus (H2c, H4c, H6a). While one could intuitively argue that the scientists publishing the official numbers of persons tested positive on the virus, the number of people who died having the virus and the reproduction number (R-value) (e.g., France's General Director for Health Prof. Jérôme Salomon) might contribute to the perceived threat, it needs to be highlighted that perceived threat and fatality can be understood as a subjective evaluation instead of an objective statistical measure. This interpersonal character was underlined by Leppin and Aro (2009) who emphasized that to this day it is not systematically investigated whether the perception of risk can be characterized as a cognition or emotion. This affective component could also be one of the main reasons why the general media consumption turned out to be a significant predictor. Even though the present study did not show a direct significant connection between perceived threat and the adherence to preventive measures, the variable needs to be taken seriously as our data showed a connection to COVID-19 related self-efficacy and the feeling of fear and uncertainty.

General media consumption and exposure to scientists: Effects on Fear and Uncertainty (H2d, H4d & H6b)

The results of the present study showed that general media consumption and scientists both are connected to feelings of fear and uncertainty during the COVID-19 crisis. However, the present data revealed that general media consumption is a positive predictor while exposure to scientists is negatively connected. The positive influence of general media consumption seems to be highly plausible as analyses of both, traditional and social media, showed that messages that could evoke

fear and uncertainty are part of the press coverage and social media postings (e.g., Boberg et al., 2020; Klemm et al., 2016).

However, fear can also be judged as positive as it motivates behavior. Witte (1992) highlighted fear as an important aspect of the persuasiveness of messages (Harper et al., 2020; Popova, 2012). In line with this, our data indicate that negative emotions and the adherence to protective measures are significantly connected.

The negative relation between the exposure to scientists and the felt fear and uncertainty might be influenced also by the positive relation between the exposure to scientists and COVID-19 related self-efficacy. It is conceivable that listening to experts, who might potentially even work towards solutions (e.g., vaccines), could positively affect the feeling of conquering the situation (self-efficacy) which in turn might positively affect the emotional state of a person.

General media consumption and exposure to scientists: Adherence to preventive Behaviors (H2 & H4)

The present data shows that when looking at the direct paths, the general COVID-19 related media consumption across different media channels (including traditional and social media) does not affect the intention to adhere to preventive measures while exposure to scientists does. While this at first glance would suggest a general superiority of direct communication of scientists, a second glance at the data reveals that also general media consumption can be helpful in promoting adherence to the measures. The data indicate that both stimuli affected the intention to adhere indirectly via completely different paths. While general media consumption affected more emotionally emphasized mechanisms (fear/uncertainty and perceived threat) which eventually also affected intention to adhere to the measures, the exposure to scientists rather affected cognitive processes of knowledge and self-efficacy. Previous evidence already suggests, however, that for sustainable behavior change, both fear/threat and knowledge/self-efficacy need to be present (Leventhal, 1971; Witte, 1992). For the derivation of practical implications this would mean that well-orchestrated collaboration of journalists and scientists could be especially fruitful in fostering people's compliance to adhere to measures to combat the pandemic. The NRD Podcast *Corona Virus Update* (NDR, 2020) might serve as a first good example of a fruitful collaboration.

Trust in media (H3)

As consumption of media and the acceptance of published information is said to depend on individuals' level of trust in media, we aimed to investigate whether trust in media moderates the impact of media consumption on laypeople's knowledge about COVID-19, their COVID-19 related self-efficacy, perceived threat, negative emotions, and their intention to adhere to the measures (H3). Results revealed that media trust solely influenced participants' fear and uncertainty whereas all other outcomes were not affected by trust.

The fact that the personal attitude towards media largely did not moderate the results might be due to the fact that during the time of data collection the consistency across media type and formats was very high (all reporting that prevention measures such as hand washing, contact

restrictions and the cancellation of large events will help to “flatten the curve”) and that therefore trust might have been comparably strong as no indication for selectivity of facts (Kohring & Matthes, 2007) was present. Probably examining long-term media effects in later stages of the pandemic with a more diverse media coverage could lead to a clearer picture concerning the development of trust in media and its change over time. It can be concluded that in the specific situation of a beginning crisis, trust in media is not central for recipients’ perceptions. In crisis situations it seems to be more important to gather any kind of information and to act accordingly. In parallel, the generally high levels of trust in media is probably also a characteristic of our sample. In conclusion, there was little variance, which is why trust has probably only small effects as a moderator.

Nevertheless, one specific moderating effect of trust in media was observed for the impact of media consumption on the negative emotions of fear and uncertainty. Here, distrust in media increased participants’ fear and uncertainty. This might mean that, at least in the early phase of the pandemic, people with low trust in media might have suspected that the situation is worse than officially reported. To gain more detailed insights on the moderating effect of trust in media future studies need to analyze long-term developments.

Trust in science (H5)

A further objective of the study was to investigate whether the impact of exposure to scientists on laypeople’s knowledge about COVID-19, their COVID-19 related self-efficacy, perceived threat, negative emotions, and their intention to adhere to the measures was moderated by trust in science (H5).

