Increased belief in vaccination conspiracy theories predicts increases in vaccination hesitancy and powerlessness: Results from a longitudinal study.

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Highlights

Increased conspiracy theory beliefs predicted increased powerlessness one-month later

Increased conspiracy theory beliefs predicted increased hesitancy one-month later

Vaccination conspiracy theories may not satisfy an unmet need for personal control

Abstract

Rationale: Vaccinations are an important part of a public health strategy against preventable diseases, and uptake is influenced by factors including hesitancy. The belief of vaccine related misinformation including anti-vaccination conspiracy theories has been found to be associated with increased vaccine hesitancy.

Objective: While research suggests that these conspiracy theory beliefs may arise to satisfy unmet needs such as restoring loss of personal control, somewhat ironically these anti-vaccination conspiracy theories may frustrate these needs. This study examined the causal relationships between vaccination hesitancy, vaccination conspiracy theories, and vaccination related powerlessness.

Methods: Using a stationary random intercepts cross lagged panel model, we investigated the temporal ordering of vaccination hesitancy, powerlessness, and vaccination conspiracy theory beliefs in a sample of Australian adults ($N = 500$) in a longitudinal study with 5-timepoints over 4-months between June and October 2021.

Results: Results from a random intercept cross-lagged model, that separates between-person stability from within-person change, suggested that increased belief in vaccination conspiracy theories was associated with future increases in vaccination hesitancy and powerlessness (but not vice versa). Findings also showed that increases in vaccination hesitancy and conspiracy theory beliefs predicted respective increases from a person's trait-level mean at subsequent timepoints.

Conclusions: Vaccination conspiracy theories appear to increase vaccination powerlessness and hesitancy, rather than satisfying an unmet need for personal control.

Keywords: conspiracy beliefs, vaccination hesitancy, powerlessness, random intercept cross-lagged panel model

1. Introduction

Vaccinations are one of the most important scientific contributions to public health, credited with saving millions of lives (Andre et al., 2008). Despite their success, the World Health Organisation (2019) emphasized growing vaccination hesitancy—delayed acceptance or refusal to vaccinate despite the availability of services (Dubé et al., 2014)—as a major threat to global health. More recently, the COVID-19 pandemic highlighted the need to understand and address drivers that influence hesitancy given the impact on uptake of COVID-19 vaccines among the public including adults (Razai et al., 2021). Personal factors such as confidence (e.g., trust in vaccine or provider), complacency (e.g., lack of perceived need), and convenience (e.g., access) shape vaccination hesitancy. Furthermore, social and economic changes as a result of the pandemic have left many individuals feeling uncertain and vulnerable, seeding the fertile ground for the spread and adoption of vaccination related conspiracy theories. In a recent large synthesis of COVID-19 conspiracy belief research, van Mulukom et al. (2022) identified a range of antecedents (e.g., lack of control, uncertainty) and consequences (e.g., protective behaviours, vaccination intention) linked with COVID-19 conspiracy beliefs. Specifically, belief in conspiracy theories during the pandemic were found to prospectively predict decreased intention to receive a COVID-19 vaccination (e.g., Romer and Jamieson, 2020), consistent with previous findings of associations between belief in vaccination conspiracy theories, vaccination hesitancy and vaccination intentions for children (Shapiro et al., 2016).

Research suggests that conspiracy theories are alluring for individuals to satisfy unmet epistemic (i.e., need for accuracy), existential (i.e., need to reduce threat and uncertainty), and social motives (i.e., desire to belong and maintain a positive image of the self and ingroup; Douglas et al., 2017). They are harmful (Douglas, 2021) and may frustrate or increase those unmet needs (Douglas et al., 2017), despite providing some instant

gratification in the short term (c.f. van Prooijen, 2022). Vaccination conspiracy theories suggest that information about adverse vaccine side effects and efficacy are being kept secret from the public by powerful groups like the government or pharmaceutical industry (Kata, 2010). These narratives propose vaccines are ineffective and promoted by authorities with sinister motives. These accounts may be appealing for individuals who feel powerless to meaningfully act on issues that are important to their health. Given individuals may be attracted to vaccination conspiracy theories to satisfy unmet needs, and that these needs may then be thwarted or increased, a question of interest is whether powerlessness is an antecedent or consequence of belief in conspiracy theories.

