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Research Paper

# Stockpile purchasing in the emerging COVID-19 pandemic is related to obsessive-compulsiveness

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ABSTRACT

*Background:* During the COVID-19 pandemic people started stocking up on daily necessities although no long-term shortage thereof could be expected. Among other variables such as perceived and desired control, experienced scarcity, and psychopathy, obsessive-compulsiveness has been proposed as plausible explanation for this seemingly irrational behavior.

*Methods:* We collected data of 1379 participants in an online survey. Buying behavior during the COVID-19 pandemic was measured with the Hamsterkauf Questionnaire (HQ), which was specifically developed for this purpose. As independent variables, we measured participants' obsessive-compulsiveness on the Dimensional Obsessive-Compulsive Scale (DOCS) and potential fears of incapacitation and destabilization it might fuel. We also determined the extent to which participants experienced scarcity, exhibited psychopathic traits, felt in control of the situation and desired control in general.

*Results:* The average DOCS score was found to be strongly elevated. Higher obsessive-compulsiveness was associated with stronger stockpile purchasing behavior. This association was partly mediated by fears of incapacitation and destabilization. Obsessive-compulsiveness was predicted by experienced scarcity and psychopathic personality traits. By contrast, desirability of control and perceived control were not significantly associated with obsessive-compulsiveness or panic buying behavior.

*Limitations:* Survey data were collected in form of a convenience sample at one measurement point.

*Conclusions:* The widespread stockpile purchasing behavior during the COVID-19 pandemic can partly be understood as safety behavior to reduce fears related to strongly elevated levels of obsessive-compulsiveness. In turn, elevated levels of obsessive-compulsiveness were partly accounted for by personality factors such a psychopathy and situational stress factors such as scarcity.

## 1. Introduction

When the COVID-19 pandemic reached countries in Europe and North America, representatives of the industry and political decision makers were quick to emphasize that serious disruptions of the supply chains for daily essentials such as food were not to be expected (Askew, 2020; Sault, 2020). Furthermore, governments ensured that people could access these supply chains even during lockdowns (Deutsche Welle, 2020; Sullivan and Winfield, 2020). Nevertheless, the COVID-19 pandemic led to a remarkable spike in the demand for daily essentials that became particularly evident for storable foods (e.g. pasta or frozen food, indicating major changes in people's food choices, as pointed out by Bracale and Vaccaro, 2020) and home care products such as toilet paper (Casal and Moynihan, 2020; Information Resources Incorporated and Boston Consulting, 2020; Keane and Neal, 2020). People stocked up so quickly and extensively that some shelves in stores remained empty for notable periods of time as suppliers just could not keep up with the enormous demand despite largely intact supply chains (Barrett, 2020; Benton, 2020; Hobbs, 2020). Such buying behavior may appear irrational or maladaptive (He and Harris, 2020, p. 178; Rajkumar, 2020) and certainly calls for an assessment of possible explanations (Arafat *et al.*, 2020b; Hobbs, 2020, p. 5; Yuen *et al.*, 2020). As the expression "panic buying behavior" might prematurely imply that a feeling of panic is the cause of such behavior, we decided to use the more neutral expression "stockpile purchasing behavior" or merely "stockpiling behavior" in the following to refer to the behavior in question. The expression "stockpile purchasing" probably comes closest to the verb

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"hamsterkaufen", which is a commonly used term in German to describe the act of buying as many goods as possible with the goal of stockpiling them.

### 1.1. OCD as a possible explanation for stockpile purchasing behavior

One explanation that specifically draws on the apparent irrationality of stockpile purchasing behavior is a sudden COVID-19-related increase in the prevalence of obsessive-compulsive symptoms (Banerjee, 2020; Rajkumar, 2020). Obsessive-compulsive disorder (OCD) is a severe psychiatric disorder with a lifetime prevalence of 1–3% (Bebbington, 1998; Kessler *et al.*, 2012; Ruscio *et al.*, 2010; Weissman, 1998) characterized by obsessions (unwanted intrusive thoughts or images) and compulsions (ritualized repetitive behaviors). The experience of distress and fear in reaction to obsessions has been attributed to OCD-specific dysfunctional beliefs and biases (Olatunji et al., 2019), most notably an overestimation of threat (Miegel *et al.*, 2019; Moritz and Pohl, 2009; Steketee *et al.*, 1998). Compulsions can be understood as safety behaviors that are often exhibited by individuals with OCD to reduce distress and fear that is associated with obsessions.

It has been proposed that clinical and subclinical obsessive-compulsive symptoms lie on a continuum so that they can also be observed in the general population (Rachman and de Silva, 1978; Fullana *et al.*, 2010; Sulis, 2018). Consistent with this view, Pozza *et al.* (2020) consider it likely that the COVID-19 pandemic led to a rather widespread onset or exacerbation of fears of contamination. Yuen *et al.* (2020, p. 7) suggest that stockpile purchasing in times of the COVID-19 pandemic might, at least in some cases, function as safety behavior to reduce these fears (see also Banerjee, 2020, and Rajkumar, 2020). Specifically, some people might have stocked up on daily necessities to avoid contact with the possibly contaminated outside world, or to be equipped for extensive cleansing rituals. Thus, an increase in obsessive-compulsive symptoms in the general population could, at least partly, explain why some supermarket shelves were emptied so quickly during the beginning of the COVID-19 pandemic.

The overestimation of threat, which is characteristic for those vulnerable to OCD, might not only result in excessive fears of contamination. In times of the COVID-19 pandemic, it may also result in other fears relevant to stockpile purchasing behavior. Specifically, an overestimation of threat may make the prospect of being incapacitated either by the disease itself or by corresponding quarantine measures appear particularly likely and catastrophic. Anticipation of such a perceived catastrophic situation may lead to stockpile purchasing behavior. Similarly, the threat that other people pose might be grossly overestimated, for instance by fearing that goods will become scarce due to the failure of employees to play their part in vital supply chains or due to the anarchic behavior of fellow citizens. Such a fear of destabilization of societal order might contribute to stockpile purchasing behavior as well. Hence, it is possible that obsessive-compulsiveness does not only fuel fears of contamination but also other crisis-specific fears that are likely to lead to stockpile purchasing behavior, such as a fear of incapacitation and a fear of destabalization. This lends some additional plausibility to the hypothesis that stockpile purchasing behavior during the COVID-19 pandemic can be explained by increased levels of OCD in the general population.

