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Fostering compliance with physical distancing by interactive feedback in the context of the COVID-19 pandemic: evidence from the CorDis study.

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Abstract

Background: To slow down the spread of COVID-19, the observance of basic hygiene measures, and physical distancing is recommended. Initial findings suggest that physical distancing in particular can prevent the spread of COVID-19. Attitudes towards these measures are influenced by many factors and are likely to play an important role in their compliance. Information on the effectiveness and significance of the measures could have an influence on this, but there is empirical evidence that this influence depends on the way of presentation.

Objective: To investigate how information to prevent the spread of infectious diseases should be presented in order to increase willingness to comply with preventive measures.

Methods: In a preregistered online experiment, 817 subjects were presented with either interactively controllable graphics on the spread of COVID-19 and information that enable them to recognize how much the spread of COVID-19 is reduced by physical distancing (experimental group) or text-based information about quantitative evidence (control group). It was hypothesized that participants receiving interactive information on the prevention of COVID-19 infections show a significantly higher willingness to comply with future containment measures than participants reading the text-based information. Explorative analyses were conducted to examine whether other factors influence compliance.

Results: As predicted, we found a small effect (d = 0.22) for the tested intervention. In the exploratory analysis, the only additional significant predictor of change in compliance was health-related anxiety, but the effect was trivial.

Conclusions: When presented interactively, information on how the own behavior can help prevent infectious diseases can lead to slightly stronger changes in attitude towards behavioral prevention measures than just text-based information. Given the scalability of this simple internet-based intervention, it could play a role in fostering compliance during a pandemic within universal prevention strategies. Future work on the predictive validity of self-reported compliance and the real-world effects on the intervention is needed. Clinical Trial: AsPredicted #37823 - https://aspredicted.org/nz4gd.pdf

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Abstract

Introduction: To slow down the spread of COVID-19, the observance of basic hygiene measures, and physical distancing is recommended. Initial findings suggest that physical distancing in particular can prevent the spread of COVID-19. Attitudes towards these measures are influenced by many factors and are likely to play an important role in their compliance. Information on the effectiveness and significance of the measures could have an influence on this, but there is empirical evidence that this influence depends on the way of presentation.

Objective: To investigate how information to prevent the spread of infectious diseases should be presented in order to increase willingness to comply with preventive measures.
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Results: As predicted, we found a small effect (d = 0.22) for the tested intervention. In the exploratory analysis, the only additional significant predictor of change in compliance was health-related anxiety, but the effect was trivial.

Discussion: When presented interactively, information on how the own behavior can help prevent infectious diseases can lead to slightly stronger changes in attitude towards behavioral prevention measures than just text-based information. Given the scalability of this simple internet-based intervention, it could play a role in fostering compliance during a pandemic within universal prevention strategies. Future work on the predictive validity of self-reported compliance and the real-world effects on the intervention is needed.

Keywords: COVID-19, Prevention, Feedback, Visualization

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Introduction

On social media, the hashtag *#stayhome* went viral during the first phase of the COVID-19 pandemic (March / April 2020), reminding people to comply with the social respectively physical distancing regulations for slowing the COVID-19 spread. Physical distancing and pronounced hygiene measures were announced to be the most important strategies to slow the spreading of the disease (World Health Organisation, 2020). Following the suggestion of the WHO, in this paper we favor the term "physical distancing" as opposed to "social distancing", since it is a physical separation that prevents transmission. However, people can still remain socially connected, e.g. via technology. Initial findings from Italy suggest that physical distancing in particular can prevent or slow down the spread of COVID-19 (Dowd et al., 2020). Thus, it is crucial to effectively communicate the urgency and meaningfulness of these measures to the population so that people are motivated to comply with these regulations. However, there is a lack of research on how exactly such information should look like to convince and motivate people to stick to them as effectively as possible. Thus, this randomized, controlled online study aimed to investigate how information should be designed for the general population to increase the acceptance of and compliance with these measures.

According to the theory of planned behavior (TPB; Ajzen, 1991), intentions are modulated by three important factors: personal attitude (including all positive and negative outcome beliefs and evaluations), subjective norms (the perception of social norms and the willingness to comply), as well as perceived behavioral control (PBC). The TPB has been applied to a wide range of studies on health behaviors (Hagger et al., 2016; McEachan et al., 2011; C. Q. Zhang et al., 2020). The three included constructs were found to successfully predict intentions and behavior (see Armitage & Conner, 2000 for a review). In the context of health-related behavior, the TPB has been successfully applied to increase motivation, for example in smoking cessation (Norman et al., 1999). It can be concluded that compliant behavior that results in fewer infections emerges, at least in part, from intentions towards future behavior. The current study testing whether compliance in engaging in and maintaining physical distancing in the context of the COVID-19 pandemic can be fostered using an online exercise that is based on visual feedback.