Compensatory control theory suggests that individuals are motivated to perceive themselves as having control over their lives, and experiences that frustrate or oppose this may lead some to compensate by seeking an epistemic structure to order their environments (Landau et al., 2015). For some the belief in a conspiracy theory that suggests powerful actors are coordinating in secret to hide the harmful side-effects of vaccinations may be desirable to a belief that may be the result of an overestimation or confirmation bias of vaccination dangers and harms (Meppelink et al., 2019). This perceived feeling of a lack of autonomy and an inability to change or control one's own circumstances has been found to be associated with increased belief in conspiracy theories (e.g., Abalakina-Paap et al., 1999) and health-related intentions such as vaccination. For example, one study found that exposure to childhood vaccination conspiracy theory information led parents to report a decreased likelihood to vaccinate a hypothetical child, and this was in part explained by increased feelings of powerlessness (Jolley and Douglas, 2014). Other studies have considered the causal direction in reverse.

A meta-analysis examining the association between experimentally manipulated powerlessness on belief in conspiracy theories (k=45) found there was a small, but

statistically nonsignificant association between the two (Stojanov and Halberstadt, 2020). However, the authors noted that the relationship appeared to be more robust when considered from conspiracy theory belief to powerlessness. Therefore, while some experimental research proposes that powerlessness may be an antecedent, the evidence in support of this is mixed. It is also possible that feelings of powerlessness may be a consequence of belief in conspiracy theories, consistent with the notion that they are self-defeating and harmful (Douglas, 2021; Douglas et al., 2017). While rigorous experimental designs have the advantage of strong internal validity and establishing causality between constructs of interest, they may limit the generalizability beyond an artificial setting and immediate measurement.

Traditional approaches examining the temporal ordering of variables, such as the cross-lagged panel model (CLPM), have been used to investigate reciprocal associations between variables over time. Recent critiques have suggested this approach confounds within-person change with between-person stability (Hamaker et al., 2015) and "give rise to estimates that are difficult (or impossible) to interpret meaningfully" (Berry and Willoughby, 2017, p. 1187). A random intercepts cross-lagged panel model (RI-CLPM; Hamaker et al., 2015) separates between-person stability (i.e., stable trait like differences) from within-person (i.e., time variant state like) changes. A recent study used RI-CLPM to establish the direction of associations between conspiracy mentality and psychological motivations of interest including anxiety and existential threat with 4-timepoints over a shorter (6 week) and longer (1 year) timeframe (Liekefett et al., 2021). Results suggested that conspiracy mentality predicted small significant increases in anxiety and existential threat over a shorter period, and not in the other direction. Another recent study used a RI-CLPM to examine the associations between conspiracy mentality and COVID-19 protective behaviours, finding some evidence for a bi-directional association between these variables over 4-timepoints (Oleksy et al., 2021). Therefore, an advantage of this technique in the present study is the

ability to examine whether within-person changes in vaccination conspiracy theory beliefs are associated with subsequent changes in vaccination powerlessness and hesitancy over time (and vice versa).

In this study we describe the associations between vaccination hesitancy, conspiracy beliefs, and powerlessness over a 4-month period in a sample of adults. Examining the temporal ordering of these variables will provide useful information about the antecedents and consequences of belief in vaccination related conspiracy theories in a naturalistic setting.

