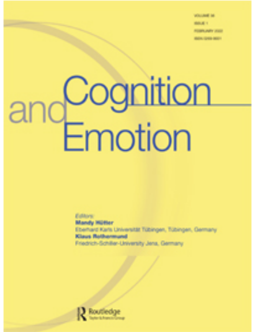

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BRIEF ARTICLE

The effect of induced COVID-19-related fear on psychological distance and time perception

Iris Schelhorn [a]*, Emily Buchner[a]*, Ferdinand Kosak[a], Fabian Hutmacher[a,b], Max Kinateder[c] and Youssef Shiban[d]

[a]Department of Experimental Psychology, University of Regensburg, Regensburg, Germany; [b]Human-Computer-Media Institute, University of Würzburg, Würzburg, Germany; [c]National Research Council Canada, Ottawa, Canada; [d]Department of Clinical Psychology, PFH – Private University of Applied Sciences, Göttingen, Germany

ABSTRACT

Emotional experience can influence cognitive estimates such as perceived psychological distance and time judgements. These estimators are crucial in threatening situations like the COVID-19 pandemic because the subjective perception of the closeness of a potential infection might influence behaviour. However, to date it remains unclear how fear affects these estimates. We report on data from $N = 183$ participants collected in Germany during the summer of 2020, when a "second wave" of COVID-19 infections was still only on the horizon of public awareness. We induced COVID-19-related fear in members of one group and compared their estimates of psychological distance and time judgements to those of a neutral group. Fear induction influenced these conjoint estimates in the way that an increase in infection rates appeared farther away and of shorter duration. Mediation analysis revealed inverse effects of changes in valence and ratings of Fear of COVID-19 on psychological distance. Possible explanations for these effects are discussed.

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KEYWORDS
Psychological distance; fear induction; passage of time judgements; COVID-19

Introduction

Many people perceive the COVID-19-pandemic as a threatening event, mainly because it poses an actual death threat (Klaiber et al., 2021). Terrifying pictures and videos have been published world-wide which is likely to induce emotions such as fear (Joseph et al., 2020) and alter cognition as well as behaviour. Behaviour indeed changed with the onset of the pandemic, also including unnecessary protective actions ranging from the excessive shopping of hygiene articles (Hall et al., 2020) to an increase in firearm purchases (Lyons et al., 2021). These behavioural observations are in line with emotion theories proposing that emotions have an impact on people's motivational tendencies, behaviour and cognition (e.g. Scherer, 2009). However, while there are numerous studies on behavioural effects of fear induction in response to threatening events like the COVID-19 pandemic, less is known about cognitions prior to behaviour that can be triggered by fear.

This study has been conducted to investigate how induced fear influences three cognitive estimates: Psychological distance (PD), an expected duration judgement (DJ^{exp}) referring to the future and a passage of time judgement (POTJ) referring to the past. The common basis of PD and DJ^{exp} is that they are subjective manifestations of the perception of threat during a pandemic, and all three estimates are likely to change in threatening situations (Arstila, 2012; Bar-Haim et al., 2010; Stefanucci & Storbeck, 2009). Therefore, in the threatening event of a pandemic, these judgements represent important fear-cognition-links. Furthermore, misjudgements of the proximity, speed and duration of danger might be

CONTACT Iris Schelhorn iris.schelhorn@ur.de Department of Experimental Psychology, University of Regensburg, Regensburg, Germany
*These authors contributed equally to this manuscript and share first authorship.
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inappropriate and can in extreme situations even lead to death (Van Bavel et al., 2020), emphasizing the relevance of their investigation during a pandemic.

Psychological distance

Psychological distance (PD) is a construct suggested in the "Construal-level Theory" (Trope & Liberman, 2010). Estimates of PD are created from the individual's subjective current situation and comprise four facets of one's perceived temporary (imminent – later), spatial (near – far) and social distance (self – others) to an event and its hypotheticality (whether or not something will occur). Studies investigating the influence of fear on distance-related measures showed that speed and therefore temporal distance (Witt & Sugovic, 2013) as well as heights and therefore spatial distance (Stefanucci & Storbeck, 2009) of threatening stimuli were overestimated. From these findings, it could be concluded that fear leads to misperceptions of threat-relevant facets of stimuli in the way that they appear more threatening than they actually are. A greater PD to COVID-19 was also shown to be associated with people's life satisfaction (Zheng et al., 2020). Furthermore, physical and contextual proximity to high infection rates during a previous SARS epidemic were associated with higher self-reported anxiety (Wong et al., 2007) indicating that measures of distance and anxiety were related in threatening situations. No further studies investigating COVID-19 and measures of PD have been found.

Expected duration judgement

Similar cognitive alterations during high arousal states were found for duration judgements (**DJs**). Previous studies investigating short time intervals (< 1 min) widely showed that a high level of arousal was associated with an extension of DJs: for example, even the mere expectation of an aversive sound led to an overestimation of the actual duration of an interval experienced compared to a non-aversive stimulus (Droit-Volet et al., 2010). Furthermore, DJs were shown to be prolonged for fear-inducing stimuli (Grommet et al., 2011). In our study, it was of interest how people estimate the future duration of the pandemic when fear induction is involved as perception of duration can also have an impact on further processes, such as decision-making (Ariely & Zakay, 2001). We therefore introduced a new subjective estimate: *expected duration judgement* (**DJ^{exp}**). To our knowledge, no studies have examined how fear affects DJs of future threatening events.

