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High-Frequency and High-Quality Survey Data Collection: The Mannheim Corona Study

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The outbreak of the COVID-19 pandemic has a massive impact on society. To curb the spread of the SARS-CoV-2 virus, unprecedented containment measures are being taken by governments around the world. These measures and the fear of the disease itself are likely affecting the economy, social inequality, mental and physical health, and even people's perception of good democratic governance. Equally unprecedented is the speed at which these massive changes take place and the lack of statistical evidence that accompanies them. Within days of the first containment measures in Germany, the German Internet Panel (GIP) launched the Mannheim Corona Study (MCS), a daily rotating panel study of the general adult population of approximately 3,600 respondents. Its data and reports now inform the crisis cabinet of the German government and are the basis for groundbreaking social and economic research. This paper gives insights into the MCS methodology and data quality.

Keywords: COVID-19; Corona; pandemic; online panel; response rate; sample accuracy

1 Purpose of the study

Since the worldwide outbreak of COVID-19 and its classification by the WHO as a global pandemic (World Health Organization, 2020) everyday lives have changed dramatically. Millions of people worldwide have been infected with the SARS-CoV-2 virus (European Centre for Disease Control and Prevention, 2020) and the fight against the pandemic has affected citizens globally.

The societal impact of the pandemic is highly dynamic, with infection rates and policies changing weekly, if not daily. At the same time, we observe a lack of reliable epidemiological and social statistical evidence that needs to be equally fast-paced. In a metaphor voiced by the German Chancellor Angela Merkel "Wir fahren auf Sicht.", governments and scientists alike are navigating almost blindly, because what lies ahead is masked by fog. In a country like Germany, the current lack of social and economic data may be surprising at first, given its excellent government, academic, and commercial data infrastructure in non-crisis times. However, as demonstrated by Cornesse et al. (2020) the past two decades have seen an increasing chiasm in the survey field: Fast data collection is predominantly based on non-probability samples, which do not accurately reflect the general population. The large industry of highly-selective pools of online survey participants (i.e. non-probability online panels) falls into this category. However, data collection methodologies based on a probability sample that more accurately and reliably reflect the general population are typically slow. The sampling process for a face-to-face survey in Germany alone takes several months adding to another few months of on-the-ground fieldwork.

In addition to a need for fast and accurate data, the current situation also demands detailed information on the circumstances before the Corona-crisis. Without prior information we have no way of evaluating change caused by the pandemic. Furthermore, a one-off picture of social life in a given week is quickly outdated, as infection rates and containment measures evolve. As a consequence, we observe a need for fast, frequent, and accurate data collection based on an existing long-term panel that contains pre-Corona information on society.

At the outbreak of the COVID-19 pandemic the German Internet Panel (GIP) was in the extraordinary position to serve all of these needs with a fast and frequent data col-

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lection based on an existing longitudinal probability-based panel of the general adult population. On 20th March 2020, the data collection of the Mannheim Corona Study (MCS) was thus launched with the aim to provide decision-makers in politics and the economy, the public, and academia with the information needed to understand the societal effects of the COVID-19 pandemic and swiftly react to them. The MCS collects daily information on a variety of social, psychological, political, and economic topics: on employment, on financial and childcare situations, on people's satisfaction with selected politicians, on attitudes towards democratic processes, on the economic costs and societal benefits of containment measures taken, on feelings of threat and fears, on subjective evaluations of health risks, and on people's risk, social, and health behavior during the crisis. The daily tracking of changes and the GIP longitudinal data structure allow the MCS to monitor social change over time as we live through the pandemic.

Figure 1 showcases the analytic power of the MCS data. The graph depicts the reduction in in-person social contacts, as social-distancing measures were implemented in Germany and the gradual increase of contacts in the weeks since Easter. The figure shows that with the introduction of lockdown measures at the end of March, the German population swiftly curtailed their in-person contacts with family and friends. For the beginning of March, when the Robert Koch Institut, i.e. the German center for disease control, still assessed the threat of the COVID-19 pandemic in Germany as "low to moderate", 84.9% of the population reported having met friends and/or family at least once in the preceding week, this figure dropped to 30.4% during the height of the lockdown measures. The figure also shows that we are approaching pre-Corona levels in recent weeks with 82.2% of the population meeting friends and/or family in the week preceding 22nd May.

