Article:
Adinugroho, I., Stafford, T. and Bentall, R.P. (2024) The correlation between conspiracy mentality and vaccine intentions is moderated by social events: evidence from longitudinal data during COVID-19 pandemic in the UK. Vaccine, 42 (16). pp. 3607-3614. ISSN: 0264-410X

https://doi.org/10.1016/j.vaccine.2024.04.071

Vaccine 42 (2024) 3607–3614

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

The correlation between conspiracy mentality and vaccine intentions is moderated by social events: Evidence from longitudinal data during COVID-19 pandemic in the UK

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ARTICLE INFO

Keywords:
Conspiracy mentality
COVID-19
Vaccines
Social
Events

ABSTRACT

Social events may provide important cues that influence the sense of reality, including the perception that conspiracy theories are plausible. Using longitudinal panel data collected in the UK from March 2020 to December 2021, this study aims to identify whether social events influenced the strength of the association between conspiracy mentality and vaccine intentions during the COVID-19 pandemic. Consistent with previous research, the conspiracy mentality was a significant predictor of vaccine intentions across three-time points, but also that conspiracy mentality measured in March 2020 predicted that participants were more hesitant to the vaccines in December 2020. The primary finding was that different social events moderated the strength of the correlation between conspiracy mentality and vaccine intentions within similar participants. Conspiracy mentality became more vital to evaluate COVID-19 vaccines in December 2020, when the vaccination program was about to commence.

1. Introduction

Many studies have shown negative correlations between conspiracy beliefs and vaccine intention [1,2,3,4,5,6]. Some studies have suggested that the perceived dangers of vaccines [3] and poor vaccine knowledge [4] mediate this relationship. People who rely on conspiracy theories may perceive that the vaccine is the outcome of secret agreements or produced by malicious actors to control the human population. However, most studies examining the relationship between conspiracy beliefs and vaccine intentions have relied on cross-sectional data. The few studies that have utilised longitudinal data to test the relationship between conspiracy beliefs and vaccine intention [7,8], have not considered the different social events that occurred at each time point.

Social events can be cues that affect decision-making, and it seems likely that they could affect the way that existing beliefs about conspiracies influence the way that people evaluate vaccines. Sociologists have argued that, in addition to the rationality of decision-makers, environmental cues and social elements should be considered when understanding decision-making processes [9]. Two theories have been used to understand the importance of environmental cues and ecological factors: social judgement theory [10,11] and ecological rational theory [12,13]. Social judgement theory assumes that the outcome of a decision is influenced by how well decision-makers can perceive relevant social factors, how consistently they utilise the data and their ability to understand the world. Different individuals will therefore make different decisions even though they are exposed to the same situation because they have different abilities in selecting and integrating social cues. Evidence in support of social judgement theory can be found in an experimental study investigating the effect of online comments in social media and public opinion polls [14]. It was found that negative comments were considered acceptable only when participants had similar prior attitudes, but not when participants had positive attitudes. Hence, prior attitudes became the antecedent of how participants interpreted and responded to the environmental cues.

Unlike social judgement theory, which highlights the importance of deliberative processes in managing environmental cues for decision-making, ecological rational theory proposes that, under some conditions, people act quickly without employing analytic processes that involve probabilities. This allows rapid decision-making through the activation of mental shortcuts, known as heuristics [12]. The concept of heuristics has been applied to several fields, including in politics [15] and economics [16]. Political ideologies (left vs right or liberal vs

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https://doi.org/10.1016/j.vaccine.2024.04.071
Received 1 November 2023; Received in revised form 13 April 2024; Accepted 23 April 2024
Available online 3 May 2024

conservative) may function as availability heuristics, they affect the availability of information in memory that may be activated when evaluating vaccines during COVID-19 pandemic. Hence, conservative people in the US tend to have a more negative evaluation of COVID-19 vaccines than liberals because they are more sensitive to messages about medical health risks [17]. Political ideology and party affiliation have thereby become a rule of thumb in decision making that can lead to poor decisions, even for health care workers who have appropriate knowledge on health issues [18].

The COVID-19 pandemic was a fast-evolving global emergency, with impacts on the lives of people that changed rapidly, and sometimes unpredictably over time. For example, in the UK, the first lockdown was introduced with little warning on March 23rd, 2020 [19,20], before being relaxed on June 23rd, 2020 [21]. However, new restrictions were introduced again as the second lockdown on October 31st, 2020 [22]. Rapid progress in the development of COVID-19 vaccines that was widely reported in the national media resulted in the first AstraZeneca vaccines and quickly becoming available on January 4th, 2021 and becoming rapidly accessible for the UK adults population [23].

