Psychological distance towards COVID-19: Geographical and hypothetical distance predict attitudes and mediate knowledge

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Highlights:

What is already known on this subject?

-The spread of COVID-19 varies geographically, entailing differences in peoples' evaluation of the disease

-Closeness to diseases is psychologically constructed

-Psychological distance already showed to be relevant for different other diseases and health-related behaviours

What does this study add?

-Geographical and hypothetical distance affect peoples' evaluation of COVID-19

-Geographical and hypothetical distance mediated the effect of knowledge on attitudes

-Psychological distance needs to be considered in science communication and education

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Abstract

Objectives: We applied the concept of psychological distance to understand the perceived affection by COVID-19 and investigated its connection with protective behaviour (RQ_1), context-specific antecedents (RQ_2), and its possibility to mediate the effect of knowledge on attitudes (RQ_3).

Design: We conducted a quantitative cross-sectional study (N = 395, M_{age} = 32.2 years, SD_{age} = 13.9 years, 64.3% female) in Germany in July 2020, a time with a low incidence of people infected with Sars-CoV2.

Methods: People completed online questionnaires about socio-psychological constructs addressing COVID-19, further information was included from external sources.

Results: Geographical distance only predicted cognitive attitudes towards COVID-19 (β = -0.25, $p < 0.001$), hypothetical distance (i.e. feeling to be likely affected by COVID-19) predicted participants' affective, cognitive, and behavioural attitudes ($-0.16 < \beta < -0.28$) and the installation of a warning-app (β = -0.18, $p < 0.01$). Geographical distance to COVID-19 was predicted by living in cities and knowledge. Hypothetical distance was affected by Sars-CoV2 cases in social surrounding, knowledge, and level of education. Hypothetical and geographical distance mediated the effect of knowledge on attitudes.

Conclusions: While geographical distance affected peoples' cognitive evaluation of COVID-19, hypothetical distance predicted the evaluation and the implementation of protective behaviours. Since Sars-CoV2 affects spatial regions differently, there is a need for addressing the likelihood of infecting oneself with COVID-19, which may be an objective for formal and informal educational activities. However, the success of these activities depends on peoples' geographical and hypothetical distance, given their mediating role between knowledge and attitudes.

Keywords: COVID-19, psychological distance, behaviour, attitudes, knowledge, warning-app

Psychological distance towards COVID-19: Geographical and hypothetical distance predict attitudes and mediate knowledge

Introduction

Since the beginning of the COVID-19 pandemic, global efforts started to halt or delay the progression of pandemic by applying protective regulations. For example, the German government issued several measures to contain the virus outbreak (Bundesregierung, 2020). This included to temporally close borders, restrict large parts of the public and social life, make people wear mouth-and-nose covers, and keep at least 1.5 meters distance to each other. However, the adherence to these legislations often depends on psychological reactions to the situation (Arden et al., 2020). To understand these reactions, it is of vital interest to investigate peoples' motivations and attitudes to follow the recommended preventive behaviours such as wearing masks, practicing social distancing, or installing a contact tracing app for better tracking active cases (Arden et al., 2020).

Besides these motivations, knowledge represents a central reason for people to behave in concordance with health-favourable behaviours (Arnold, 2018). Therefore, science communication plays a major role for bringing scientific knowledge to action and may help people to better understand infection diseases such as COVID-19 (Bavel et al., 2020). But information alone may not lead to intended changes in behaviour, which may also be affected by mediating variables such as attitudes or personal connections (Puspitasari, Yusuf, Sinuraya, Abdulah, & Koyama, 2020). To sufficiently respond, a further investigation of possible mediators between knowledge and related constructs is essential.

The identification of relevant variables requires the consideration of different socio-psychological and demographic variables. Prior studies in the context of COVID-19 already investigated factors such as media exposure, risk perception, or emotion regulation (Lin et al., 2020; Rubaltelli, Tedaldi, Orabona, & Scrimin, 2020). In addition, Marinthe et al. (2020)

showed that the motivation for protecting oneself may be connected to complying with specific containment measures. For demographic variables, studies demonstrated how age and prior illness may be connected to a larger concern about this issue (Lauri Korajlija & Jokic-Begic, 2020). These findings allow for a detailed intra-psychological view on peoples' motivations. However, they may be biased by the fact, that the severity of the COVID-19 pandemic varies across geographical regions, which needs to be addressed as a relevant demographic characteristic (Ascani, Faggian, & Montresor, 2020). While the geographical spread also has been investigated in prior studies (e.g. Ascani et al., 2020), it may be likely to assume that these effects are psychologically constructed. Currently, this psychological construction of distance to COVID-19 is scarcely understood. Besides explaining peoples' adherence to the protective measures within the selected issue, the connection to health contexts such as COVID-19 may be relevant for general health-related decision-making.

The present paper addresses this research gap by applying the concept of psychological distance to the recent COVID-19 pandemic. The framework describes peoples' evaluation of distance to specific objects in the four dimensions of geographical, social, temporal, and hypothetical distance. Within the study we investigate the connections of these dimensions with attitudes towards COVID-19 and the installation of the warning-app as an exemplary behavioural outcome (RQ_1). We then tested possible antecedents of psychological distance (RQ_2) and its ability to mediate the link between knowledge and attitudes (RQ_3).