Passage of time judgement

At the beginning of our recruitment period, the pandemic had already been lasting for over five months. Therefore, it seemed likely that a threat from COVID-19 would not only affect perceptions of the future, but also of the past. An established measure in this context are passage of time judgements (**POTJs**), which are also called "feeling judgements", and are considered temporal expressions of internal emotions (Jones, 2019). POTJs assess how quickly time seems to pass in certain situations, relative to the objective clock (Wearden, 2015). It was found that high levels of arousal and a positive affect seem to precede the experience of a faster passage of time in the presence (e.g. Droit-Volet & Wearden, 2015). Vice versa, for present moments and for retrospective time assessments of life events, negative affect and low arousal were predictive for a slowing down of POTJs (e.g. Wittmann et al., 2006). Still, the connection between arousal and POTJs is not yet clear. For instance, in extreme situations, such as accidents, cognitive processes seemed to rapidly increase (Arstila, 2012). As a result, according to the author, the perception of the passage of time is distorted in life-threatening situations and the external world seems to decelerate. With regard to time perception during COVID-19, as a recent life-threatening event, it is interesting to measure this temporal "feeling judgement": Studies conducted during COVID-19 in different European countries demonstrated that negative emotional states were associated with a perceived deceleration (e.g. Droit-Volet et al., 2020). Up to date, however, no studies have examined the influence of experimentally induced fear on passage of time judgements during COVID-19.

The present study

We conducted this study in a unique timeframe in the summer of 2020 with a German sample when the "second wave" of COVID-19 infections (that would arrive in the fall) was still only on the horizon of public awareness. We induced COVID-19-related fear in one group and asked participants about their estimates of PD, DJ^{exp} and POTJ as dependent variables, which include an assessment of threat as a common basis. Overall, we expected interrelatedness between these variables and an increase in perceived threat in the fear condition (H1). More specifically, based on previous studies (e.g. Stefanucci & Storbeck, 2009), we hypothesised that the future threatening event would appear to be at a smaller PD to participants with induced fear compared to the neutral group, as this would mean a greater threat. Next, we expected that participants of the fear induction group would overestimate the duration of a potential "second wave" since the mere expectation of an aversive event can lead to an overestimation of the actual duration (e.g. Droit-Volet et al., 2010). In addition, we explored the effect of fear induction on POTJ.

Materials and method

Participants

This study was pre-registered (doi: 10.17605/OSF.IO/GUAXP) and was conducted in accordance with the Helsinki Declaration and the University Research Ethics Standards. Psychology undergraduate students at the University of Regensburg received course credit. Our targeted sample size ($n = 204$) was based on a power analysis (G*Power 3.1.718; Faul et al., 2007) with 102 per group to have sufficient power (0.80, alpha = 0.05, one-tailed) to detect small-to-medium sized effects ($d = 0.35$). Of 208 cases, we excluded[1] three participants due to age (<18) and two participants because their sessions timed out (> 500 min). Then, we calculated Mahalanobis distance (*MD*) which is commonly used to detect outliers in multivariate data and excluded one case with $MD = 19.25$, $p < .001$, as suggested by Fidell and Tabachnick (2003). Two cases were excluded because they were identified twice as univariate outliers in boxplots due to choosing extreme poles of the scales. Based on boxplots, we had to exclude extreme outliers who spent a comparatively long time answering the part of the questionnaire that included emotion induction and dependent variables ($n = 6$; completion time > 43 min) which likely dissolved effects of emotion induction. Vice versa, regarding the lower cut-off, we excluded all participants who spent less than 5 min answering the emotion induction and dependent variables part ($n = 11$). On average, participants needed twice as long to complete this section. Usually, low effort cases in web-based data correlate with critically low page submit scores (Buchanan & Scofield, 2018). An outlier analysis, however, would not have been valid here, because some pages of the questionnaire included enforced page times. Because of these necessary exclusions, we analysed data of 183 representative participants aged between 18 and 78 years ($M = 44.41$, $SD = 15.12$, 72.0% female). Demographic data are displayed in Table 1.

Table 1. Demographics of responders ($N = 183$).

Variable	Total sample *N (%)*	Fear induction group *n (%)*	Neutral group *n (%)*
Total	183 (100%)	92 (100%)	94 (100%)
Gender			
Male	50 (27.3%)	23 (25.3%)	27 (29.3%)
Female	132 (72.1%)	67 (73.6%)	65 (70.7%)
Diverse	1 (0.5%)	1 (1.1%)	
Job Status			
Trainee	2 (1.1%)	1 (1.1%)	1 (1.1%)
Student	25 (13.7%)	12 (13.2%)	13 (14.1%)
Psychology student (rec. credit)	6 (3.3%)	4 (4.4%)	2 (2.2%)
Employed	94 (51.4%)	42 (46.2%)	52 (56.5%)
Self-Employed	13 (7.1%)	8 (8.8%)	5 (5.4%)
Retired	26 (14.2%)	13 (14.3%)	13 (14.1%)
Else	17 (9.7%)	12 (12.1%)	6 (6.5%)
Education obtained			
Lower secondary school ^{X}	12 (6.6%)	10 (11.0%)	2 (2.2%)
Qualified secondary school $^{X X}$	8 (4.4%)	2 (2.2%)	6 (6.5%)
Middle school $^{X X}$	31 (16.9%)	15 (16.5%)	16 (17.4%)
High school	42 (23.0%)	20 (22.0%)	22 (23.9%)
University or higher	72 (39.3%)	34 (37.4%)	38 (41.3%)
Else	17 (9.3%)	9 (9.9%)	8 (8.7%)
COVID-19 risk group	53 (29.0%)	29 (31.9%)	24 (26.1%)
COVID-19 diagnosis in friends/family	15 (8.2%)	8 (8.8%)	7 (7.6%)
Hot Spot			
Yes	14 (7.7%)	7 (7.7%)	7 (7.6%)
Unknown	17 (9.3%)	8 (8.8%)	9 (9.8%)
No	152 (83.1%)	76 (83.5%)	76 (82.6%)