2 Study design

The German Internet Panel (GIP)

The MCS was implemented in the GIP, a multi-topic, offline-recruited, probability-based online panel of the general adult population in Germany. To date, the GIP has seen three recruitment rounds: in 2012, 2014, and 2018. The 2012 and 2014 samples were recruited by means of an area probability sample with full address listings and subsequent interviewer-mediated face-to-face interviews (for details see Blom et al., 2016; Blom, Gathmann, & Krieger, 2015). To ensure coverage of persons with and without access to computers and the internet, the GIP provided necessary equipment and support to offline households to enable their participation in the study (for more information see Blom et al., 2017). The 2018 sample took a novel approach by sampling from population registers and sending subsequent postal mail invitations experimentally testing various recruitment strategies including push-to-web.

Since 2012, GIP participants have always received one survey invitation every other month. All sample members are invited to each wave. Unless they explicitly and actively drop out, GIP members officially remain part of the panel and can return to the surveys at every wave, even if they paused their participation for various consecutive waves. For each completed survey, respondents receive an incentive of 4 Euros. If they participate in all six data collection waves of a year or only miss one wave, respondents receive an additional bonus incentive of 10 or 5 Euros, respectively. Incentives are credited towards respondents' panel accounts and paid out twice a year as online vouchers, bank transfers or charitable donation according to the panelists' preferences. The topics covered by the GIP are diverse and include attitudes towards political reforms, the welfare state, German and EU politics, health, social inequality, education, and employment, as well as key socio-demographic information.[1]

The Mannheim Corona Study (MCS)

To conduct the MCS, the GIP sample of 5,598 panel members was divided into random sub-samples. Sub-samples 1 through 7 were each assigned to a specific day of the week, while the eighth sub-sample serves as a control group and is not surveyed in the MCS. 2.7% of the GIP sample (149 individuals) was excluded from the random sub-group allocation of the MCS and not invited to participate for survey practical reasons, because they could not be invited at short notice via the automatic invitation procedures.

On each day of the week, one of the designated subsamples receives an email invitation to the day's survey. Contacted panel members are given 48 hours to participate. However, they are encouraged to take part on the day of the week that they were assigned to, i.e. within the first 24 hours. MCS participation is incentivized with 2 Euros upon completion. Incentives are credited towards respondents' panel accounts and paid out together with the regular GIP incentives.

Every weekday the result reports of the MCS are updated with the new daily data from yesterday and published on the MCS website[2]. Responses on a specific day are analyzed together, i.e. persons who responded directly on the first day (e.g. Monday) are included in the analysis of that specific day (Monday). Answers of respondents, who participated on the day after (Tuesday), are analyzed together with the answers on that day of the next sub-sample. In this way, we minimize biases, because every daily analysis includes both early as well as late respondents.

[1] The GIP survey data and documentation can be retrieved here: https://www.uni-mannheim.de/en/gip/for-data-users.

