Adaptive function and correlates of anxiety during a pandemic

Gul Deniz Salali (guldeniz.salali@ucl.ac.uk)  
University College London

Mete Sefa Uysal  
Dokuz Eylül University

Abi Bevan  
University College London

Research Article

Keywords: anxiety, evolution, uncertainty, future orientation, mindfulness, COVID-19

DOI: https://doi.org/10.21203/rs.3.rs-271498/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

The majority of the studies to date have focused on the negative aspects of anxiety. Anxiety, however, is an evolved emotional response serving to decrease mortality risk. Pandemics are characterized by increased mortality risk coupled with future uncertainties, both of which result in heightened anxiety. Here, we examined the factors associated with anxiety levels and risk avoidance behaviours during the first wave of the COVID-19 pandemic in the UK (N = 1088) and Turkey (N = 3935). We asked how individual time perspectives (future orientation and present moment attention) affect anxiety in an uncertain time, and whether an elevated anxiety response reduces mortality risk by promoting risk avoidance behaviour. We found that people who were more future-oriented and less tolerant of uncertainties had higher levels of generalized and pandemic anxieties. Those with higher anxiety levels engaged in risk avoidance behaviours more frequently. Mindfulness reduced anxiety levels without reducing risk avoidance, suggesting that mindfulness-based therapies can be used to alleviate anxiety without interfering with the benefits of a healthy anxiety response. Trust in others reduced anxiety, but also reduced risk avoidant behaviour. Several behavioural and social factors contributed to the country-level differences in the overall anxiety levels and engagement in risk avoidance behaviours.

Introduction

Anxiety is an emotional response triggered in the anticipation of a possible threat. From an evolutionary perspective anxiety can be seen as a detector that helps an individual to prepare for and deal with a dangerous situation. Pandemics like the COVID-19 are characterized by high level of threat, i.e., risk of infection and mortality, coupled with future uncertainties. These characteristics are expected to result in an increase in anxiety responses across populations. Nevertheless, how people cope with uncertainties will depend on individual-level traits such as how much a person is invested in their future. Being too future-oriented may come at a cost, because constantly planning and reflecting about the future may increase individuals’ anxiety levels, especially at times with high future uncertainties. On the other hand, elevated levels of anxiety during a pandemic can be part of an adaptive response that has evolved to minimize mortality risk. In this paper, we examine the factors associated with anxiety levels during the first wave of the COVID-19 pandemic in the UK and Turkey, focusing on individual time perspectives, and ask whether anxiety has an adaptive role in times of pandemics.

Future orientation: a potential mismatch leading to anxiety?

Since anxiety is an emotional response that occurs in the anticipation of a threat that is happening in the future, how much an individual considers future outcomes, and their degree of future orientation may affect their anxiety levels. While there is much individual variation in time perspectives, many people living in the Western countries often think and plan about the future. In modern societies, future-oriented plans are vast: investment accounts, pension benefits, insurance schemes etc. Future orientation, however, was not the dominant mode of time perspective throughout human evolutionary history. Research on contemporary hunter-gatherers in Congo has shown that forest hunter-gatherers discount
the future more compared to neighbouring farmers and more market-integrated hunter-gatherers. This suggests that future orientation in humans is a flexible behavioural adaptation associated with the emergence of food storage systems and agriculture. Going a step further in time, future orientation in modern societies can be seen as the extreme end of the time perspective spectrum, where the amount of time needed to achieve many personal goals is counted in years. This is very much in mismatch with the duration of goals set by a prehistoric hunter-gatherer who consumed food immediately, did not store and accumulate materials, and “lived in the present”. An evolutionary perspective on happiness predicts that the size and duration of personal goals in modern societies may be the major contributor to the current mental health problems. Following this perspective, the observed mismatch in time perspectives may be contributing to the increased levels of anxiety and mood disorders in recent years.

Previous studies on the link between future orientation and anxiety have shown mixed results. In one study trait anxiety was associated with less future discounting, i.e. more future orientation. Two studies found a weak but significant negative relationship between future orientation and anxiety. However, as the authors of one of those studies acknowledged the negative association may be due to the future scale used in the studies (Zimbardo Time Perspective Inventory) which focused on measuring the expectations of a positive future and rewards. Nevertheless, attribution of negative outcomes to future events are at the core of an anxiety response. Studies have shown that future negative time perspectives are significantly associated with anxiety, and the majority of worry contents concern future events. Since worry occurs as a mental problem-solving in response to anticipation of negative future events, we predict that the combination of too much future-orientation (a feature of modernity) and a tendency towards attributing negative outcomes to future uncertainties will be positively associated with anxiety levels during a pandemic, when future uncertainties prevail.

Following on the predicted association between future orientation and anxiety, we can expect that present orientation may reduce anxiety by taking one’s focus away from the potential future outcomes, especially during pandemics. Mindfulness is the awareness of experiences in the present moment, achieved through paying attention to one’s thoughts, sensations and the environment nonjudgmentally. There is growing research showing that mindfulness-based therapies may be effective in treating anxiety and mood disorders, and that mindfulness is related to lower unpleasant affect and higher life satisfaction and positive affect.

Adaptive function of anxiety: signal detection

Although much research on trait anxiety has focused on its negative effects and therapeutic solutions, it is important to acknowledge the evolved function of emotions to decide when an emotional response can be considered as normal and when it is pathological. Our emotions serve a purpose. They are systems of response shaped by natural selection in response to threat or opportunity situations. Anxiety, for example, prepares the individual to detect and handle threats. Because there is often ambiguity in whether a threat is present and absent, how is the threat response optimised? According to the signal
detection theory each individual establishes a threshold above which they accept the evidence that the threat (or any event) is present. One prediction from this theory is that in an environment where there are many threats, the threshold for threat detection should be lower, leading individuals to present more anxiety symptoms. Moreover, intrinsic individual variation in the threshold for threat detection results in variation in susceptibility to anxiety. Those with lower thresholds for threat detection experience higher levels of anxiety.