Theoretical background

Psychological distance as closeness to COVID-19

Psychological distance describes the subjectively perceived distance to certain objects, events, or actions (Liberman & Trope, 2008; McDonald, Chai, & Newell, 2015) and is characterized by four dimensions: geographical, temporal, social and hypothetical distance (Liberman & Trope, 2014). Consequently, people perceive an issue as psychologically close if

it affects them in their direct spatial environment, in an immediate time frame, them personally, and if they evaluate to be likely concerned by the event at all.

Psychological distance is evaluated based on the construal level theory, according to which humans use mental constructs of different levels of abstraction to access objects (Trope & Liberman, 2010). Based on Liberman and Trope (2010), low-level and high-level construal may be differentiated from each other. Low-level construal is more concrete and detailed, as it is formed for rather close objects and events. High-level construal, on the other hand, is more abstract and refers to distant objects and events. Table 1 gives an overview of how the dimensions of psychological distance can be applied to the COVID-19 pandemic with the respective construal level.

[Please insert Table 1 about here]

The concept of psychological distance has already been applied to various health contexts, including virus-induced Ebola haemorrhagic fever or Zika disease (Johnson, 2018; Van Lent, Sungur, Kunneman, Van De Velde, & Das, 2017). In these studies, lower psychological distance was associated with an increased motivation for engaging in protective measures (i.e., avoiding traveling in Zika-effected areas). In another study, White, Johnson, and Kwan (2014) showed that people evaluate psychologically close viral diseases as more dangerous than psychologically distant ones. Besides this, psychological proximity increased the willingness for conforming with protective behaviours (i.e., paying for vaccines; White et al., 2014). However, it remains unknown whether such findings also hold true for psychological distance and COVID-19. Zheng, Miao, & Gan (2020) already applied the construct of psychological distance to COVID-19, but had a focus on general health and life satisfaction. While they found the regional number of confirmed COVID-19 cases as a negative predictor of the psychological distance towards the disease (Zheng et al., 2020), further possible correlates remain unknown.

Attitudinal and behavioural correlates of psychological distance

Attitudes are defined as a psychological tendency towards specific objects, actions, ideas, behaviours, or persons (Ajzen, 1991). Psychological tendencies are expressed by the fact that a particular attitude object is evaluated with a certain degree of favour or disfavour. Thus, attitudes are understood as an overall evaluation of that object (Maio & Haddock, 2010). Eagly and Chaiken (1993) described attitudes as a tripartite construct, differentiating between affective, cognitive and behavioural attitudes (ABC model). While the cognitive component includes the beliefs about the attitude object, the affective component develops from associated emotions. The behavioural dimension, on the other hand, represents behavioural intentions towards the respective outcome (Ajzen, 2002; Rosenberg, Hovland, McGuire, Abelson, & Brehm, 1960).

Prior studies already showed how attitudes are relevant for following protective behaviours such as washing hands and practicing social distancing in the context of COVID-19 (Lin et al., 2020). We therefore hypothesise the same relation in our study (H_1). To investigate the effect of psychological distance on a specific behavioural outcome, we included the installation of a contact tracing app for mobile devices (H_2). Similar to other countries, German authorities decided to develop such an application for mobile devices ("corona warning-app"), which may be used to monitor and improve the understanding of contact chains. As the app potentially helps to contain the spread of COVID-19 through better contact tracing (Blasimme & Vayena, 2020), it can be considered as a relevant protective behaviour.

Hypothesis 1 (H_1): *Psychological distance is connected to peoples' affective, behavioural and cognitive attitudes.*

Hypothesis 2 (H_2): *Psychological distance is connected to peoples' willingness to install the corona warning-app.*

Antecedents of psychological distance towards COVID-19

People may strongly differ for their individual psychological distance. Based on prior studies, we hypothesised overall five different characteristics, that may be connected to peoples' evaluation of psychological distance towards COVID-19. First of all, this includes the residence of people, as more cases were found in cities than on the countryside (H_3; Schaff, 2020) and cases in specific districts (H_4; Zheng et al., 2020). Additionally, cases in peoples' social surrounding may be one of the few unmediated experiences of the pandemic, which is why they also may affect the psychological distance (H_5). Nguyen et al. (2020) further showed that the profession is a relevant demographical variable that may be connected to the perception of COVID-19 (H_6; Nguyen et al., 2020). In particular, the daily contact with COVID-19 patients is an extraordinary situation for medical personnel (Bielicki et al., 2020). Finally, we assumed that more knowledge (e.g. about ways of spreading the virus, about understanding the research, etc.) has an influence on the psychological distance (H_7). This would be in line with construal-level theory, which assumes less psychological distance for issues with more concrete representations (Liberman & Trope, 2014).

Hypothesis 3 (H_3): *People from cities report a smaller psychological distance towards COVID-19 than people from the countryside*.

Hypothesis 4 (H_4): *People with more cases in their district report a smaller psychological distance towards COVID-19.*

Hypothesis 5 (H_5): *People that report cases of COVID-19 in their social environment report a smaller psychological distance towards COVID-19.*

Hypothesis 6 (H_6): *People that work in the medical sector report a smaller psychological distance towards COVID-19 than people from other professions.*

Hypothesis 7 (H_7): *People with more knowledge about COVID-19 report a smaller psychological distance towards COVID-19.*

Furthermore, we controlled for demographic variables such as gender, age, and the level of education, which have been found to be connected to concern of COVID-19 in prior studies (Lauri Korajlija & Jokic-Begic, 2020).