Note: ^{X}5th-9th grade. $^{X X}$5th-10th grade.

Material

Fear induction

In order to induce COVID-19-related fear, we used a one-minute video made of nine pictures showing for instance tests, face-masks, an empty train station and a coffin from the OASIS image set (Kurdi et al., 2017), an open-access online stimulus set. As autobiographical recall is the most effective method for inducing fear (Joseph et al., 2020), the videos were used to support the participants in recalling three memories from the past six months which "had induced fear or sorrow" and to select the strongest one.

Participants were then asked to write down in detail their memories and feelings associated with it. Afterwards, they were instructed to accept their emotional state as it was, to increase unpleasant emotional experience in the short term (Boehme et al., 2019). The neutral group was presented with another one-minute video which consisted of nine neutral images from the OASIS image set (Kurdi et al., 2017): for instance a roof, a piece of paper. They were instructed in the same way to elicit a "neutral emotional state" and to write down neutral memories. Both videos were presented without music or sounds.

Measures

Affective state

To measure participants' affective state, we used an affect-grid displaying arousal and valence as two orthogonal scales theoretically derived from the circumplex model of affect (Russell, 1980). The participants were asked to indicate their current feelings via a stick figure. To measure specific fear of COVID-19, we used a self-translated version of the Fear of COVID-19 Scale (Ahorsu et al., 2020). Participants responded to seven items on a five-point Likert scale from "strongly disagree" to "strongly agree", Cronbach's $\alpha = .87$.

Psychological distance

To measure PD according to Construal level theory (Trope & Liberman, 2010), we used four items employing an adjustable scroll bar between two specified poles which were marked with opposites for each category. Hypotheticality: "Do you think there will be an increase in COVID-19 infections?". Spatial distance: "If there is a significant increase in COVID-19 infections – do you think, it will happen rather near or far away from you?" Temporal distance: "If there is a significant increase in COVID-19 infections – when do you think will it happen?" Social distance: "Do you think, rather you or others will be affected by a significant increase in infections?" The responses were coded on two response scales ranging from 0 to 100. We calculated the sum of the ratings and used it as a composite score for PD, Cronbach's $\alpha = .67$.

Time judgements

We used the question "If there is a significant increase of COVID-19 infections – how long will the peak persist?" with the two poles "very short" and "very long" for the DJ^{exp}. The responses were coded on two response scales ranging from 0 to 100. For the POTJ we asked the participants to remember a point in time shortly before the beginning of the pandemic in Germany and look back to the time since. Then they were asked to answer the following question: "How did this time go by for you personally?" The answer was given on a seven-point Likert scale ranging from "very slow" to "very fast".

Anxiety

We used the German version of the State-Trait Anxiety Inventory (Spielberger, 2010), to measure trait as well as state anxiety, Cronbach's $\alpha = .96$ (State) and Cronbach's $\alpha = .94$ (Trait).

COVID-19-related control variables

Zheng et al. (2020) demonstrated during past epidemics that anxiety increases in regions with high infection rates. Therefore, we integrated questions about the individually objective proximity to COVID-19 in relation to current infection rates, belonging to a risk group and knowing infected people.

Procedure

After activating the study link, participants were forwarded to the independent platform SoSci Survey (Leiner, 2019) and first gave their informed consent. They filled in the STAI and received an explanation on how to use the affect grid, followed by a random distribution to the emotion induction. Then, the emotion induction procedure was initiated. Afterwards, participants filled in the second affect grid and answered the questions regarding PD, DJ^{exp} and POTJ. Last, participants were asked about their prior experience with COVID-19, answered the Fear of COVID-19 scale and filled in demographic data.

Statistical analysis

Statistical analyses were performed using SPSS 25 (SPSS Inc., IBM, Chicago, IL). A 2×2 repeated measures' ANOVA was used with the within-subject-factor "time" and the between-subject-factor "group" in order to investigate whether the emotion induction had succeeded. We investigated between-group differences in *z*-standardised PD and DJ^{exp} ratings using a MANOVA with dependent variable as within-subject factor. We used a descriptive discriminant analysis as suggested by Field (2018) and Smith et al. (2020) for follow-up investigations. For the investigation of our exploratory hypothesis, we included the *z*-standardised POTJs in the analysis and calculated two MANOVAs with the POTJ coded in either direction. Last, we conducted a mediation analysis, to detect indirect effects of changes in arousal and valence as well as ratings in the Fear of COVID-19 scale on the dependent variables, using the PROCESS tool for IBM SPSS statistics developed by Hayes (2012).