The optimal response threshold depends on the costs and benefits of expressing the defence response. Firing a false alarm when there is no predator in the jungle can be costly— it may cost a forager a few calories that they could be obtaining. Nevertheless, not firing an alarm when there is a predator is much more costly (death). That is why according to the “smoke detector principle” many more false alarms are expected in an optimal defence response. Anxiety is one such defence response, benefiting individual survival and reproduction by decreasing the risk of mortality, and is expected to be “fired falsely” in certain situations. Adolescents with higher levels of trait anxiety, for example, are found to have reduced risk of mortality from accidents in later life. Anxiety comorbid with depression was found to reduce mortality compared with depression alone in Norwegian adults. In a recent study, we showed that anxiety levels were positively associated with accepting a COVID-19 vaccination.

Since pandemics are situations where mortality risk is elevated, we expect to observe an overall heightened anxiety levels during a pandemic. Moreover, following the application of the signal detection theory to anxiety disorders, and earlier empirical studies, we predict that individuals with lower thresholds for exhibiting a threat response, i.e. those with elevated levels of risk perception, will have increased anxiety levels during a pandemic. Since anxiety is a defence response against potential threats to survival, we also predict that those with increased anxiety will engage in risk avoidance behaviours, such as complying with social distancing measures or staying at home, more frequently.

To test the above predictions on the correlates and potential adaptive function of anxiety during a pandemic, we conducted an online survey in the UK and Turkey in April and May 2020, when both countries were going through the first wave of the COVID-19 pandemic.

We hypothesized:

1. Average population-wide anxiety levels, measured by generalised-anxiety disorder assessment (GAD-7), will be higher during a pandemic.
2. The overall anxiety level of a person will be positively associated with their level of pandemic-related anxiety as anxiety-prone people will already have lower thresholds for threat response.
3. Following on the above point, risk perception (measured as the perceived risk of catching the novel coronavirus) will be positively associated with pandemic-related anxiety levels.
4. Increased future orientation and increased intolerance of future uncertainties will be positively associated with levels of generalized and pandemic anxiety.
5. Mindfulness will be negatively associated with levels of generalized and pandemic anxiety.
6. Participants with increased levels of pandemic anxiety will engage in risk avoidant behaviour more frequently.

We conducted a study in the UK and Turkey to examine whether the above hypotheses will be supported across different cultures, and whether population-level differences exist in the levels of anxiety and risk avoidance behaviours during a pandemic. We also controlled for several other behavioural, social and demographic factors that may be contributing to the anxiety response in both countries.

Results

Increased tolerance of uncertainty and mindfulness are associated with decreased levels of generalized anxiety in both UK and Turkey

Intolerance of uncertainty score had the largest effect on the generalized anxiety levels during the first wave of the COVID-19 pandemic in both countries. Higher levels of uncertainty intolerance were associated with higher GAD-7 scores (Table 1, Fig. 1A-B). The second largest predictor was the mindful attention awareness score both in the UK and Turkey. Participants who scored higher on the mindfulness scale had decreased levels of generalized anxiety (Table 1, Fig. 1C-D). Future-oriented consideration was positively associated with generalized anxiety in both countries; however, the effect sizes were small (Table 1).
Table 1  
Regression Models of Generalized Anxiety (GAD-7)

|                          | U.K.          |           |           |           | Turkey      |           |           |           |
|--------------------------|---------------|-----------|-----------|-----------|-------------|-----------|-----------|-----------|
|                          | β             | SE        | t         | p         | β           | SE        | t         | p         |
| Age                      | −.08**        | .00       | −2.96     | .003      | −.16***     | .00       | −8.51     | <.001     |
| Gender (Female = 0, Male = 1) | −.07**        | .04       | −2.99     | .003      | −.08***     | .02       | −6.04     | <.001     |
| Gender (Female = 0, Other = 1) | .02           | .10       | .69       | .490      | .01         | .10       | .558      |           |
| Education (Below UG = 0, UG = 1) | −.12***       | .05       | −4.06     | <.001     | −.05***     | .02       | −3.41     | .001      |
| Education (Below UG = 0, PG = 1) | −.11**        | .05       | −3.41     | .001      | −.06***     | .03       | −3.96     | <.001     |
| Financial Satisfaction   | −.14***       | .00       | −5.42     | <.001     | −.10***     | .00       | −7.56     | <.001     |
| Child (No = 0, Yes = 1)  |               |           |           |           | .05**       | .03       | −2.92     | .003      |
| Mental Health (Yes = 0, No = 1) | −.05***       | .02       | −4.04     | <.001     |               |           |           |           |
| Mental Health (Yes = 0, 1 = Prefer not to say = 1) | .00           | .06       | −.11      | .912      |               |           |           |           |
| Government Satisfaction  | −.05          | .02       | −1.88     | .060      | −.03*       | .01       | −2.35     | .019      |
| Trust in Others about Social Distancing | −.07*         | .02       | −2.56     | .011      | −.03*       | .01       | −2.06     | .040      |
| Following COVID-19 News  |               |           |           |           | .08***      | .01       | −6.30     | <.001     |
| Life Expectancy          | −.09***       | .00       | −3.53     | <.001     | −.05***     | .00       | −3.57     | <.001     |
| Risk Perception          |               |           |           |           | .07***      | .00       | 5.83      | <.001     |
| Future-Oriented Consideration | .05*          | .02       | 1.98      | .049      | .04**       | .01       | 2.89      | .004      |
| Intolerance of Uncertainty | .33***         | .02       | 11.16     | <.001     | .35***      | .01       | 24.20     | <.001     |
| Mindfulness Attention Awareness | −.21***       | .02       | −7.51     | <.001     | −.21***     | .01       | −15.31    | <.001     |
| F                        | 62.523***     |           |           |           | 162.373***  |           |           |           |
| R²                       | .41           |           |           |           | .41         |           |           |           |
| df1 / df2                | 12 / 1075     |           |           |           | 17 / 3918   |           |           |           |

Note. *p < .05, **p < .01, ***p < .001
As people got older their generalized anxiety levels decreased (supplementary Fig. S1). Women had higher anxiety scores than men (average total GAD-7 scores for women vs men on a scale of 0–21: $M_{\text{women}} = 8.7$ vs. $M_{\text{men}} = 6.7$ in Turkey, $M_{\text{women}} = 6.5$ vs. $M_{\text{men}} = 4.5$ in the UK). Increased financial satisfaction, increased education levels, increased perceived life expectancy were all associated with decreased levels of generalized anxiety in both countries (Table 1). Participants who trusted people in their country in following the social distancing rules had lower generalized anxiety scores.