2. Methods

2.1 Participants and Procedure

Online data collection was carried out at 5 timepoints approximately 4 weeks apart between June 19 and October 15, 2021, during the second year of the COVID-19 pandemic. This period was marked by the arrival of the Delta variant, various state government lockdowns and restrictions and the vaccination rollout in Australia. Participants were recruited through Prolific Academic (https://prolific.ac), a reliable and popular crowdsourcing platform for behavioural research (Palan and Schitter, 2018). We recruited 500 Australian adults aged 18 and over at Time 1 (M_{age}=33.68, *SD*=12.35, 53% women, 46% men, 1% nonbinary) and invited participants back at each subsequent timepoint. Due to attrition at Time 2, we recruited an additional 70 participants (excluding these participants produces the same pattern of results; see supplementary materials for a breakdown of demographics and attrition across each timepoint). The average time for survey completion was under 7 minutes for the first survey which included demographic questions at the end, with subsequent timepoints averaging 4 minutes. To ensure a minimum hourly rate in line with Prolific guidelines, participants received .74 British pounds (£) for the first timepoint, and between £.38 and £.45 for subsequent timepoints with an additional bonus (£.18) for the final timepoint. Materials described below were presented in a random order at and across

each timepoint. The [redacted] Human Participants Ethics Committee approved all procedures, and participants gave informed consent.

2.2 Materials

Ten items covering general vaccination hesitancy (3 items), trust in vaccines (1 item), and the three C's (6 items; confidence, complacency, and convenience) were used to assess vaccination hesitancy (Quinn et al., 2019). Nine items were reverse scored, and items recoded to a 5-point scale (due to differing scale points before averaging together to form a scale (1=*Low vaccine hesitancy*; 5=*High vaccine hesitancy*). It had excellent reliability across all timepoints (α_{T1}=.90; α_{T2}=.90; α_{T3}=.89; α_{T4}=.90; α_{T5}=.89).

Vaccination conspiracy beliefs scale (Shapiro et al., 2016) included 7 items on a 5-point scale (1=*Strongly Disagree*, 5=*Strongly Agree*). An example item was, "Pharmaceutical companies cover up the dangers of vaccines". The scale has been found to be moderately associated with general conspiracy mentality (Shapiro et al., 2016) and strongly with lack of confidence and risk in vaccination (Shapiro et al., 2018). It had excellent reliability (α_{T1}=.94; α_{T2}=.94; α_{T3}=.94; α_{T4}=.94; α_{T5}=.95).

A five item scale measuring a person's feelings of powerlessness, specifically concerning vaccination was developed from previous research (Abalakina-Paap et al., 1999; Jolley and Douglas, 2014). Participants responded on a 6-point scale (1=*Strongly Disagree*, 6=*Strongly Agree*). An example item was, "When it comes to vaccinations, I feel powerless". Items have been found to be positively associated with anti-vaccination conspiracy beliefs and negatively with future vaccination intentions (Jolley and Douglas, 2014). The scale had excellent reliability (α_{T1}=.88; α_{T2}=.89; α_{T3}=.89; α_{T4}=.90; α_{T5}=.90).

See supplementary materials for complete measures including demographic items. Evidence that the items from each scale load onto separate factors at each timepoint is

available in the supplementary materials. We do not report on two additional measures (right wing authoritarianism and intellectual humility) included as part of related group projects.

2.3 Analytic strategy

To investigate our aims, we used a RI-CLPM (see Figure 1) to examine prospective relationships between vaccination hesitancy, conspiracy beliefs, and powerlessness across five adjacent timepoints using Mplus version 8.0 (Muthén and Muthén, 2017). Model fit was assessed using comparative fit index (*CFI*), root mean square error of approximation (*RMSEA*), and standardised root mean square residual (*SRMR*). Fit indices values of $CFI > .90$, $RMSEA \leq .06$, and $SRMR \leq .08$, are considered a good fit with the data (Hu and Bentler, 1999). We constrained the auto-regressive (congeneric) and cross-lagged associations between variables because we were more interested in the overall and comparative effects of vaccination hesitancy, conspiracy theory beliefs, and powerlessness on each other, rather than whether these effects changed during the interval measured. We used a threshold of $p < .05$ to indicate significance of findings, and describe the magnitude of effects using Cohen's *d* (Cohen, 1992).

