

COVID-19-Related Distress Predicts Analog PTSD Symptoms After Exposure to an Analog Stressor

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Abstract

The long-term impact of the COVID-19 pandemic on mental health is only starting to emerge. Beyond direct effects on mental health, it is crucial to investigate how negative psychological responses to the COVID-19 pandemic might affect etiological processes of different mental disorders. In the current online study, we investigated whether a negative psychological response to the pandemic might predispose individuals towards posttraumatic stress disorder (PTSD) development after exposure to a non-COVID-19-related traumatic stressor. Moreover, we examined if these effects are mediated by the strength of associative fear learning during trauma. Using an established analog procedure, we demonstrate that COVID-19-related distress predicts analog PTSD symptoms of a non-COVID-19-related stressor and that these effects are fully mediated by the strength of associative fear learning during exposure to the analog stressor. As such, our findings indicate that negative psychological responses to the COVID-19 pandemic should be considered as an emerging pretraumatic risk factor.

1. Introduction

First findings indicate that the general population is experiencing an increase in mental health problems since the coronavirus disease 2019 (COVID-19) outbreak¹. These mental health problems are mostly reflected in anxiety, depression, and/or symptoms of obsessive-compulsive disorder²⁻⁴. Although heavily debated, some studies even indicate that a significant percentage of the general population might be suffering from COVID-19-related posttraumatic stress disorder (PTSD)⁵ with prevalence estimates ranging from 17.7 to 29.5%^{6,7}.

However, it is important to take into account whether the COVID-19 pandemic qualifies as a traumatic stressor (involving actual or threatened death, serious injury, or sexual violence) or as a psychosocial stressor (involving – amongst other things – social isolation, societal uncertainty, and financial insecurity). This distinction should be made on a single-subject basis to improve prevalence estimates⁸. Epidemiological studies conducted prior to the pandemic indicate that averaged across different trauma types approximately 4% of trauma survivors suffer from persistent PTSD⁹. The core symptoms of PTSD are recurring, unwanted (intrusive) memories of the trauma, hyperarousal, and avoidance of trauma-related stimuli. Amongst these core symptoms, intrusive memories are assumed to play the key role in PTSD development¹⁰. Consonantly, longitudinal studies indicate that distressing intrusions co-occurring with trauma-related rumination predict chronic PTSD^{11,12}.

Beyond its putative role as a traumatic stressor, the COVID-19 pandemic could also act as a pretraumatic risk factor, modulating the effects of subsequent trauma. That is, the pandemic's impact as a psychosocial stressor could predispose individuals towards the development of posttraumatic stress symptoms after a (non-COVID-19-related) traumatic event. Consistent with this assumption, we found that above-average COVID-19-related distress and rumination were associated with a significant increase of psychopathology from pre- to post-outbreak¹. Moreover, research on risk factors of PTSD has

identified previous adversities as one of the most consistent distal predictors of posttraumatic stress symptoms¹³. That is, experiencing a period of prolonged stress prior to trauma might predispose individuals towards maladaptive processing during and after the trauma, resulting in the development of PTSD symptoms.

A critical process that is assumed to contribute to the development and persistence of PTSD symptoms is associative fear learning^{14,15}. During trauma, individuals are assumed to acquire associations involving neutral, trauma-associated stimuli (e.g., approaching headlights) and their traumatic stress response (e.g., fear of dying during car crash). After trauma, these associations are assumed to trigger intrusive memories in response to similar stimuli. Correspondingly, studies have demonstrated a link between associative fear learning and intrusion development¹⁶. Critically, the strength of associative fear learning varies systematically between individuals, which is assumed to result in interindividual differences in intrusion frequency and distress¹⁷. Trauma-associated rumination occurs frequently in response to intrusions and is, in turn, assumed to perpetuate intrusive re-experiencing symptoms^{11,12,18}. Though phenomenologically different¹⁹, it has been suggested that rumination can also be initiated by memory processes²⁰ and, thus, could be likewise affected by differences in associative fear learning²¹. Considering that high stress levels are assumed to strengthen associative fear learning²², we hypothesize that negative psychological responses to the COVID-19 pandemic may enhance associative fear learning during analog trauma, resulting in more frequent intrusive trauma memories. Furthermore, we hypothesize that COVID-19-related distress predicts rumination after analog trauma and investigate whether the strength of fear associations could similarly mediate this relationship.