These rapidly occurring events during the pandemic required UK citizens to quickly adapt to emerging situations. Fig. 1 maps some related COVID-19 events that might influence psychological conditions and how judgements should be made by them. All reported events were taken from the following sources: Institute for Government [24]; BBC news (https://www.bbc.co.uk/news/uk) and The Guardian newspaper (https://www.theguardian.com/uk). Under some conditions, there were no opportunities for them to generate deliberative decisions and they therefore had to rely on ecological rationality. We assume that, in these circumstances, people created mental shortcuts to manage the situation and generate judgements, including relying on conspiracy theories. We also hypothesise that different social events convey different meanings depending on pre-existing conspiracy mindsets and would affect hesitancy toward acceptance of the vaccine. Thence, the strength of the correlation between conspiracy beliefs and vaccine attitudes would be expected to vary following different social events.

To test our hypotheses, we applied mixed-effect regression analysis by including random components (i.e., random slopes and random intercepts). Random components are those that are assumed to be sampled from a wider universe of possible values, whereas fixed components are those that have definite values. For example, if, say, researchers intended to investigate how conspiracy beliefs and other factors predict individual political participation in Europe or Asia, political trust and economic conditions within each continent could be included as predictors and considered random factors (had different people sampled in each continent their values would be different) that vary to influence the fixed coefficient predicting political participation from conspiracy beliefs; whether or not the participants were in Europe or Asia would be considered a fixed factor. By taking into account random factors in the analysis, standard errors can be reduced, and a more accurate estimate of the regression coefficients can be obtained. In the current longitudinal analyses, PID will be included as random intercept and dummy coding for waves as random slopes.

2. Method

2.1. Participants and data collection

The data was taken from the COVID-19 Psychological research consortium (C19PRC) project (https://www.sheffield.ac.uk/psychology-consortium-COVID19) a longitudinal survey designed primarily for mental health surveillance initiated by University of Sheffield, Ulster University, University of College London, The University of Liverpool, and Royal Holloway University of London [25,26]. The project aims to assess the psychological impacts of the COVID-19 pandemic in a representative quota sample of UK population stratified by age, sex, and household income. The project has been granted ethical clearance from University of Sheffield (Ref: 033759) and the sample was recruited and assessed online by the survey company, Qualtrics. Eight waves of data collection have been completed at the time of writing, but this study only utilises data collected in three waves where the core variables, conspiracy mentality and vaccine intentions were available (wave 1 collected in March 2020, wave 4 in November to December 2020, and wave 7 in December 2021).

In each wave, participants who completed previous waves were invited to take part, with participants missing at follow-up replaced with new participants required to meet the sampling quotas in each wave. The total participants at wave 1 was 2008 after we removed participants who answered option (4) which is "not applicable" (n = 17) in the vaccine intention question (i.e., "*If a new vaccine were to be developed that could prevent COVID-19, would you accept it for yourself?*"). These consisted of 51.74 % females, with the mean age of 45.52 (SD = 15.91). Of these, 1262 were carried through to wave 4 which, with replacement