Mediation of knowledge and attitudes

Variables such as knowledge may be seen as a requirement for understanding governmental regulations surrounding COVID-19 and may lay the foundation for a positive evaluation of the taken actions (Hamza, Badary, & Elmazar, 2020). But similar to other diseases, this connection may be affected by other factors such as psychological distance. To investigate differences in the connection of the evaluation of the protective measures when someone feels only a small distance to COVID-19, we proposed this as our final hypothesis (H_8).

Hypothesis 8 (H_8): *Psychological distance mediates the effect of knowledge on attitudes.*

Methods

Research design and sample

We chose a cross-sectional quantitative research design with a standardized online questionnaire, which was distributed via the platform *SociSurvey* (https://www.soscisurvey.de/). The survey was online for two weeks from July 1st 2020 to July 15th 2020, in direct proximity to the publication of the corona tracing-app. The link to the questionnaire was distributed via convenience sampling, mainly through social networks (e.g. Facebook, Instagram, Snapchat, Twitter and WhatsApp). Participants needed on average approximately 11 minutes to complete the questionnaire. The questionnaire was distributed in German. The final version of all items with corresponding English translations can be found in the Supplementary Table 1.

Inclusion criteria for study participants were a minimum age of 18 years and a place of residence in Germany (self-reported data). Overall, a total of 395 persons completed the survey

($mean_{age}$ = 32.22 years, SD_{age} = 13.86 years, age range from 18 to 80 years, 64.3% female,). The majority of the participants had at least a university entrance qualification ("Abitur", n = 329, 83.3%). In addition, about half of the participants lived in urban or suburban areas (n = 195, 49.4%). Based on the self-reported professions, we have divided the participants into certain occupational groups that are probably more affected by COVID-19. These groups were education (n = 123, 31.3%), medical (n = 32, 8.1%), and other (n = 157, 39.7%).

All procedures were in line with the ethical standards of national and international research committees such as the Code of Conduct of the American Psychological Association or the Helsinki Declaration. We guaranteed anonymity and provided information about the purpose of the study. Informed consent was obtained from all participants involved in the study and no incentives were given. All participants had the possibility to cancel their participation at any time. Due to this, we did not seek consent from an institutional ethics review board in adherence to national and institutional guidelines. The data is available in the open science framework (https://osf.io/j4hvc/?view_only=7decec27e2ab4d0f8cca2e0de9a9ede3).

Questionnaire design

Demographic and other contextual variables

While age, profession, and district were assessed in an open-ended format, gender (male, female, diverse), educational level, installation of the warning-app, and residence (rural to urban) were formulated as closed questions. The district was used to determine the number of active cases with the help of the "Robert Koch-Institute: COVID-19-Dashboard" (Esri Deutschland GmbH, 2020). We also asked, if participants knew about a positively-tested COVID-19 case in their close social surrounding and whether they have the corona warning-app installed with closed binary items.

Psychological distance

Due to the lack of standardized scales to measure psychological distance, we adapted the scale based on existing studies (Büssing, Dupont, & Menzel, 2020; Jones, Hine, & Marks, 2017). We designed three items for each of the four dimensions of psychological distance as displayed in Table 1. These items were constructed as statements, which allow people to indicate their agreement with the respective items (Bryman, 2008). This resulted in a total of 12 items, which were assessed on a 6-point rating scale. Since several items were measured as concern and not as distance, these items have been reversely coded as displayed in Table 2 before combining all items of the respective dimension to one mean value (Trope & Liberman, 2010).

Attitudes

Based on the tripartite model of Eagly and Chaiken (1993), two positively and two negatively formulated items were designed for each of the affective, cognitive and behavioural dimension of attitudes. This resulted in a total of 12 items for the measurement of attitudes and each item was assessed on a 6-point rating scale. Mean values for the individual items were formed to create scales for the different dimensions. The negatively formulated items were reversely coded before they were aggregated for the analysis.

Knowledge test

The study included a knowledge test on COVID-19 consisting of seven items, which was adapted from other studies (Hamza et al., 2020). The knowledge tested was about risk groups, symptoms, statistical indicators of the pandemic, the first occurrence of the virus, the use of mouth-nose covers, and the molecular mechanism of the virus' entry into the human body. The items were presented in a closed answer format. Correct answers were scored with 1 and the number of correct responses was summed to a knowledge score, ranging from 0 to 7. The higher the score, the higher the knowledge about COVID-19.

Statistical analysis

Before investigating the research questions, we ensured the measurement abilities of the scales and conducted a confirmatory factor analysis for the psychological distance (Table 2). As recommended by Schermelleh-Engel, Moosbrugger, & Müller (2003), different indices were used to evaluate the fit of the model to the data (chi-square values (χ^2), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fitting index (CFI)), which were then evaluated according to the cut-offs for good fit ($\chi^2 \leq 2$, CFI ≥ 0.97, RMSEA ≤ 0.05, and SRMR ≤ 0.05). As the dimensions of psychological distance were correlated only with medium strength ($0.14 < r < 0.52$), we analysed the research questions based on the individual dimensions.