Results

Preliminary analysis

No significant between-group differences were found across any of the control variables before emotion induction: state- and trait-anxiety (all $p > .262$) and personal risk to have a severe COVID-19 infection, staying in a hot spot and knowing infected people (all $p > .242$). Therefore, it was decided to be safe to assume that these factors can be ignored.

Emotion induction

As expected, the repeated-measures' ANOVAs revealed a significant interaction after emotion induction in valence and arousal ratings. Simple within-subject contrasts were significant for valence $F\ (1,176) = 13.10$, $p < .001$, $\eta_p^2 = .07$, and arousal, $F\ (1,176) = 22.96$, $p < .001$, $\eta_p^2 = .12$, and in the expected direction. Regarding valence, participants who were exposed to fear induction reported significantly lower valence values, $M = 2.98$, $SD = 44.97$, than participants in the neutral condition, $M = 24.18$, $SD = 50.50$, $t(178) = -2.97$, $p = .003$, $d = 0.44$. Vice versa, arousal values were significantly higher after fear induction, $M = 13.62$, $SD = 38.86$, compared to the neutral group, $M = -11.26$, $SD = 42.88$, $t(178) = 4.21$, $p < .001$, $d = 0.61$. The fear of COVID-19 scale, that was applied after the dependent variable inputs, also revealed a significant effect, due to higher levels of fear in the fear group, $M = 15.25$, $SD = 6.06$, and lower levels in the neutral group, $M = 13.57$, $SD = 4.77$, $t\ (181) = 2.09$, $p = .038$, $d = 0.31$.

Estimates of psychological distance

Descriptively, as can be seen in Figure 1A and B, the reported PD and DJ^{exp} estimates were both rated around 50 (which marked the exact middle). More specifically, estimates were rated higher than 50 with regard to spatial and social distance and rated lower than 50 for hypotheticality and temporal distance. With regard to temporal distance, both groups showed conspicuously low values. In conclusion, an increase in the number of infections seemed to be likely in the near future regardless of condition. With regard to POTJ, on average, participants perceived the passage of time as "rather fast" (Figure 1C).

Main analysis: psychological distance and expected duration judgement

We found a significant between-group difference in the MANOVA including PD and DJ^{exp}, $F(1,181) = 7.63$, $p = .006$, partial $\eta^2 = .04$. The interaction was not significant, $p = .940$. The multivariate effect was in the opposite direction of our hypothesis (H1): Participants in the fear group estimated the threatening event as farther away from them than the participants in the neutral group and estimated the duration to be shorter. In the follow-up descriptive discriminant analysis (Smith et al., 2020), the discriminant function significantly differentiated between groups, $\Lambda = .96$, $\chi^2(2) = 7.44$, $p = .024$. As can be seen in Table 2, both variables loaded highly on the function and equally contributed to the effect of the MANOVA. The covariance matrices revealed that associations between variables differed between the groups. When looking at the correlations between the outcome variables separated by groups, we found a significant correlation between PD and DJ^{exp} only in the fear group. This pattern of correlations specifically appeared in two sub-dimensions for PD: social distance and hypotheticality (see Table 3).

Exploratory analysis: passage of time judgement

The overall main effect of group remained significant, when we added the *z*-standardised POTJ to the MANOVA, coded in the direction that high POTJ meant slow passage of time, $F(1,122) = 15.01$, $p < .001$, partial $\eta^2 = .11$. Reverse-coding resulted in an interaction effect of group and the type of dependent variable (PD vs. DJ^{exp} vs. POTJ), $F(2,180) = 5.79$, $p = .004$, partial $\eta^2 = .06$, for all available test statistics. Overall, the subjects of the fear group perceived the passage of time as slower than the subjects of the neutral group. Correlations between all dependent variables are depicted in Table 3. Further analyses of both models can be found in the supplemental material.

