The effect of threat appraisal on adherence to COVID-19 containment measures among young adults in Germany and the Netherlands

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Abstract

Background: To decrease the spread of COVID-19, the German and Dutch governments applied different social restriction measures to contain the virus. The adherence to those measures varies among individuals. This variability in behaviour might be based on different perceptions of threat. Earlier literature already found an association between threat appraisal and adherence to COVID-19 rules within the general population. Nevertheless, less is known about young adults, who are especially affected by COVID-19 containment measures. Therefore, this study examines the threat appraisal of young adults and its association to adherence to COVID-19 measures.

Methods: A cross sectional survey design was used. The questionnaire measured threat appraisal by two concepts, namely perceived vulnerability (perceived vulnerability to disease questionnaire, PVD) and perceived severity of COVID-19. Adherence to containment policies was measured with a set of specific items indicating prevailing behavioural instructions by the governments. Non-probability convenience sampling was used to spread the questionnaire. Descriptive analysis was used to describe the perceived vulnerability, perceived severity towards COVID-19, and the general adherence to COVID-19 rules of young adults. Spearman's rank correlations were used to examine the correlation of threat appraisals (perceived vulnerability, perceived severity) and adherence to COVID-19 rules.

Results: The sample of 172 young adults (aged 18-25) was composed of 31% males and 68% females. The majority were German citizens (95%). Results show that young adults who perceive the threat of COVID-19 as severe, overall adhere more to COVID-19 measures than those who do not perceive COVID-19 as a severe disease ($r_s = .18$, $p = .02$, $N = 172$). No significant correlation was found between perceived vulnerability and adherence to COVID-19 rules. The most significant correlations were found between adherence to specific behavioural rules and germ aversion. Especially containment measures aiming at social distancing like avoiding busy places, limiting contact with others, and keeping a distance to others correlate with germ aversion.

Conclusion: Young adult's adherence seems to be more strongly associated with the perceived severity of COVID-19 than with perceived disease vulnerability. Hence, future health communication targeted at improving the adherence of young individuals to COVID-

19 measures should focus on providing information about the seriousness of potential health consequences of a COVID-19 infection for young adults.

Introduction

With reporting the first case of the new respiratory virus called coronavirus disease 2019 (COVID-19) on December 31st in Wuhan, the beginning of a worldwide pandemic was set (WHO, 2021a; Zhu et al., 2020). From then on, the virus spread around all over the globe, with more than 100 million individuals being affected and 2 million deaths (WHO, 2021a). To control the virus and reduce its spread, different containment policy instructions were applied by the German and Dutch governments. Maintaining a 1.5 meter distance to other persons, avoiding traveling and unnecessary journey by public transport, or not leaving the house from 9 PM to 4.30 AM are measures individuals had to adhere to. (Ministry of General Affairs, 2021; Informationsamt der Bundesregierung, 2021a). These aim at mitigating the chances of contracting with COVID-19 and minimise the harmful consequences of individuals' health, delaying the spread of the original and new coronavirus variants and preventing the new variants' entry into Germany and the Netherlands as much as possible (National Institute for Public Health and the Environment, 2021a). Hence, to reduce the spread of COVID-19, adherence of the general population to containment measures is of importance.