Having children was positively associated with generalized anxiety score in Turkey but not in the UK (Table 1). Participants in Turkey who reported following news about the pandemic more frequently and those who had higher perceived risk of catching the novel coronavirus had higher GAD-7 scores (Table 1).

**Generalized anxiety score is highly correlated with pandemic related anxiety score**

GAD-7 scores were strongly correlated with pandemic related anxiety scores in both countries (Fig. 1E-F, for UK: $B = 0.59, p < 0.001$, for Turkey: $B = 0.47, p < 0.001$). As in the case of generalized anxiety, intolerance of uncertainty had the largest effect on pandemic related anxiety levels (Table 2). Pandemic related worries increased as the uncertainty intolerance increased (Fig. 2A-B). Lower levels of mindful attention awareness and higher perceived risk of catching the virus were associated with increased levels of pandemic related anxiety (Table 2, Fig. 2C-D). In both countries, perceived life expectancy, financial satisfaction and level of trust in others in following social distancing measures were negatively associated with anxiety (Table 2). Participants who thought it would take more than 12 months for life to return to normal had higher pandemic related anxiety scores (Table 2). Participants who reported following news about the pandemic more frequently also had higher pandemic related anxiety scores (Table 2). The level of education was negatively associated with anxiety levels in the UK, but not in Turkey (Table 2).
Table 2
Regression Models of Pandemic related Anxiety

|                        | U.K.       |            |            |            | Turkey     |            |            |            |
|------------------------|------------|------------|------------|------------|------------|------------|------------|------------|
|                        | β          | SE         | t          | p          | β          | SE         | t          | p          |
| Age                    | −.11***    | .00        | -6.87      | <.001      | - .16***   | .02        | -11.61     | <.001      |
| Gender (Female = 0, Male = 1) | −.11***    | .04        | -4.40      | <.001      | - .16***   | .02        | -11.61     | <.001      |
| Gender (Female = 0, Other = 1) | −.02       | .10        | -.63       | .531       | − .00      | .10        | -.24       | .813       |
| Education (Below UG = 0, UG = 1) | −.12***    | .04        | -3.86      | <.001      | 0.03       | .02        | 1.75       | .081       |
| Education (Below UG = 0, PG = 1) | −.15***    | .05        | -4.67      | <.001      | - .02      | .03        | -.72       | .470       |
| Financial Satisfaction | −.18***    | .00        | -6.90      | <.001      | - .12***   | .00        | -8.16      | <.001      |
| Mental Health (Yes = 0, No = 1) | −.01       | .02        | -6.90      | <.001      | 0.03       | .02        | -5.33      | .539       |
| Mental Health Yes = 0, Prefer not to say = 1) | −.03*      | .06        | -2.16      | .031       | 0.00       | .02        | -2.16      | .031       |
| Following COVID-19 News | 0.07**     | .02        | 3.08       | .002       | 0.11***    | .01        | 7.75       | <.001      |
| Normalization Expectation | 0.07       | .07        | 1.65       | .099       | 0.09***    | .03        | 5.39       | <.001      |
| Normalization Expectation (0–6 months = 0, 6–12 months = 1) | 0.14**     | .07        | 2.82       | .005       | 0.16***    | .02        | 9.31       | <.001      |
| Normalization Expectation (0–6 months = 0, 12 + months = 1) | 0.11**     | .07        | 2.72       | .007       | 0.06***    | .04        | 4.26       | <.001      |
| Normalization Expectation (0–6 months = 0, Other = 1) | 0.05**     | .01        | -3.35      | .001       | 0.00       | .01        | -3.35      | .001       |
| Finance Plan           | - .05**    | .01        | -3.35      | .001       | 0.00       | .01        | -3.35      | .001       |
| Risk Perception        | 0.11***    | .00        | 4.28       | <.001      | 0.13***    | .00        | 9.58       | <.001      |
| Life Expectancy        | - .15***   | .00        | -5.55      | <.001      | - .05**    | .00        | -3.13      | .002       |
| Trust in Others about Social Distancing | - .09**    | .02        | -3.42      | .001       | - .04**    | .01        | -2.70      | .007       |
| Government Satisfaction | - .05**    | .01        | -3.35      | .001       | 0.00       | .01        | -3.35      | .001       |
| Future-Oriented Consideration | 0.07**     | .02        | 2.67       | .008       | 0.08***    | .01        | 5.59       | <.001      |
Anxiety promotes risk avoidance behaviour during a pandemic

The strongest predictor for risk avoidance behaviours such as keeping a social distance and staying at home (see supplementary Table S1 for the full list of behaviours) was pandemic related anxiety score (Fig. 2E-F). People with higher levels of anxiety reported engaging in risk avoidance behaviours more frequently (Table 3). Age significantly increased risk avoidance behaviours (Table 3, supplementary Fig. S1). In both countries, women were more risk avoidant than men (Table 3, supplementary Table S2). Education was positively associated with engaging in risk avoidance behaviours in Turkey, but negatively associated in the UK (Table 3). In both countries people who trusted others in following the social distancing measures more engaged in risk avoidance behaviours less (Table 3), however the effect size was small for Turkey (supplementary Fig. S2). The amount of time expected for life to return to normal was positively associated with risk avoidance behaviours in Turkey (Table 3, for mean values see supplementary Table S2). Mindful attention awareness had a significant positive effect on risk avoidance behaviour; however, the effect sizes were small (Table 3).

|                         | U.K.                          | Turkey                        |
|-------------------------|-------------------------------|-------------------------------|
|                         | \(\beta\) | SE | t     | \(p\) | \(\beta\) | SE | t     | \(p\) |
| Intolerance of Uncertainty | .23*** | .02 | 7.45 | <.001 | .26*** | .01 | 17.27 | <.001 |
| Mindfulness Attention Awareness | -.17*** | .02 | -5.91 | <.001 | -.10*** | .01 | -6.58 | <.001 |
| \(F\)                    | 40.675***                     | 95.092***                     |
| \(R^2\)                 | .36                           | .33                           |
| \(df1 / df2\)           | 15 / 1072                     | 20 / 3914                     |