[2] https://www.uni-mannheim.de/en/gip/corona-study/

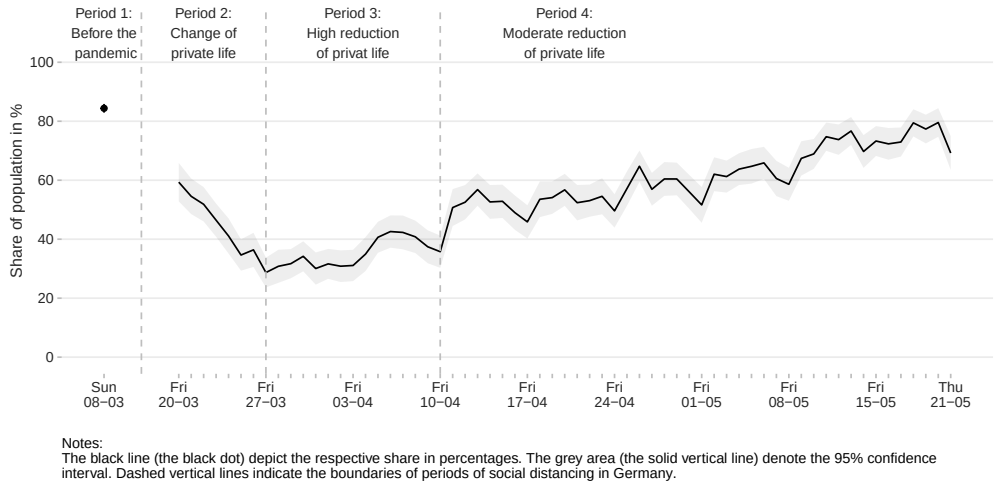

Figure 1. Proportion of the German population with at least one in-person contact with friends or family during the preceding week.

Within one week, the questionnaire remains exactly the same for all participants. Across weeks, the questionnaires are kept largely constant to allow for a long-term continuation of our time series. However, to conduct in-depth analyses of selected topics and to react to unforeseen events, the questionnaire is re-evaluated and updated every week. The MCS questionnaires are available on the study website[3].

All analyses conducted with the MCS are weighted and weights are calculated for each daily sample. Each day we carry out a two-stage weighting procedure: At the first stage, we estimate a response propensity weight, which projects the characteristics of the MCS respondents to the general GIP sample (weighting characteristics: employment and occupational sector). At the second stage, we estimate a raking weight, which extrapolates the characteristics of MCS respondents to the general population of Germany according to the German Mikrozensus[4] (weighting characteristics: age, gender, marital status, highest level of education, household size, and federal state)—i.e., a chained equation algorithm imputes missing values in the weighting variables. The final weight is trimmed for values > 4 and values < 1/4.

3 Participation

To assess the extent to which the GIP participants can be recruited into the MCS, we first examine the MCS response rates. This also allows us to assess how participation changes across the MCS weeks of data collection and to examine whether the MCS sub-samples that are invited on different days of the week differ in their participation rate. For the analyses, we define the response rate as the number of people who responded to an MCS survey request divided by the number of people who were invited to participate.

The average response rate across data collection weeks is 62.4%. The daily response rate ranges from 59.2% on Fridays to 65.7% on Mondays (see "daily response rate" in Table 1, for more detailed information see also Tables A1–A3 in the online appendix, which can be downloaded from from the MCS website.[5]).

Table 1
Average daily response rate, immediate response rate, and share of immediate responses by week day

Week day	Daily response rate (%)	Immediate response rate (%)[a]	Share of immediate responses (%)
Monday	65.7	58.6	89.1
Tuesday	59.8	53.1	88.8
Wednesday	64.5	56.9	88.3
Thursday	62.0	54.3	87.5
Friday	59.2	50.8	85.8
Saturday	61.2	49.3	80.6
Sunday	64.4	55.5	86.1
Total	62.4	54.1	86.6

Averaged across the first nine data collection weeks
[a] Response on the day of invitation rather than on the following day

We encouraged participants to respond on the day of their invitation. However, respondents were able to also respond the day after their invitation. As Table 1 shows, the average response rate on each day of data collection would have been

[3] https://www.uni-mannheim.de/en/gip/corona-study/questionnaires

[4] See https://www.forschungsdatenzentrum.de/en/household/microcensus

[5] https://www.uni-mannheim.de/en/gip/corona-study/methodology.

considerably lower, had we allowed participants to only respond on the day of their invitation (on average 62.4% compared to 54.1%; see columns "daily response rate" and "immediate response rate" in Table 1, respectively). Nonetheless, the vast majority of responses was always obtained on the day of the invitation (on average 86.6% of all responses; see column "share of immediate responses" in Table 1). This share is lowest on Saturdays (80.6%) and highest on Mondays (89.1%), indicating that Monday is generally the best day to invite people to achieve high response rates and a high share of immediate responses.