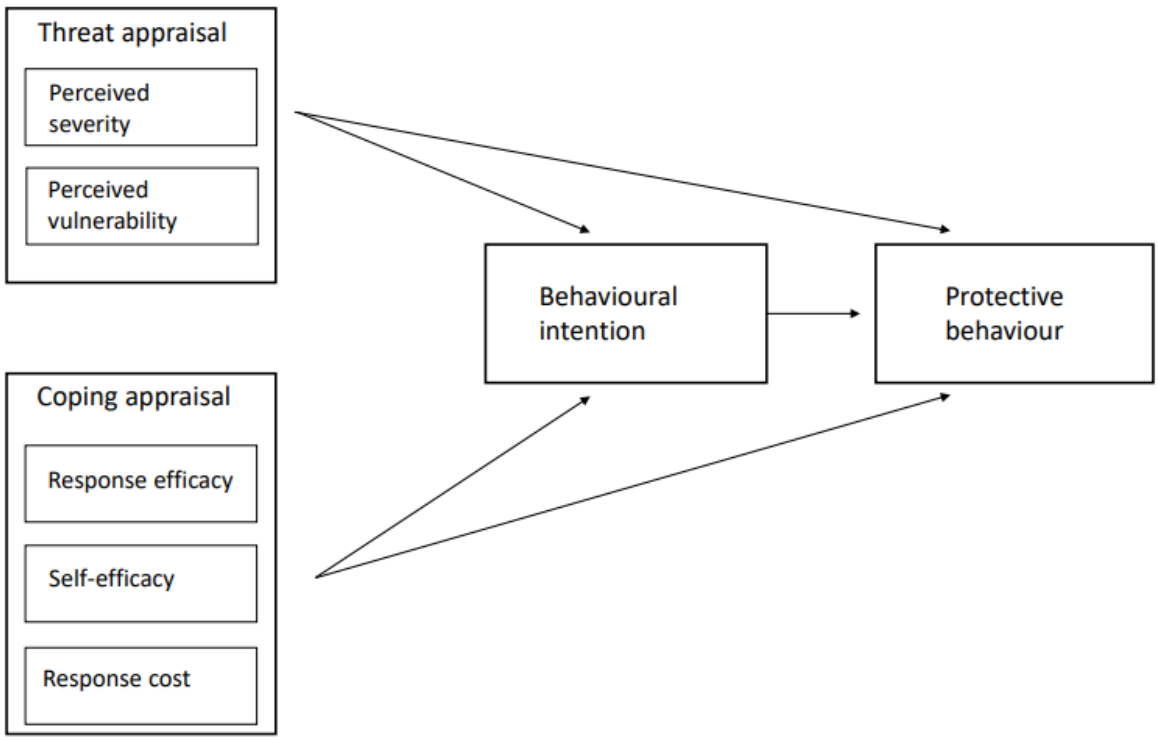
Data from Germany and the Netherlands shows that generally a high percentage of individuals of the population adhere to governmental containment measures (Informationsamt der Bundesregierung, 2021b; National Institute for Public Health and the Environment, 2021b). Nevertheless, adherence varies among individuals, and the trend shows that during the course of the pandemic, adherence to some containment measures declines (Aschwanden et al., 2021; Informationsamt der Bundesregierung, 2021b; National Institute for Public Health and the Environment, 2021b). Whereas 97% of the Dutch population complied with receiving only one other household at home in October 2020, only 74 % complied with the measurement in March 2021(National Institute for Public Health and the Environment, 2021c). The higher the perceived threat, the more it is expected that individuals are motivated to execute protective behaviours (Rogers & Prentice-Dunn, 1997). This is explained by the protection motivation theory (PMT), positing that adherence to COVID-19 containment measures is adopted by individuals when the threat resulting from COVID-19 is considered to be severe for the individual, and they perceive themselves as vulnerable to be affected by the disease (Farooq et al., 2020). Hence, the decline in adherence to containment measures might be related to a decline in the perceived threat of COVID-19 (Al-Hasan et al., 2020). Further, extreme behaviours of adherence or non-adherence to COVID-19

containment rules might be related to extreme high or extreme low perceived threat of COVID-19 (Stangier et al., 2021).

Next to the perceived threat influencing the motivation to engage in protective behaviours, protection motivation is also determined by coping appraisal (see Figure 1), which evaluates the efficacy and cost to engage in protective behaviour. The assessment of coping appraisal is based on an individual's response-efficacy, self-efficacy, and response cost. Response efficacy is about the individual's belief that the coping response is effective in reducing the threat. Self-efficacy is about believing that one is able to perform the coping response, whereas an individual's belief about the cost or sacrifice to perform the protective behaviour is assessed by response cost (Rogers & Prentice-Dunn, 1997). Because of the severe health issues that often accompany a COVID-19 infection (WHO, 2021a), it is expected that especially threat appraisal is of importance when looking for underlying factors associated with the motivation to adhere to COVID-19 rules. Hence, this study focuses on threat appraisal and its association with protective behaviour.

Figure 1

Protection motivation theory



Note. Schematic representation of the protection motivation theory from Rogers (1975)

Recent studies already investigated the effect of threat appraisal on adherence to COVID-19 containment measures of the general population (Al-Hasan et al., 2020; Farooq et al., 2020; Kim & Crimmins, 2020; Kowalski & Black, 2021). The work from Al-Hasan et al. (2020) in particular, gathered data in the US, South Korea and Kuwait of the general population and found a positive significant association between perceived severity and social distancing adherence as well as perceived vulnerability and social distancing adherence. However, to date, less attention has been devoted to threat appraisal as a predictor to compliance to COVID-19 containment measures in Germany and the Netherlands and, in particular, among young adults. Further, less is known about differences among adherence to specific COVID-19 rules, as recent studies examine sum scores of overall adherence by grouping specific COVID-19 rules (Farooq et al., 2020).

Especially for young adults (18- 25 years), adherence to COVID-19 containment measures is difficult (Zysset et al., 2021). One reason is that this period in life, when people become an adult, is normally characterised by many social contacts (TVETipedia Glossary, n.d.). Additionally, according to Berg- Beckhoff et al. (2021) young adults' lives are most affected by the COVID-19 pandemic. Among students, for example, online teaching was most prolonged compared to other educational settings, whereas in-classroom teaching was possible only very occasionally (Diel et al., 2021). Further, potential semesters or internships abroad, or generally international exchange plans were stopped immediately at the pandemic's beginning (Berg-Beckhoff et al., 2021). Also, job options were reduced dramatically, which is especially a burden for young adults trying to start their occupational careers (Bell & Blanchflower, 2020; Montenovo et al., 2020).