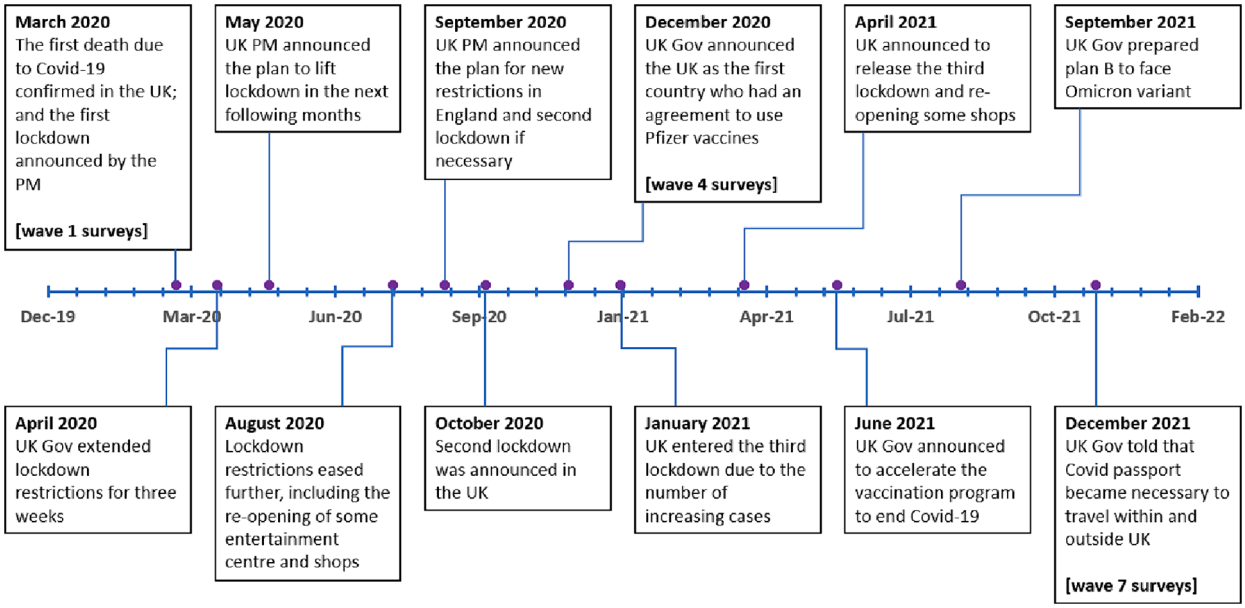

Fig. 1. Timeline of COVID-19 events in the UK.

participants (n = 2605), consisted of 51.48 % females with a mean age of 48.36 (SD = 16.13). At wave 7, 740 participants from wave 1 and wave 4 remained in the sample, and replacements were recruited (n = 665). In total with replacement participants (n = 1405), wave 7 data consisted of 49.96 % females with the mean age of 48.844 (SD = 15.10). Only participants who contributed to all three waves (n = 740) were involved to test our hypotheses, consisting of 48.37 % females with mean age of 52.30 (SD = 14.74).

2.2. Data quality measures

To ensure the quality of the data, the C19PRC core team eliminated participants who did not complete the surveys in full; have a technical issue with the informed consent; those who were not English-speaking adults; those with short completion times and any suspected duplicate respondents, those who join the survey more than one time with identical ID [25]. Also, eliminating speedy participants is conducted to reduce errors in the analysis. The minimum time allowed was set as 11 min and 11 s for wave 1 surveys. Similar principles also applied for wave 4 for which the core team conducted a pilot study (n = 100) to identify the minimum time which is half of the median time from the pilot study [26].No papers have been published using wave 7 data prior to this one, however the C19PRC team applied the similar parameters as in wave 1 and wave 4 to ensure the quality of the data.

2.3. Open science practices

To follow the best practice of open science, all materials, including measurement scales, codebook, user guide and measure information for wave 1 and wave 4 surveys have been uploaded to an open science webpage at https://osf.io/v2zur/. The technical report for wave 7 already uploaded in the webpage, but the full data is still being managed at the time of writing.. Raw data for explanatory analysis also have been anonymised to ensure confidentiality for all participants based in compliance with general data protection regulation (GDPR). All personal data is restricted to members of the research team [25].

2.4. Measures

2.4.1. Recording time points and identification number

Dummy coding with three categories was used to indicate data from the three-time points (i.e., wave 1, wave 4, and wave 7). These categories allow us to map and identify numerical data in each wave. To provide participants ID, Qualtrics recorded those with unique numbers called PID. These unique numbers were used to identify similar participants across the three waves.

2.4.2. Self-report instruments

The C19PRC utilised the conspiracy mentality scale (CMS); [27]. CMS is a self-report instrument with five items measuring the likelihood of believing in conspiracy theories. To note, CMS does not address content-specific conspiracy theories (e.g., anti-vaccine conspiracy theories or COVID-19 conspiracy theories) that are related to COVID-19 vaccines, yet they assess the likelihood to engage in conspiracist ideation. Each item is rated using a Likert scale ranging from 1 (certainly not − 0 %) to 11 (certainly 100 %). The validity of the scale had been assessed by Bruder et al. [27] using samples from five countries, the US, UK, and Ireland, Germany, and Turkey. Exploratory factor analysis suggested that five items in CMS were explained by one factor that explained 60.6 % of the variance with all factor loadings larger than 0.71. An example item is "*I think that, many very important things happen in the world, which the public is never informed about*".

Vaccine intentions were measured at each wave using one question developed by the C9PRC core team. At wave 1, no vaccines had been developed, and the question used was "*If a new vaccine were to be developed that could prevent COVID-19, would you accept it for yourself?*" By wave 2, multiple COVID-19 vaccines had been developed and the question asked was "*Multiple vaccines for COVID-19 have now been developed. Will you take a vaccine for COVID-19 when it becomes available to you?*". By wave 7, the vaccination program was well under way and booster vaccines had been available and were easy to obtain, so the question asked was "*Have you been fully vaccinated against COVID-19 (*i.e. *have you received all jabs/shots)?*". Questions at each time point were constructed differently following those conditions. The outcome of the measurements was categorical variables where participants were given several options to respond to the question, (1) yes; (2) maybe; (3) no. The option of (4) not applicable was only available at wave 1.