### 1.2. Other possible explanations

Nevertheless, several other explanations of stockpile purchasing behavior have been proposed. A particularly prominent theory is that stockpile purchasing behavior can be understood as an attempt to regain control of at least some aspects of life in a situation where life is perceived as largely uncontrollable (Arafat *et al.*, 2020b; McCloy, 2020; Sim *et al.*, 2020). Those who have a high desirability of control might be particularly tempted to make such attempts. Arafat et al. (2020b) point out that a feeling of losing control may be further reinforced by the experience that daily necessities become scarce. Indeed, it is well established that perceived scarcity of a good which is due to an increased demand can make the good appear more desirable (e.g. van Herpen *et al.*, 2009; Worchel *et al.*, 1975; for a review on the effects of demand-induced scarcity see Hamilton *et al.*, 2019). In turn, higher desirability of a good can increase the demand for it. Such a cycle of increasing desirability and demand has been termed "bandwagon effect" (Leibenstein, 1950) and might easily add to a feeling of losing control in a situation that is already perceived as largely uncontrollable. We refer to the review of Yuen *et al.* (2020) for a more in-depth discussion of experienced scarcity and perceived or desired control as possible explanations for stockpile purchasing behavior.

Another aspect that has received less attention in the literature is that a certain degree of psychopathy seems to be required to engage in stockpile purchasing behavior. Psychopathic personality traits find their expression in a self-centered disregard for the well-being of others. Individuals who display such an attitude are more likely to engage in stockpile purchasing behavior as they might care less about the negative consequences of their actions on more vulnerable individuals (Nicomedes and Avila, 2020). Thus, it seems warranted to also examine psychopathic personality traits as potential contributors to stockpile purchasing behavior.

### 1.3. Interconnections between explanations

The explanations outlined above are not mutually exclusive. They involve the variables "stockpile purchasing behavior", "obsessive-compulsiveness", "fear of incapacitation, "fear of destabilization", "perceived control", "experienced scarcity", "desirability of control", and "psychopathy". Some of these variables are known to be associated with each other. For instance, OCD was found to positively correlate with psychopathic personality traits in the general population (Coid *et al.*, 2009) and with a higher desirability of control (Moulding *et al.*, 2008; Moulding and Kyrios, 2006, 2007). The observation that some of the variables are associated with each other does not mean, however, that they are all of the same kind. For heuristic purposes, they can be clustered, very coarsely, into a group of (i) situational and personal level variables, (ii) psychopathological variables, (iii) variables describing psychological (i.e. perceptual, emotional, and cognitive) mechanisms, and (iv) behavioral variables. Desirability of control, psychopathy and experienced scarcity can be assigned to group (i), obsessive-compulsiveness to group (ii), fear of destabilization, fear of incapacitation, and perceived control to group (iii), and stockpile purchasing behavior to group (iv), as illustrated in Fig. 2. It is plausible that these groups are causally interrelated, broadly corresponding with the diathesis-stress model that has been discussed as a general mechanism to explain the increase in affective disorders after events that may be perceived as mass traumata (Wood et al., 2013). Variables in group (i) might influence variables in groups (ii)-(vi), variables in group (ii) might influence variables in groups (iii)-(iv), and variables in group (iii) might influence variables in group (iv).

### 1.4. Rationale of our study

There is currently not much empirical evidence (Arafat et al., 2020a; Yuen *et al.*, 2020) that could confirm or disconfirm whether the variables discussed above have direct or indirect effects on buying behavior. However, considering the apparent irrationality of buying behavior during the COVID-19 pandemic, it is particularly plausible that stockpile purchasing is strongly linked to a variable located on the psychopathological level, such as obsessive-compulsiveness. Interestingly, there are anecdotal reports of a considerable increase in OCD symptoms during the COVID-19 pandemic (Banerjee, 2020) and clinically elevated levels of anxiety have been found in the general population (Huang and

Zhao, 2020; Lee, 2020; Lee *et al.*, 2020). This provides some initial plausibility especially for the hypothesis that the seemingly irrational buying behavior in the first phase of the COVID-19 pandemic is associated with obsessive-compulsiveness and the fears it potentially triggers.

We therefore decided to put this hypothesis to the test by measuring stockpile purchasing behavior as dependent variable and obsessive-compulsiveness, fear of incapacitation, and fear of destabilization as independent variables. We expected fear of incapacitation and destabilization to act as mediators between the behavioral and the psychopathological level since these fears are likely to be fueled by obsessive-compulsiveness.

According to the considerations made above, obsessive-compulsiveness might appear as a particularly promising candidate for explaining stockpile purchasing behavior. However, additional and related factors may still play a role, including desirability of control, perceived control, experienced scarcity, or psychopathy, either directly or via obsessive-compulsiveness. We therefore decided to measure these variables as well, in order to test their potential effects and to control for them.

## 2. Methods

### 2.1. Participants

A link to the German version of our online survey was posted publicly on the website of the Center for Economics and Neuroscience (CENs), University of Bonn, and was also distributed via e-mail lists and social media. Participation was fully informed and voluntary. Specifically, participants were informed on the start page that they would be taking part in an anonymous, unpaid, and roughly twenty minutes long survey on buying behavior and personality in times of the COVID-19 pandemic. They were asked to read through a consent form and could start the survey upon agreement. The study protocol conformed to the ethical standards of the Declaration of Helsinki and had been approved by a local ethics committee.