Next to adherence to COVID-19 containment measures being difficult for young adults, they additionally might be less motivated to engage in COVID-19 protective behaviour. Young adults are not regarded as a risk group for COVID-19 mortality, but they are still able to spread the virus to vulnerable populations (Berg- Beckhoff et al., 2021; Williamson et al., 2020). Hence, their response cost to adhere to COVID-19 rules might be perceived as high in light of "only" doing it to protect other vulnerable groups instead of oneself. Therefore, in light of the PMT, young adults might be less motivated to adhere to COVID-19 rules, as they appraise engaging in protective behaviour as too costly (Rogers & Prentice-Dunn, 1997). Nevertheless, high compliance to COVID-19 rules among young individuals is crucial (Kabamba Nzaji et al., 2020). Therefore, looking into underlying factors

influencing adherence of young adults, in this case specifically threat appraisal, is of importance.

To date, little attention has been devoted to examining the association of threat appraisal among young individuals (18- 25 years) on adherence to COVID-19 containment measures. Kim and Crimmins (2020), for instance, found no significant relationship between threat appraisal and the adoption of preventive behaviours among young individuals aged 18 to 34 within the US. However, Farooq et al. (2020) found perceived severity, as one component of threat appraisal, to be a significant positive predictor of COVID-19 protective behaviour within the Finish population, represented by a relatively young sample consisting of 71 % of individuals aged between 18 and 34. Further, little is known about threat appraisal to COVID-19 itself of young adults in Germany and the Netherlands. Berg-Beckhoff et al. (2021) found that the majority of Danish university students (66%) were not concerned about being infected with COVID-19. Similarly, Zysset et al. (2021) found 59% of the students from Switzerland not being worried about their health. Both findings might indicate a low threat appraisal among young individuals. Nevertheless, both studies did not measure perceived severity and perceived vulnerability accurately, but only with one item, respectively. Also, both studies did not focus on German and Dutch young adults (Berg-Beckhoff et al., 2021; Zysset et al., 2021).

In sum, perceived vulnerability and perceived severity among young adults has not yet been sufficiently investigated in relation to adherence to COVID-19. Accordingly, this study aims to investigate the following questions:

1. To what extent is perceived severity towards COVID-19 associated with adherence towards COVID-19 regulations in young adults aged 18- 25 from Germany and the Netherlands.
2. To what extent is perceived vulnerability towards COVID-19 associated with adherence towards COVID-19 regulations in young adults aged 18- 25 from Germany and the Netherlands.
3. To what extent is threat appraisal, perceived vulnerability and perceived severity, respectively, associated with different types of COVID-19 containment behaviour of young adults aged 18- 25 from Germany and the Netherlands.

Method

Design

A cross sectional online survey design was used to examine threat appraisal, so perceived severity and perceived vulnerability respectively, of German and Dutch young adults (18- 25 years) with regard to COVID- 19. The study was approved by the BMS ethics committee of the University of Twente (210563).

Participants

Respondents of the survey were included for analysis when being between 18 and 25 years old, and living in Germany or the Netherlands. Participants not fulfilling this criterion were excluded. To estimate the required samples size, a power analysis was conducted using the program R. By taking the Pearson r's as a statistical test and aiming for a power of .80, 2-sided tested and a significance level of .05, the minimum required sample size is $N = 84$ to be able to detect a significant correlation of at least moderate size (r = .3) (Cohen, 1988).

To recruit participants, the link of the online survey was spread through social media (Instagram, WhatsApp, Facebook). Further, the survey was uploaded to the BMS sona system of the University of Twente, an online system for students where studies are posted, and students can participate in the studies. Hence, non-probability convenience sampling was used to gain participants.

Materials

The software "Qualtrics" was used to design the survey. The language of the survey was English. The survey started with sociodemographic background questions, like age and gender. Further, it consisted of two specific questionnaires, namely the perceived vulnerability to disease scale and the perceived severity scale developed by Champion (1984) to measure the construct threat appraisal. Also, a set of specific items was included in the survey to examine the adherence to COVID-19 restriction measures.

Threat appraisal

To measure threat appraisal, the two variables that capture threat appraisal were assessed, namely perceived vulnerability and perceived severity (Rogers & Prentice-Dunn, 1997). Perceived vulnerability was measured with the perceived vulnerability to disease questionnaire (PVD) by Duncan et al. (2009), whereas perceived severity was measured by adjusting the scale developed by Champion (1984) to COVID-19.

Perceived vulnerability

To measure the perceived vulnerability of young adults in relation to COVID-19, the perceived vulnerability to disease questionnaire (PVD) was included within the survey (Duncan et al., 2009). The PVD consists of 15 items, with a 7- point scale from "1= strongly disagree" to "7= strongly agree". Further, the PVD is composed of two sub-scales, measuring perceived infectability and germ aversion. The personal susceptibility to infectious diseases and one's belief about the functioning of the immune system was assessed by the perceived infectability sub-scale (7 items). An example item is:" In general, I am very susceptible to colds, flu and other infectious diseases" (Duncan et al., 2009, p. 2). The Cronbach's alpha of the original sub-scale was .87 (Duncan et al., 2009). The sub-scale perceived infectability used in this research had a Cronbach's alpha of .83. The germ aversion sub-scale (8 items) assessed the response to situations that have a relatively high likelihood of pathogen transmission (Duncan et al., 2009). An example item is: "It really bothers me when people sneeze without covering their mouths" (Duncan et al., 2009, p. 2). Cronbach's alpha of the original sub-scale was .75 (Duncan et al., 2009). The original item 15: "I avoid using public telephones because of the risk that I may catch something from the previous user" was adjusted into "I disinfect shopping carts or shopping baskets before using them because of the risk [...]", as the original item was no longer appropriate. The Cronbach's alpha of the adjusted sub-scale in the current study was .63. Items 3, 5, 11, 12, 13, and 14 were positively formulated and therefore, recoded into the reversed score. The final score of both subscales respectively was calculated by adding the scores and dividing them by the number of items. Hence, the higher the score of each sub-scale, the higher the perceived vulnerability.