We used a path model with the means of the respective variables to investigate the connection of psychological distance to the attitudinal and behavioural outcomes (H_1 and H_2). For model evaluation the same indices were used as for the confirmatory factor analysis. To test the antecedents, we used a two-step regression approach with the individual dimensions of psychological distance as dependent variables ($H_{3\text{-}7}$). Finally, we estimated indirect effects of knowledge with individual dimensions of psychological distance as a mediator with mediator analyses based on four different models (H_8).

We used robust estimators such as spearman-rho as a correlation coefficient, a robust maximum likelihood estimator for the path model, robust regression for the multiple regressions, and robust mediation tests (Field & Wilcox, 2017). All computations were made with R-Studio (version 1.3.1073), the code can be found in the open science framework.

Measurement results of psychological distance

Based on the factor analysis, we obtained good measurement abilities for the psychological distance, even when slight modifications were needed (Table 2). The adapted model achieved a satisfactory fit to the data (χ^2 (21) = 46,478, CFI = 0.97, RMSEA = 0.06, SRMR = 0.04). To confirm the four dimensions of psychological distance, we estimated an

alternative one-dimensional model, that showed the worst fit (χ^2 (27) = 316.645, CFI = 0.67, RMSEA = 0.18, SRMR = 0.10). The modified theoretical model was significantly better in explaining the data than the modified one-dimensional (χ^2 (6) = 238.6, $p < 0.001$).

[Please insert Table 2 about here]

The tests for the measurement abilities of the other scales can be accessed in the supplementary material (Supplementary table 2). These factor analyses confirmed in accordance with the Cronbach`s alpha the theoretical assumption of the tripartite models. All values and bivariate correlations are displayed in Table 3.

[Please insert Table 3 about here]

Results

Effects of psychological distance on behavioural correlates

The path model (Figure 1) showed a very good fit to the data (χ^2 (28) = 578.331, CFI = 1.00, RMSEA = 0.00, SRMR = 0.00). While the geographical distance towards COVID-19 was a significant predictor only for the cognitive attitudes (β = -0.26, $p < 0.001$), hypothetical distance was a significant predictor for the affective (β = -0.18, $p < 0.01$), cognitive (β = -0.28, $p < 0.001$), and also the behavioural attitudes (β = -0.16, $p < 0.01$). Finally, the hypothetical distance also a significantly predicted the installation of the warning-app (β = -0.18, $p < 0.01$). The detailed effects and 95% confidence intervals can be found in the Supplementary Table 3.

[Please insert Figure 1 about here]

The path model explained 33% of the variance for the behavioural attitudes (adj. R^2 = 0.33), 21% of the variance for the cognitive attitudes (adj. R^2 = 0.21), but only 10% of the variance for the installation of the warning-app (adj. R^2 = 0.10) and 6% of the variance for affective attitudes (adj. R^2 = 0.06).

Antecedents of psychological distance

The results for the antecedents of the individual dimensions of psychological distance are described in Table 4. In the first regression step, the geographical distance was negatively predicted by the residence (β = -0.17, p < 0.01) and knowledge (β = -0.14, p < 0.05). Cases in the district, which showed a bivariate correlation to the geographical distance (r = -0.15, p < 0.01; Table 2), was no significant predictor (β = -0.03, p > 0.05). Concerning the temporal distance, none of the variables showed a significant relationship. The social dimension was significantly predicted by the medical profession (β = -0.24, p < 0.01) and cases in the district (β = -0.10, p < 0.01). Finally, the hypothetical distance was significantly predicted by the cases in the social surrounding (β = 0.12, p < 0.01) and knowledge (β = -0.19, p < 0.01).

[Please insert Table 4 about here]

The demographic control variables, which were added in the second regression step, had only a small impact on the results of the regression analyses. All effects remained similarly with small decreases, except for the hypothetical distance. In the second step this dependent variable was only predicted by level of education (β = 0.20, p < 0.01) and knowledge (β = -0.18, p < 0.01), but not by cases in the social surrounding (β = -0.11, p > 0.05). Overall, the models explained only a small amount of variance for the individual dimensions of psychological distance, as no model explained more than 10% of the variance in the dependent variables (0.00 < R^2 < 0.09).

Mediation of knowledge

As displayed in Table 5, geographical and hypothetical distance predicted the effect of knowledge on cognitive and behavioural attitudes. While knowledge was a predictor for the hypothetical (β = 0.21, p < 0.001) and geographical distance (β = 0.19, p < 0.001), hypothetical distance fully mediated the effect of knowledge on cognitive attitudes (β_{TOTAL} = 0.11, p < 0.01), as knowledge itself had no direct effect on cognitive attitudes (β_{DIRECT} = 0.07, p > 0.05). The same full mediation was found for the behavioural attitudes (β_{TOTAL} = 0.10, p < 0.05). While

geographical distance partially mediated the effect of knowledge on the cognitive attitudes ($\beta_{TOTAL} = 0.14$, $p < 0.01$), as knowledge also was a direct predictor ($\beta_{DIRECT} = 0.10$, $p < 0.05$), it again fully mediated the effect of knowledge on the behavioural attitudes ($\beta_{TOTAL} = 0.09$, $p < 0.05$).