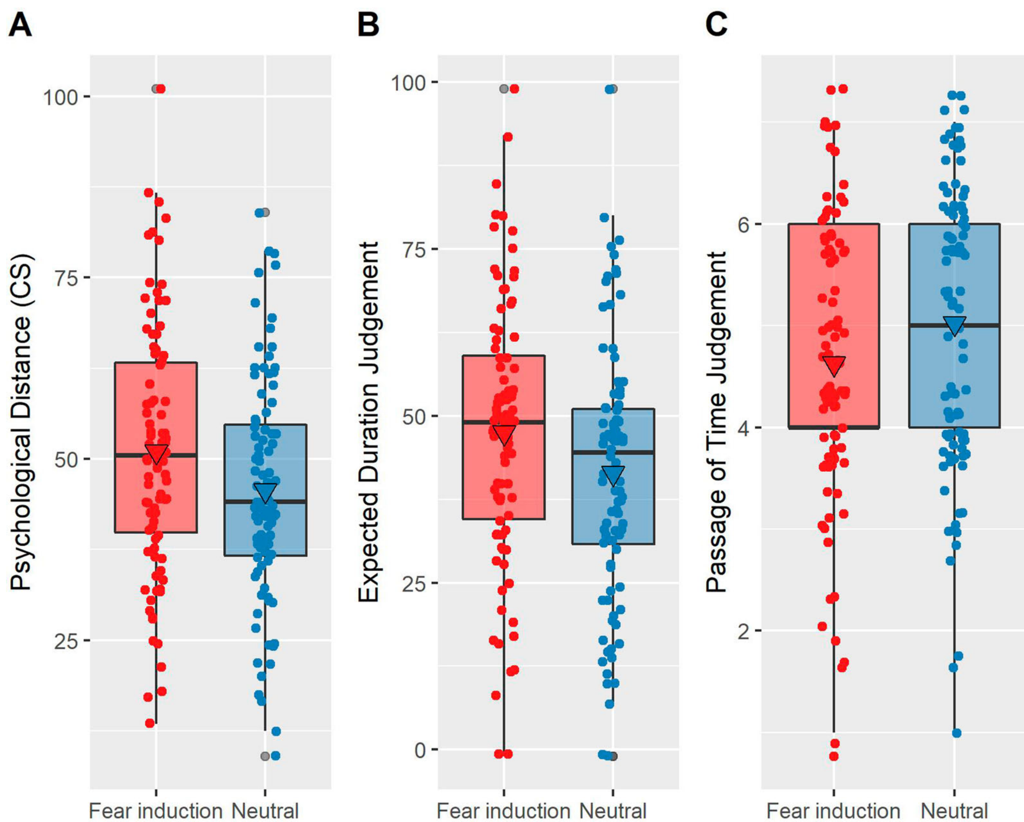

Figure 1. Psychological Distance compound score (A), Expected Duration Judgement (B), and Passage of Time Judgements (C) in the Fear induction group and the Neutral group. Triangles indicate average scores.

Mediation analysis

We also investigated whether the effects on our dependent variables were mediated by changes in the arousal and valence ratings (measured as the difference between pre and post manipulation) and Fear of COVID-19 ratings. As can be seen in Figure 2, the effect of group on PD was mediated through changes in valence and Fear of COVID-19. A decrease in valence and higher fear levels were associated with estimates of shorter distance of an increase of infections. Both effects were in line with our original hypothesis. However, both did not correspond with the detected direct effect of group on PD, showing that participants of the fear group estimated an increase in infection rates to be at greater distance and of shorter duration. No mediation was found for changes in arousal and valence, or Fear of COVID-19 on DJ^{exp}, although there was a direct effect of group on DJ^{exp}. Any effects of group on POTJ could be entirely explained through changes in arousal: an increase in arousal was associated with a tendency to perceive a deceleration of time. Coefficients for the indirect effects can be found in Table 4.

Table 2. Means (*M*), standard deviations (*SD*), results of univariate ANOVAs and *t*-tests of the sub-dimensions of PD as well as standardised discriminant function coefficients (SDF) and structure coefficients of the descriptive discriminant analysis.

Variable	SDF coeff. of *z*-standardised variable	Structure coeff. of *z*-standardised variable
Psychological distance	.659	.802
Expected duration judgement	.614	.768

Discussion

In this study, we found that fear induction influenced the combination of PD and DJ^{exp} of a hypothetical "second wave" of the COVID-19 pandemic in Germany as dependent variables. The acute threat associated

Table 3. Correlations between dependent variables separated by group.

	Correlations							
	Fear induction group				Neutral group			
	POTJ		DJ^{Exp}		POTJ		DJ^{Exp}	
Variables	*r*	*p*	*R*	*p*	*r*	*P*	*r*	*p*
Psychological distance	.13	.221	.36*	.001	.01	.134	.10	.359
Spatial distance	.06	.545	.19	.068	−.01	.960	.00	.999
Social distance	.05	.671	.24*	.025	.10	.329	.04	.702
Temporal distance	.12	.260	.17	.100	−.03	.793	.11	.301
Hypotheticality	.13	.210	.38**	<.001	−.05	.669	.13	.230
Expected duration judgement	.13	.214			.13	.202		

with certain characteristics of the pandemic, such as its distance and its future duration, was underestimated in the fear condition compared to the neutral group. Moreover, we found that the distance and duration estimates were only related in the fear condition, in line with the assumption that both are relevant when individuals are afraid and that both change through fear induction in the same direction. Regarding our exploratory analysis of POTJ, when coded in the direction that high arousal went along with a slowing-down of passage of time, the main effect of group in the MANOVA became even more pronounced. However, POTJ was not correlated with the other two estimates, which indicates that this judgement regarding the past is not directly related to future expectations. The mediation analysis revealed that two of the mediator variables – changes in valence and Fear of COVID-19 – seemed to act as suppressors of the main effect of group on PD. This is in line with our initial assumption that fear induction enlarges threatening characteristics of negative events (e.g. Stefanucci & Storbeck, 2009; Bar-Haim et al., 2010). However, this also means that the reported changes in valence, arousal and ratings of Fear of COVID-19 did not account for the main effect of group on PD or DJ^{exp} of the MANOVA. Hence, we can only assume that another variable might be responsible for the effects we found. It is likely that this variable was influenced by fear induction, had an effect on our dependent variables, but did not correspond with reported changes in valence and arousal, and Fear of COVID-19.