Data collection started on April 19th, 2020, yielded 1280 responses after one week, and ended on Mai 8th, 2020. By this time, a total of 1379 persons had participated in the survey, and 1010 had fully completed it. Of these, six participants were removed as they did not confirm at the end of the survey that they responded in a serious way. Further six participants were removed since they completed the survey in less than 9.1 min, indicating a reading speed of more than 450 words per minute. While individual reading speeds can differ in the range of several hundred words per minute (Brysbaert, 2019; Jackson and McClelland, 1975), a reading speed of 450 words per minute seems to be indicative of skimming rather than of reading for comprehension (Carver, 1992), and is more than twice as fast as the median reading speed of the other participants (Mdn = 22.9 min). Hence, a total of 12 participants were excluded. The data of the remaining 998 participants were subjected to further analyses. The mean age of participants was 30.8 (SD = 12.9) years. Further demographic characteristics of the sample are presented in Table 1.

### 2.2. Study design and data analysis

As no measure of stockpile purchasing was readily available, we designed a questionnaire to this end. Its psychometric characteristics were tested using a cross-validation design with two independent subsamples, one used for exploratory factor analysis and item selection, the other for testing the final scale using confirmatory factor analysis. Model fit was evaluated in terms of $\chi^2$, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), and the comparative fit index (CFI). Rules of thumb for a good or acceptable model fit are a low and non-significant $\chi^2$-value, an RMSEA < 0.05 and < 0.08, an SRMR < 0.06 and < 0.08, and a CFI > 0.95 and > 0.90, respectively (Hu and Bentler, 1999; Kline, 2015).

In line with the theoretical considerations made above, we investigated the predicted relationships between stockpile purchasing and the explanatory variables using path analyses. First, a mediation model was tested specifying obsessive-compulsiveness as a predictor of stockpile purchasing behavior, and fear of incapacitation and fear of destabilization as (partial) mediators of the effect (Fig. 2A). In a second step, we tested if the hypothesized relation between obsessive-compulsiveness and stockpile purchasing could be maintained when additionally including the other variables with potential explanatory value for stockpile purchasing behavior (Fig. 2B), namely psychopathy, experienced scarcity, desirability of control, and perceived control. In both steps, variables on the same level were allowed to be intercorrelated, to model their potential dependency. Furthermore, variables were allowed to predict all variables in subsequent levels to test their potential (partial) effects.

For cross-validation, we used a machine learning approach to test whether obsessive-compulsiveness can predict stockpile purchasing if the variable representing the latter is structured more coarsely, i.e. in a binary way. We classified those scores on the stockpile purchasing severity scale (SPS, see below) that were larger than the score of a respondent who chooses the median response option on each item (i.e. $5 \times 4 = 20$) as "high" and the rest as "low". Using random sampling, we divided the full data set into a test set consisting of 140 participants and a training set which was sampled down such that it contained an equal percentage of "low" and "high" SPS cases. A binary machine learning classifier was trained on the training set using logistic regression. The corresponding predictions were tested on the test set to determine the classifier's accuracy. This process was repeated 30 times. It was then tested whether the mean of the resulting 30 accuracy values is above the classification accuracy of a classifier that randomly chooses "high" vs. "low" with equal probability (i.e. chance level).

Data analyses were performed using *R* version 3.6.3 (R Development Core Team, 2008) along with the packages *psych* (Revelle, 2020) for psychometric analyses, and *lavaan* (Rosseel, 2012) and *semTools* (Jorgensen *et al.*, 2020) for confirmatory factor analyses and path analyses, respectively. To estimate robust standard errors for the path analyses, we used the se="bootstrap" argument of the lavaan sem function with 1000 resamples. We generated 10,000 bootstrap resamples in all other cases where bootstrapping was used. All path coefficients that are reported in the following are standardized, that is, they are (partial) correlations and their square corresponds to the percentage of explained variance.

### 2.3. Measures

#### 2.3.1. Hamsterkauf Questionnaire (HQ)

Lending from the German verb "hamsterkaufen" our questionnaire was named "Hamsterkauf Questionnaire" (HQ). The HQ consists of four scales. The "stockpile purchasing severity" (SPS) scale measures the extent to which a respondent engages in stockpile purchasing behavior; it does not assess the respondent's motives. Possible motives for engaging in stockpile purchasing behavior are measured by the other scales. The second scale assesses whether respondents "experienced scarcity" (SCA). The remaining two scales serve to capture possible fears that might have motivated participants to engage in stockpile purchasing behavior. The "fear of incapacitation" (FOI) scale measures the fear of being prevented from providing oneself onewith daily necessities (e.g. due to being sick or quarantined). The "fear of destabilization" (FOD) scale measures the extent to which a respondent expects other people to behave in such a way that daily necessities will become unavailable. The items of the scales SPS, SCA, and FOD were constructed in such a way that they can be used not only in the context of a pandemic, but also in other contexts of interest (e.g. wars, natural disasters, political instability, or economic disruptions). The items of all scales are listed in the supplementary materials.

We instructed participants to answer the items with regard to the period of time when the COVID-19 crisis got going in their country since