[Please insert Table 5 about here]

Discussion

Behavioural correlates

We found a significant relationship between the geographical distance and the cognitive attitudes towards COVID-19 (H_1). This implies differences in the cognitive evaluation of the pandemic, depending on the experienced geographical distance. This result was in line with prior studies, since spatial proximity has been found as prerequisite for psychological distance. (Arden et al., 2020). Furthermore, this underlines the priority of sufficient science communication, as a disease momentarily far away may quickly spread into geographical closeness (Whitworth, 2020). But besides geographical distance, especially the hypothetical distance showed to be an antecedent of the subsequent attitudes.

Hypothetical distance predicted all attitudes, which is in line with prior studies. For example, Lin et al. (2020) found, that people with increased risk perception and corresponding self-efficacy are more likely to take preventive measures to contain COVID-19 in order to minimize their own risk. This may be explainable, for example, by the higher risk people may attribute to the disease if they feel to be likely affected by COVID-19. Another study showed, how people believing in conspiracy theories are unlikely to follow preventive measures, but may be more motivated if they experience a risk of death for themselves (Marinthe et al., 2020). This could be explained by a change in hypothetical distance, which may induce a change of abstract representations of COVID-19 to more concrete ones. Such a concretisation could be

the objective of formal and informal educational activities, which may be used to communicate with people, for example through social media.

Furthermore, hypothetical distance significantly predicted the installation of the warning-app, meaning people more likely installed the app, if they believe that they likely will be concerned by COVID-19 (H_2). The geographical distance showed a bivariate correlation to the installation of the warning-app, but was no significant predictor. This underlines the role of hypothetical distance as an antecedent of protective behaviours in the recent COVID-19 pandemic. Therefore, a more concrete communication about personal risks may be able to foster people´s motivation to install the warning-app.

Regardless of the significant effect of hypothetical distance, the predictors were able to explain about ten percent of the variance in the dependent variable. This was a much smaller amount than was explained for the behavioural attitudes, regardless of the conceptual similarities between both variables. This may partly be explained by the binary coding of the variable. For example, some participants may have had the willingness to install the app, but were not able to do so, for example due to owning a too old smartphone. This variance could not be explained and therefore may have entailed a larger error variance. Even when the models are unable to explain this error variance, the effect of the hypothetical distance makes also sense for this behavioural outcome. To explain more variance, it would be possible to rely on a Likert scale measurement in further studies, similar to prior studies (Altmann et al., 2020).

Antecedents of psychological distance

Our results showed different antecedents for the individual dimensions of psychological distance. Concerning our first hypothesis (H_3), residence significantly predicted only the geographical distance. This illustrates how the higher amount of cases in cities also leads to a smaller geographical distance in these densely populated places. This is in line with prior research, which showed that people from rural areas may hold more negative attitudes towards

COVID-19 (Chen & Chen, 2020). This may be explainable due to the different challenges people face in these regions. For example, people living in the city probably have more frequent contact with strangers (e.g. when using public transport) than people from the countryside. For containing the disease, this implicates that different communication and education strategies may be taken in cities than on the countryside, due to the differing concern of the issue in these regions.

The next variable, cases in the district (H_4), was only predictive for the social dimension of psychological distance. While the social distance was not related to the attitudinal or behavioural outcomes, the effect of cases in the district only on this dimension contradicts prior expectations. As we found a correlation between the geographical distance and cases in the region, a similar connection was expected in the regression. Nonetheless, other variables were better in explaining the variance in the dependent variable. One reason for this could be the connection of residence and cases in the district, as cities generally have also more cases (Schaff, 2020). Another reason may be the time of the study. The questionnaire was filled in July, a time, in which only some districts already had a lot of cases. This could have been affected the results. For future studies a more comparative approach between times with high and low cases in general would be interesting, for example also in the longitudinal perspective. This also concerns the next variable, the cases in the direct surrounding of the participants.

The cases in social surrounding (H_5) were significant predictors of the hypothetical distance. This is a very interesting result, which illustrates how a more concrete experience of the pandemic (i.e. knowing someone infected) entails a more concrete representation of the pandemic. This result is in line with construal level theory (Liberman & Trope, 2008). Nonetheless, we found this connection only in the first step of our regression. In the second step, this variable had no longer a significant relationship to the hypothetical distance, which

was now predicted by the level of education. As the participants were rather well educated, future studies need to replicate this with more diverse samples.

Participants' profession only affected the social dimension, for which people from the medical sector reported a smaller distance (H_6). This is in line with prior studies, which showed how people in medical professions are tested for COVID-19 more often than people in other professions (Allen et al., 2020). They also found that medical workers are at increased risk of infection and should be given greater priority for testing. This could be a reason for a lower psychological distance in these professions.

Concerning our final hypothesis (H_7), we identified knowledge as the only antecedent, which predicted more than one dependent variable. This, again, confirms the assumptions of construal-level-theory about how a smaller distance entails more concrete representations about the respective issue (Trope & Liberman, 2010). The fact that more knowledge leads to less geographical distance may be due to the fact that people with more knowledge are also informed about the current pandemic situation in their district.

While this underlines the role of good public education about the pandemic, we found level of education as the only demographic predictor of psychological distance. The is in line with prior research (Cvetković et al., 2020), but also contradicts prior expectations. For exmaple, it would have been reasonable to expect a connection with age an psychological distance, given the higher risk of a bad course for older age groups. In our study, only 15% of the participants were older than 50. This may be due to the nature of the study, which was established as an online study. Future studies could also further generalize this to explicitly selected older age groups.