Perceived severity

To measure perceived severity, the scale developed by Champion (1984) was used. The original scale measuring the perceived severity of breast cancer was adjusted to COVID-19. It consists of 12 items with a 5- point scale from "1= strongly disagree" to "5= strongly agree". The original scale by Champion (1984) had a Cronbach's alpha of .78. The Cronbach's alpha of the adjusted scale in the current study was .82. An example item is:" Problems I would experience from COVID-19 would last a long time." The final score of perceived severity was calculated by adding the scores and dividing them by the number of items. The higher the total score, the higher the perceived severity.

Adherence to containment measures

Self-reported adherence to COVID-19 containment policies was measured with a set of specific items about prevailing containment policies derived from the German and Dutch governments (Ministry of General Affairs, 2021; Informationsamt der Bundesregierung, 2021a). In total, there was a set of 15 items describing behavioural rules, which apply to both countries. With a 4- point scale from "1= never" to "4= always" and "0= not applicable", participants could indicate whether they adhered to those behavioural rules within the last six weeks. An example item is "sneezing and coughing into a tissue or the crook of your arm." The total score was a sum of all scores divided by the number of items. The higher the total score, the more did young adults adhere to COVID-19 containment measures.

Procedure

On the 13th of April 2021, the spread of the survey started via social media. Further, on the 18th of April 2021, the survey was uploaded to the BMS test subject pool of the University of Twente. Participants had access to the survey via a link directing them to the platform Qualtrics. During the time frame the study was online, Germany and the Netherlands were facing the third lockdown situation with introducing severe lockdown rules like a nightly curfew. Hence, while answering questions about adherence to COVID-19 rules, participants were still exposed to those rules during everyday life.

Before respondents started the survey, the aim of the research and the content of the survey was explained. Following, the participant was informed about being able to withdraw from the study at any given moment, and further that participation is voluntary and data is handled anonymously. Respondents who consented completed the online survey, which then approximately took 20 minutes.

Data Analysis

To analyse the data, the statistical program SPSS, version 25 was used. First, all participants with an age above 25, those who did not complete the questionnaire and those who were not German or Dutch were excluded from the dataset. To test the normality of all continuous variables (perceived vulnerability, perceived severity, adherence to COVID-19 rules), the Kolmogorov- Smirnov test and a scatterplot were used. Descriptive analysis for gender, nationality, perceived severity, perceived vulnerability and adherence to COVID-19 rules was performed. For nominal variables, the frequency and percentage were calculated. For scale

variables, the mean and standard deviation were calculated if the data was normally distributed. In case of non-normality, the median and interquartile range were calculated.

To assess the correlation between perceived severity and perceived vulnerability to the sum score of adherence to COVID-19 restriction measures, Spearman rank correlation was calculated. Further, to assess the correlation between different containment behaviours to perceived severity and perceived vulnerability, Spearman rank correlation was used for non-normal distributions. Additionally, to assess the difference of extreme non-compliance (<=25th percentile of the data set) and extreme compliance (>=75th percentile of the data set) to COVID-19 containment measures in association to perceived vulnerability and perceived severity, the Wilcoxon signed rank test was used.

Results

In total, there were 226 responses to the questionnaire, from which 54 participants were older than 25, did not complete the questionnaire or were not German or Dutch. Hence, 172 participants were included in further analyses. As visible in Table 1, 68 % of the sample was female and 31% was male. The majority of the sample was German (95%) (see Table 1).

Table 1

Demographic characteristics and descriptive statistics

		Frequency	%	M (SD)
Age in years	18-25	172	100	21 (1.57)
Gender	Male	53	31	
	Female	117	68	
	Non-binary	2	1	
Nationality	German	164	95	
	Dutch	8	5	

Note. M= mean. SD= Standard Deviation

As visible in Table 2, the mean (*SD* = 0.78) of perceived vulnerability towards COVID-19 of the sample was 4.20. Hence, being above the middle of the potential scale range. The average score (*SD* = 0.65) of perceived severity towards COVID-19 was 2.44, which is slightly below the middle of the potential scale range measuring perceived severity (see Table 2).