While the response rates in the MCS vary to some extent across the seven daily invitation sub-samples, they are generally very stable across the first nine weeks of data collection, varying only between 60.2% on average in the first week of data collection and 64.4% in the second week of data collection (see "weekly response rate" in Figure 2 and Table A1 in the online appendix). Figure 2 displays the daily changes in the response rate and the immediate response rate across the first nine weeks of data collection. Whereas there is some variation across weekdays, response rates are surprisingly stable across the weeks of data collection.

Placing the MCS response rates into the larger picture of responses to the GIP, we draw a comparison between the MCS and the most recent GIP wave prior to the beginning of the COVID-19 outbreak (January 2020). Of the 5,598 sample members that were invited to both studies, 70.4% participated in the January GIP wave, whereas 73.2% participated in at least one of the MCS surveys during the month of April.

Overall, 41.5 % of sample members participated in all first nine MCS waves, another 10.4% missed only one MCS wave. Furthermore, GIP participation correlates highly with MCS participation (Cramér's V= 0.75).

4 Data accuracy

While it is important to achieve high response rates at each day of data collection, it is also crucial that the collected data are as accurate as possible. We examine the extent to which the MCS respondent samples at each day of data collection accurately represent the German population with an estimation of the Average Absolute Relative Bias (AARB; see Groves, 2006).

The AARB is an aggregate measure of bias across a set of variables. Essentially, it provides an overview of how much a particular sample deviates from the target population in terms of known characteristics available from an external benchmark. We calculate the AARB for each respondent sample at each day of data collection using the German Mikrozensus as an external benchmark. The Mikrozensus provides the official population statistics for Germany and is a mandatory annual survey of one percent of the German resident population conducted by the German Federal Statistical Office (Destatis). The variables that we use in the calculation of the AARB are age, gender, education, household size, marital status, region, and citizenship (see Tables A4 and A5 in the online appendix for more information).

Table 2
Average daily AARB by participation day and invitation day

Week day	Daily AARB by participation day %	Daily AARB by invitation day %
Monday	10.8	11.2
Tuesday	13.3	14.0
Wednesday	11.2	12.1
Thursday	10.7	11.1
Friday	11.9	11.8
Saturday	10.4	11.4
Sunday	12.5	12.5
Total	11.6	12.0

Averaged across the first nine data collection weeks

The AARB across data collection weeks is low at 11.6% on average (see "daily AARB by participation day" in Table 2; for more detailed information see Tables A6-A7 in the online appendix). On average across data collection weeks, the daily AARB ranges between 10.4% on Saturdays and 13.3% on Tuesdays. The day with the highest response rate (Monday; see Table 1) is among the days with the highest respondent sample accuracy, whereas the day with the lowest response rate (Friday) is among the days with the lowest accuracy. But note that, on the whole, differences in AARBs across weekdays are rather small (3%-points at maximum).

Participants who respond on a particular day may have been invited on this specific day or on the day before. Therefore, it is pertinent to examine the accuracy of the respondent sample of a particular invitation day (i.e. regardless of whether respondents participated on the invitation day or on the day after), in addition to the accuracy of the respondent sample of a particular participation day (see "daily AARB by invitation day" in Table 2). As Table 2 shows, the average daily AARB by invitation day is 12.0%. There is virtually no difference between the AARBs for the two sample definitions.

Just like the AARB is highly stable across data collection week days, it is also highly stable across data collection weeks, varying only between 11.2% on average in the third week of data collection and 12.0% in the first week of data collection (see "AARB weekly average" in Figure 3 and Table A6 in the online appendix). Moreover, the week with the lowest response rate (first week) is associated with the lowest respondent sample accuracy, whereas the week with the highest response rate (second week) is associated with higher accuracy. However, on the whole, differences in