Mediation of knowledge and attitudes

Our results showed geographical and hypothetical distance as mediators of the effect of knowledge on attitudes, in line with our hypothesis (H_8). Due to the full mediation of

psychological distance for some models, attempts of informing the public with more knowledge need to consider the perceived distance to the issue. While prior studies found severe differences between peoples' knowledge concerning COVID-19 (Hamza et al., 2020), knowledge will only then entail more positive attitudes, if people experience a small geographical or hypothetical distance. This mediating role could be a vital key for understanding how people may come to different conclusions with the same rational information about COVID-19. Therefore, future studies should more explicitly investigate this connection, as the missing hypothetical distance may be one key factor for people disbelieving the governmental information, besides other personality related factors (Marinthe et al., 2020).

Limitations and further research directions

Besides the already discussed limitations, we were unable to find suitable predictors for the temporal dimension of psychological distance. In part, this may also be due to the timepoint of the study, since the data was collected during a time of low incidence in Germany and Covid-19 outbreaks mainly took place in few specific districts. Besides this, all models generally explained only a small amount of the variance, even when this was similar in other studies (Zheng et al., 2020). The small explained variance may partly be accounted to the variance induced by the online study, as all people may completed the study in unstandardized ways, but the concordance to other studies may indicate the need for further work surrounding the construct of psychological distance.

Regardless of these limitations, we were able to investigate the relevance of perceived affection with COVID-19. One of the differences to prior studies was the application of a multidimensional was of measuring psychological distance, in contrast to prior studies, which neglected the multiple dimensions of the construct (e.g. Zheng et al., 2020). Based on this measurement approach, we were able to describe specific effects of hypothetical distance, which may be an objective for future studies. Furthermore, the mediation of knowledge

illustrated, how personality related variables affect peoples' information processing. The further consideration of such effects may strengthen the understanding of health-related decision-making.

Conclusion

The present study represents the foundation for understanding connections to health contexts such as COVID-19. Specifically, we were able to identify connections between geographical and hypothetical distance with cognitive, affective, and behavioural attitudes in the selected issue. As psychological distance also mediated the effect of knowledge on attitudes, the further investigation and consideration of variables such as psychological distance may be vital to maintain the public consent for following specific governmental measures and understand individual decisions in general. For example, psychological distance may be essential to understand changes in risk assessment, based on construal level theory. Over and above the pandemic, especially the mediating role of psychological distance points to the possibility of integrating psychological distance into models for health-related decision making.

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Table 1
The four dimensions of psychological distance with the subsequent level of construal exemplified for the COVID-19 pandemic.

Dimension	**Continuum of construal**		
	Low-level construal (concrete)		**High-level construal (abstract)**
Geographical distance	The COVID-19 pandemic affects my home town.	The COVID-19 pandemic affects my home country.	The COVID-19 pandemic affects rather distant countries.
Temporal distance	The COVID-19 pandemic currently affects me.	The COVID-19 pandemic will still affect me in five years.	The COVID-19 pandemic will affect me for many years to come.
Social distance	The COVID-19 pandemic affects mainly people like me.	The COVID-19 pandemic mainly affects my family and friends.	The COVID-19 pandemic mainly affects other people.
Hypothetical distance	The COVID-19 pandemic will most likely affect me.	The COVID-19 pandemic is questionable to affect me.	The COVID-19 pandemic is unlikely to affect me.

Table 2

Factor loadings (λ) and fit indices of the confirmatory factor analyses (CFA) for measuring the psychological distance towards COVID-19 calculated with an initial, modified (four dimensional), and modified (one dimensional) factor structure.

	Factor loading		
Item	Initial	Modified (four dim.)	Modified (one dim.)
Geographical			
The COVID-19 pandemic affects my home town. (PDgeo_01)*	.65	.68	.53
The COVID-19 pandemic affects my home country. (PDgeo_02)*	.66	.63	.52
The COVID-19 pandemic affects rather distant countries. (PDgeo_03)	.42	-	-
Temporal			
The COVID-19 pandemic currently affects me. (PDtemp_01)*	.31	-	-
The COVID-19 pandemic will still affect me in five years. (PDtemp_02)*	.90	.92	.46
The COVID-19 pandemic will affect me for many years to come. (PDtemp_03)*	.82	.81	.42
Social			
The COVID-19 pandemic mainly affects people like me. (PDsoci_01)*	.38	.68	.43
The COVID-19 pandemic mainly affects my family and friends. (PDsoci_02)*	.30	.56	.37
The COVID-19 pandemic mainly affects other people. (PDsoci_03)	.42	-	-
Hypothetical			
The COVID-19 pandemic will most likely affect me. (PDhypo_01)*	.74	.74	.75
The COVID-19 pandemic is questionable to affect me. (PDhypo_02)	.73	.72	.69
The COVID-19 pandemic is unlikely to affect me. (PDhypo_03)	.70	.70	.66
Chi-square test (*degrees of freedom*)	303.982 (48)	46.478 (21)	316.645 (27)
Comparative Fit Index (CFI)	.79	.97	.67
Root Mean Square Error of Approximation (RMSEA)	.12	.06	.18
Standardized Root Mean Square Residual (SRMR)	.11	.04	.10
Akaike Information Criterion (AIC)	14914.904	10740.778	11036.805
Bayesian Information Criterion (BIC)	15033.888	10835.965	11108.196

*Note: * = Items were reversed due to the theoretical definition as distance and not closeness.*

Table 3
Bivariate correlations between the dependent variables (dimensions of psychological distance and all attitude components), bivariate correlations of dependent and independent variables (hypotheses and control variables), and descriptive statistics of dependent variables.