**Table 1**
Demographic characteristics of the sample.

| | *n* | % |
|---|---|---|
| *Gender* | | |
| Female | 736 | 73.7 |
| Male | 254 | 25.5 |
| Diverse | 8 | 0.8 |
| *Age group (years)* | | |
| 18 – 38 | 810 | 81.2 |
| 39 – 59 | 130 | 13.0 |
| 60 – 80 | 58 | 5.8 |
| *Level of education* | | |
| No degree/lower secondary degree | 54 | 5.4 |
| Upper secondary degree | 461 | 46.2 |
| University degree/doctoral degree | 483 | 48.4 |
| *Professional status* | | |
| Student/vocational Training | 536 | 53.7 |
| Employed | 307 | 30.8 |
| Self-Employed/freelancer | 40 | 4.0 |
| Unemployed/retired/other | 115 | 11.5 |
| *Level of income per year before taxes (in Euro)* [a] | | |
| <= 25,000 | 417 | 41.8 |
| < 25,000 –50,000 | 130 | 13.0 |
| < 50,000 –75,000 | 64 | 6.4 |
| > 75,000 | 25 | 2.5 |
| *Have you ever been diagnosed with a mental disorder by a medical professional?* [b] | | |
| I do not want to tell | 43 | 4.3 |
| No | 735 | 73.6 |
| Yes | 217 | 21.7 |
| *Diagnoses of those who replied with "Yes" to the previous question* [c] | | |
| Depression | 137 | 13.8 |
| Substance use disorder | 1 | 0.1 |
| Anxiety disorder | 67 | 6.7 |
| Obsessive-compulsive disorder | 17 | 1.7 |
| Somatic symptom disorder | 8 | 0.8 |
| Eating disorder | 42 | 4.2 |
| Psychotic disorder | 4 | 0.4 |
| Personality disorder | 16 | 1.6 |
| Other | 34 | 3.4 |
| Do not know exact diagnosis | 11 | 1.1 |

***Notes.*** Total samples size is $N = 998$.
[a] Answer was not required to complete the survey ($n = 636$ replied).
[b] Three participants provided contradictory answers and were therefore not counted ($n = 995$).
[c] Multiple answers were possible.

the time course of the outbreak was different in different German speaking areas.

### 2.3.2. Exploratory factor analysis (HQ)

We divided the total sample into two sub-groups of $n = 499$ participants each that were matched for gender and age so that we could use different samples for the exploratory and confirmatory factor analyses. In the exploratory factor analysis, four factors were extracted, corresponding with the measurement intention outlined above. Since we expected factors to be correlated, factors were obliquely rotated using the *oblimin* criterion. The resulting loadings are presented in the supplementary materials. The pattern of loadings confirmed a relatively clear simple structure in line with theoretical expectations. Only two items fell short of predictions (namely items 5 and 15) with generally low loadings (all loadings < 0.3). Both items were removed to improve construct saturation of the scales, which additionally improved simple structure of loadings in a subsequent exploratory factor analysis (see the supplementary materials for details).

### 2.3.3. Confirmatory factor analysis (HQ)

The other independent sub-sample was used to perform a confirmatory factor analysis on the final HQ, testing the measurement model as obtained in the exploratory factory analysis. The model revealed an overall satisfactory fit to the data. A significant $\chi^2$-test ($\chi^2(84) = 188.278$, $p < .001$) was not surprising given the large sample size. However, an RMSEA = 0.050 (90% CI [.040, 0.060]), an SRMR = 0.050, and a CFI = 0.944 indicated close fit of the model to the data. All items loaded substantially and significantly on their theoretically assigned factors (see Fig. 1).

### 2.3.4. Reliability of HQ

Internal consistency as given by Cronbach's $\alpha$ (McDonald's $\omega$) was $\alpha = 0.77$ ($\omega = 0.78$) for SPS, $\alpha = 0.67$ ($\omega = 0.69$) for SCA, $\alpha = 0.67$ ($\omega = 0.68$) for FOI, and $\alpha = 0.58$ ($\omega = 0.62$) for FOD. Thus, internal consistency was in the range that could be expected for short scales that measure heterogeneous constructs. Importantly, unidimensionality of the scales (i.e. one factor that underlies each scale) was clearly supported by the CFA analyses.

### 2.3.5. Other questionnaires

We used the German version of the Dimensional Obsessive-Compulsive Scale (DOCS; Abramowitz *et al.*, 2010) to measure obsessive-compulsiveness. After obtaining permission from the author, we changed the instructions such that all items referred to the month after the COVID-19 pandemic got going in the participant's country of residence or, if this was less than one month ago, to the last month. Internal consistency was high in the present sample ($\alpha = 0.91$; $\omega = 0.92$). The Primary Psychopathy scale of the Levenson Self-Report Psychopa-

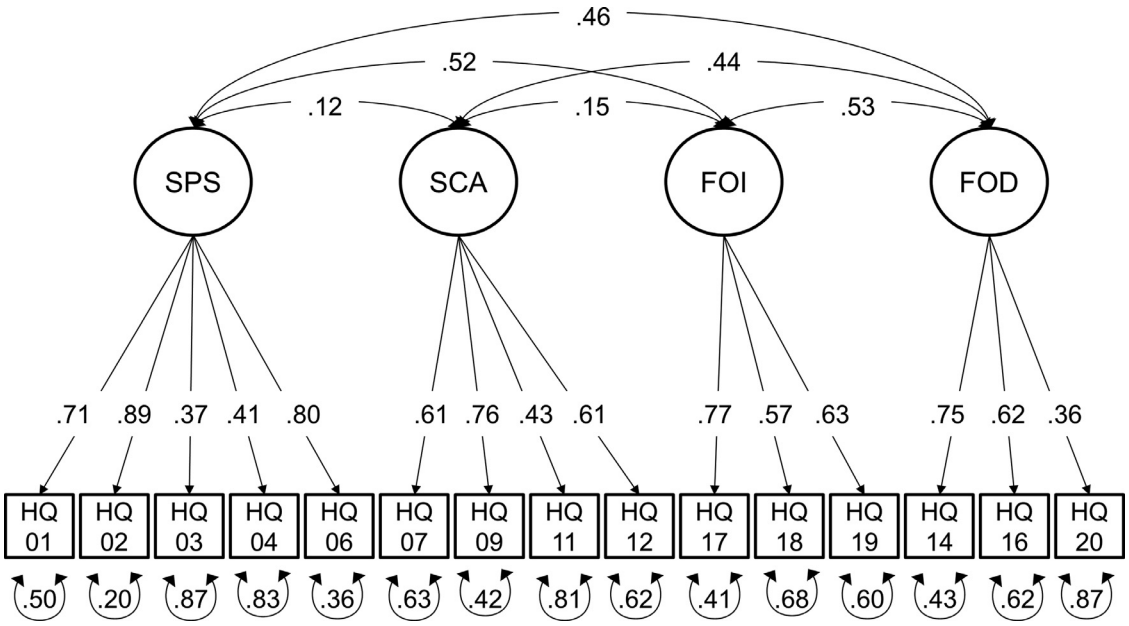


**Fig. 1.** Confirmatory Factor Analysis of the Hamsterkauf Questionnaire (HQ) scales. SPS = stockpile purchasing severity, SCA = experienced scarcity, FOI = fear of incapacitation, FOD = fear of destabilization. All parameters are standardized and significantly different from zero.