We suggest that our design – using past-related fear for emotion induction and future-related estimates as dependent variables – might have activated certain cognitive processes such as expectancy violation, which then influenced the evaluation of subsequent assessments. In clinical research (e.g. with phobic individuals), expectancy violation describes the phenomenon that the difference between predicted fear before exposure and actual fear during repeated exposure has an impact on fear attenuation (Craske et al., 2014). Transferring this to our data, violations of expectancies regarding fear during the first wave of the pandemic (which served as reference event for the emotion induction procedure) might have influenced the assessment of time and distance in relation to the future. Based on this, thoughts like the following may have arisen: "In the past, I was afraid and I expected the pandemic to be more threatening, but it was not as threatening for me as I thought it would be." Such an assessment could have led to an increase of PD and a decrease in DJ^{exp} and therefore underestimations of danger, independent of reported fear levels. Thus, there could be a specific relationship between the experience of threat in the past and the expectations regarding the proximity of threatening events in the future. Consequently, the group instructed to elicit fear regarding COVID-19 seemed to be more optimistic about the course of the pandemic.

This has important practical implications, because this observation could be related to the so-called "optimism bias" – the belief that bad things affect oneself less than others. The optimism bias was already found in association with COVID-19 (Wise et al., 2020). Fragkaki et al. (2021) also observed that people expressed higher levels of anxiety due to COVID-19 in relation to their relatives and other people than to themselves. Optimism bias could be dangerous during a pandemic as it may lead to an underestimation of the likelihood of being infected and lower engagement in protective behaviours (Helweg-Larsen & Shepperd, 2001). Furthermore, it could be that expectancy violation may even enlarge optimism bias, which would be highly relevant in pandemics with several "waves": It would paradoxically imply that high levels of fear in a first wave (which makes high expectancy violation more

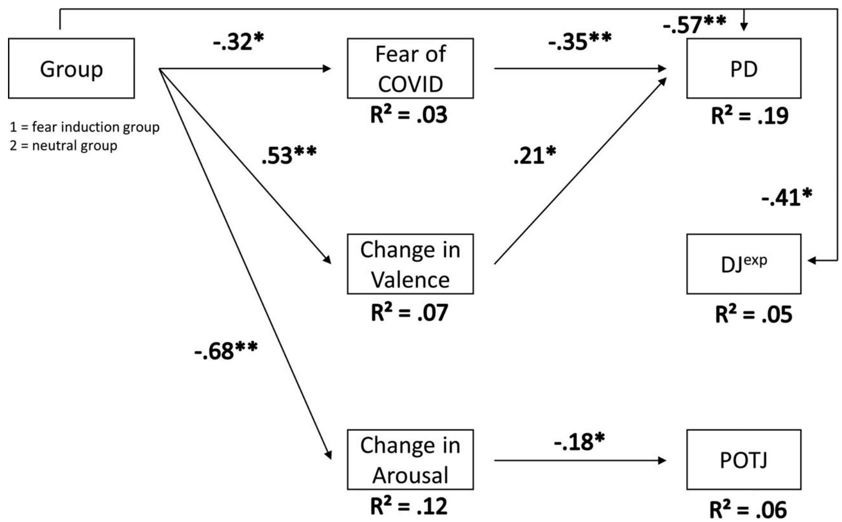

Figure 2. Full mediation model with standardised coefficients (PD = Psychological Distance, DJ^{exp} = Expected Duration Judgement, POTJ = Passage of Time Judgement; **p* < .05, ***p* < .001).

likely) could lead to lower threat estimates regarding the future course of the pandemic.

Another methodological characteristic of our study was that we used images for the emotion induction that were familiar to the participants to some degree, because our study addressed a real-life scenario. These stimuli represented everyday life situations as well as media reports in the pandemic. Thus, these may not have been "pure" stimuli, but ones that immediately activated certain regulatory mechanisms – such as cognitive avoidance. As known from generalised anxiety patients, these often tend to cognitively avoid or suppress unwanted and distressing feelings and thoughts (Olatunji et al., 2010), especially when they are afraid of an emotional state. Therefore, one could assume that a sub-group of participants in the fear condition partially succeeded in suppressing their feelings of anxiety and levels of arousal. Thus, they might also have tried, independent of experienced fear levels, to make the pandemic appear less threatening by imagining it as further away and of shorter duration.

Our exploratory results regarding POTJ correspond with some previous findings showing that in life-threatening situations, a slowdown in time was reported "despite" high arousals (Arstila, 2012). In our experiment, we induced fear that was linked to a real life-threatening scenario. In addition, our POTJ referred to a period that was already a few months ago, the pandemic was still present, and it was likely that it would continue into the future. It seems important that the excitement that is caused by life-threatening events is higher and different than an artificially induced one (Wearden, 2015). We therefore assume that arousal levels in the experimental group were more realistic than laboratory manipulations. Our findings of the mediation analyses – that the change in reported arousal mediated the effect of fear induction on POTJ – are in line with these theories. Thus, it seems that arousal induction shows its effects only in assessments regarding the past, but not regarding the future. Because of our results, we now hypothesise that during real-life threatening events people's state of arousal might be changed in its nature. This might imply that in this context-bound state of baseline arousal, acute arousal induction influences the assessment of POTJ.

Still, the mechanisms behind our findings remain unclear to a certain degree, because, even though we can state that we successfully induced COVID-19-

Table 4. Test of indirect effects with lower (LLCI) and upper (ULCI) bootstrapped confidence intervals.