	1	2	3	4	5	6	7	8
1. Geographical distance	-	.14	.23**	.52**	-.16	-.31**	-.24**	-.12
2. Temporal distance	.14**	-	.20*	.30**	-.03	-.09	-.15	-.06
3. Social distance	.23**	.20**	-	.37**	-.13	-.08	-.14	-.06
4. Hypothetical distance	.52**	.30**	.37**	-	-.21**	-.35**	-.31**	-.22**
5. Affective att.	-.16**	-.03	-.13*	-.21**	-	.39**	.30**	.19*
6. Cognitive att.	-.31**	-.09	-.08	-.35**	.39**	-	.44**	.26**
7. Behavioral attitudes	-.24**	-.15**	-.14	-.31**	.30**	.44**	-	.15
8. Warning-app	-.12*	-.06	-.06	-.22**	.19**	.26**	.15**	-
9. Residence	-.18**	.07	.03	-.11*	.00	.04	.02	.11*
10. Cases in region	-.15**	-.05	-.11*	-.14*	-.11*	.00	.01	.15**
11. Case in surrounding	.08	.00	.05	.12*	.07	.07	.04	.01
12. Medical profession	-.05	.03	-.18**	-.09	.04	.00	.02	.01
13. Knowledge	-.13*	-.07	.01	-.15**	.07	.13*	.12*	.15**
14. Gender	-.03	-.11*	-.07	-.03	-.04	.07	.25**	-.10
15. Age	.00	-.04	.05	.01	.07	.09	.02	-.09
16. Level of education	-.15**	.00	-.06	-.20**	.03	.12*	.11	.26**
Number of Items	2	2	2	3	4	3	4	1
Mean	2.53	3.56	3.98	2.57	3.45	4.96	4.90	.55
Standard deviation	1.05	1.18	1.09	1.08	1.08	1.01	0.85	.50
Median	2.50	3.50	4.00	2.33	3.50	5.12	5.00	-
Skewness	0.55	0.02	-0.29	0.58	-0.15	-1.55	-1.11	-.20
Kurtosis	0.10	-0.58	-0.10	-0.11	-0.44	2.76	1.85	-1.97
Cronbach's α	.58	.85	.55	.76	.70	.85	.70	-

Note. Correlations in the upper half of the correlation matrix are adjusted for multiple tests. * = $p < .05$, ** = $p < .01$, Corona warning-app was coded (0) not installed and (1) installed, Gender was coded as (1) male and (2) female, Cases in social surrounding was coded (1) yes and (2) no, medical profession was coded (0) not working in a medical profession and (1) working in a medical profession, Residence was coded from (1) rural to (5) urban.

Table 4
Regression results of the antecedents for the dimensions of the psychological distance with standardized regression coefficients (β) and standard error (SE)

	Psychological distance			
Predictors	Geographical	Temporal	Social	Hypothetical
Model 1: Hypotheses				
Intercept	2.47*** (.05)	3.57*** (.06)	3.99*** (.06)	2.51*** (.06)
Residence	-.17** (.06)	.08 (.06)	.04 (.06)	-.11 (.06)
Cases in region	-.03 (.04)	.01 (.03)	-.10** (.03)	.02 (.04)
Case in social surrounding	.07 (.05)	.00 (.06)	.04 (.06)	.12* (.06)
Medical sector	-.06 (.07)	.05 (.09)	-.24** (.07)	-.09 (.05)
Knowledge	-.14* (.06)	-.06 (.07)	.01 (.05)	-.19** (.06)
R^2 (Adjusted R^2)	.06 (.05)	.00 (.00)	.05 (.04)	.06 (.05)
Model 2: Hypotheses and demographic control variables				
Intercept	2.47*** (.05)	3.57*** (.06)	3.99*** (.06)	2.51*** (.05)
Residence	-.16** (.06)	.07 (.06)	.07 (.06)	-.08 (.06)
Cases in region	-.02 (.04)	.02 (.03)	-.10** (.03)	.03 (.04)
Case in social surrounding	.06 (.05)	.00 (.06)	.04 (.06)	-.11 (.06)
Medical sector	-.06 (.07)	.06 (.09)	-.24** (.07)	-.09 (.05)
Knowledge	-.13* (.06)	-.05 (.08)	.02 (.05)	-.18** (.06)
Gender	.00 (.05)	-.14 (.06)	-.06 (.06)	-.02 (.06)
Age	-.03 (.07)	-.06 (.07)	.10 (.06)	-.07 (.06)
Level of education	-.10 (.07)	-.05 (.06)	-.04 (.06)	-.20** (.07)
R^2 (Adjusted R^2)	.07 (.05)	.02 (.00)	.07 (.05)	.09 (.07)

Note. F = F-statistic, *df* = Degrees of freedom, R^2 = Explained variance, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, Gender was coded as (1) male and (2) female, Cases in social surrounding was coded (1) yes and (2) no, medical profession was coded (0) not working in a medical profession and (1) working in a medical profession, Residence was coded from (1) rural to (5) urban.