2.5. Statistical analysis

We conducted descriptive and explanatory analysis from the longitudinal data collected at the three time points. A Sankey diagram was used to visualise the movement of vaccine intentions across time. We excluded participants who answered (4) or "not applicable" in responding to the vaccine intention question because this option was only available at wave 1. Intercorrelation matrices were constructed to identify inter-correlations among study variables. Three correlational methods are used, the Spearman rank test to identify the correlation between vaccine intentions as ordinal scales [28], point biserial correlations to assess correlations between continuous and categorical variables [29] and Pearson correlations when both variables were continuous [30]. We applied mixed-effect regression analysis to test our hypotheses. The scores derived from the CMS were transformed into standardised Z scores to obtain standardised coefficients. All the computations were conducted using *R studio* with the {ggsankey} package for descriptive analysis [31] and {lme4} package for mixed-effect regressions [32].

3. Results

3.1. Attrition analysis

Attrition analysis was conducted to assess how loss of participants in the longitudinal study influenced the internal validity of the findings We followed the approach of Oleksy et al. [33] and McBride et al. [25] to compare socio-demographic variables (i.e., age, gender, and educational background) between participants who completed all waves (n = 740) and incomplete participants (n = 1268) using wave 1 as the first stage. We then conducted logistic regression to assess the effect of demographic variables and conspiracy mentality in predicting the status of being complete or incomplete responders, dummy coding categorised participants at wave 1 into incomplete responders (participants who did not complete the survey in all three waves: 0) and complete responders (1). Comparison analysis with *t-test* (*t*) and *Mann-Whitney U test* (Z) demonstrated that two groups were different in terms of age ($t(2006) = -12.09$, $p < .05$) and gender ($Z = -2.84$, $p < .05$), but not for educational background ($Z = -1.24$, $p > .05$). The levels of conspiracy mentality were also significantly different ($t(2006) = 2.36$, $p < .05$, $d = .10$) between complete responders ($M = 34.51$; SD = 9.67) and incomplete responders ($M = 35.47$; SD = 8.81). However, the effect size (*d*) was categorised as a small effect because, even though conspiracy mentality differed significantly between the groups, the difference in mean scores and variances were small [34].

In the second stage, we applied logistic regression to assess whether being complete or incomplete responders can be predicted through demographic variables and conspiracy mentality. Two demographic variables, age ($\beta = .56$; $p < .01$) and gender ($\beta = -.27$; $p < .01$) were significant predictors of the number of time points participants responded to, but educational background was not significant ($\beta = -.03$; $p > .05$). Conspiracy mentality also significantly predicted the status of being complete or incomplete responders ($\beta = -.10$; $p < .05$). Overall, the analyses indicate that the differences between complete and incomplete

responders were small and the main findings of our study are likely robust.

3.2. The overview of participants

There were 159 participants who did not provide the full informed consent and were eliminated; 35 participants completed the survey from outside the UK or under 18-year-old (n = 6) also removed from the survey; 77 participants who categorised as speedy and 64 potential duplicate participants were removed in wave 1 surveys [25]. In wave 4, two phases of data collection were employed. Phase 1 data collection focused on recontacting participants from wave 1 (March 2020) with n = 1796 and wave 3 (August 2020), whilst phase 2 recruited replacement participants with n = 2071. For over 62.8 % (n = 1271) participants were successfully recontacted from the previous waves and 3073 participants collected in phase 2. From this, the C19PRC core team removed 344 participants who did not complete the surveys in full; 185 participants who were not English-speaking adults and those who were too quick in completing the surveys (n = 50) [2635].

Of the 740 participants who joined the survey in all three waves and included in our primary analysis, the majority were from England (85 %), followed by Scotland (8.78 %), Wales (4.05 %) and Northern Ireland (2.16 %). Related to ethnicity, the survey classified eleven ethnic groups, which can be seen in the supplementary materials. Most participants were white British (91.49 %), with the rest white non-British (3.24 %), Indian (2.03 %) and other ethnic groups (1.49 %). In terms of educational background measured in wave 1 (n = 740), 3.24 % of participants had no qualification, followed by 19.19 % with GCSE-level qualifications, 18.11 % with A-levels, 9.86 % having a technical qualification, 29.46 % with an undergraduate degree, 5 % with a diploma, and 13.51 % with postgraduate degree; 1.62 % mentioned other qualifications.