	Predictor	Partially stand. coeff.	LLCI	ULCI
Variable				
PD	Change in Arousal	.02	−.08	.11
	Change in Valence	.11*	.03	.29
	Fear of COVID-19	.11*	.01	.24
DJ^{Exp}	Change in Arousal	.30	−1.76	2.45
	Change in Valence	.34	−1.70	2.19
	Fear of COVID-19	.99	−.11	3.15
POTJ	Change in Arousal	.18*	.03	.37
	Change in Valence	-.07	−.23	.05
	Fear of COVID-19	.04	−.02	.14

related fear, we cannot differ whether we induced Fear of COVID-19, general fear or general negative affect. Moreover, the mediation analysis was partially inconclusive. Hence, even though our results support the assumption that there is a connection between fear induction and distance as well as time estimates, there are replication studies needed to ascertain that the effects are robust and to investigate what caused them. However, our sample was recruited in a crucial and unique time frame. Thus, our study provides insights into people's cognitions during an extreme situation in which they were influenced by fear. The study design allowed us to reach people in exactly the situation we wanted to examine: In the middle of the pandemic, at home, with an uncertain future run, when the second as well as all further "waves" were still to follow.

To this end, we assume that estimates of distance and duration of a future threatening event such as the COVID-19 pandemic depend not only on actual fear levels, but also on the individual cognitive regulatory mechanisms people use in response to fear induction. These cognitions could be the result of prior experience with handling the threatening situation of being confronted with the specific fear-evoking stimuli or of other emotion regulation processes. Further investigating this cognition–emotion link is of crucial importance, because the perception and assessment of hazards can have fundamental consequences for behaviour. The topic of the present study will therefore continue to be relevant beyond the COVID-19 pandemic.

Note

1. Please note that we had not specified any procedure for excluding participants in the preregistration. As it is important to ensure that the data that is used for the analyses is of sufficient quality, however, we chose the exclusion rules described in the manuscript.

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Data availability statement

The data that support the findings of this study are openly available in osf.io at https://doi.org/10.17605/OSF.IO/3YP2W.

ORCID

Iris Schelhorn http://orcid.org/0000-0001-7262-0581

References

Ahorsu, D. K., Lin, C. Y., Imani, V., Saffari, M., Griffiths, M. D., & Pakpour, A. H. (2020). The fear of COVID-19 scale: Development and initial validation. *International Journal of Mental Health and Addiction*, 1–9. https://doi.org/10.1007/s11469-020-00270-8

Ariely, D., & Zakay, D. (2001). A timely account of the role of duration in decision making. *Acta Psychologica*, *108*(2), 187–207. https://doi.org/10.1016/s0001-6918(01)00034-8

Arstila, V. (2012). Time slows down during accidents. *Frontiers in Psychology*, *3*, 196. https://doi.org/10.3389/fpsyg.2012.00196

Bar-Haim, Y., Kerem, A., Lamy, D., & Zakay, D. (2010). When time slows down: The influence of threat on time perception in anxiety. *Cognition and Emotion*, *24*(2), 255–263. https://doi.org/10.1080/02699930903387603

Boehme, S., Biehl, S. C., & Mühlberger, A. (2019). Effects of differential strategies of emotion regulation. *Brain Sciences*, *9*(9), 225. https://doi.org/10.3390/brainsci9090225

Buchanan, E. M., & Scofield, J. E. (2018). Methods to detect low quality data and its implication for psychological research. *Behavior Research Methods*, *50*(6), 2586–2596. https://doi.org/10.3758/s13428-018-1035-6

Craske, M. G., Treanor, M., Conway, C. C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: An inhibitory learning approach. *Behaviour Research and Therapy*, *58*, 10–23. https://doi.org/10.1016/j.brat.2014.04.006

Droit-Volet, S., Gil, S., Martinelli, N., Andant, N., Clinchamps, M., Parreira, L., Rouffiac, K., Dambrun, M., Huguet, P., & Dubuis, B. (2020). Time and covid-19 stress in the lockdown situation: Time free, "dying" of boredom and sadness. *PloS one*, *15*(8), e0236465. https://doi.org/10.1371/journal.pone.0236465

Droit-Volet, S., Mermillod, M., Cocenas-Silva, R., & Gil, S. (2010). The effect of expectancy of a threatening event on time perception in human adults. *Emotion*, *10*(6), 908–914. https://doi.org/10.1037/a0020258

Droit-Volet, S., & Wearden, J. H. (2015). Experience sampling methodology reveals similarities in the experience of passage of time in young and elderly adults. *Acta Psychologica*, *156*, 77–82. https://doi.org/10.1016/j.actpsy.2015.01.006

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Fidell, L. S., & Tabachnick, B. G. (2003). Preparatory data analysis. In J. A. Schinka, & W. F. Velicer (Eds.), *Handbook of psychology: Research methods in psychology, Vol. 2* (pp. 115–141). John Wiley & Sons Inc.

Field, A. P. (2018). *Discovering statistics using IBM SPSS statistics*. SAGE Publications. ISBN 9781526419521.