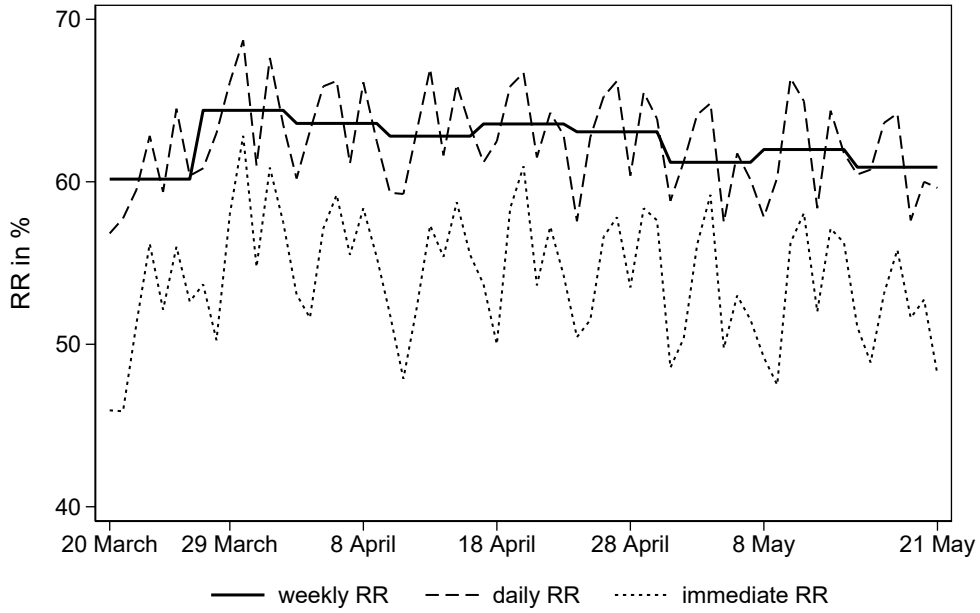

Figure 2. Average weekly response rates ("weekly RR"), response rates per day ("daily RR"), and response rates on the day of invitation ("immediate RR").

AARBs across weeks are again small.

In addition to weekly average AARBs, Figure 3 also shows the daily changes in the AARB by participation day and by invitation day across the first nine weeks of data collection. In contrast to the response rate results, the findings presented in Figure 3 suggest that sample accuracy is not only highly stable across data collection weeks, but also from one day to the next. In fact, to distinguish any daily variation in sample accuracy, we considerably zoomed and re-scaled the y-axis to the observed bias range.

Observed biases are mostly due to an underrepresentation of non-German citizens in the MCS (on average 3.1% in the MCS compared to 12.8% in the Mikrozensus). In addition, the youngest age group (16 to 29 years) and people with low education are slightly underrepresented (youngest age group: 17.2% in MCS and 20.9% in Mikrozensus; low education: 26.2% in MCS and 31.0% in Mikrozensus). Gender, household size, marital status, and geographic region are highly accurate across the MCS data collection weeks (see Table A4 and A5 in the online appendix for more detailed findings). These biases for the MCS are very similar to those of the regular GIP data collection waves. In fact, all German-language surveys in Germany show such underrepresentation of non-German citizens.

5 Open science approach

The COVID-19 pandemic has changed people's everyday lives profoundly and is continuing to have ever-changing social, psychological, political, and economic consequences. To be able to accurately and timely inform the public and government decision-makers about these highly dynamic processes, it is imperative to collect accurate longitudinal survey data at daily time-intervals. This is the purpose of the MCS in Germany.

However, the data collection does not suffice in and by itself. To be effective, the data also have to be processed and analyzed quickly and the results have to be brought to the attention of the relevant social, political, and economic actors. Therefore, it is necessary to access information outlets less familiar to academics, such as free online reports, press-releases, media interaction, and direct contact with governmen decision-makers.

To this end, the MCS built a public dissemination strategy into its design. Every workday, the MCS team updates its daily reports with key indicators from the survey and publishes them together with detailed results tables on the study website under a Creative Commons licence (CC BY) for free retrieval and re-use. To enable this process, the data delivery, preparation, weighting, analysis, and reporting procedures have been largely standardized. In fact, by now, these daily reports, which are available in English and German and contain results up to the previous day, are uploaded to the study website by noon of the current workday.