Arguing with statistical risks is a predominant technique trying to convince people to comply with measures regarding health-related behavior and protection. During the current COVID-19 pandemic, all justifications for fostering behavioral changes and shutdowns were based on prevalence and incidence of infection, and mortality rates in one's own country or other countries (not more than a few weeks old). Based on these current extrapolated observations, predictions were made as to which measures can best contribute to slowing down the spread and flatten the curve. The resulting information for the public was therefore mainly of probabilistic and statistical nature (e.g., getting the R-factor below 1). Statistical evidence, in particular, was found to effectively alter judgments and attitudes (Boster et al., 2000; Campo et al., 2004) – stronger than anecdotal evidence (Hoeken & Hustinx, 2009). However, one major constraint of using statistical information is that humans' estimations of probabilities are biased in several ways (Sanborn & Chater, 2016). Humans

have substantial difficulties to estimate the course of variables that follow exponential growth functions (Levy & Tasoff, 2016). Nevertheless, statistical information is mainly presented in the media as purely text-based information (i.e., numbers), which might not be the optimal form of how information is presented. We used this popular form of communication in our control group as a test of how the information would change compliance in a “treatment as usual” fashion. Thus, individuals receiving this “usual” information were treated as the control group in our study.

In the current online experiment, we wanted to investigate how media representations can be modified to increase the intention of individuals to follow disease prevention guidelines. Therefore, we provided optimized communication strategies that were hypothesized to increase compliance with the safety measures. In the first step, we tried to increase the comprehension of growth functions by stating the results as discrete case numbers of infections (Hoffrage & Gigerenzer, 1998; Munnich et al., 2007). Furthermore, we added graphical visualizations as they have been shown to offer several benefits: First, infographics attract attention (Geidner et al., 2015). Secondly, visualizations support learning when combined with text and information (Y. Kim et al., 2018), and thirdly, they do require less cognitive effort in processing leaving unoccupied capacity that can be used to integrate the new information and adapt the attitude accordingly (Stenning, 1995). In the context of the current COVID-19 pandemic, visually supported information about behavior measures was repeatedly advocated by the research team of the COVID-19 Snapshot Monitoring (COSMO) from the University Konstanz (e.g. Betsch et al., 2020). However, visualization alone is sometimes not impelling enough to yield a benefit in the context of reasoning (Boster et al., 2000; Micallef et al., 2012). People have to engage more with the materials and activate their prior knowledge (Kim et al., 2017). Thus the information is processed more elaborately which contributes to learning (Marraffino et al., 2012), reduced misperception (Geidner et al., 2015), and lesser counterarguing so that even incongruent information might be integrated and prior beliefs changed accordingly.

Based on these findings in this randomized online study, participants in the experimental group are presented with interactively controllable exponential curves and information using concrete examples that enables them to recognize, how much the spread of COVID-19 is reduced by physical distancing (sources: Dowd et al., 2020; Signer & Warshaw, 2020). Participants in the control group are presented with simple text-based information provided by German institutions (Bundeszentrale für Gesundheitliche Aufklärung, 2020; Robert Koch Institut, 2020). We predict that participants who receive interactive information on the prevention of COVID-19 infections show a significantly higher willingness to adhere to containment measures afterwards than participants who only read the text-based information.

Additionally, explorative analyses are conducted to examine whether other possible factors influence compliance. Our choice of variables was guided by similar investigations into compliance with COVID-19 preventive measures (e.g. Clark et al., 2020). In addition to socio-demographic variables like age and gender, the general health status will be included to explore whether subjects who perceive themselves as less healthy

show higher compliance. Knowing infected persons or even having friends or family members with a COVID-19 infection could influence compliance as well, so we included the number of infected acquaintances, friends, and family members as exploratory predictors. Finally, psychometric variables were included. Symptoms of anxiety and depression could reflect a behavioral tendency towards withdrawal, possibly making it less difficult to maintain physical distancing. Self-reported health-related anxiety is also included as a possible predictor, as generally more cautious health behavior makes compliance more likely. The Big Five personality factors might interact with compliance in various ways. While we suspect persons higher in neuroticism and conscientiousness to show higher compliance, extraverted persons and persons more open to experience could find prolonged reductions in social interaction more difficult to maintain. According to the TPB, perceived control about future actions is a predictor of future behavior. Thus, we included a self-efficacy scale.