Table 2

Descriptive statistics of Perceived vulnerability and Perceived severity

	Mean	SD	Range
Perceived vulnerability	4.02	.78	1-7
Perceived infectability	3.32	1.02	1-7
Germ aversion	4.62	.88	1-7
Perceived severity	2.44	.65	1-5

Note. SD= Standard Deviation. Perceived vulnerability= perceived vulnerability towards diseases. Perceived severity= perceived severity towards diseases

The overall adherence to public health instructions to reduce the spread of COVID-19 was high (*Mdn* = 3.2, *IQR* = 0.6), with the scale ranging from 1, indicating never adhering to policies, to 4, indicating always adhering to COVID-19 policies. Especially wearing face masks in buildings (*Mdn* = 4, *IQR* = 0) or during public transports (*Mdn* = 4, *IQR* = 0), and sneezing and coughing into a tissue or the crook of one's arm (*Mdn* = 4, *IQR* = 0) were adhered to often (see Table 3). Furthermore, there was a high variation in the adherence to getting tested when having symptoms (*Mdn* = 4, *IQR* = 4), stay at home when the roommate is having symptoms (*Mdn* = 3, *IQR* = 4), and adherence to the curfew (*Mdn* = 3, *IQR* = 4) (see Table 3).

Table 3

Descriptive statistics of Adherence towards COVID-19 regulations

	Median	IQR
Adherence towards COVID-19 regulations	3.2	.60
Keep distance to others	3	1
Avoid busy places	3	1
Stay at home	3	1
Limit contact with others	3	1
Only have one visitor	3	1
Visit only one other household	3	1
Avoid unnecessary journeys	3	1
Do not travel abroad	4	1
When having symptoms stay home	4	1
When having symptoms get tested	4	4
When Roommates have symptoms stay home	3	4
Wear mask in buildings	4	0
Wear mask in public transport	4	0
Sneeze and cough into a tissue	4	0
Adhere to the curfew	3	4

Note. IQR= Interquartile range. Adherence= sum score of adherence towards behavioural public health instructions to reduce the spread of COVID-19.

Association of Perceived severity and Perceived vulnerability to Adherence

Results of the Spearman's rank correlation indicate that there was a significant, positive association between perceived severity and adherence towards COVID-19 rules (r_s = .18, p =.02, N =172) (see Table 2). Therefore, individuals scoring high on perceived severity do slightly more adhere to behavioural public health instructions of COVID-19 than those who score low on perceived severity. There was no significant correlation between perceived infectability (r_s = .14, p = .06, N = 172) and germ aversion (r_s = .14, p = .07, N = 172) to adherence towards COVID-19 rules.

Table 4

Spearman's rank correlation between Perceived vulnerability, Perceived severity and Adherence

	Adherence to COVID-19 rules
Perceived vulnerability	
Perceived infectability	.14
Germ aversion	.14
Perceived severity	.18*

Note. Perceived vulnerability= perceived vulnerability towards diseases. Perceived severity= perceived severity towards diseases. Adherence= sum score of adherence towards behavioural public health instructions to reduce the spread of COVID-19.
**Correlation is significant at the .05 level (2-tailed)*

Association of specific COVID-19 behavioural rules to Perceived Vulnerability and Perceived Severity

As displayed in Table 5, most of the significant correlations can be found between adherence to specific behavioural rules and germ aversion in comparison to adherence to behavioural rules and perceived infectability or perceived severity. Especially behavioural rules aiming at minimising social contact and social distancing significantly correlate with germ aversion: Results of the Spearman's rank correlation indicate a significant, positive correlation between the adherence to keep a distance to others (r_s = .26, p < .001, N = 172), avoid busy places (r_s =.24, p = .002, N = 172), the adherence to stay at home (r_s =.24, p = .002, N = 172) and germ aversion. Further, a positive significant correlation was found between the adherence to limit contact with others (r_s = .82, p = .02, N = 172), only have one visitor a day (r_s = .21, p =.01, N = 172), the adherence to avoid unnecessary journeys (r_s = .22, p = .004, N = 172) and germ aversion (see Table 5). Hence, individuals who score high on the germ aversion sub-scale minimize social contacts and maintain a distance to others more often than those who score low on germ aversion.

Table 5

Spearman's rank correlation between perceived infectability, germ aversion, perceived severity and specific types of COVID-19 containment measures

	Perceived infectability	Germ aversion	Perceived severity
Keep distance to others	.157*	.257*	.209*
Avoid busy places	.237*	.235*	.150*
Stay at home	.090	.234*	.252**
Limit contact with others	.115	.182*	.161*
Only have one visitor	.053	.210*	.243**
Visit only one other household	.117	.140	.094
Avoid unnecessary journeys	.177*	.216*	.144
Do not travel abroad	.049	.010	.087
When having symptoms stay home	.049	-.059	.012
When having symptoms get tested	.063	-.063	-.103
When Roommates have symptoms stay home	.046	-.034	.057
Wear mask in buildings	-.093	.040	-.149

Wear mask in public transport	-.096	-.005	.078
Sneeze and cough into tissue	.005	-.018	.025
Adhere curfew	.038	.106	.157*

Note. Perceived severity= perceived severity towards diseases.