Fragkaki, I., Maciejewski, D. F., Weijman, E. L., Feltes, J., & Cima, M. (2021). Human responses to covid-19: The role of optimism bias, perceived severity, and anxiety. *Personality and Individual Differences*, *176*, 110781. https://doi.org/10.1016/j.paid.2021.110781

Grommet, E. K., Droit-Volet, S., Gil, S., Hemmes, N. S., Baker, A. H., & Brown, B. L. (2011). Time estimation of fear cues in human observers. *Behavioural Processes*, *86*(1), 88–93. https://doi.org/10.1016/j.beproc.2010.10.003

Hall, M. C., Prayag, G., Fieger, P., & Dyason, D. (2020). Beyond panic buying: Consumption displacement and COVID-19. *Journal of Service Management*, *32*(1), 113–128. https://doi.org/10.1108/JOSM-05-2020-0151

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling [White paper]. http://www.afhayes.com/public/process2012.pdf.

Helweg-Larsen, M., & Shepperd, J. A. (2001). Do moderators of the optimistic bias affect personal or target risk estimates? A review of the literature. *Personality and Social Psychology Review*, *5*(1), 74–95. https://doi.org/10.1207/S15327957PSPR0501_5

Jones, L. A. (2019). The perception of duration and the judgment of the passage of time. In A. Bardon, V. Arstila, S. Power, & A. Vatakis (Eds.), *The illusions of time: Philosophical and psychological essays on timing and time perception* (pp. 53–67). Palgrave-Macmillan.

Joseph, D. L., Chan, M. Y., Heintzelman, S. J., Tay, L., Diener, E., & Scotney, V. S. (2020). The manipulation of affect: A meta-analysis of affect induction procedures. *Psychological Bulletin*, *146*(4), 355–375. https://doi.org/10.1037/bul0000224

Klaiber, P., Wen, J. H., DeLongis, A., & Sin, N. L. (2021). The ups and downs of daily life during COVID-19: Age differences in affect, stress, and positive events. *The Journals of Gerontology: Series B*, *76*(2), e30–e37. https://doi.org/10.1093/geronb/gbaa096

Kurdi, B., Lozano, S., & Banaji, M. R. (2017). Introducing the open affective standardized image set (OASIS). *Behavior Research Methods*, *49*(2), 457–470. https://doi.org/10.3758/s13428-016-0715-3

Leiner, D. (2019). *Sosci survey* (version 3.1. 06)[computer software]. SoSci Survey GmbH.

Lyons, V. H., Haviland, M. J., Azrael, D., Adhia, A., Bellenger, M. A., Ellyson, A., Rowhani-Rahbar, A., & Rivara, F. P. (2021). Firearm purchasing and storage during the COVID-19 pandemic. *Injury Prevention*, *27*(1), 87–92. https://doi.org/10.1136/injuryprev-2020-043872

Olatunji, B. O., Moretz, M. W., & Zlomke, K. R. (2010). Linking cognitive avoidance and GAD symptoms: The mediating role of fear of emotion. *Behaviour Research and Therapy*, *48*(5), 435–441. https://doi.org/10.1016/j.brat.2009.11.014

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178. https://doi.org/10.1037/h0077714

Scherer, K. R. (2009). The dynamic architecture of emotion: Evidence for the component process model. *Cognition and Emotion*, *23*(7), 1307–1351. https://doi.org/10.1080/02699930902928969

Smith, K. N., Lamb, K. N., & Henson, R. K. (2020). Making meaning out of MANOVA: The need for multivariate post hoc testing in gifted education research. *Gifted Child Quarterly*, *64*(1), 41–55. https://doi.org/10.1177/0016986219890352

Spielberger, C. D. (2010). State-Trait anxiety inventory. *The corsini encyclopedia of psychology*. John Wiley & Sons, Inc. https://doi.org/10.1002/9780470479216.corpsy0943

Stefanucci, J. K., & Storbeck, J. (2009). Don't look down: Emotional arousal elevates height perception. *Journal of Experimental Psychology: General*, *138*(1), 131–145. https://doi.org/10.1037/a0014797

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, *117*(2), 440–463. https://doi.org/10.1037/a0018963

Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., & Druckman, J. N. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, *4*(5), 460–471. https://doi.org/10.1038/s41562-020-0884-z

Wearden, J. (2015). Passage of time judgements. *Consciousness and Cognition*, *38*, 165–171. https://doi.org/10.1016/j.concog.2015.06.005

Wise, T., Zbozinek, T. D., Michelini, G., & Hagan, C. C. (2020). Changes in risk perception and protective behavior during the first week of the COVID-19 pandemic in the United States. *Royal Society Open Science*, *7*(9), 200742. https://doi.org/10.1098/rsos.200742

Witt, J. K., & Sugovic, M. (2013). Spiders appear to move faster than non-threatening objects regardless of one's ability to block them. *Acta Psychologica*, *143*(3), 284–291. https://doi.org/10.1016/j.actpsy.2013.04.011

Wittmann, M., Vollmer, T., Schweiger, C., & Hiddemann, W. (2006). The relation between the experience of time and psychological distress in patients with hematological malignancies. *Palliative & Supportive Care*, *4*(4), 357–363. https://doi.org/10.1017/S1478951506060469

Wong, T. W., Gao, Y., & Tam, W. W. S. (2007). Anxiety among university students during the SARS epidemic in Hong Kong. *Stress and Health*, *23*(1), 31–35. https://doi.org/10.1002/smi.1116

Zheng, L., Miao, M., & Gan, Y. (2020). Perceived control buffers the effects of the COVID-19 pandemic on general health and life satisfaction: The mediating role of psychological distance. *Applied Psychology: Health and Well-Being*, *12*(4), 1095–1114. https://doi.org/10.1111/aphw.12232