*Note.* \(p < .05, **p < .01, ***p < .001\)
Table 3
Regression Models of Risk Avoidance Behaviour

|          | U.K.     |        |        |        |        |        | Turkey |        |        |        |
|----------|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|          | β        | SE     | t      | p      | β      | SE     | t      | p      |        |        |
| Age      | 0.13***  | 0.00   | 3.97   | < .001 | 0.08***| 0.00   | 4.52   | < .001 |        |        |
| Gender (Female = 0, Male = 1) | -0.08*   | 0.06   | -2.50  | 0.013  | -0.12***| 0.02   | -7.64  | < .001 |        |        |
| Gender (Female = 0, Other = 1) | -0.04    | 0.15   | -1.35  | 0.178  | -0.02   | 0.10   | -1.30  | 0.193  |        |        |
| Education (Below UG = 0, UG = 1) | -0.13***| 0.06   | -3.63  | < .001 | 0.06**  | 0.02   | 3.29   | 0.001  |        |        |
| Education (Below UG = 0, PG = 1) | -0.13***| 0.07   | -3.55  | < .001 | 0.04*   | 0.03   | 2.12   | 0.034  |        |        |
| RegionUK (South = 0, North = 1) | 0.05     | 0.08   | 1.78   | 0.075  |        |        |        |        |        |        |
| RegionUK (South = 0, Midlands = 1) | 0.03    | 0.10   | 1.07   | 0.284  |        |        |        |        |        |        |
| RegionUK (South = 0, Non-England = 1) | 0.06   | 0.11   | 1.94   | 0.053  |        |        |        |        |        |        |
| Region TR (Istanbul = 0, Ankara = 1) | -0.06***| 0.03   | -3.58  | < .001 |        |        |        |        |        |        |
| Region TR (Istanbul = 0, Izmir = 1) | -0.02   | 0.03   | -1.14  | 0.254  |        |        |        |        |        |        |
| Region TR (Istanbul = 0, Other = 1) | -0.05**  | 0.02   | -3.02  | 0.004  |        |        |        |        |        |        |
| Financial Satisfaction | -0.06   | 0.00   | -1.81  | 0.071  | -0.02  | 0.00   | -1.27  | 0.204  |        |        |
| Live with (Alone = 0, Other people = 1) | 0.02    | 0.05   | 1.25   | 0.213  |        |        |        |        |        |        |
| Live with (Alone = 0, Family = 1) | 0.06**   | 0.03   | 2.92   | 0.004  |        |        |        |        |        |        |
| Live with (Alone = 0, Other = 1) | 0.01    | 0.07   | 0.76   | 0.449  |        |        |        |        |        |        |
| Trust in Others about Social Distancing | -0.10** | 0.03   | -3.37  | 0.001  | -0.03* | 0.01   | -1.74  | 0.083  |        |        |
| Normalization | 0.05*    | 0.03   | 2.45   | 0.014  |        |        |        |        |        |        |
| (0–6 months = 0, 6–12 months = 1) |        |        |        |        |        |        |        |        |        |        |
|                                | U.K.     |       |       |       | Turkey |       |       |       |
|--------------------------------|----------|-------|-------|-------|--------|-------|-------|-------|
|                                | $\beta$  | $SE$  | $t$   | $p$   | $\beta$| $SE$ | $t$   | $p$   |
| Normalization                  | .04*     | .02   | 1.99  | .046  | .07*** | .04   | 4.35  | < .001|
| (0–6 months = 0, 12+ months = 1) |          |       |       |       |        |       |       |       |
| Normalization                  |          |       |       |       |        |       |       |       |
| (0–6 months = 0, Other = 1)    |          |       |       |       |        |       |       |       |
| Origin (0 = Not sure, 1 = Natural) | .01     | .02   | .40   | .687  | .04*   | .03   | 2.06  | .040  |
| Origin (0 = Not sure, 1 = Artificial) |        |       |       |       |        |       |       |       |
| Following COVID-19 News        | .07***   | .01   | 4.21  | < .001|        |       |       |       |
| Life Expectancy                | .04*     | .00   | 2.55  | .011  |        |       |       |       |
| Risk Perception                |          |       |       |       |        |       |       |       |
| Intolerance to Uncertainty     | - .08*   | .03   | -2.17 | .030  | - .07***| .00   | -3.59 | < .001|
| Mindful Attention Awareness    | .10**    | .03   | 2.77  | .006  | .04*   | .01   | 2.04  | .042  |
| COVID-Related Anxiety          | .25***   | .04   | 7.25  | < .001| .23*** | .02   | 12.46 | < .001|
| $F$                            |          |       |       |       | 12.052***|     |       |       |
| $R^2$                          | .13      |       |       |       | .10    |       |       |       |
| df1 / df2                      | 13 / 1074|       |       |       | 24 / 3911|     |       |       |

Note. *$p$ < .05, **$p$ < .01, ***$p$ < .001

Population-level behavioural and social factors contribute to the observed differences in anxiety levels and risk avoidance behaviour between countries

The average total GAD-7 score (on a scale of 0 to 21) was significantly higher in Turkey ($M = 7.95$, $sd = 5.05$) than in the UK ($M = 6.01$, $sd = 5.12$, $t(1714) = 11.1$, $p < 0.001$). Likewise, the average total pandemic related anxiety score (on a scale of 0 to 18) was significantly higher in Turkey ($M = 11.37$, $sd = 4.05$) than in the UK ($M = 8.13$, $sd = 4.08$, $t(1725) = 23.2$, $p < 0.001$).
As predicted from the correlation between anxiety levels and uncertainty intolerance, the mean intolerance of uncertainty was higher in Turkey than in the UK (supplementary Table S1, \( t(1623) = 15.9, p < 0.001 \)). The average mindful attention awareness score, however, was higher in the UK than in Turkey (supplementary Table S1, \( t(1647) = -11.0, p < 0.001 \)). There was a small but significant difference in future oriented consideration between the two countries with participants in the UK scoring higher on future consideration (supplementary Table S1, \( t(1542) = -7.3, p < 0.001 \)).