Method

The study was reviewed and approved by the Institutional Review Board of the Department of Psychology, University of Marburg (Ref. 2020-27k). It was preregistered at AsPredicted (ID #37823) and implemented with the online survey platform “SoSciSurvey” (Leiner, 2019). The survey was available to users via https://www.soscisurvey.de/CorDis from March 27th to May 14th, 2020.

Design and procedure

This is an experimental randomized-controlled study with two groups: interactive information (experimental group) and text-based information (control group).

Control group. The ‘text-based information’ group received an informational text based on recommendations (quantitative evidence) from the Robert Koch Institute and the Federal Centre for Health Education (Bundeszentrale für Gesundheitliche Aufklärung). To make sure that participants had read and understood the information, they had to answer three comprehension questions afterwards. Participants were instructed to indicate whether the following statements were true or false: “Quarantine and social distancing only serve your own protection from COVID-19.”, “If possible, sneeze and cough into a disposable handkerchief or your crook of your arm and turn away from other people”, and “Social distancing means, among other things, staying at home as much as possible”. While the first statement should be rated “false”, the remaining two questions were “true”. Subjects that failed to provide correct answers to any of these questions were excluded.

Experimental group. The ‘interactive information’ group included individual feedback and visualizations of the latest findings in COVID-19 research. In the first part, the effect of physical distancing on the overall number of cases was addressed: A graph showed the development of COVID-19 infections in two cities in Italy (Bergamo and Lodi), with only one of them enforcing contact restrictions (Dowd et al., 2020). The second focused on the impact of the individual comparing three intensities of compliance with physical distancing behavior (either none, 50% less contact, or 75% less contact). The projections were based on the

virus spread on the cruise ship Princess Diamond (Signer & Warshaw, 2020; Zhang et al., 2020). A step-by-step graphical depiction of the experimental condition is given in the supplementary material (https://osf.io/tf7be/?view_only=0078edc2ff8d45809a6c10df0b8ee7f0)

Possible participants following the study's URL were greeted with an introduction page containing general information. Participation was only possible if subjects confirmed that they are at least 18 years old and have read the informed consent page. Next, subjects answered the psychometric scales, followed by the experimental or control tasks. After completing the tasks, subjects filled out the post-trial compliance scale. Optionally, they could provide free-text comments on the study. It was also possible to optionally enter the e-mail address to participate in the raffle of a 30€ Amazon voucher.

Questionnaires

Participants

Recruiting procedure.

The subjects were recruited through media distribution of the questionnaire link and accompanying information. The study was advertised in reports in German newspapers and social media. As an incentive, there was an opportunity to participate in a raffle of Amazon vouchers. This opportunity was used by 30 test persons. As this was an online survey without personal contact with the participants, several criteria were established to ensure the quality of the data. These included control questions on the content of the information provided, as well as the processing time of the questionnaire. Subjects who completed the study in an implausibly short time (i.e. more than two times faster than the average respondent, as proposed by Leiner, 2013) were excluded.

Sample size planning.

A simulation was conducted to determine the sample size. In the simulation, we assumed that pre-trial compliance was influenced by self-efficacy, health concerns, anxiety, and depression symptoms, as well as personality variables. We also predicted a small effect for the experimental condition: subjects in the experimental group were expected to score 0.2 standard deviations higher on the post-trial compliance scale. To detect this effect, the simulation showed that a sample size of N=800 was needed to detect a small effect with 80% power. Details on the simulation procedure, including code to reproduce the results, are provided in the supplementary material. The survey was opened 4069 times and 1367 persons started the survey. 908 subjects completed the study. After removing subjects who met the predefined exclusion criteria, the data of 817 subjects were analyzed.

Statistical analysis

For the main hypothesis, we regressed the compliance scale value after completing the trial on the compliance score before the trial (pre-trial compliance) and a binary-coded variable indicating group membership. For the exploratory analysis, we included additional predictors to determine their influence on intent to comply. The variables included were the sum scores of the PHQ-9, GAD-7, PSWQ, FPI-R, GSE as well as the factor scores of the TIPI, age in years, gender, subjective general health status, number of infected persons in the

family, in close relationships and in distant relationships. All statistical analyses were conducted using the R statistical programming language (R Core Team, 2020).