We tested these assumptions based on data from an analog study that we conducted online from March to July 2020. As part of a larger study, healthy participants completed two questionnaires measuring their psychological responses to the COVID-19 outbreak (see 4.2.). On a subsequent day, they went through an associative fear learning task (see 4.3.). Throughout the task, two originally neutral stimuli (conditioned stimuli, CS⁺s) were repeatedly paired with the appearance of an aversive film clip (unconditioned stimulus; US). Subjective ratings (US expectancy, fear, arousal, and valence) were assessed as indicators of the strength of associative fear learning. Approximately 28 hours later, participants were asked to document film-related intrusive memories they had experienced in the meantime (see 4.4.). Since intrusions are assumed to have a particularly negative impact on posttraumatic symptom development if they co-occur with rumination, we additionally assessed ruminative, trauma-related thoughts. We hypothesized that negative responses to the COVID-19 pandemic would be correlated with stronger associative fear learning as reflected in post-learning CS⁺ ratings (US expectancy, fear, arousal, and valence). Moreover, we predicted that negative responses to the COVID-19 pandemic would be correlated with analog PTSD symptoms. Finally, we hypothesized that the effect of psychological responses to the COVID-19 pandemic on analog symptoms would be mediated by the strength of associative fear learning as assessed by means of post-learning CS⁺ ratings.

2. Result

2.1 Correlations between COVID-19-related measures and analog PTSD symptoms

Analyses revealed significant positive correlations between COVID-19-related distress and film-related intrusions ($r = .23, p = .016$) and rumination ($r = .25, p = .009$). COVID-19-related rumination was not correlated with either measure (all $p > .05$; see Table 1).

Table 1. Bivariate associations between COVID-19 related measures, strength of associative learning, and analog PTSD symptoms

Measures	1	2	3	4	5	6	7	8
1. COVID-19 distress	-	$r = .75^*$	$r = -.17$	$r = .28^*$	$r = .28^*$	$r = .01$	$r = .23^*$	$r = .25^*$
2. COVID-19 rumination	$r = .75^*$	-	$r = -.06$	$r = .19^*$	$r = .13$	$r = .13$	$r = .08$	$r = .09$
3. Post-ACQ CS+ Valence	$r = -.17$	$r = -.06$	-	$r = -.64^*$	$r = -.63^*$	$r = -.26^*$	$r = -.44^*$	$r = -.37^*$
4. Post-ACQ CS+ Arousal	$r = .28^*$	$r = .19^*$	$r = -.64^*$	-	$r = .84^*$	$r = .24^*$	$r = .37^*$	$r = .31^*$
5. Post-ACQ CS+ Fear	$r = .28^*$	$r = .13$	$r = -.63^*$	$r = .84^*$	-	$r = .20^*$	$r = .44^*$	$r = .31^*$
6. Post-ACQ CS+ US EXP	$r = .01$	$r = .13$	$r = -.26^*$	$r = .24^*$	$r = .20^*$	-	$r = .14^*$	$r = .14$
7. Intrusion Index	$r = .23^*$	$r = .08$	$r = -.44^*$	$r = .37^*$	$r = .44^*$	$r = .14$	-	$r = .72^*$
8. Rumination Index	$r = .25^*$	$r = .09$	$r = -.37^*$	$r = .31^*$	$r = .31^*$	$r = .14$	$r = .72^*$	-

Note. ACQ = Acquisition; EXP = Expectancy; CS+ = conditioned stimulus (reinforced); US = unconditioned stimulus; * = $p < .05$.

2.2 Correlations between COVID-19-related measures and post-learning ratings

Analyses revealed significant positive correlations between COVID-19-related distress and post-learning CS⁺ arousal ($r = .28, p = .003$) and fear ratings ($r = .28, p = .004$). Critically, these associations were neither evident for pre-learning ratings nor for CS⁻ ratings (all $p > .05$). COVID-19-related rumination was only correlated with post-learning CS⁺ arousal ratings ($r = .19, p = .047$). No significant correlations were evident for valence or US expectancy ratings (all $p > .05$; see Table 1).