Moreover, the average financial satisfaction score was higher in the UK than in Turkey (67 vs 48 on a scale of 0-100, \( t(1930) = -22.3, p < 0.001 \)). Likewise, the perceived life expectancy was higher in the UK than in Turkey (perceived chance of living to be 75 or more: 75 vs 57 on a scale of 0-100, \( t(2302) = -22.2, p < 0.001 \)). Participants in the UK trusted others in following the social distancing rules more than participants in Turkey did (2.78 vs 1.80 on a scale of 1–4, \( t(1775) = -36.9, p < 0.001 \)). Finally, the average risk avoidance behaviour score was significantly higher among the participants in Turkey (3.46 vs 2.56 on a scale of 1–4, \( t(1401) = 32.9, p < 0.001 \)).

**Discussion**

In this paper, we examined the correlates and adaptive function of anxiety during the first wave of the COVID-19 pandemic in the UK and Turkey. As predicted, more future-oriented participants had higher levels of generalized and pandemic related anxieties, however the effect sizes were small, and intolerance of uncertainty had the largest effect on anxiety levels. Participants with elevated pandemic-related anxiety levels engaged in risk avoidance behaviour more frequently, stressing the adaptive role of anxiety in reducing mortality risk. Participants with increased mindful attention awareness had lower levels of both generalized and pandemic related anxiety. Several other behavioural and demographic factors, such as age, following the news, financial satisfaction and trust in others were associated with pandemic related anxiety levels and risk avoidance behaviour. Overall and pandemic driven anxiety levels were higher among Turkish participants whose risk avoidance behaviour scores were also higher compared to the participants in the UK. Below, we discuss each of these findings.

**Future orientation and anxiety**

We hypothesized that “too much” future orientation in modern societies may be contributing to the recent rise in anxiety disorders, since anxiety at it is core is an emotional response triggered in anticipation of possible future outcomes. Previous research on anxiety showed that anxious individuals exhibit a cognitive bias that they are more likely to attribute negative outcomes to uncertain situations\(^{26,27}\) and find it hard to tolerate or accept uncertainty\(^{28,29}\). Moreover, self-labelled worriers are primarily concerned about the uncertain future\(^{13}\). Our findings support these observations suggesting that it is not future-oriented thinking per se but intolerance of future uncertainties that contribute to increased anxiety response. Since pandemics such as the COVID-19 bring about many future uncertainties, those who are less tolerant of uncertainty exhibit the highest anxiety response.
To further examine the association between individual time perspective and anxiety levels during a pandemic we measured participant’s awareness of the present moment experience (i.e. mindfulness). We found that participants with higher mindful attention awareness scores had lower levels of both generalized and pandemic anxiety. Our results reinforce previous findings on the positive effect of the cognitive therapies that involve mindfulness techniques, such as mindfulness based cognitive therapy and acceptance and commitment therapy ACT, on reducing anxiety. Training the mind to focus on the present-moment experience seems to alleviate anxiety, possibly by taking one’s focus away from the future and the excessive thoughts of potential negative outcomes. We will discuss the benefits of anxiety response during a pandemic below, but it is important to note here that although mindfulness decreased the anxiety response, it did not make people less risk averse. On the contrary, mindfulness was positively associated with risk avoidance behaviour, suggesting that mindfulness-based therapies can alleviate anxiety without interfering with the benefits of a healthy anxiety response.

Adaptive function of anxiety during a pandemic

Only a few studies have demonstrated the benefits of anxiety, however an emphasis on “diagonal psychology” (i.e. the benefits of negative states and disadvantages of positive states) can help with better clinical decisions on when to act on emotional states and when a response can be considered normal. By focusing on the levels of anxiety during a pandemic, we were able to measure the effect of anxiety response on the avoidance of infection risk. Signal detection theory allows us to make predictions on the situations in which the anxiety response will be evoked, and which individuals will be more likely to fire this response. One such prediction is that the probability of dangerous events occurring in the environment should increase anxiety response. Supporting this prediction, our results showed that the mean GAD-7 scores during the first wave of the COVID-19 pandemic in both countries (Turkey: 8, UK: 6) were higher than the cut point of 5 for the mild levels of anxiety. Another prediction is that individuals with lower thresholds for threat detection should experience more anxiety. In line with this prediction, participants in both countries who reported higher levels of perceived risk of catching the novel coronavirus had higher pandemic related anxiety levels.

We found a strong correlation between an individual’s overall anxiety level (measured as generalized anxiety) and their level of pandemic-related worries, such as feeling stressed about leaving their house or being worried about their/their family’s health. Since individuals with high anxiety are predicted to have lower threat detection threshold, their pandemic related anxiety levels were also expected to be higher. Furthermore, the anxiety subtypes (e.g. various anxiety disorders) can be considered as partially differentiated responses of a general anxiety response adapted to different threat situations. For example, while social threats may trigger an anxiety response that evokes submissive behaviour, an encounter with a predator may trigger a response promoting freezing behaviour. Following this, pandemic driven anxieties are expected to trigger avoidance behaviours to protect against infectious agents. Indeed, our findings showed that risk avoidance behaviours such as keeping a distance from other people, avoiding crowded places and staying at home, were higher among the participants who
reported higher levels of pandemic related anxiety. Elsewhere, we also showed that participants with higher pandemic related anxieties were more likely to vaccinate against COVID-19\textsuperscript{24}, which supports the adaptive role of anxiety in reducing mortality risk.

The benefit of anxiety in specific situations, such as a pandemic, brings about the question of what level of anxiety can be considered normal, especially given that the anxiety response is context dependent. In clinical psychology a condition is thought to be pathological if it is impairing the quality of life of an individual. Nevertheless, it is important to acknowledge that anxiety is on a spectrum and the clinical anxiety share the continuous spectrum with the normal anxiety response\textsuperscript{2}. An evolutionary perspective suggests that if a biological system is not producing the effects that it was selected for and is leading to harm, then it is not functioning normally, and can be considered a disorder\textsuperscript{34}. In the case of anxiety, a decision on whether to intervene with a therapeutic method can be based on asking whether the individual is avoiding situations and activities that are harmless or even beneficial, as avoidance is the core component of generalized anxiety\textsuperscript{32}. Moreover, although cognitive therapies and administration of drugs have been the main therapeutic methods, an evolutionary perspective reminds us of the importance of the situations (environments) that trigger negative mood states at the first place\textsuperscript{19}. Although it may not be possible to alter certain situations, such as an ongoing pandemic, more focus should be given on changing structural inequalities that put certain groups under more risk\textsuperscript{35}, leading to anxiety.