The model was run with a Maximum Likelihood Robust estimator which adjusted the standard errors and Chi-square statistic for non-normality (Yuan and Bentler, 2000). Missing data were handled using Full information maximum likelihood (FIML). Given the inevitability of missing data in longitudinal research, this approach has several strengths. Firstly, FIML neither imputes missing values nor requires data to be missing completely at random (Enders, 2001). Secondly, FIML is an efficient way to utilize all available data without discarding responses, as would be the case in list-wise or case-wise deletion, and outperforms both of these methods in producing unbiased and efficient parameter estimates while managing Type 1 errors (Enders and Bandalos, 2001). We also estimated bias-

corrected (BC) 95% Confidence Intervals (CIs) using 1,000 bootstrapped resamples (with replacement).

Materials, data, and syntax for all analyses can be accessed here https://osf.io/4uw96/?view_only=cb81fe8596064c1682dc556a38cec106

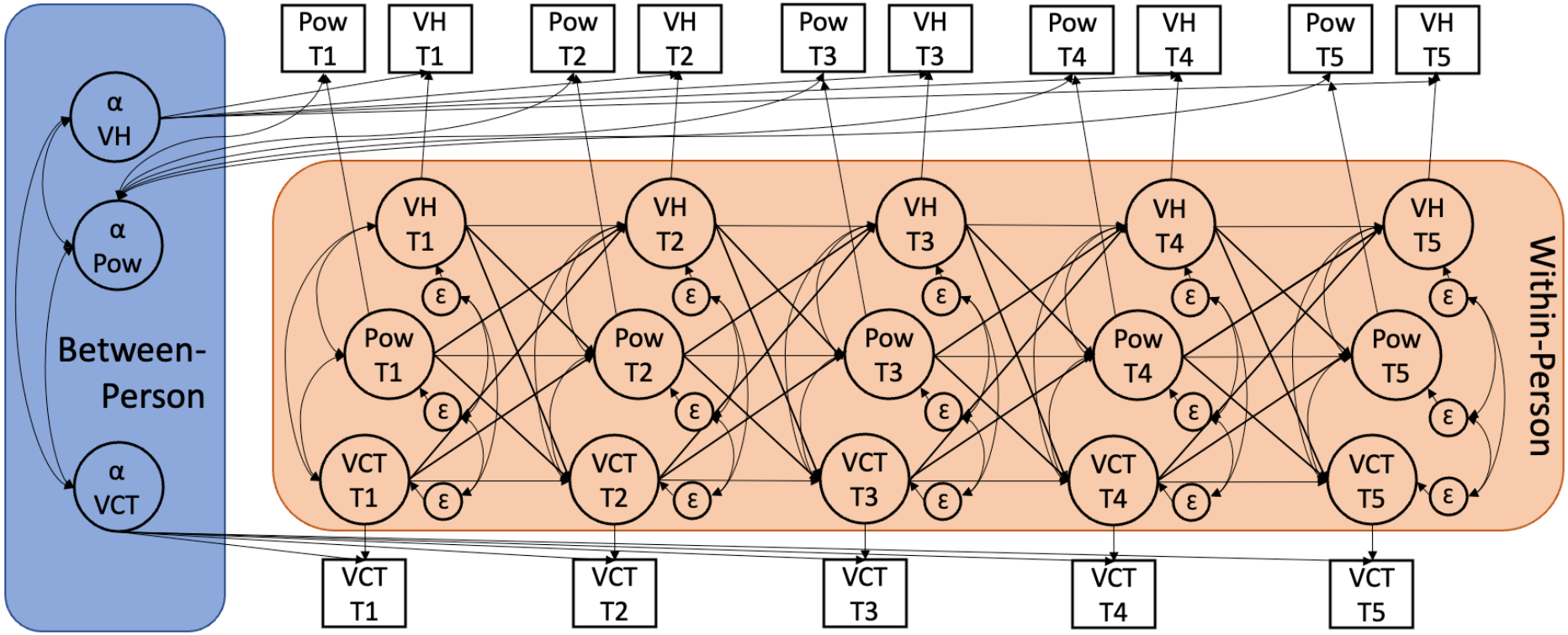

Figure 1. Conceptual random intercepts cross-lagged panel model of the associations between vaccination hesitancy, powerlessness and vaccination conspiracy theory beliefs.