thy Scale (LSRP; Levenson *et al.*, 1995) was translated into German (consensus of two independent translations forth and then one back translation) and revealed satisfactory internal consistency ($\alpha$ = 0.85; $\omega$ = 0.86). Desirability of control was determined using the Desirability of Control Scale (DCS; Burger and Cooper, 1979), which we also translated (internal consistency: $\alpha$ = 0.82; $\omega$ = 0.84) since the lockdown made it impossible to get a hold of a previous German translation (Braukmann, 1981), of which only one hardcopy seems to exist, namely in the University Library of Trier. We also translated the Perceived Control Over Stressful Events Scale (PCOSES; Frazier *et al.*, 2011; internal consistency: $\alpha$ = 0.74; $\omega$ = 0.74) to measure perceived control. Since we wanted to refer to the same period of time as in the HQ, namely the period of time when the COVID-19 pandemic got going, we had to modify the instruction and labels of the response options accordingly. For reasons of completeness, we would like to mention that, in addition to the assessments described above, we also assessed our participants' buying behavior with regard to different product categories and their intended future buying behavior. Results pertaining to these assessments need to be reported elsewhere due to limitations of space.

## 3. Results

### 3.1. DOCS scores

Obsessive-compulsiveness as measured with DOCS was notably elevated in our sample. Abramowitz *et al.* (2010, pp. 190–191) suggest a DOCS cutoff score of 21 to distinguish "OCD patients from those with other anxiety disorders" and a cutoff score of 18 to distinguish "OCD patients from nonclinical adults" because these values provide "the best balance between sensitivity and specificity", respectively. 28% of our participants had a DOCS score higher than 21 points. The percentage increased to 38% when a cutoff value of 18 was used. Both values were far above ($\chi^2(1) = 742$, $p < .001$ and $\chi^2(1) = 1183$, $p < .001$, respectively) the 12-month OCD-prevalence of 3.6% that can be expected in the German general population (Jacobi *et al.*, 2014). The mean DOCS score was 16.2 (95% CI[15.6, 16.9]) and thus significantly higher ($t(1219) = 5.57$, $p < .001$) than the mean DOCS score of 11.9 pertaining to a German control sample of 223 participants (Fink-Lamotte et al., 2020; cf. also Abramowitz *et al.*, 2010, who report a mean score of 11.9 for a control sample of unscreened American undergraduate students). The DOCS total score of those participants who report that they had been diagnosed with OCD (27.4) by a medical professional (1.7%, see Table 1) was significantly increased ($t(16.22) = -2.71$, $p = .015$; $U = 4733.5$, $z = -3.060$, $p = .001$) compared to the rest of the sample. Bootstrapping analyses confirmed these results.

### 3.2. Path model

Stockpile purchasing severity and obsessive-compulsiveness were significantly correlated with $r(996) = 0.248$, $p < .001$, so that obsessive-compulsiveness explained 6.2% of the variance of stockpile purchasing severity. The relationship between obsessive-compulsiveness and stockpile purchasing severity was mediated by fear of incapacitation and fear of destabilization (see Fig. 2A). All path coefficients leading to stockpile purchasing severity were significantly different from zero. The indirect effect via fear of destabilization on stockpile purchasing severity was $\beta = 0.293^{*}0.189 = 0.055$ ($z = 5.241$, $p < .001$) and the indirect effect via fear of incapacitation on stockpile purchasing severity was $\beta = 0.337^{*}0.305 = 0.103$ ($z = 7.445$, $p < .001$). The total indirect effect of obsessive-compulsiveness on stockpile purchasing severity is the sum of the two indirect effects and was thus $\beta = 0.158$ ($z = 9.379$, $p < .001$). Adding the remaining direct effect of $\beta = 0.090$ ($z = 2.912$, $p = .004$) gives the total effect of obsessive-compulsiveness on stockpile purchasing severity, which is identical to the correlation between the two variables of r = 0.248. The direct effect of fear of incapacitation and fear of destabilization on stockpile purchasing severity was $\beta = 0.305$ ($z = 9.886$, $p < .001$) and $\beta = 0.189$ ($z = 6.231$, $p < .001$), respectively. The model illustrated in Fig. 2A explained 20.0% of the variance of stockpile purchasing severity.

### 3.3. Extended path model

To validate that the relationship between stockpile purchasing severity and obsessive-compulsiveness cannot be attributed to third variables with potential explanatory value, we extended the model in Fig. 2A (Fig. 2B). In this extended model, perceived control was added to the level of psychological mechanisms and a fourth level was considered, which contained variables that capture situational and individual