2.3 Mediation models

Mediation analyses with COVID-19-related distress as independent variable and film-related intrusions as dependent variable showed that the association was fully mediated by the strength of associative fear

learning, as indicated by post-learning CS⁺ fear and arousal ratings (see Figure 1a). That is, participants with greater COVID-19-related distress experienced higher arousal and fear after learning in presence of the CS⁺, which was in turn associated with more intrusions. The same pattern emerged for film-related rumination as dependent variable (see Figure 1b). COVID-19-related distress and post-learning CS⁺ arousal ratings accounted for 15% of variance in film-related intrusions ($R^2 = .15$) and 13% of variance in film-related rumination ($R^2 = .13$), whereas COVID-19-related distress and post-learning CS⁺ fear ratings accounted for 21% of variance in film-related intrusions ($R^2 = .21$) and 13% of variance in film-related rumination ($R^2 = .13$). No significant mediation effects emerged for valence or US expectancy ratings.

3. Discussion

The current study investigated whether a negative psychological response to the COVID-19 pandemic may predispose healthy individuals towards PTSD development after exposure to a non-COVID-19-related traumatic stressor. We found partial support for this hypothesis: COVID-19-related distress – but not COVID-19-related rumination – was correlated with greater analog PTSD symptoms after repeated exposure to an aversive film clip. In addition, we tested whether a negative psychological response to the COVID-19 pandemic enhances analog PTSD symptoms by strengthening associative fear learning during trauma. In line with this hypothesis, we found that post-learning arousal and fear responses to the CS⁺ fully mediated the association between COVID-19-related distress and analog symptoms.

By demonstrating these associations, our study makes several theoretical contributions: First of all, it confirms the role of associative fear learning in intrusion development^{14,16} and extends it towards the development of posttraumatic rumination¹². Second, it provides further support for the assumption that pre-trauma stressors unrelated to trauma can affect peritraumatic processing, resulting in posttraumatic symptom development¹³. Third, it is amongst the first to shed light on the processes by which the COVID-19 pandemic may affect mental health. Previous studies have documented the impact of the COVID-19 pandemic on mental health¹⁻⁴. However, the pandemic's impact on successful coping with trauma has yet to be investigated. Confirming COVID-19's relevance as a psychosocial stressor, our results suggest that experiencing COVID-19-related distress may influence memory processing during trauma, resulting in the development of posttraumatic stress symptoms. That is, individuals experiencing the COVID-19 pandemic as a chronic stressor may show an increase in allostatic load²³, which alters stress hormone secretion thereby strengthening associative fear learning processes during trauma^{17,22}. As such, the COVID-19 pandemic may not inflict psychological trauma on the majority of the general population, but associated stress responses may result in an earlier "tipping point" at which trauma exposure results in PTSD development¹³. This assumption should be explored further by utilizing endocrinological markers of stress responses. If confirmed and replicated in the context of real-life trauma, these associations are of major importance for public mental health since epidemiological research indicates that a majority of the world population (70.4%) will experience trauma at some point in life⁹.

Despite remarkably consistent associations between COVID-19-related distress and analog PTSD symptoms, no correlations were evident between COVID-19-related rumination and analog symptoms. Although it may appear unintuitive that rumination related to the COVID-19 pandemic was not predictive of film-related rumination, it is important to differentiate between rumination as a pathogenic process and rumination as a symptom of PTSD. Studies investigating rumination as a pathogenic process indicate that rumination enhances depressive affect, whereas worry enhances anxious affect and leads to the strengthening of fear associations^{24,25}. Hence, COVID-19-related rumination may be more relevant for predicting depressive symptoms than for predicting anxious affect, whereas only anxious affect may be involved in modulating the strength of associative fear learning processes resulting in more frequent intrusions and rumination in response to intrusions¹⁸. In line with this assumption, previous research has shown that rumination related to analog trauma – but not trait-rumination – was correlated with analog intrusive memories^{12,18,26}. Our measure of COVID-19-related distress may thus have assessed anxious responses to COVID-19, whereas COVID-19-related rumination may have measured responses relating to depression.