Results

Descriptive statistics

817 subjects (612 female, 201 male, four third gender) were included in the analysis. The mean age was 34.47 (SD = 13.99). 12.2% of subjects stated that they had at least a secondary school leaving certificate, 35.13% had a high school diploma, and 36.96% had a university or college degree. 5.75% of subjects had a doctorate. 37.21% of subjects were still in training or studying while 50.80% were either employed or civil servants. The remaining participants were either self-employed (4.28%), unemployed (2.10%), retired (4.28%), or exclusively housewives/househusbands (1.35%). No significant differences in these variables were observed between the experimental and the control group.

In the control group, the median time to complete the task (i.e. reading the information) was 69 seconds (MAD = 47.44. In the experimental group, it took subjects 302.50 seconds to read the text and perform the interactive procedures (MAD = 151.97).

Health-related and data and psychometrics

The majority of subjects rated their health as good. The mean of the five-point item was 4.22 (SD = 0.77, Median = 4). Only 14.44% of subjects chose “3” or lower. A summary of all psychometric scale values can be found in table 1. The average score on the depression scale (PHQ-9) was higher than the value observed in a representative sample of the German population (M = 3.30, SD = 4.27, N = 2693; Hinz et al., 2016). This corresponds to a standardized mean difference (Cohen’s *d*) of 0.68 (95% confidence interval: 0.6; 0.76). Similarly, the GAD-7 in this sample was higher than the mean score in the German normative sample (M = 2.95, SD = 3.41, N = 5030; Löwe et al., 2008), corresponding to *d* = 0.61 (95% CI: 0.56; 0.66)-

Table 1:

Descriptive statistics of all psychometric scales used in the study

	Mean	SD	Median	Min	Max
PHQ-9	6.35	5.13	5.00	0.00	27.00
GAD-7	5.27	4.47	4.00	0.00	21.00
PSWQ	45.49	12.33	44.00	19.00	80.00
TIPI Openness	5.22	1.10	5.50	1.00	7.00
TIPI Conscientiousness	5.50	1.09	5.50	2.00	7.00
TIPI Extraversion	4.32	1.38	4.50	1.00	7.00
TIPI Agreeableness	5.19	1.00	5.50	2.00	7.00

TIPI Neuroticism	3.16	1.40	3.00	1.00	7.00
GSE Self-efficacy	29.55	4.48	30.00	12.00	40.00
FPI-R Health concerns	5.70	2.39	6.00	0.00	12.00

Note. SD: standard deviation, Min: observed minimum, Max: observed maximum. TIPI scales are mean scores, all other scores are sum scores.

Post-trial compliance

The results are summarized in the first column of table 2. A large part of the outcome variance (65.85%) was explained by pre-trial compliance. As predicted, we also found evidence for a small effect of the interactive information condition. On average, subjects in the interactive information condition scored 0.17 points higher on the post-trial compliance scale. The group variable explained 1.17% of outcome variance, corresponding to a small effect (r = .11, d = .22).

Table 2:

Results of the linear regression model testing the main hypothesis

Predictor	b	95% CI	$t(814)$	p
Intercept	1.54	¿, 1.77¿	13.39	< .001
Pre-trial compliance	0.77	¿, 0.81¿	40.18	< .001
Experimental group	0.17	¿, 0.23¿	5.36	< .001

Note. All estimates are unstandardized. The 95% confidence interval was calculated analytically.

Exploratory analyses.

We found no evidence for the additional explanatory power of the included variables. Only the effect of the FPI health concerns scale on post-trial compliance was significant but small. It explained an additional 0.16% of variance, which corresponds to a trivial effect (r = .04, d = .08). The effect of the interactive information group, however, remained stable after including the additional variables. The results of the model are summarized in the second column of table 3.

Table 3:

Results of the linear regression model testing additional explanatory variables

Predictor	b	95% CI	$t(794)$	p
Intercept	1.16	¿, 1.69¿	4.30	< .001
Pre-trial compliance	0.76	¿, 0.80¿	38.01	< .001