**Correlation is significant at the .05 level (2-tailed)*

***Correlation is significant at the .001 level (2-tailed)*

Table 6 shows that the high adherence group scores higher on perceived infectability, germ aversion and perceived severity, thus all threat appraisal measures than the low adherence group. Nevertheless, on the population level, no significant difference between all extreme groups of high (*N*= 44) vs low (*N*= 47) adherence to COVID-19 containment measures was found.

Table 6

Comparison of extreme groups on adherence to COVID-19 containment rules

	high adherence (*N* = 44)		low adherence (*N* = 47)		*T*	Range
	Median	IQR	Median	IQR		
Perceived infectability	3.5	1.54	3.29	1.43	-.82	1-7
Germ aversion	4.81	1.19	4.50	1.38	-.60	1-7
Perceived severity	2.58	.92	2.25	1.08	-.93	1-5

Note. High adherence= those who adhered the most to COVID-19 rules, which are <=25th percentile of the data set (N= 44). Low adherence= those who adhered the least to COVID-19 rules, which are >=75th percentile of the data set (N= 47). T= Wilcoxon test value. IQR= Interquartile range. Perceived severity= perceived severity towards diseases.

Discussion

This study explored the association between threat appraisal, composed of perceived vulnerability and perceived severity, and adherence towards COVID-19 rules of young adults (18- 25 years) from Germany and the Netherlands. It showed that there was no significant association between perceived vulnerability and adherence to COVID-19 rules. However, perceived severity was found to be significantly, although weakly, associated with adherence to COVID-19 rules of young adults. Further, adherence to COVID-19 containment measures especially aiming at social distancing (keeping a distance from others, avoiding busy places, staying at home, only having one visitor), were significantly associated with perceived severity and perceived vulnerability (perceived infectability and germ aversion).

Previous research has shown that the perceived severity of a health threat, as one construct of threat appraisal, influences the motivation to execute protective behaviours (Milne et al., 2000), which is similar to the findings of this study. Young adults who perceive the severity of COVID-19 as high adhere more to COVID-19 containment measures than young adults who do not perceive COVID-19 as a severe disease. This further replicates the findings of Farooq et al. (2020), who also found perceived severity to be a significant positive predictor of COVID-19 protective behaviour within the Finish population. With the study of Farooq et al. (2020) being based on a wider population, our study further indicates that this association also holds for only the young adult population.

It was noticeable that there was no association between the perceived vulnerability of young adults and their overall adherence to COVID-19 rules. This is contradictory to the protection motivation theory, indicating that threat appraisal, composed of perceived vulnerability, influences the motivation of individuals to execute protective behaviours (Rogers & Prentice-Dunn, 1997). Earlier literature found that young people generally perceive themselves as less vulnerable towards COVID-19 than older people (Bechard et al., 2021). One explanation might be that especially older adults have a higher risk of developing more severe forms of COVID-19 (WHO, 2021b). Hence, less variability within the young population can be expected. This is confirmed by this study, as perceived vulnerability towards COVID-19 was not particularly high among young adults, and low variation in scores within the sample was found. To be able to find a strong correlation between perceived vulnerability and adherence to COVID-19 rules, a sufficient amount of people scoring high on perceived vulnerability is needed. This not being the case in the current study might

explain the missing association between perceived vulnerability and overall adherence to COVID-19.

There were some limitations within this study. First, there was probably not enough power to find a significant difference between the two extreme groups of high compliance and low compliance to COVID-19 containment measures on the population level. A small effect was expected, as a difference in median scores between both groups in all threat appraisal measures was found. Further, Stangier et al. (2021) also found a significant difference in the change in preventative and risk behaviour among Germans' which was related to scoring extremely high and scoring extremely low on perceived vulnerability to COVID-19. Hence, future studies should aim for a larger sample of young individuals to further explore differences between the two extreme groups of compliance and non-compliance to COVID-19 rules.

A second limitation was that German and Dutch young adults were analysed in one sample and not separately. Even though general COVID-19 containment measures set by the German and Dutch governments overlap, there were still some differences in the intensity and timing of applying those measures. In Germany, the threshold to relax COVID-19 containment rules was higher and stricter compared to the Netherlands. For example, there had to be less than 100 positive COVID-19 cases per 100.000 inhabitants for the curfew to be lifted (Informationsamt der Bundesregierung, 2021c). In the Netherlands, the curfew was already lifted at 331 positive COVID-19 cases per 100.000 inhabitants (National Institute for Public Health and the Environment, 2021f). Hence, there might be different findings when looking at German and Dutch young adults separately, as Dutch young adults might perceived the threat of COVID-19 differently due to the containment policy of the Netherlands being less strict compared to Germany. Nevertheless, as the sample consisted mainly of Germans (95%) this study's findings are already more generalizable to the German young adult population.

A third limitation was the measurement of perceived vulnerability to COVID-19. To measure perceived vulnerability, the PVD questionnaire by Duncan et al. (2009) was used. One of the components to measure perceived vulnerability was germ aversion, which assessed responses to situations with pathogen transmission. As COVID-19 is not caused by any germs but by the virus SARS-CoV-2 (National Institute for Public Health and the Environment, 2021d), the outcome of perceived vulnerability to COVID-19 might be different if using a sub-scale focusing on responses to situations of virus transmission.