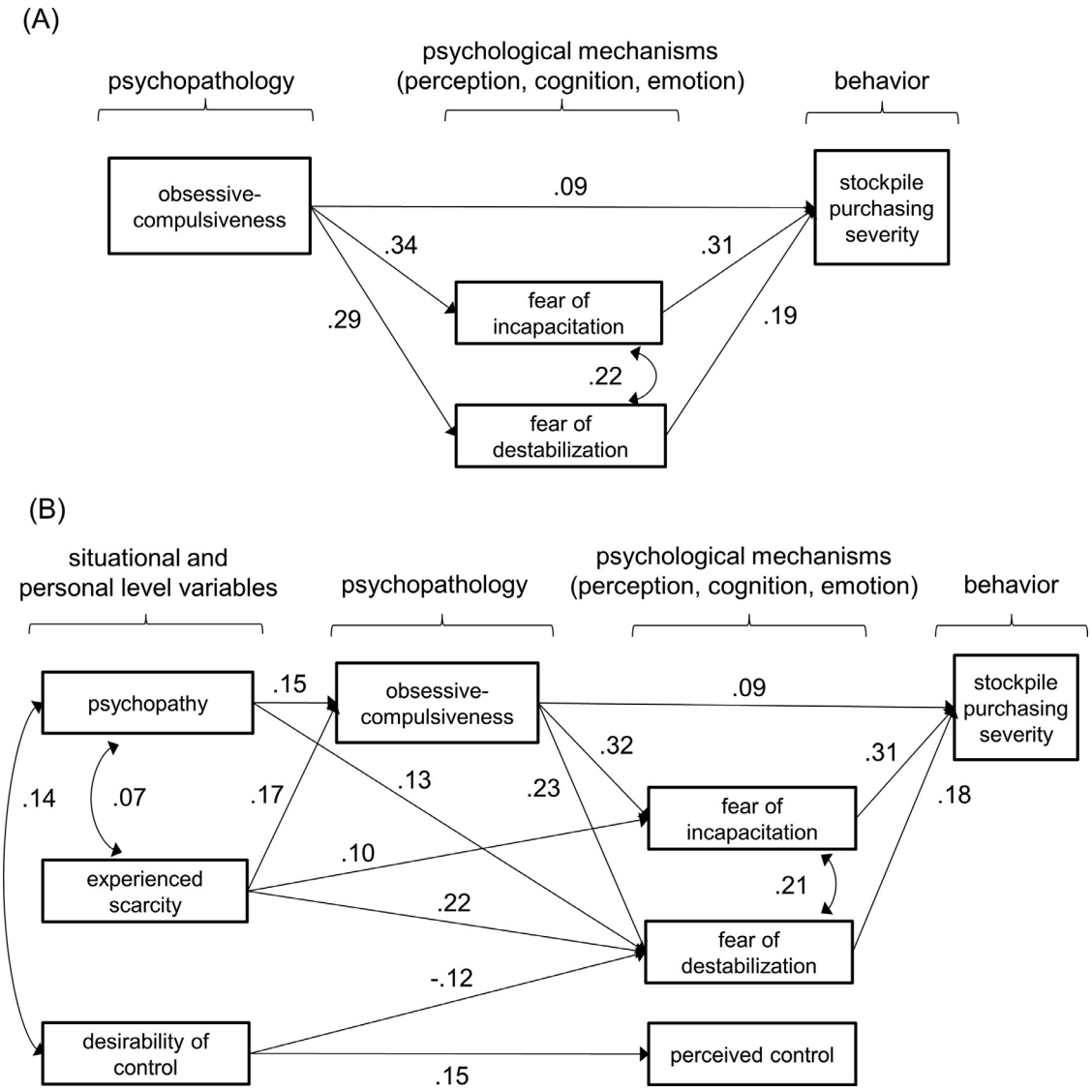


**Fig. 2.** (A) Path model illustrating the direct and indirect (via fear of incapacitation and fear of destabilization) effects of obsessive-compulsiveness on stockpile purchasing severity. (B) Extension of the path model in Fig. 2 (A), additionally comprising perceived control, psychopathy, experienced scarcity, and desirability of control. All path coefficients are standardized; only significant paths are displayed.

boundary conditions (psychopathy, desirability of control, experienced scarcity). Fig. 2B shows only the significant paths of this analysis.

Importantly, the pattern of results concerning obsessive-compulsiveness, fear of incapacitation, fear of destabilization, and stockpile purchasing severity remained stable when including these additional variables. There was a direct effect of obsessive-compulsiveness on stockpile purchasing severity ($\beta = 0.085$, $z = 2.722$, $p = .006$), an indirect effect of obsessive-compulsiveness on stockpile purchasing severity that was mediated by fear of incapacitation ($\beta = 0.318^{*}0.305 = 0.097$, $z = 7.165$, $p < .001$), and an indirect effect of obsessive-compulsiveness on stockpile purchasing severity that was mediated by fear of destabilization ($\beta = 0.230^{*}0.182 = 0.042$, $z = 4.608$, $p < .001$). The total indirect effect of obsessive-compulsiveness on stockpile purchasing severity was thus $\beta = 0.139$ ($z = 8.684$, $p < .001$).

There was neither a direct effect of perceived control ($\beta = -0.028$, $z = -0.962$, $p = .336$) nor of desirability of control on stockpile purchasing severity ($\beta = -0.007$, $z = -0.244$, $p = .807$). Of the indirect effects of desirability of control on stockpile purchasing severity, only the indirect effect via fear of destabilization ($\beta = -0.022$, $z = -3.393$, $p = .001$) was significant. The total indirect effect of desirability of control on stockpile purchasing severity thus became significant ($\beta = -0.031$, $z = -2.337$, $p = .019$). However, the total effect of desirability of control was not significant ($\beta = -0.038$, $z = -1.223$, $p = .221$).