3.3. Tracking the movement of vaccine intentions

We show the movement of participants responding to vaccine intention questions with a Sankey diagram (Fig. 2). New participants in wave 4 and wave 7 were not considered in our flow analysis. Also, 746 participants in wave 1 (NC-W4) were not considered in the analysis because they decided to leave the survey in wave 4 and there were 1268 participants in wave 1 (NC-W7) who were not involved in wave 7. It has previously been reported that vaccine hesitancy ("maybe") and vaccine refusers ("no") were more prevalent at time 4 but no statistical analysis has previously been reported for time 7 [36].

3.4. Intercorrelation among study variables across times

There was a significant negative correlation between conspiracy mentality and vaccine intentions at each of the three-time points, with the largest correlation coefficient at wave 4. Table 1 shows the correlations across times between conspiracy mentality and vaccine intentions at the three waves. Vaccine intentions at wave 1 correlated with those at the 4th wave and the 7th wave. The negative correlations between conspiracy mentality and vaccine intentions confirmed similar findings reported in previous studies that used C19PRC data [2,5].

3.5. The cross-lagged effects of conspiracy mentality

We conducted two regression models to assess how previous conspiracy mentality influenced vaccine evaluations at a particular wave. Model 1a calculates the effects of conspiracy mentality and vaccine intentions at wave 1 as predictors of vaccine intentions at wave 4. Model 1b and Model 1c replicate the previous model with similar predictors at wave 1 and wave 4, respectively predicting vaccine intentions at wave 7 (see Table 2). All models included PID as the random intercept. PID represents categories that reflect individual differences in term of

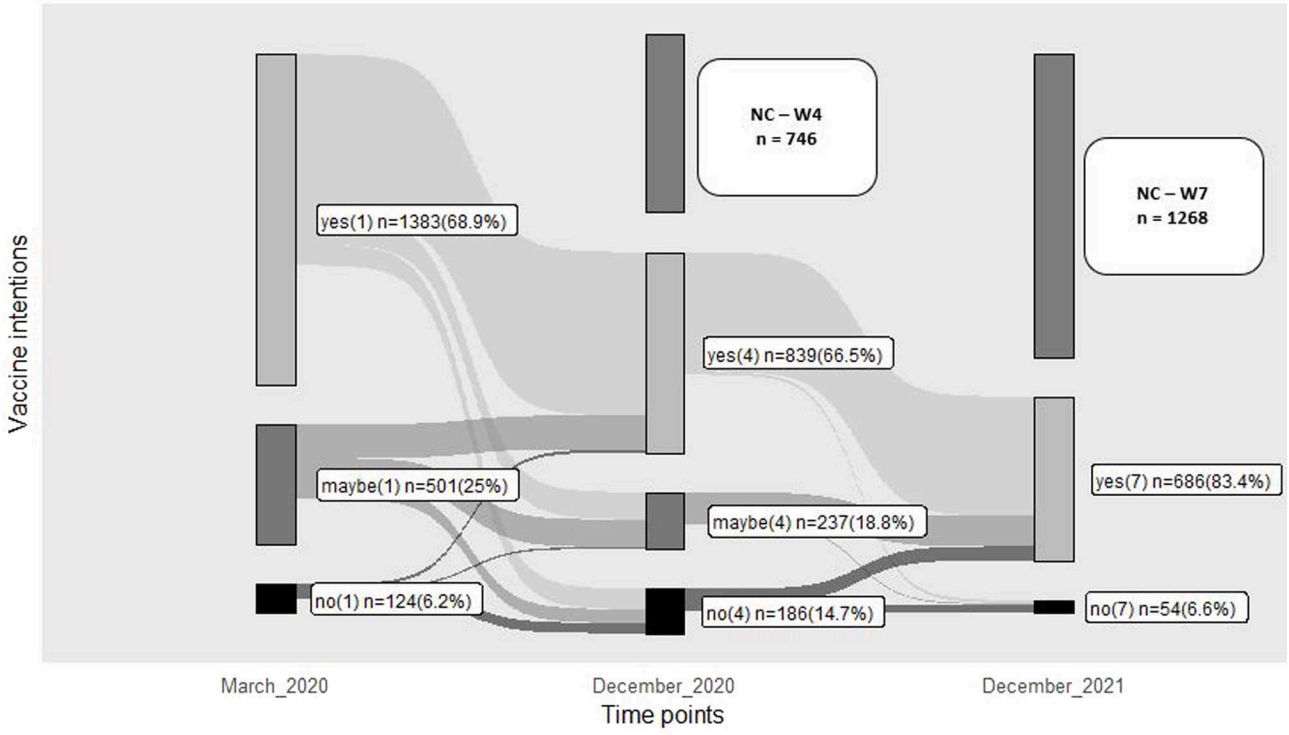

Fig. 2. The movement of vaccine intentions from identical participants at three-time points (March 2020 to December 2021).