**Age and anxiety**

Although elderly people have been among the most vulnerable group during the COVID-19 pandemic, our findings showed that both generalized and pandemic-related anxiety levels declined with age in both countries (supplementary Fig. S1). Our results support previous findings on the prevalence of generalized anxiety disorder by age in the UK, where the prevalence start declining by age 55, with a sharper decline after 65\textsuperscript{36}. Moreover, a recent survey found a negative relationship between GAD-7 scores and age in Cyprus during the COVID-19 pandemic\textsuperscript{37}. It is possible that as people get older, they may get more experienced at coping with uncertainties, which render them less susceptible to anxiety. Indeed, we found a strong significant negative correlation between age and uncertainty intolerance in both countries (supplementary Table S3 and S4). It is also possible that there are fewer uncertainties associated with long-term future goals (e.g., getting promoted, completing a degree etc.) for the elderly. Likewise, financial satisfaction score was positively correlated with age in both countries (supplementary Table S3 and S4).

Moreover, we found a strong positive correlation between the MAAS score and age, suggesting that mindful attention awareness is higher among the elderly (supplementary Table S3 and S3). These findings suggest that despite high mortality risk for the elderly during the COVID-19 pandemic, their increased tolerance of uncertainty and mindfulness result in decreased anxiety levels. Interestingly, being less anxious did not result in less risk avoidant behaviour in the older population, on the contrary engagement in risk avoidance behaviour increased with age (supplementary Fig. S1).

**Trust in others, anxiety and risk avoidance behaviour during a pandemic**
We found that trust in others in following social distancing rules decreased pandemic related anxiety but also decreased risk avoidance behaviour, especially in the UK (effect sizes were larger in the UK sample). This suggests that trust in others do not always act positively to contain the spread during pandemics. A recent multi-national study, for example, has found that social trust was associated with more COVID-19 deaths. Studies also showed that shared group membership and increased trust in others result in lower risk perception and higher risk-taking behaviours. Therefore, trust in others during a pandemic can act as a double edge knife, increasing pro-social behaviours such as mutual-aid and cooperation on one hand, and promoting risky health behaviours on the other.

Country-level differences

We found differences in the overall emotional and behavioural response to the pandemic between the UK and Turkey. For example, both generalized anxiety levels and pandemic related anxiety levels were higher among Turkish participants. There was significant difference in the mean intolerance of uncertainty score between the two countries (on a scale of 1–5, $M_{\text{Turkey}} = 3.49$ vs. $M_{\text{UK}} = 2.94$), which was probably the main driver behind the higher anxiety scores in Turkey. Another factor that potentially contributed to the elevated levels of pandemic anxieties in Turkey was financial satisfaction. The average level of financial satisfaction, on a scale of 0-100, was 48 for Turkish participants, and 67 for the participants in the UK. Moreover, we found that perceived life expectancy was much lower among the Turkish participants, which predicts that perceived mortality risk and hence anxiety levels are higher. Finally, Turkish participants reported a lower level of trust in others in following the social distancing rules compared to the participants in the UK, which might have contributed to the increased pandemic anxieties in Turkey.

Engagement in risk avoidance behaviour during the COVID-19 pandemic was also significantly higher among the Turkish participants. It is possible that elevated anxiety levels in Turkey rendered people to be more careful in maintaining a social distance, wearing masks outside and avoiding crowded places. Another factor explaining the reported differences in following government guidelines (social distancing, staying home, wearing a mask, frequent hand washing and avoiding crowded places and social gatherings) may be the cultural differences in collectivist attitude (individualism score for Turkey was 37, as opposed to 89 for the UK). Collectivist cultures may be more receptive to government guidelines and interventions, such as contact tracing, during an epidemic compared to individualistic cultures. Indeed, in a recent study levels of collectivism was associated with higher intentions to engage in social distancing behaviours during the COVID-19 pandemic. Our findings showed that there was an especially large difference in mask-wearing behaviour between the two countries. The majority of Turkish participants reported wearing a mask when outside at the start of the pandemic, whereas the score for UK participants was much lower (supplementary Table S1). This may also be due to the differences in government policies on mask-wearing between the two countries at the start of the pandemic.

Conclusion
Our study shows that an elevated anxiety response can be beneficial in avoiding risk of infection during pandemics. These findings open up further discussions on the normal anxiety response and stress the importance of the context in which an anxiety response is triggered. Our results also add to the growing literature on the benefits of mindfulness-based therapies, showing that mindfulness can alleviate anxiety by reducing the focus on future uncertainties.

**Methods**

**Participants**

We distributed the link to the online survey through social media (Twitter and Facebook), e-mail and WhatsApp groups and used snowball sampling. Data were collected during the first wave of COVID-19 pandemic in April and May 2020 (from 27 April 2020 until 25 May 2020), when both countries were in national lockdown. All participants completed the online questionnaire voluntarily. A total 6067 self-identified Turkish participants and 1534 self-identified UK participants participated in the study. We excluded the participants who did not complete the survey until the end and who did not live in Turkey and UK. The final sample was composed of 5023 participants (3935 Turkish and 1088 UK).

Supplementary Table S5 lists demographic information of the study participants in each country. The study was approved by the UCL Research Ethics Committee (ethics ID: 13121/002) and the methods were carried out in accordance with the approved guidelines. Informed consent was obtained from all participants.