Another inconsistency of the current findings is that only post-learning fear and arousal ratings – and not valence and US expectancy – mediated the impact of COVID-19-related distress on analog PTSD symptoms. With respect to valence ratings, it is important to note that the analysis descriptively revealed a small – yet non-significant – correlation in the expected direction (see Figure 1 and Table 1). Hence, restricted statistical power may have resulted in inconsistent findings for valence ratings. By contrast, US expectancy was not found to be associated with any of the other study variables. This lack of significant associations could be related to statistical issues: Descriptive statistics indicate that variance ($SD = 12.09$) was markedly lower for US expectancy than for the other indicators of associative learning ($SD = 19.78-30.60$). Hence, restricted variance in US expectancy could have prevented finding significant associations. Beyond these statistical considerations, it is important to note that previous studies have also failed to find a significant correlation between US expectancy and intrusions^{16,27}. This pattern of results could suggest that the subjective, emotional responses to the CS^+ – rather than the expectation of seeing the US – may be relevant for analog symptom development. Relatedly, it has been proposed that subjective fear – as compared to indirect or (neuro-)physiological measures of fear – may be the most important indicator of clinical anxiety and its successful treatment²⁸. Future research should investigate associations between different indicators of associative fear learning and analog symptoms in greater depth.

Although providing several interesting indications, our study has limitations that need to be considered. First, we investigated analog symptoms in a sample of healthy participants. Thus, generalization to processes during real-life trauma is restricted. At the current state of the pandemic, it is difficult to investigate longitudinal processes such as the one that we propose here. Hence, it is vital to conduct experimental studies that provide first insights. Nevertheless, further research examining real-life traumatic events is required to confirm our findings before any strong conclusions can be drawn. Another limitation of our study is that we conducted all assessments online. Although necessary in light of the

public restrictions that were in place during the assessment period, remote testing might have introduced error variance due to lack of compliance and non-standardized testing conditions. A further limitation is the current sample size and composition. Although we sampled enough participants to be able to detect small-to-medium sized effects ($r = .26$) with sufficient statistical power ($1-\beta = .80$), small effects may have remained undetected. Moreover, due to our sampling strategy, the current sample characteristics are not representative of the general population. Finally, it is important to bear in mind that the current analyses were conducted based on data of a larger study and that further confirmatory research is needed to consolidate our results.

If confirmed by future research, the current findings have several implications for practice: On the one hand, COVID-19-related distress could be considered as a vulnerability factor in individuals at high risk of traumatization. On the other hand, clinicians could assess COVID-19-related distress in PTSD patients to address this pathogenic factor during treatment. Moreover, on a general level, our findings emphasize the importance of taking individual long-term stressors into consideration when treating PTSD patients.

4. Methods

4.1 Participants

One hundred twenty-two undergraduate university students took part in the study. Students were recruited online and invited to participate as part of a larger study on sleep and associative fear learning. Due to technical errors, responses of 10 participants were not recorded. Moreover, four participants did not show successful contingency learning and were discarded from further analyses. Successful contingency learning was defined as a non-negative difference between US expectancy during the final CS⁺ and CS⁻ trial. Thus, our final sample comprised 108 participants (87♀, 21♂). Study eligibility was restricted to individuals meeting the following criteria: normal or corrected-to-normal vision, sufficient German language skills, no current or chronic neurological or psychological disorders, and no lifetime interpersonal trauma exposure. The study protocol was approved by the local ethics committee of the Faculty of Human and Business Sciences at Saarland University and all participants gave written informed consent in accordance with the Declaration of Helsinki.

4.2 Pre-experimental measures

Psychological responses to the COVID-19 pandemic were assessed using adapted rumination and distress measures (for details see Schäfer et al.¹). COVID-19-related rumination was evaluated using a modified version of the Perseverative Thinking Questionnaire²⁹. COVID-19-related distress was measured using a modified version of the Peritraumatic Distress Inventory³⁰. Sum scores were calculated and used for all further analyses. Data was collected using the online platform SoSci Survey³¹.

4.3 Differential associative fear learning task

Participants were subjected to a differential associative fear learning task (for details see Supplementary File 1) adapted from Pace-Schott et al.³² using an aversive film clip of a kitchen accident as US³³. To further increase ecological validity, we used naturalistic stimuli (i.e., everyday objects) as CSs. By using a partial reinforcement schedule (75%), we aimed to limit the reliability with which participants were able to predict the appearance of the US. Such *weak situations* are assumed to increase interindividual variance, which is critical for the differentiation between adaptive and pathological associative fear learning³⁴.