Results were strikingly similar to those of trust in media: While trust in science solely influenced the relation between exposure to scientists and the negative emotion of fear and uncertainty, all other outcomes were not moderated by trust. Interestingly, only explicit distrust influenced recipients’ outcomes on the affective component. Similarly, as argued above, this might result from the fact that those who mistrust scientists and their messages might have felt that they hide facts and dangers during the early stage of the pandemic.

In times in which the erosion of trust in science is summoned, the good news of our results is that we find a general high level of trust in science in our sample which can serve as a reasonable explanation for the lack of a moderating influence of trust in science.

Limitations

When interpreting the findings, some limitations have to be considered. First, the study was conducted in Germany with a German sample which limits the generalizability of the results concerning the exposure to media and scientists for other countries. In addition, participants had an above-average level of education and more women than men participated. Furthermore, the data collection took place in the early stage of the pandemic. Probably this results in a very unique picture of the situation displaying recipients’ general need for any kind of information.

For participants' media consumption it was not specified which exact programs and formats were consumed through the different media types. Further investigations could therefore differentiate between media types, sources and consumed content to gain more detailed insights into individuals' media consumption behavior during a pandemic crisis.

For the assessment of participants' exposure to scientists, we only asked for three scientists which, however, were the most present ones at the time of the data collection. Due to the changes in scientists' media appearances over time during the pandemic, repeated measures and the integration of more scientists are reasonable to investigate long-term effects of science communication.

Overall, effect sizes appear to be quite small indicating that explained variance for the effects is rather low and probably influenced by additional factors which need further investigation.

Conclusion

The most important conclusion that can be derived from the study is that the direct communication by scientists (ranging from appearances in governmental press conferences to podcasts or social media content) is fundamental in influencing people's knowledge and attitudes regarding a pandemic crisis. Direct paths in the model show that when directly exposed to scientists, recipients achieve greater knowledge about the virus and develop more self-efficacy compared to consuming general media contents. Moreover, consuming information from scientists as a primary source, is significantly connected to the adherence to preventive measures. Still, also general media consumption contributes to beneficial behavior by influencing the affective measure of negative emotion as well as perceived threat. The present study therefore showed that the ways in which scientists and general media do impact the individual willingness to adhere to preventive measures differ. Interestingly, we found no indication that recipients - at least during the early stage of the pandemic - were unduly influenced by individual tendencies to mistrust media or scientists. The results allow to derive recommendations for future pandemics and crises: First of all, a strong presence of directly communicating scientists proved to be beneficial and second, the advantages of this kind of cognitive based communication might be supplemented by a collaboration with journalists who have more expertise in influencing the more affective variables which also proved to be helpful in having people recognize the importance of the preventive measures.

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Appendix: Tables**Table 1***Regression analysis on perceived threat.*

Predictor	Perceived threat			
	β	t	df	p
Step 1				
Media consumption	.221	5.969	2	< .001
Step 2				
Media consumption	.201	4.896	2	< .001
Exposure to scientists	.046	1.124	2	.261

Table 2*Regression analysis on fear and uncertainty.*

Predictor	Fear and uncertainty			
	β	t	df	p
Step 1				
Media consumption	.250	6.799	2	<.001
Step 2				
Media consumption	.291	7.170	2	<.001
Exposure to scientists	-.096	-2.358	2	.019

Table 3*Regression analysis on knowledge.*

Predictor	Knowledge			
	β	t	df	p
Step 1				
Media consumption	.065	1.726	2	.085
Step 2				
Media consumption	.005	.128	2	.898
Exposure to scientists	.139	3.327	2	.001

Table 4*Regression analysis on self-efficacy.*

Predictor	Self-efficacy			
	β	t	df	p
Step 1				
Media consumption	.049	1.304	2	.193
Step 2				
Media consumption	-.097	2.311	2	.021
Exposure to scientists	.109	2.612	2	.009

Table 5*Moderating effects of trust in media.*

DVs	<i>b</i>	<i>t</i>	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
Knowledge	.005	-.565	-.0123.	-.0222	.572
Self-efficacy	.005	.831	-.0063	-.0154	.406
Perceived threat	-.008	-1.336	-.0196	-.0037	.182
Negative emotions	.018	-2.026.	-.0351	-.0006	.043
Intention to adhere to the measures	-.001	.131	-.0073	-.0084	.900

Table 6*Moderating effects of trust in science.*

DVs	<i>b</i>	<i>t</i>	95% CI		<i>p</i>
			<i>LL</i>	<i>UL</i>	
Knowledge	-.023	-0.111	-.0043.	.0391	.912
Self-efficacy	-.001	.750	-.0163	.0364	.455
Perceived threat	-.003	-.230	-.0320	.0253	.818
Negative emotions	-.005	-2.280	-.0930	-.0069	.023
Intention to adhere to the measures	-.005	-.513	-.0241	.0141	.608