Table 1
Inter-correlation matrix between conspiracy mentality and vaccine intentions among three-time points.

	1	2	3	4	5	6
1.Vaccine intentions (W1)	1					
2.Vaccine intentions (W4)	.37**	1				
3.Vaccine intentions (W7)	.16***	.33**	1			
4.Conspiracy mentality (W1)	−.08*	−.22***	−.13***	1		
5.Conspiracy mentality (W4)	−.05	−.21***	−.14***	.62***	1	
6.Conspiracy mentality (W7)	−.06	−.18***	−.09*	.59***	.69**	1

Note:
* *Significant at 95% CI.*
** *Significant at 99% CI.*
*** *Significant at 99.99% CI.*

Table 2
Logistic regression for cross-analysis between conspiracy mentality and vaccine intentions at wave 1, wave 4 and wave 7.

	Vacc intentions (W4)			Vacc intentions (W7)		
	β	OR	SE	β	OR	SE
Model 1a − 1b						
(Intercept)	−1.46	.23***	.26	1.14	3.15***	.31
Vacc intentions (W1)	2.88	17.99***	.31	2	7.40***	.40
Consp mentality (W1)	−.50	.60***	.09	−.45	.64**	.15
Model 1c						
(Intercept)				.82	2.28***	.22
Vacc intentions (W4)				3.11	22.61***	.38
Consp mentality (W4)				−.32	.72*	.16

Note: *Model 1a shows wave 1 predictors of vaccine hesitancy at wave 4; model 1b shows the same wave 1 variables as predictors of hesitancy at waves 7, and 7 model c shows the wave 4 predictors of hesitancy at wave 7 with n = 740 for similar participants joined in three waves.*
* *Significant at 95% CI.*
** *Significant at 99% CI.*
*** *Significant at 99.99% CI.*

conspiracy mentality and vaccine intentions.

Models 1a and 1b show that levels of vaccine acceptance at wave 4 and wave 7 can be predicted by the previous levels of vaccine intentions and conspiracy mentality in wave 1, and not only by conspiracy mentality at the same wave. Similar results are shown by Model 1c where conspiracy mentality and vaccine intentions at wave 4 significantly predicted the level of vaccine intentions at wave 7. An equation can be constructed to predict vaccine intentions in wave 4 (Y^4) and two equations for vaccine intentions in wave 7 (Y^7) from the two models. Equations below describe the formula to predict vaccine intentions based on the previous levels of vaccine intention (X), the level of conspiracy mentality (Z) and random errors (∈). There is no variance contribution from the random intercepts to our fixed predictors in the models.

$$\text{Vac\_intentions W4 } (Y^4) = -1.46 + (2.88{*}X^1) + (-.50{*}Z^1) + \in$$

$$\text{Vacc\_intentions W7 } (Y^7) = 1.14 + (2{*}X^1) + (-.45{*}Z^1) + \in$$

$$\text{Vac\_intentions W7 } (Y^7) = .82 + (3.11{*}X^4) + (-.32{*}Z^4) + \in$$

3.6. Moderation analysis

We applied moderation analysis to (1) compare the strength of the correlations between our study variables at three-time points and (2) identify effects of time points that reflect different social events influencing the strength of the correlation. PID was included as the random intercept, and dummy coding for waves as the random slope. By including PID, we could control the magnitude of individual factors that may influence vaccine intentions apart from conspiracy mentality (e.g., risk perception, vaccine knowledge and *needle-phobic*). Table 3 illustrates the regression coefficients of time points, conspiracy mentality and the interaction between fixed predictors. Results show time points are significant predictors of vaccine intentions, reflecting the increase of vaccine acceptance over time from March 2020 to December 2021, whereas conspiracy mentality reduced vaccine acceptance at all time points.

Table 3
Logistic regression with random effects describing the interaction between time points and conspiracy mentality.

	β	OR	SE	Confidence interval	Random effects
Model 2					$\sigma^2 = 3.29$
(Intercept)	.73	2.08***	.08	1.74–2.47	$\tau_{00} = .50$
Time points	2.05	7.82***	.26	4.66–13.14	$\tau_{11} = .80$
Consp mentality	−.17	.84*	.08	.71-.98	
Time*Consp mentality	−.32	.72*	.15	.53-.98	

Note: n = 740 for similar participants joined in three waves.
Marginal R^2 /Conditional R^2 = .203/ NA.
* Significant at 95% CI.
** Significant at 99% CI.
*** Significant at 99.99% CI.