Task presentation as well as the assessment of analog PTSD symptoms (see 4.4.) were conducted via Labvanced³⁵. Following Landkroon et al.³³, we first presented a full length version of the aversive film clip (10 seconds) and provided participants with information about the protagonist. Participants were instructed that a short version of the film clip would follow some (but not all) everyday objects that were to be presented on the screen and to pay attention which objects were associated with the clip. After a short habituation phase, participants saw all three objects (brush, cellphone, and glasses) that would be presented in the upcoming learning task and were asked to provide valence (0 = highly unpleasant, 100 = highly pleasant), arousal (0 = absolutely non-arousing, 100 = very arousing), and fear (0 = no fear at all, 100 = maximal fear) ratings. During the learning phase, one of these objects was presented as the CS⁻ whereas the other two objects were presented as CS⁺¹ and CS⁺². The two different CS⁺s were used to implement two separate learning procedures, which was necessary for further manipulations that took place after the assessment of analog symptoms (see 3.4.). Hence, the learning procedure was divided in two halves. In one half of the procedure, participants saw eight CS⁻ trials and eight CS⁺¹ trials, six of which were followed by the US. In the other half of the procedure, participants saw eight CS⁻ trials and eight CS⁺² trials, six of which were followed by the US. Both halves were presented without interruption and the order of presentation was counterbalanced across participants.

During each trial, participants first saw an empty wooden box, serving as the learning context (10 seconds). Subsequently, the CS (brush, cellphone, or glasses) appeared in the wooden box (7 seconds) and participants were asked to provide their US expectancy rating (0 = very low expectancy, 100 = very high expectancy). During reinforced trials, the US (6 seconds) was presented immediately after CS offset. During unreinforced trials, the trial ended after CS offset. At the end of the learning procedure, participants were again asked to provide valence, arousal, and fear ratings for each CS. Since distinguishing between CS⁺¹ and CS⁺² is not relevant for the current research questions, ratings were averaged across both CS⁺s for further analyses. Prior to averaging, we compared post-learning ratings and US expectancy during the final CS⁺ trial between CS⁺¹ and CS⁺². None of these comparisons yielded significant results and successful fear learning was evident for each CS⁺. Post-learning ratings (arousal, valence, and fear) and US expectancy during the final CS⁺ trial were subjected to correlation and mediation analyses.

4.4 Assessment of film-related intrusions and rumination

Intrusive memories of the aversive film clip were assessed using the Intrusive Memory Questionnaire (IMQ)³⁶. The IMQ was adapted to assess frequency and duration (in seconds) of intrusions as well as distress (0 = not at all, 100 = extremely) associated with intrusions since watching the aversive film clip. Intrusions were defined as sudden, spontaneous, and non-initiated memories of the film clip. Subsequently, participants completed an adapted version of the IMQ that assessed film-related rumination. They were asked to indicate how often (frequency) and long (duration) they had ruminated about scenes of the film. Moreover, they were asked to rate their level of distress while ruminating (0 = not at all, 100 = extremely). For further analyses, we calculated an intrusion index and a rumination index by standardizing (z-transformation) and summing the frequency, duration, and distress items.

4.5 Data analyses

Data analyses were conducted using SPSS 25 and the PROCESS macro³⁷. Bivariate Pearson correlation coefficients (r) were used to quantify the relationship between COVID-19-related measures, post-learning CS⁺ ratings, and analog PTSD symptoms. Whenever COVID-19-related measures were significantly correlated with analog PTSD symptoms, we conducted mediation analyses to examine whether the effect of psychological responses to the COVID-19 pandemic on analog symptoms was mediated by the strength of associative fear learning (as reflected in post-learning CS⁺ ratings). To this end, we employed Hayes's PROCESS macro using 5,000 bootstrap resampling for calculation of confidence intervals³⁷. Due to missing values for rumination duration, degrees of freedom vary across analyses. The alpha level was set to .05 for all analyses.

Declarations

Author contributions

E.F., **M.R.S.**, and **T.M.** conceived and designed the experiment. **S.K.S.** provided resources and promoted the investigation. **E.F.** and **M.R.S.** performed the experiment and analyzed the data. **E.F.** wrote the first draft of the manuscript and **M.R.S.** provided critical revisions. All authors read, edited and approved the manuscript.

Competing interests

The authors declare no competing interests.