Table 5
Mediation analyses of the indirect effects between knowledge and the cognitive and behavioural attitudes with hypothetical (model 1-2) and geographical distance (model 3-4) as mediators.

Model 1	Hypothetical distance			Cognitive attitudes		
	β (SE)	LL	UL	*β* (SE)	LL	UL
Hypothetical distance	-	-	-	-0.20*** (0.05)	-0.29	-0.11
Knowledge (direct)	-0.21*** (0.06)	-0.33	-0.08	0.07$^{n.s.}$ (0.04)	-0.01	0.15
Knowledge (indirect)	-	-	-	0.04*** (-)	0.02	0.08
Knowledge (total)	-	-	-	0.11** (0.04)	0.03	0.20
R^2 (adj. R^2)	0.04 (0.03)			0.10 (0.10)		
Model 2	Hypothetical distance			Behavioural attitudes		
	β (SE)	LL	UL	*β* (SE)	LL	UL
Hypothetical distance	-	-	-	-0.22*** (0.05)	-0.32	-0.13
Knowledge (direct)	-0.21*** (0.06)	-0.33	-0.08	0.05$^{n.s.}$ (0.04)	-0.03	0.13
Knowledge (indirect)	-	-	-	0.05*** (-)	0.02	0.09
Knowledge (total)	-	-	-	0.10* (0.04)	0.01	0.18
R^2 (adj. R^2)	0.04 (0.03)			0.10 (0.10)		
Model 3	Geographical distance			Cognitive attitudes		
	β (SE)	LL	UL	*β* (SE)	LL	UL
Geographical distance	-	-	-	-0.18** (0.06)	-0.29	-0.07
Knowledge (direct)	-0.19*** (0.06)	-0.30	-0.08	0.10* (0.04)	0.02	0.18
Knowledge (indirect)	-	-	-	0.03** (-)	0.01	0.07
Knowledge (total)	-	-	-	0.14** (0.04)	0.05	0.22
R^2 (adj. R^2)	0.03 (0.03)			0.08 (0.08)		
Model 4	Geographical distance			Behavioural attitudes		
	β (SE)	LL	UL	*β* (SE)	LL	UL
Geographical distance	-	-	-	-0.18*** (0.05)	-0.27	-0.08
Knowledge (direct)	-0.19*** (0.06)	-0.30	-0.08	0.06$^{n.s.}$ (0.04)	-0.02	0.14
Knowledge (indirect)	-	-	-	0.03*** (-)	0.01	0.07
Knowledge (total)	-	-	-	0.09* (0.04)	0.01	0.17
R^2 (adj. R^2)	0.03 (0.03)			0.06 (0.06)		

Note. *β* = Standardised regression coefficient, SE = Standard error, LL = Lower limit of the 95% confidence interval, UL = Upper limit of the 95% confidence interval, $^{n.s.}$ = not significant, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, R^2 = Explained variance, adj. R^2 = Adjusted explained variance.

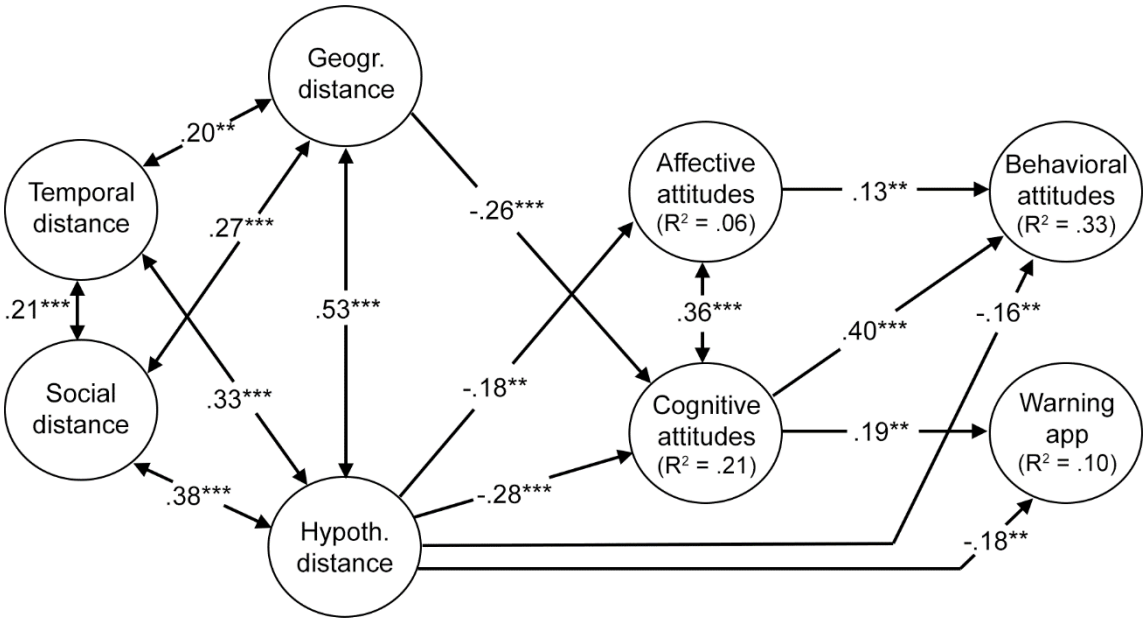

Figure 1. Final path model for the prediction of the behavioural component of attitudes and installation of corona warning-app by psychological distance and other selected study variables.