The analysis also revealed that time points, reflecting various social events during the pandemic, moderated the strength of the correlation between conspiracy mentality and vaccine intentions, where the strongest correlation occurred at wave 4 (see Table 1). The strongest effect of conspiracy mentality led to the lowest vaccine intentions at wave 4, whereas the highest vaccine acceptance occurred at wave 7 (see Fig. 2). Supporting analysis also revealed a significant difference ($F(2,737) = 76.67$; $p < .05$) in conspiracy mentality across the three waves but the highest levels of conspiracy mentality occurred at wave 1 ($M = 34.95$; $SD = 9.30$), followed by wave 7 ($M = 32.62$; $SD = 9.99$) with the lowest conspiracy mentality at wave 4 ($M = 30.89$; $SD = 11.08$). Hence, the increased effects of conspiracy mentality at wave 4 is not in line with changes in conspiracy mentality over time. Further explorations of this result will be discussed in the discussion section. Using Model 2, the levels of vaccine intentions can be predicted by fixed predictors, the interaction between time points (X), conspiracy mentality (Z), and random errors (∈) (see Fig. 3).

$$\text{Vac\_intentions } (Y) = .73 + (2.05{*}X) + (-.17{*}Z) + (-.32{*}X{*}Z) + \in$$

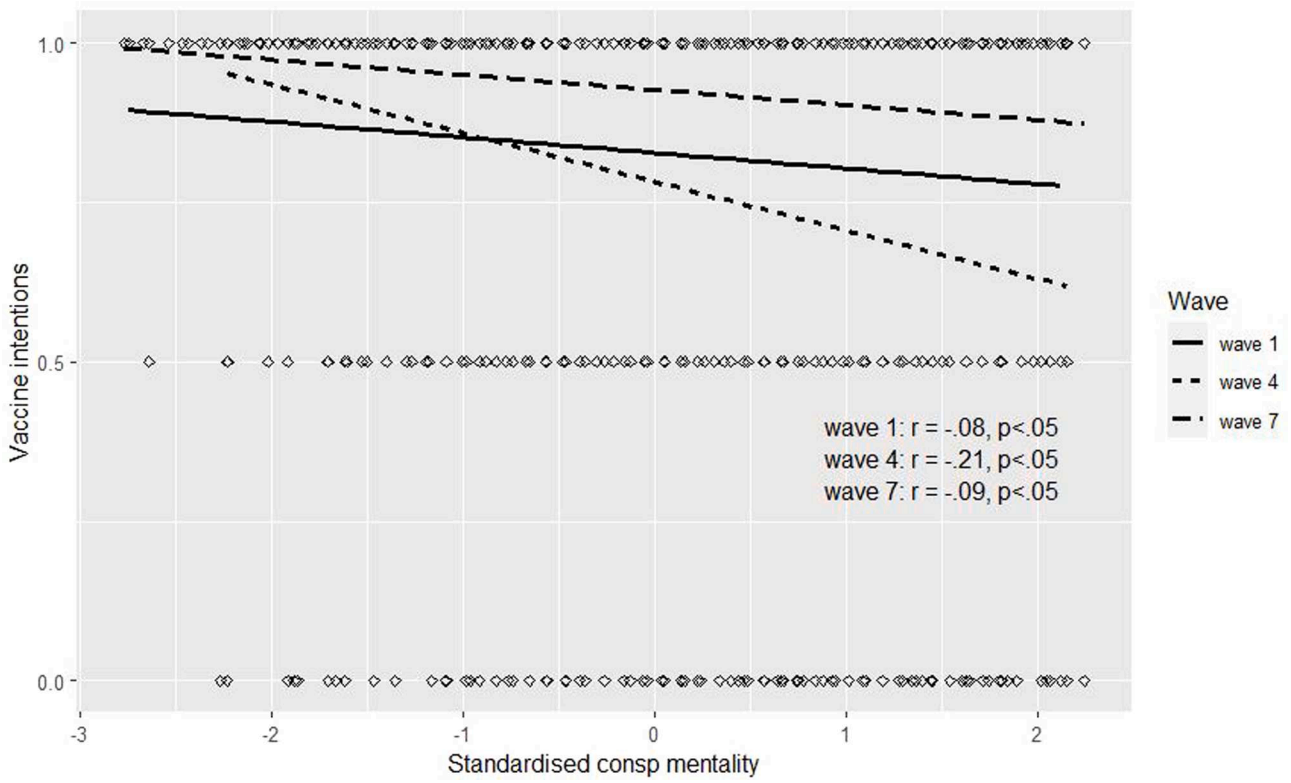

Fig. 3. Linear model describing the strength of the correlation between conspiracy mentality and vaccine intentions at three-time points *Note: Vaccine intentions are described with dummy coding where 0 = no; 0.5 = maybe and 1 = yes.*