Another limitation of the measurement of perceived vulnerability is that items about "long-COVID" were not included within the questionnaire. Long-COVID describes the phenomenon of having COVID-19 symptoms for up to a few weeks or several months after an infection with COVID-19 (National Institute for Public Health and the Environment, 2021e). Frequent symptoms are not only shortness of breath, muscle pain and long-term loss of smell, but also persistent cognitive problems like memory difficulties and impaired ability to concentrate (National Institute for Public Health and the Environment, 2021e; Miskowiak et al., 2021). Recent studies found that these symptoms can also occur after mild courses of COVID-19 and across all ages (Townsend et al., 2020). Hence, including items concerning long-COVID might have influenced young adults' perception of the morbidity of an COVID-19 infection. Concluding, both limitations might explain why perceived vulnerability towards COVID-19 was found to be not particularly high among young adults within this study.

This study also has some strong points. While asking about adherence behaviour, 15 different COVID-19 containment measures were taken into account. Therefore, data could not only be gathered for measures focusing on social distancing or wearing masks but also about more specific measures of the German and Dutch governments. Additionally, a standardised scale for perceived severity was used, facilitating a more accurate measurement of the construct. Even though the scale was based on the theoretical framework of the health belief model and this study focused on the protection motivation theory, it still can be used. Both theories share the component of perceived severity, so the meaning is the same (Prentice-Dunn & Rogers, 1986).

The findings of this study point out that young adults engage more in COVID-19 protective behaviours when they consider the threat resulting from the illness to be severe. On the other hand, their compliance with COVID-19 rules is not affected by the perception of being vulnerable to disease in general. Nevertheless, in light of the limitations and perceived vulnerability being the second component next to perceived severity conceptualising threat appraisal in the PMT, there still might be an association between perceived vulnerability and adherence to COVID-19 rules. Hence, future studies should focus on developing a questionnaire for perceived vulnerability by, for example, adapting the germ aversion subscale to virus-induced illnesses like COVID-19. Further, items measuring the perceived vulnerability of long-COVID should be included in future studies.

Even though the perceived vulnerability of young adults towards COVID-19 should be examined further, the findings of this study already provide solid ground to conclude that

interventions grounded in information provision about health consequences of COVID-19 could increase young adults' adherence to COVID-19 rules. Protection motivation of young adults is influenced by their perception of the severity and probably also the perceived vulnerability of COVID-19. Hence, education about the threat of COVID-19 might increase young adults' perception of this threat which further improves their motivation to engage in protective behaviour. Based on the behaviour change wheel (BCW), developed by Michie et al. (2011), communication instruments like media campaigns support interventions aiming at increasing knowledge. Accordingly, public health communication tailored towards educating young adults about the health threat of COVID-19 might be a constructive intervention in light of the findings of this study. Further, as social media use is especially high among young adults it should be used as a communication tool to target this group (Madden et al., 2013).

Earlier interventions based on the PMT point out that next to threat appraisal, addressing coping information further facilitates behaviour changes. McClendon and Prentice-Dunn (2001), for example, found alteration to the behaviour of sun exposure within a group that received videos of a young Australian suffering from skin cancer. They also found a change to more protective behaviour within another group provided with ways to avoid unpleasant consequences of sun's UV rays. Thus, behaviour change was not only achieved by increasing threat appraisal but also by increasing coping appraisal. Therefore, future studies should further explore whether this association of coping appraisal to behavioural change also holds for adherence to COVID-19 rules to examine a solid ground for future interventions.

In conclusion, the finding that young adults' adherence to COVID-19 rules is associated with how they perceive the threat of the illness helps increase young adults' compliance by tailored interventions and further helps prevent the spread of COVID-19 to vulnerable populations. This research of underlying factors affecting compliance remains important. Even though the rate of people getting vaccinated against COVID-19 rises, virologists are still unsure about how long the protective effect might hold. Hence, social distancing and health protective behaviour remain important to diminish the spread of COVID-19.

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Appendix

Bachelor thesis survey

Start of Block: Consent form

Q1 The aim of this research is to detect the relationship between threat appraisal, adherence to COVID- 19 containment measures and factors that might be associated with mental wellbeing of young adults.
In this survey we kindly ask you to answer multiple questions regarding your adherence to COVID- 19 containment measures, daily life changes, wellbeing, personality and some social demographic background characteristics. The questionnaire will take approximately 20 minutes to complete.
Your participation in this survey is completely voluntary and all your responses are treated anonymously. None of the responses will be connected to identifying information. Data will only be used for statistical analyses. However, you can withdraw from the survey at any time.
If you want to get more information about the outcome of the research, you can contact the researchers Julia Jörgens (j.j.joergens@student.utwente.nl), Fabiola Ruiz Alfranca (f.ruizalfranca@student.utwente.nl) and Lea Ganzer (l.ganzer@student.utwente.nl).
If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Behavioural Sciences at the University of Twente, Drs. L. Kamphuis- Blikman P.O. Box 217, 7500 AE Enschede (NL), telephone: +31 (0)53 489 3399; email: l.j.m.blikman@utwente.nl).
I read and understood all the above mentioned and agreed to participate in the study. Further, I partake out of my own free will and I am informed that I can withdraw from the study at any time without providing a reason. By proceeding the study, I consent to participate.