**Study variables**

Supplementary Table S1 lists all the study variables, along with the corresponding survey questions, response scales, and summary statistics of the measured variables in each country. We measured overall anxiety levels using the 7-item generalised-anxiety disorder assessment, GAD-7. For pandemic related anxiety levels, we generated a six-item questionnaire related to the worries a person may be experience during the COVID-19 pandemic (α = .77 for both countries). To assess participants’ risk avoidance behaviour during the pandemic, we generated a six-item questionnaire (α = .87 for UK and α = .80 for Turkey). To measure uncertainty intolerance, we used three items (α = .70 for UK and α = .72 for Turkey) of Intolerance of Uncertainty Scale, IUS-12. We used five items (α = .80 for UK and α = .66 for Turkey) of Mindfulness Attention Awareness Scale, MAAS, to measure mindfulness. We measured future orientation by using 1) six items (α = .77 for UK and α = .70 for Turkey) of the two-factor Consideration of Future Consequences Scale, CFC-14, and 2) a question on the time period for finance planning.

When the original scales were shortened, we did so by the relevance of the scale item to our study purpose and the corresponding factor loadings in previous studies. In addition, we measured several other behavioural predictors such as perceived infection risk, perceived life expectancy, normalization expectation, frequency of following COVID-19 news, satisfaction with the government’s response to the pandemic, trust in others with social distancing and presence of a mental health condition.
Statistical Analysis

We conducted regression analyses to examine the predictors affecting 1) overall anxiety levels, 2) pandemic-related anxiety levels, 3) risk avoidance behaviours during the pandemic. Prior to the regression analyses, we examined the correlations between all variables to check multicollinearity. We started with full models where all the demographic and behavioural variables presented at supplementary Table S1 and S5 were entered in the models for each of the response variables (the mean generalized anxiety score, the mean pandemic related anxiety score, and the mean risk avoidance behaviour score), separately for each country. The results of these full models are presented in the supplementary information (supplementary Tables S6-11). We then conducted stepwise model selection using backward elimination to obtain the most parsimonious model for each response variable. The results presented here are based on the most parsimonious models. We examined the country level differences in the mean generalized and pandemic related anxiety, intolerance of uncertainty, mindfulness attention awareness, risk avoidance behaviour scores, and the mean perceived life expectancy, financial satisfaction, trust in others in following social distancing rules using pairwise t-tests. Statistical analyses were conducted using SPSS (version 25) and R (version 4.0.3).

Declarations

Acknowledgments

GDS is funded by the British Academy Postdoctoral Research Fellowship. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Author Contributions

GDS conceived the project. All authors contributed to the survey design. MSU and GDS conducted the statistical analyses. GDS wrote the manuscript with the help of all other authors.

Competing Interest Statement

The authors declare no competing interest.

References

1. Nesse, R. M. Natural selection and the regulation of defenses. A signal detection analysis of the smoke detector principle. *Evol. Hum. Behav.* **26**, 88–105 (2005).
2. Bateson, M., Brilot, B. & Nettle, D. Anxiety: an evolutionary approach. *Can. J. Psychiatry.* **56**, 707–715 (2011).
3. Zimbardo, P. G. & Boyd, J. N. Putting time in perspective: A valid, reliable individual-differences metric. *J. Pers. Soc. Psychol.* **77**, 1271–1288 (1999).
4. Henrich, J. The weirdest people in the world: How the west became psychologically peculiar and particularly prosperous (Farrar, Straus and Giroux, 2020).

5. Salali, G. D. & Migliano, A. B. Future Discounting in Congo Basin Hunter-Gatherers Declines with Socio-Economic Transitions. *PLoS One*. **10**, e0137806 (2015).

6. Nesse, R. M. Natural selection and the elusiveness of happiness. *Philos. Trans. R. Soc. B Biol. Sci.* **359**, 1333–1347 (2004).

7. Hidaka, B. H. Depression as a disease of modernity: explanations for increasing prevalence. *J. Affect. Disord.* **140**, 205–214 (2012).

8. Steinglass, J. E. *et al.* Temporal discounting across three psychiatric disorders: Anorexia nervosa, obsessive compulsive disorder, and social anxiety disorder. *Depress. Anxiety*. **34**, 463–470 (2017).

9. Papastamatelou, J., Unger, A., Giotakos, O. & Athanasiadou, F. Is Time Perspective a Predictor of Anxiety and Perceived Stress? Some Preliminary Results from Greece. *Psychol. Stud. (Mysore)*. **60**, 468–477 (2015).

10. Zaleski, Z. Future orientation and anxiety. *Underst. Behav. Context time Theory, Res. Appl.* 125–141 (2005).

11. Åström, E., Carelli, M. G. & Wiberg, B. Exploring multiple concepts of psychological time in relation to anxiety. *Pers. Individ. Dif.* **60**, S11 (2014).

12. Carelli, M. G., Wiberg, B. & Åström, E. Broadening the TP profile: Future negative time perspective. *Time Perspect. Theory; Rev. Res. Appl. Essays Honor Philip G. Zimbardo*. 87–97 https://doi.org/10.1007/978-3-319-07368-2_5 (2015).

13. Borkovec, T. D., Robinson, E., Pruzinsky, T. & DePree, J. A. Preliminary exploration of worry: Some characteristics and processes. *Behav. Res. Ther.* **21**, 9–16 (1983).

14. Borkovec, T. D. Worry: a potentially valuable concept. *Behav. Res. Ther.* **23**, 481–482 (1985).

15. Zinn, J. K. Mindfulness-based interventions in context: past, present, and future. *Clin. Psychol. Sci. Pract.* **10**, 144–156 (2003).

16. Hofmann, S. G., Sawyer, A. T., Witt, A. A. & Oh, D. The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *J. Consult. Clin. Psychol.* **78**, 169 (2010).

17. Brown, K. W. & Ryan, R. M. The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being. *J. Pers. Soc. Psychol.* **84**, 822–848 (2003).

18. Nesse, R. M. Evolutionary explanations of emotions. *Hum. Nat.* **1**, 261–289 (1990).

19. Nettle, D. & Bateson, M. The evolutionary origins of mood and its disorders. *Curr. Biol.* **22**, 712–721 (2012).

20. Nesse, R. & Williams, G. Why we get sick: The new science of Darwinian medicine. (Vintage Books/Random House 1994).

21. Marks, I. M. & Nesse, R. M. Fear and fitness: An evolutionary analysis of anxiety disorders. *Ethol. Sociobiol.* **15**, 247–261 (1994).
22. Lee, W. E., Wadsworth, M. E. J. & Hotopf, M. The protective role of trait anxiety: A longitudinal cohort study. *Psychol. Med.* **36**, 345–351 (2006).