By contrast, perceived scarcity and psychopathy both had a notable influence on obsessive-compulsiveness ($\beta = 0.168$, $z = 5.457$, $p < .001$, and $\beta = 0.154$, $z = 4.934$, $p < .001$). The indirect effect of experienced scarcity on stockpile purchasing severity via obsessive-compulsiveness ($\beta = 0.014$, $z = 2.436$, $p = .015$), via fear of incapacitation ($\beta = 0.029$, $z = 3.022$, $p = .003$), and fear of destabilization ($\beta = 0.040$, $z = 4.551$, $p < .001$) was significant as well. So was the sum of all indirect effects of experienced scarcity on stockpile purchasing severity ($\beta = 0.085$, $z = 6.025$, $p < .001$). Psychopathy had a significant influence on stockpile purchasing severity via obsessive-compulsiveness ($\beta = 0.013$, $z = 2.384$, $p = .017$) and via fear of destabilization ($\beta = 0.024$, $z = 3.545$, $p < .001$). The sum of all indirect effects of psychopathy was also significant ($\beta = 0.043$, $z = 3.227$, $p = .001$). Although the direct effects were not significant, the total effects (direct and indirect) of experienced scarcity and psychopathy on stockpile purchasing severity reached significance ($\beta = 0.090$, $z = 2.936$, $p = .003$, and $\beta = 0.073$, $z = 2.351$, $p = .019$, respectively). The model illustrated

in Fig. 2B explained 20.1% of the variance of stockpile purchasing severity. Hence, the additional variables tested in model 2B neither revealed a substantial incremental validity for stockpile purchasing severity over the previously tested variables in model 2A ($\Delta R^2 = 0.1\%$) nor did they diminish the effects of the predictors tested in model 2A. The pattern of results pertaining to the path analyses did not change when bootstrapping was used to estimate robust standard errors.

### 3.4. Corroborating the main results using machine learning

Obsessive-compulsiveness could retain its predictive power even if the dependent variable was structured more coarsely by classifying stockpile purchasing severity as "high" vs. "low" using a split at the median category of the SPS scale (i.e. a total SPS score > 20). A binary machine learning classifier with only obsessive-compulsiveness as predictor achieved a classification accuracy of 67.9% (95% CI [66.2%, 69.6%]). This classification accuracy was significantly above chance level ($t(29) = 15.058$, $p < .001$). An accuracy of 69.1% ($t(29) = 16.760$, $p < .001$, 95% CI [67.4%, 71.0%]) was obtained when all predictors illustrated in Fig. 2B were used for classification. Results remained significant when non-parametric tests were used or when participants were classified as having "high" stockpile purchasing severity if they exhibited a larger total SPS score than 50% of the other participants (i.e. a total SPS score > 10).

## 4. Discussion

The average level of obsessive-compulsiveness in our sample was elevated. Roughly a third of participants reached a level of obsessive-compulsiveness that was of clinical relevance. While not identical to a diagnosis, such high levels indicate the presence of notable symptoms of OCD. This finding is in line with anecdotal evidence of considerable increments in OCD symptoms during the COVID-19 pandemic (Banerjee, 2020; Rajkumar, 2020).

Furthermore, we confirmed the hypothesis put forward by Banerjee (2020) and Rajkumar (2020) that stockpile purchasing behavior is associated with OCD. Obsessive-compulsiveness predicted stockpile purchasing behavior directly and also indirectly via fears of incapacitation and destabilization. The indirect relationship is consistent with studies reporting an overestimation of threat in OCD. Specifically, OCD patients deem themselves less protected than others to experience negative (especially OCD-related) events (Moritz and Pohl, 2009), and provision of correcting information appeases OCD patients to a significantly lesser degree than healthy controls (Moritz and Jelinek, 2009; Moritz and Pohl, 2006). While the aforementioned findings can explain why obsessive-compulsiveness predicts fears of incapacitation and destabilization, it remains open whether this relationship is due to an overestimation of the probability that a negative event will occur or due to an overestimation of the awfulness of the event. The fact that fear of incapacitation and destabilization are predictive of stockpile purchasing behavior supports the notion that such behavior was at least to some extent driven by fear and can thus partly be regarded as safety behavior, e.g. to avoid the threat of infection or to be able to engage in extensive cleansing rituals.

The direct and indirect effects of obsessive-compulsiveness on stockpile purchasing severity were not diminished when further variables with explanatory potential were taken into account. Psychopathy and experienced scarcity both were indirectly predictive of stockpile purchasing behavior (via obsessive-compulsiveness, fear of incapacitation, or fear of destabilization) and directly predictive of obsessive-compulsiveness. Particularly the latter finding provides insights into the etiology of OCD and is thus of relevance beyond the context of the COVID-19 pandemic. Psychopathic personality traits have previously been found to be positively associated with OCD in the general population (Coid *et al.*, 2009) and experiencing scarcity is a significant stressor (Brooks *et al.*, 2020, p. 916). This lends further support to a diathesis-stress model (Cromer *et al.*, 2007; Real *et al.*, 2011; Ceschi *et al.*, 2011) of OCD, according to which stressful life events may contribute to the development of obsessive-compulsive symptoms in those who have (personality) dispositions that make them vulnerable to OCD. Since people were subjected not only to an experience of scarcity but to numerous other stressors during the beginning of the pandemic (Rotter et al., 2021), a diathesis-stress model of OCD can plausibly explain why 38% of respondents exhibited clinically elevated levels of OCD. This percentage may, given that a diathesis-stress model is appropriate, be regarded as a rough and conservative estimate for the vulnerability of the general population to OCD. The estimate is rough and conservative because not everybody may have been subjected to the same stressors that were brought about by the COVID-19 pandemic to the same degree. At the same time, it appears unlikely that the number was inflated by self-selection biases since the self-reported pre-COVID-19 lifetime prevalence of OCD in our sample (1.7%) was well within what could be expected from a typical population of an industrialized nation. Usually, an estimate for the vulnerability of the general population to OCD is hard to come by since the genetic architecture of OCD is still not understood well enough (see e.g. Arnold *et al.*, 2017) and lifetime risk estimations are likely to severely underestimate the true numbers. The COVID-19 pandemic, however, might have provided us with the dismal yet unique opportunity to determine such an estimate. If this is true, at least every third person in the general population has a risk of developing OCD levels of clinical relevance if subjected to the "right" unfavorable circumstances.