- ○ Proceed (1)
- ○ Do not proceed (2)

Skip To: End of Survey If The aim of this research is to detect the relationship between threat appraisal, adherence to COV... = Do not proceed

End of Block: Consent form

Start of Block: Background information

Q2 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

Q3 What is your age?

_____

Q4 What is your nationality?

- ○ German (1)
- ○ Dutch (2)
- ○ Other (3) _____

End of Block: Background information

Start of Block: adherence to containment measures

Q5 This part of the survey is about your adherence to different recommendations related to COVID- 19 set by the German and Dutch government. When you think about the last 6 weeks, how often did you adhere to the following recommendations?

	Never (1)	Rarely (2)	Often (3)	Always (4)	Not applicable (5)
Stay 1.5 meters away from other persons. (1)	○	○	○	○	○
Sneezing and coughing into a tissue or the crook of your arm. (2)	○	○	○	○	○
Avoid busy places as much as possible. (3)	○	○	○	○	○
Stay at home as much as possible. (4)	○	○	○	○	○
Avoiding unnecessary journeys by public transport. (5)	○	○	○	○	○
Limit your contact with others. (6)	○	○	○	○	○
When having symptoms of COVID-19 I stay at home, don’t do any shopping’s, and don’t receive visitors. (7)	○	○	○	○	○
When having symptoms of COVID-19 I get tested. (8)	○	○	○	○	○
When roommates have symptoms of COVID-19 AND have fever above 38 degrees, I stay at home, don’t do any shopping’s and don’t receive visitors. (9)	○	○	○	○	○
Wear a face mask in buildings and covered	○	○	○	○	○

spaces accessible to the public. (10)							
Wear a face mask during public transport. (11)	○	○	○	○	○		
Stay in the Netherlands/Germany and don't travel abroad. (12)	○	○	○	○	○		
Have no more than one visitor per day. (13)	○	○	○	○	○		
Visit no more than one other household per day. (14)	○	○	○	○	○		
Adhering to the curfew from 9 PM to 4.30/ 5.00 AM. (15)	○	○	○	○	○		

End of Block: adherence to containment measures

Start of Block: Threat appraisal measure

Q7 This part of the survey is about your perception of threat. When thinking about the last week, how much do you agree or disagree with the following statements.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
It really bothers me when people sneeze without covering their mouths. (1)	○	○	○	○	○	○	○

If an illness is ‘going around’, I will get it. (2)	○	○	○	○	○	○	○
I am comfortable sharing a water bottle with a friend. (3)	○	○	○	○	○	○	○
I do not like to write with a pencil someone else has obviously chewed on. (4)	○	○	○	○	○	○	○
My past experiences make me believe I am not likely to get sick even when my friends are sick. (5)	○	○	○	○	○	○	○
I have a history of susceptibility to infectious disease. (6)	○	○	○	○	○	○	○
I prefer to wash my hands pretty soon after shaking someone’s hand. (7)	○	○	○	○	○	○	○

In general, I am very susceptible to colds, flu and other infectious diseases. (8)	○	○	○	○	○	○	○
I dislike wearing used clothes because you do not know what the last person who wore it was like. (9)	○	○	○	○	○	○	○
I am more likely than the people around me to catch an infectious disease. (10)	○	○	○	○	○	○	○
My hands do not feel dirty after touching money. (11)	○	○	○	○	○	○	○
I am unlikely to catch a cold, flu or other illness, even if it is 'going around'. (12)	○	○	○	○	○	○	○
It does not make me anxious to	○	○	○	○	○	○	○

be around sick people. (13)							
My immune system protects me from most illnesses that other people get. (14)	○	○	○	○	○	○	○
I disinfect shopping carts or shopping baskets before using them because of the risk that I may catch something from the previous user. (15)	○	○	○	○	○	○	○

Q8 This part of the survey is about your perception of threat in regard to COVID- 19. When thinking about the last week, how much do you agree or disagree with the following statements.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
The thought of COVID-19 scares me. (1)	○	○	○	○	○

When I think about COVID-19 I feel nauseous. (2)	○	○	○	○	○
If I had COVID- 19 my study would be endangered. (3)	○	○	○	○	○
When I think about COVID-19 my heart beats faster. (4)	○	○	○	○	○
Getting COVID- 19 would endanger my relationship. (5)	○	○	○	○	○
COVID- 19 is a hopeless disease. (6)	○	○	○	○	○
My feelings about myself would change if I got COVID-19. (7)	○	○	○	○	○
I am afraid to even think about COVID-19. (8)	○	○	○	○	○
My financial security would be endangered if I got COVID-19. (9)	○	○	○	○	○

Problems I would experience from COVID-19 would last a long time. (10)	○	○	○	○	○
If I got COVID-19, it would be more serious than other diseases. (11)	○	○	○	○	○
If I had COVID- 19, my whole life would change. (12)	○	○	○	○	○

End of Block: Threat appraisal measure