In addition to these daily reports, we publish focus reports, which explore selected topics in more detail, are less standardized and updated at larger time intervals. Topics of the focus reports published so far include dynamics in employ-

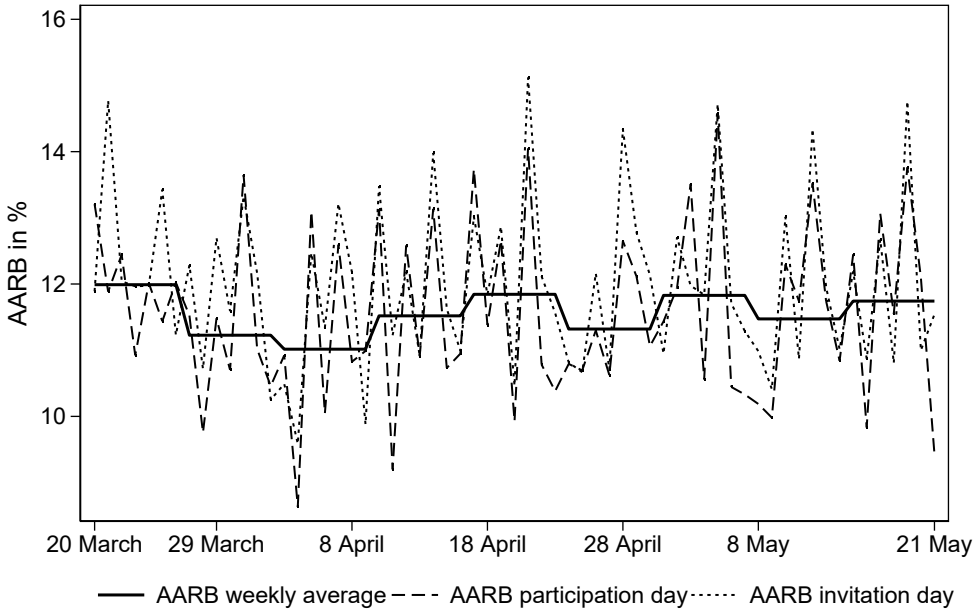

Figure 3. Absolute Average Relative Bias (AARB) at each day of data collection in the MCS among the respondent samples by day of invitation, day of participation, and as weekly averages.

ment and the provision of childcare, attitudes towards democratic control during the pandemic, developments and correlates of social distancing behaviors and the development and social structures of fears.

In addition to the publications on the website, researchers involved with the study write press releases and invest in media relations to further communicate the MCS findings to a wider public audience. This has led to a media coverage that has been overwhelming at times and includes newspaper articles as well as radio and television appearances of various participating researchers (e.g. SPIEGEL, 2020; Südwestrundfunk (SWR) Aktuell, 2020).

Most importantly, however, the MCS invests in communicating its results to national decision-makers. For example, researchers at the MCS are now working closely with the Federal Ministry of Labour and Social Affairs (BMAS) and the Federal Institute for Population Research (BiB) at the Federal Ministry of Domestic Affairs (BMI), which rely on the MCS data for current developments in the labour market, working from home, and childcare arrangements. Furthermore, our results on the acceptance of containment measures, social distancing and fears are regularly discussed by members of the German Corona-crisis cabinet.

To the researchers involved in the study, the MCS open science approach and public outreach endeavours are probably the most innovative, upheaving, and directly rewarding feature of the MCS design.

Acknowledgements

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Commentary

As did past epidemics, the COVID crisis touches upon social reality in two related ways: highlighting key characteristics, on one hand, while also fostering change at potentially unprecedented speed, on the other. The public research infrastructure is one such aspect of social reality that is suddenly thrown into the limelight. This observation is obvious with regard to epidemiological or pharmaceutical expertise, but it applies to social research as well. To obtain timely, recurrent, and reliable information on COVID-related behaviors and views, the best option by far is to have a large-scale on-line panel based on off-line probability sampling already in place. The possibility of kick-starting a COVID survey based on as sophisticated a panel as the GIP inevitably triggers the envy of less fortunate research communities elsewhere, who can only hope that this crisis convinces their governments (and perhaps private-sector stakeholders) of the need for sustained long-term investment in survey research infrastructure in general and a GIP-style panel, in particular.