23. Mykletun, A. *et al.* Levels of anxiety and depression as predictors of mortality: The HUNT study. *Br. J. Psychiatry.* **195**, 118–125 (2009).

24. Salali, G. D. & Uysal, M. S. COVID-19 vaccine hesitancy is associated with beliefs on the origin of the novel coronavirus in the UK and Turkey. *Psychol. Med.* 1–3 (2020).

25. Butler, G. & Mathews, A. Anticipatory anxiety and risk perception. *Cognit. Ther. Res.* **11**, 551–565 (1987).

26. Eysenck, M. W., Mogg, K., May, J., Richards, A. & Mathews, A. Bias in Interpretation of Ambiguous Sentences Related to Threat in Anxiety. *J. Abnorm. Psychol.* **100**, 144–150 (1991).

27. Koerner, N. & Dugas, M. J. A Cognitive Model of Generalized Anxiety Disorder: The Role of Intolerance of Uncertainty. *Worry its Psychol. Disord. Theory, Assess. Treat.* 201–216 https://doi.org/10.1002/9780470713143.ch12 (2008).

28. Dugas, M. J., Gosselin, P. & Ladouceur, R. Intolerance of uncertainty and worry: Investigating specificity in a nonclinical sample. *Cognit. Ther. Res.* **25**, 551–558 (2001).

29. Carleton, N. R. *et al.* Increasingly certain about uncertainty: Intolerance of uncertainty across anxiety and depression. *J. Anxiety Disord.* **26**, 468–479 (2012).

30. Segal, Z. V., Williams, M. & Teasdale, J. Mindfulness-based cognitive therapy for depression (Guilford Publications, 2018).

31. Hayes, S. C., Strosahl, K. D. & Wilson, K. G. *Acceptance and commitment therapy* (American Psychological Association, Washington, DC, 2009).

32. Roemer, L. & Orsillo, S. M. Expanding our conceptualization of and treatment for generalized anxiety disorder: Integrating mindfulness/acceptance-based approaches with existing cognitive-behavioral models. *Clin. Psychol. Sci. Pract.* **9**, 54–68 (2002).

33. Spitzer, R. L., Kroenke, K., Williams, J. B. W. & Löwe, B. A brief measure for assessing generalized anxiety disorder: The GAD-7. *Arch. Intern. Med.* **166**, 1092–1097 (2006).

34. Wakefield, J. C. The Concept of Mental Disorder: On the Boundary Between Biological Facts and Social Values. *Am. Psychol.* **47**, 373–388 (1992).

35. Aldridge, R. W. *et al.* Black, Asian and Minority Ethnic groups in England are at increased risk of death from COVID-19: indirect standardisation of NHS mortality data. *Wellcome open Res.* **5**, (2020).

36. McManus, S., Bebbington, P. E., Jenkins, R. & Brugha, T. *Mental Health and Wellbeing in England: the Adult Psychiatric Morbidity Survey 2014*. (NHS digital, 2016).

37. Solomou, I. & Constantinidou, F. Prevalence and predictors of anxiety and depression symptoms during the COVID-19 pandemic and compliance with precautionary measures: Age and sex matter. *Int. J. Environ. Res. Public Health.* **17**, 1–19 (2020).

38. Elgar, F. J., Stefaniak, A. & Wohl, M. J. A. The trouble with trust: Time-series analysis of social capital, income inequality, and COVID-19 deaths in 84 countries. *Soc. Sci. Med.* **263**, 113365 (2020).
39. Cruwys, T. et al. When trust goes wrong: A social identity model of risk taking. *J. Pers. Soc. Psychol.* **120**, 57 (2021).

40. Drury, J., Carter, H., Ntontis, E. & Guven, S. T. Public behaviour in response to the COVID-19 pandemic: understanding the role of group processes. *BJPsych Open*. **7**, 1–6 (2021).

41. Cruwys, T., Stevens, M. & Greenaway, K. H. A social identity perspective on COVID-19: Health risk is affected by shared group membership. *Br. J. Soc. Psychol.* **59**, 584–593 (2020).

42. Hofstede, G. *Culture’s consequences: Comparing values, behaviors, institutions and organizations across nations* (Sage publications, 2001).

43. Arnot, M. et al. How evolutionary behavioural sciences can help us understand behaviour in a pandemic. *Evol. Med. Public Heal.* 2020, 264–278 (2020).

44. Biddlestone, M., Green, R. & Douglas, K. M. Cultural orientation, power, belief in conspiracy theories, and intentions to reduce the spread of COVID-19. *Br. J. Soc. Psychol.* **59**, 663–673 (2020).

45. Carleton, R. N., Norton, M. A. P. J. & Asmundson, G. J. G. Fearing the unknown: A short version of the Intolerance of Uncertainty Scale. *J. Anxiety Disord.* **21**, 105–117 (2007).

46. Freeston, M. H., Rhéaume, J., Letarte, H., Dugas, M. J. & Ladouceur, R. Why do people worry? *Pers. Individ. Dif.* **17**, 791–802 (1994).

47. Joireman, J., Shaffer, M. J., Balliet, D. & Strathman, A. Promotion Orientation Explains Why Future-Oriented People Exercise and Eat Healthy: Evidence From the Two-Factor Consideration of Future Consequences-14 Scale. *Personal. Soc. Psychol. Bull.* **38**, 1272–1287 (2012).

48. Adams, J. & Nettle, D. Time perspective, personality and smoking, body mass, and physical activity: An empirical study. *Br. J. Health Psychol.* **14**, 83–105 (2009).

**Figures**
Figure 1

Correlates of generalized anxiety score (GAD-7) in the UK (A, C) and Turkey (B, D). Pandemic related anxiety score by GAD-7 in the UK (E) and Turkey (F).
Figure 2

Correlates of pandemic related anxiety score in the UK (A, C) and Turkey (B, D). Risk avoidance behaviour score by pandemic related anxiety score in the UK (E) and Turkey (F)

Supplementary Files
This is a list of supplementary files associated with this preprint. Click to download.

- Salalietscientsificreportssupp.pdf