Experimental group	0.17	¿, 0.23¿	5.34	< .001
PHQ-9	-0.01	¿, 0.00¿	-1.17	.242
GAD-7	0.00	¿, 0.01¿	0.36	.716
PSWQ	0.00	¿, 0.01¿	0.78	.436
FPI Health Concerns	0.01	¿, 0.03¿	1.99	.047
Openness	0.01	¿, 0.05¿	0.87	.386
Conscientiousness	0.00	¿, 0.03¿	0.14	.885
Extraversion	0.02	¿, 0.04¿	1.15	.251
Agreeableness	0.00	¿, 0.03¿	-0.15	.883
Neuroticism	0.01	¿, 0.05¿	0.63	.531
Self-efficacy	0.01	¿, 0.02¿	1.20	.231
Age (years)	0.00	¿, 0.00¿	-0.94	.346
Gender: male	-0.02	¿, 0.05¿	-0.58	.561
General health	0.01	¿, 0.05¿	0.25	.800
Infected, family members	0.14	¿, 0.35¿	1.28	.201
Infected, close relationship	-0.03	¿, 0.09¿	-0.46	.645
Infected, distant relationship	-0.03	¿, 0.05¿	-0.67	.505

Note. All estimates are unstandardized.

Reliable change of compliance values

To illustrate the effects, we estimated a reliable change index for all subjects based on the pre- and post-trial compliance scores. We used the correlation between pre and post scores in the control group (r = .78) as a reliability measure. According to the formula proposed by Jacobson and Truax (1992), a change of 1.05 points can be considered “reliable”. In the interactive information group, reliable improvements concerning the compliance were observed in 26 subjects (6.33%), while one subject had reliably lower scores after the experiment. 384 subjects showed no reliable change. In the control group, 15 subjects (3.69%) improved while seven subjects deteriorated and 384 showed no reliable change. Overall, the chance of achieving a significant improvement in compliance was thus increased by 2.63% in the experimental group. In other words, 38 persons would have to pass the experimental condition for one person to show an improvement in compliance.

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Discussion

During a pandemic, the individual behavior of a person can potentially prevent or cause new infections (Islam et al., 2020). An important determinant of this behavior is the behavioral intent. This intent in turn is influenced by available information on the consequences of the behavior. In this study, we have shown that the way this information is presented can play a role in this. As predicted, we found a small intervention effect. Reliable change analysis suggested that a small proportion of participants significantly changed their attitude. However, given the high scalability of the information presentation method we used in the experimental condition, a small effect is not necessarily trivial. If tasks like the one used in this study are placed on highly frequented Internet sites, tens of thousands of people may go through such an intervention, possibly leading to higher rates of compliance. Thus, interactive information with feedback is a flexible, cost-effective, and quickly applicable way to build compliance with preventive measures.

Our exploratory analysis has not identified any relevant additional predictors of compliance. The statistically significant effect of the FPI scale for health-related anxiety scale was extremely small, making it difficult to interpret. An obvious explanation is that people who reach high scores on the scale show more “health motivation” and are thus more likely to adapt their behavior more quickly in response to new health-related information (Moorman & Matulich, 1993). However, mere similarities in item content may also have led to the effect, as both our outcome measure and the FPI scale ask about health behavior. It is worth noting that, even after conditioning on many other variables, the effect of the intervention remained stable.

Some limitations of this study need to be acknowledged. First, the intensity of the experimental and control condition differed substantially. Subjects in the experimental condition spent five times more time on their task. Thus, we cannot rule out that the effect was based purely on increased exposure to information related to the spread of COVID-19. Second, our sample was biased towards relatively young, healthy, and highly educated subjects. Pre-trial compliance was already fairly high and subjects with low compliance were underrepresented. Thus, it remains unclear whether the intervention works equally well for all levels of compliance. Finally, it is unclear whether a change on the compliance scale is associated with changes in disease prevention behavior. This would only be the case if the effect of the intervention was stable over time and the scale used correlated with the corresponding behavior.

Future studies could pursue this type of low-threshold, Internet-based feedback intervention to test its potential in other areas of health behavior. In the field of disease prevention, further studies could answer the open questions of this study. In particular, the predictive value of the proposed compliance scale would be of great interest. Another important aspect would be including compliance with additional prevention measures, which have not been included here. For example, wearing a face mask was not recommended by the WHO for a long time, so the focus of this study was on physical distancing. At present, however, face masks are considered in many countries to be an important part of a gradual relaxation of lockdowns and contact bans (Chu et al., 2020). Experts argue that the second wave of COVID-19 infections is imminent (Xu & Li, 2020),

so compliance with infection control measures will remain necessary until vaccines become available for the general population. Since studies show that motivation to adhere to safety measures decreases over time, it is important to explore ways to promote motivation to adhere.

In conclusion, interactive information and feedback have the potential to make a small contribution to reducing the spread of infectious diseases within the framework of broad-based, content- and methodologically diverse packages of measures.

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Multimedia Appendixes

Graphical depiction of the visual feedback condition.
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