This privileged baseline situation allowed the GIP team to launch a remarkably ambitious survey operation within days of the WHO's "global pandemic" alert. As time passes and the collective shock of the crisis' onset gives way to the realization that it will draw on for many more months, quite possibly even years, the wisdom of opting for daily data collection and publication may become increasingly questionable. While the logistic and operational capacity of handling such ultra-fast periodicity is admirable, less frequent measurement and reporting (once a week?) might be preferable with a view to preventing participation fatigue and maintaining public and media interest in the project's output – apart from opening up the option of employing bigger samples, perhaps in order to better grasp regional diversity. Similarly, some questionnaire items bear witness to the immediacy of the first outbreak and might require adaptation, even at the cost of discontinuing some item time-series. For example, the frequency of social contacts has arguably become less relevant than the fine-print of whether, and which, protection measures are taken; and rather than requesting prospective infection-rate estimates, it might be preferable to complement serological studies—a slow and expensive operation—by asking panelists to report any potentially COVID-related symptoms. Such adjustments would not diminish the merit of having put the GIP framework to use in this unprecedented crisis.

That merit is further enhanced by the MCS's emphasis on the public role of social research, comprising both the attempt to make the data as useful as possible for decision-makers, and their timely publication online. However, such transparency comes at a price: there is virtually no aspect of the paper that cannot be found somewhere on the GIP/MSC website. Were it not for the highly unusual conditions of this Special Issue, the paper would not be publishable for the simple reason that it refers to published material throughout.

From a methodological viewpoint, the paper's most interesting part by far is the "data accuracy" section which presents computations of overall sampling bias (AARB), with broadly favorable results; in contrast, somewhat excessive attention is paid to the comparison of participation rates and sampling bias by day of interview versus day of invitation. Most of the observed bias is attributed to a severe under-representation of non-German citizens in the MSC, a problem that is reported to be omnipresent in the GIP and other surveys, but left unexplained.

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Reply to Rinken

The commentary by Dr. Rinken provides a helpful ground for reflection on the approach of the Mannheim Corona Study (MCS). The methodology developed by the German Internet Panel (GIP) over the course of eight years, i.e. a probability sample base for a longitudinal online survey with the capacity to react swiftly to societal change, has seldom been appreciated by the scientific community the way it is at the moment. To our surprise and delight this appreciation has largely not been voiced in a tone of envy, but positively and collaboratively in a joint effort to better understand the dynamic times that we are living through.

Already now, just two months later, it seems unfathomable how quickly the MCS was operational. On Monday, 16th March, we applied for and received the institutional go-ahead; by the afternoon the operations and content teams were on board; by Wednesday we had contracted our programmers, project management, and hotline at forsa and finalized the week 1 questionnaire; by Thursday all other survey materials (e.g. invitation emails) had been finalized, the questionnaire programmed and tested so that by midnight before Friday, 20th March, we were in the field. It also seems surreal now how little we knew back then about how the pandemic would evolve; many assumed that we would return 'back to normal' after a month or two. In this light, Dr. Rinken's encouragement to re-think parts of our design is well taken. In fact, many suggestions like adding flexibility to the MCS questionnaire by measuring concepts relevant at specific stages of the pandemic have already been implemented from week 2 onwards. In addition, our data are now augmented with regional information on daily infection rates and official small area statistics. Finally, the current MCS is designed to run for a total of 16 weeks until 10th July. While response rates remain high, the rapid change previously experienced is now dying down, making it less pertinent to continue the data collection over the summer. Instead, we will be building the capacity to re-field the study later this year, when and if infection rates rise again.

With respect to our open science approach, we strongly believe that the COVID-19 pandemic has shown academia that a timely open communication of results is indispensable, as is the accreditation of research by peer-reviewed journals. We hope that the social sciences will catch up on to this approach that the natural and medical sciences are embracing more than ever. Now is the time to carve out the essential role that our research can play for society.