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Figures

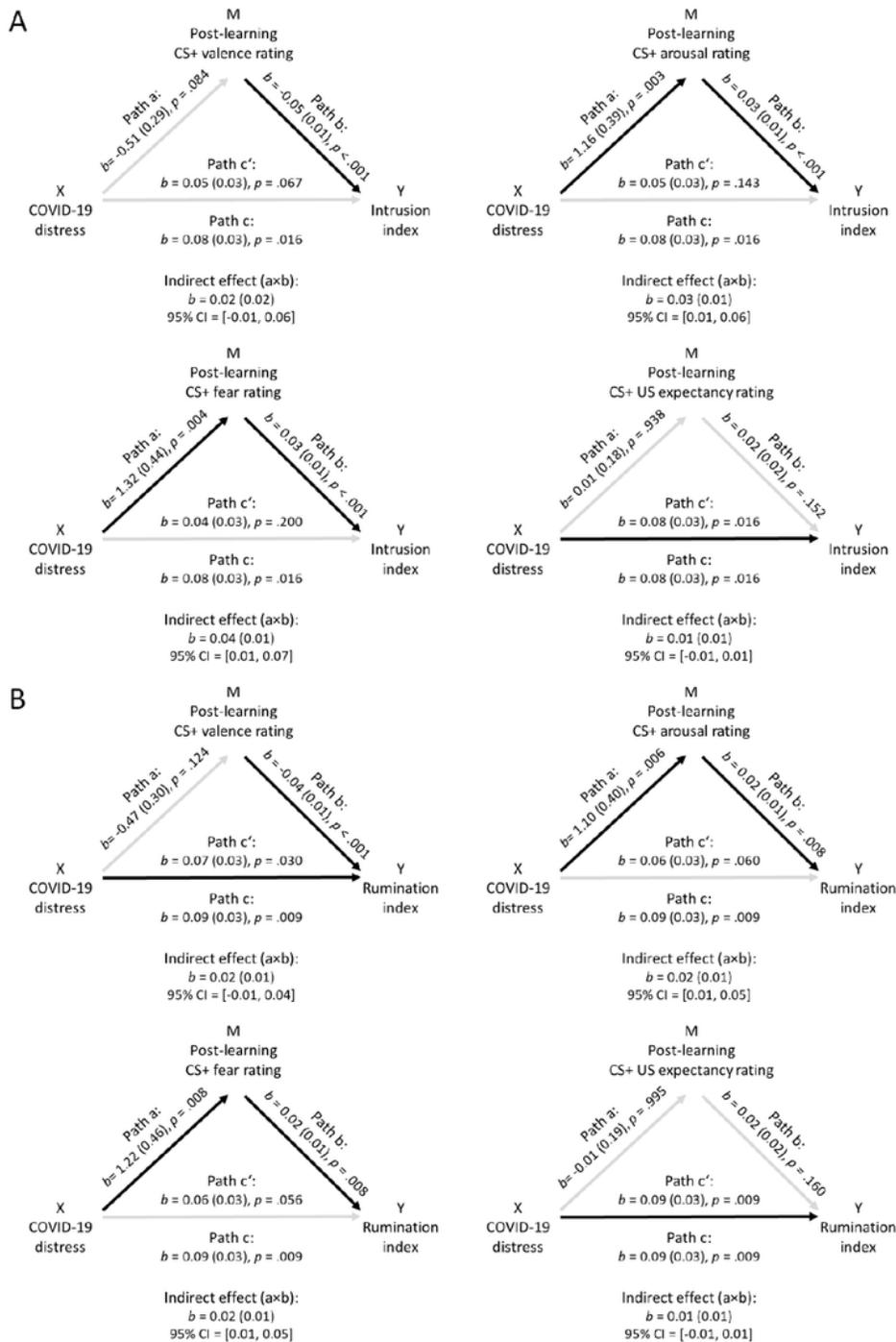


Figure 1

Mediation models showing the effect of COVID-19-related distress (X) on dependent variables (Y) mediated by the strength of associative learning (M). Path c shows the total effect of X on Y, and path c' shows the direct effect after controlling for M. Standard errors are given in parentheses. A: Mediation models including the intrusion index as dependent variable. B: Mediation models including the

rumination index as dependent variable. CI = confidence interval (bias-corrected); ACQ = Acquisition; CS+ = conditioned stimulus (reinforced); US = unconditioned stimulus.

Supplementary Files

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