While desirability of control was positively related with perceived control, as could be expected from earlier research where perceived control was measured with the Spheres of Control Questionnaire (Amoura *et al.*, 2014), neither of the two variables had a significant total effect on stockpile purchasing behavior. Desirability of control was also not predictive of obsessive-compulsiveness. At first sight, this finding may be surprising since OCD could be predicted by desirability of control in a non-clinical sample (Moulding and Kyrios, 2007). In the latter sample, however, desirability of control could only predict obsessive-compulsiveness after depression and anxiety were controlled for. Obsessive-compulsiveness and desirability of control alone were not significantly correlated (Moulding and Kyrios, 2007, p. 765). Finally, it may be worth noting that desirability of control and psychopathy were correlated in our sample. This is consistent with the view that the desire for control can be regarded as a dimension of machiavellianism (Dahling *et al.*, 2009), which is related with psychopathy (Rogoza and Cieciuch, 2019). A direct correlation between psychopathy and desirability for control was reported by Kramer *et al.* (2011) for a sample of entrepreneurship students.

In sum, our results fit well with previous findings discussed above. Cross-validation of our results with a different method of analysis using a machine learning algorithm confirmed the predictive relevance of obsessive-compulsiveness for stockpile purchasing behavior. However, while this predictive relevance is undeniable, there is still a considerable amount of variance left to be explained in stockpile purchasing behavior, which is of a magnitude that is typical for the field of research we are dealing with (Gignac and Szodorai, 2016). To be more specific, obsessive-compulsiveness alone explains about 6.2% of the variance in stockpile purchasing behavior, while the predictors in the model illustrated in Fig. 2A explain not more than 20.0%. Hence, further research is required to improve our understanding why such widespread stockpile purchasing behavior occurred in the beginning of the COVID-19 pandemic. Considering its apparent irrationality, we expect those variables that capture psychopathological processes to have a high explanatory value, in particular anxiety disorders. Among anxiety disorders, generalized anxiety disorder could be a promising candidate for explaining stockpile purchasing behavior in times of the COVID-19 pandemic. It might also make sense to check whether stockpile purchasing behavior can be attributed to impaired emotion regulation strategies as the latter

have been shown to be associated transdiagnostically with the development of several affective disorders (Muñoz-Navarro *et al.*, 2020).

From a public health perspective, the high levels of obsessive-compulsive symptoms obtained in this study are worrying. Individuals suffering from OCD often exhibit safety behaviors. Stockpile purchasing behavior in times of the COVID-19 pandemic may at least in part be counted among those safety behaviors. Cognitive models of OCD suggest that safety behaviors are likely to lead into a vicious cycle of anxiety that exacerbates obsessive-compulsive symptoms (Salkovskis *et al.*, 1998, pp. 54–58). More specifically, obsessive thoughts make the occurrence of safety behaviors more likely since safety behaviors are negatively reinforced as they reduce anxiety. Safety behaviors, in turn, lead to a stronger preoccupation with threat, which reinforce the occurrence of obsessive thoughts. Once this vicious cycle is entered, individuals might get trapped in it, even when the initial threat has already disappeared. It is unlikely that all of the participants who reported clinically relevant OCD symptoms in the beginning of the pandemic (38%) enter into such a vicious cycle. Nevertheless, this could be the case for some people, who may over time (Thompson *et al.*, 2020) develop persistent OCD which is so severe that treatment is required. We therefore concur that identification and prevention of OCD in times of the COVID-19 pandemic is highly warranted (Pozza *et al.*, 2020), and suggest that levels of OCD should be monitored in the general population to follow up on the decrease of these levels as stressors disappear.

## 5. Limitations

Data were collected in form of an online survey using a convenience sample. Hence, it would be desirable to replicate core findings with a more representative panel. We employed self-report instruments that required introspection and willingness to respond honestly. The clinical relevance of OCD symptoms was determined on this basis; it was not confirmed in clinical interviews. Participation was voluntary and unpaid, so, we cannot entirely exclude the possibility that self-selection of participants is in some way responsible for the high number of participants who exhibited OCD symptoms of clinical relevance. This number might have been artificially inflated by the low mean age of our participants, for instance, since symptom severity of OCD is known to be negatively correlated with age (Brakoulias and Rehn, 2017). Note, however, that the 1.7% lifetime prevalence of diagnosed OCD reported by our participants (see Table 1) was within the range that could be expected from a sample with a mean age of 30.8 years (see e.g. Kessler et al., 2005). This and the fact that our study was not advertised as a study on OCD suggests that the high levels of obsessive-compulsiveness were not due to self-selection biases. It is more likely that self-section biases affected scores on the stockpile purchasing severity scale since our study was advertised as a study on buying behavior and personality in times of the COVID-19 pandemic. Finally, we note that all data were collected cross-sectionally, which precludes inferences about causality. However, our data are consistent with the path models illustrated in Fig. 2. It has been discussed (e.g. Maxwell *et al.*, 2011; Jose, 2016) that mediation effects which are determined on the basis of cross-sectional data can be biased. We cannot exclude the possibility that our mediation effects are affected by such a bias. This, however, may be tolerable in scientific practice (Hayes and Rockwood, 2017).

## 6. Conclusion

The widespread stockpile purchasing behavior that could be observed in the beginning of the COVID-19 pandemic was found to be associated with elevated levels of obsessive-compulsiveness and mediated by fears of incapacitation and destabilization. It is likely that stockpile purchasing is a means to reduce these fears and thus functions to some extent as safety behavior. The elevated levels of obsessive-compulsiveness, in turn, can partly be explained by personality factors and situational stress factors, that is, by psychopathy and experienced scarcity. While the present study could shed some light on why people engaged in stockpile purchasing behavior during the beginning of the COVID-19 pandemic, the phenomenon has not yet been explained exhaustively. More research is required to fully understand which and how individual and contextual variables give rise to it.

## Declaration of Competing Interest

The authors declare that they did not have any conflict of interest.

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## Contributors

Florian Schiller, Florian Schmitz, and Katharina Bey designed the study. Florian Schiller, Florian Schmitz, and Leonhard Grabe performed statistical analyses. Florian Schiller wrote the first version of the manuscript. Katharina Bey contributed substantially to the introduction and discussion. All authors edited the text iteratively and have approved the final version of the manuscript.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2021.100116.

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