4. Discussion

4.1. Longitudinal analysis of conspiracy mentality and vaccine intentions

This study captures three important pieces of evidence by using longitudinal data. First, the percentage of people expressing positive vaccine intentions varied across 22 months and, in general, vaccine acceptance increased over time during the pandemic from March 2020 to December 2021. However, there was an increase in vaccine hesitancy and vaccine refusals in December 2020, measured at wave 4. Second, the levels of conspiracy mentality in participants were mainly stable across the three-time points but, nevertheless, the magnitude of their impact on vaccine intentions was different at the three-time points. Third, vaccine intentions at each follow-up time point were influenced by conspiracy mentality and vaccine intentions at the previous time point. These findings confirmed previous longitudinal analysis showing that conspiracy mentality has a longitudinal effect influencing vaccine hesitancy [7,8] but add to previous findings by showing that this effect is contingent on social contexts. This observation has implications for future pandemics, and the design of strategies for monitoring vaccine perceptions and identifying the effectiveness of public health communication strategies, facilitating effective interventions to encourage people to get vaccinated.

4.2. Social events influence the correlation between conspiracy mentality and vaccine intentions

The findings from this study reveal the different strengths of correlation within similar participants at three-time points. In December 2020, conspiracy theories became more important to people when evaluating vaccine efficacy even though the mean levels of conspiracy mentality at this point was the lowest in the period of study. We expect that different social events influenced the strength of the correlation by encouraging participants to be ecologically adaptive to situational factors.

Events occurred during March 2020 and December 2020 that caused UK citizens to draw more on conspiracy theories when evaluating the vaccine. Rapid changes of lockdown policies may have led to feelings of uncertainty that prompt more reliance on conspiracy theories [37]. At the time, there were also some public criticisms of the UK's rapid approval of COVID-19 vaccines, including by the Chief Medical Advisor to the US President, Dr Anthony Fauci, who later retracted his remarks [38]. Conflicting arguments between scientific advisors and the UK government regarding the decision to restrict social movements during Christmas in December 2020 was another event that may have encouraged people to be more influenced by conspiracy theories [20,39].

5. Conclusion

Specific social events experienced during the pandemic period may have bolstered the plausibility of vaccine conspiracy theories, particularly in the case of those with high conspiracy mentality. This effect likely generated different correlational strengths between conspiracy mentality and vaccine intentions in the same participants at the three time points. Despite public communications by health service providers intended to clarify the fact that COVID-19 vaccine was safe, these attempts to contrast *myth* vs *fact* may not always have been effective, as previous research has shown that these efforts can lead to backfire effects [40]. The findings from this study offer a fresh perspective for understanding the impact of a conspiracy mindset. Rather than focusing on how conspiracists perceive reality, and attempting to change the way they think, a more effective approach to reducing vaccine hesitancy may be to focus on creating supportive social environments for people who are considering whether or not to be vaccinated [41].

6. Limitations

Despite the empirical insights provided by the data, this study has limitations. First, our attrition analysis revealed the significant differences between complete and incomplete responders, such that incomplete responders may have had different vaccine intentions and levels of conspiracy mentality. Second, measures of vaccine intentions only relied on single items with categorical options. MacDonald [42] has argued that measures of vaccine intentions or vaccine hesitancy should assess three dimensions of complacency, confidence, and convenience. Third, the study could only utilise the data from three-time points from seven waves of data collection.

Author contributions

The study design was developed together by I. Adinugroho, T. Stafford and R. P Bentall. The C19PRC core team led by R. P Bentall provided the data. The analysis and writing were conducted by I. Adinugroho, supervised by T. Stafford and R. P Bentall. I. Adinugroho drafted the full manuscript. T. Stafford and R. P Bentall provided the critical evaluations. All authors approved the final manuscript before submission to the journal.

CRediT authorship contribution statement

Indro Adinugroho: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Tom Stafford:** Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing – review & editing. **Richard P. Bentall:** Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

I. Adinugroho is fully supported by the C19PRC core team who provided the longitudinal data for the analysis. *Beasiswa Pendidikan Indonesia Kemendikbudristek* - LPDP provided by Balai Pembiayaan Pendidikan Tinggi (BPPT) Kemdikbudristek and LPDP Indonesia also supported I. Adinugroho in providing the fund scheme and opportunity for I. Adinugroho to conduct the study at Department of Psychology, University of Sheffield, UK as a part of his PhD.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2024.04.071.

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