2.4 Sample size power calculation

A sensitivity analysis by way of a Monte Carlo simulation with 1,000 replications to determined the power for α=.05 with a sample size of *N*=500. Using this method, many samples are drawn from a hypothesized population model and power is assessed by examining the percentages of replications for which the null hypothesis is rejected for non-zero parameters. Plausible population values for residual variances of observed variables (.51), variances (1.00) and covariances (.40) of random intercepts, and covariances between residuals of within-person components (.10) were entered based on a similar RI-CLPM (Liekefett et al., 2021). Results indicated that power for a medium-sized cross lagged association (.30) was sufficient (.86–.95). Consistent with suggested criteria for assessing the suitability of the analysis (Muthén and Muthén, 2002), bias in parameter estimates (–.08–.07) and standard errors (-.06–.05) did not exceed .10. This provided support that our sample size was appropriate.

3. Results

3.1 Attrition analysis

We conducted a Poisson regression using the Time 1 measures vaccination conspiracy theory belief, vaccination hesitancy, powerlessness, as well as demographic variables age, gender, education (no/university), and location (urban/rural) to predict the number of subsequent timepoints participants responded to. These analyses revealed that belief in vaccination conspiracy theories (*B*=.011, *p*=.809; CI_{95}=-.077,.099), vaccination hesitancy (*B*=.021, *p*=.611; CI_{95}=--.059,.100), powerlessness (*B*=.036, *p*=.194; CI_{95}=-.018,.089), age (*B*=.001, *p*=.815; CI_{95}=-.005,.006), gender (*B*=-.063, *p*=.254; CI_{95}=-.172,.046), education (*B*=-.004, *p*=.945; CI_{95}=-.120,.112), and location (*B*=.109, *p*=.279; CI_{95}=-.089,.307) were not associated with number of subsequent timepoints completed.

3.2 Descriptive characteristics

Descriptive statistics and correlations between variables across all five time points are presented in Table 1. The average stability over time for belief in vaccination conspiracy theories ($\bar{r}$=.86, p<.001), vaccination hesitancy ($\bar{r}$=.86 p<.001), and powerlessness ($\bar{r}$=.67, p<.001) were high. Furthermore, calculated intraclass correlation coefficients (see supplementary materials) indicated that between 62% and 83% of the variance in these variables was explained by stable between-person differences, whereas between 17-38% were due to within-person fluctuations over time. On average the sample was below the mid-point on vaccination conspiracy beliefs and powerlessness and reported low levels of vaccination hesitancy.

Table 1. Summary of zero-order correlations, Means, and Standard Deviations for Random-Intercepts Cross Lagged Panel Model of Vaccination Conspiracy Theory Belief, Vaccination Hesitancy, and Powerlessness.

	M	*(SD)*	*N*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. VCT T1	1.905	(.846)	500	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. VCT T2	1.897	(.858)	501	.833	1	-	-	-	-	-	-	-	-	-	-	-	-
3. VCT T3	1.839	(.824)	477	.818	.855	1	-	-	-	-	-	-	-	-	-	-	-
4. VCT T4	1.822	(.820)	437	.809	.841	.867	1	-	-	-	-	-	-	-	-	-	-
5. VCT T5	1.814	(.826)	420	.790	.821	.834	.884	1	-	-	-	-	-	-	-	-	-
6. VH T1	1.619	(.744)	500	.722	.697	.672	.671	.662	1	-	-	-	-	-	-	-	-
7. VH T2	1.588	(.733)	500	.678	.727	.683	.707	.672	.852	1	-	-	-	-	-	-	-
8. VH T3	1.532	(.668)	477	.651	.689	.708	.708	.672	.821	.859	1	-	-	-	-	-	-
9. VH T4	1.477	(.677)	437	.622	.646	.682	.723	.671	.788	.822	.867	1	-	-	-	-	-
10. VH T5	1.462	(.657)	420	.647	.650	.679	.707	.712	.785	.825	.846	.859	1	-	-	-	-
11. Pow T1	2.673	(1.123)	500	.520	.453	.500	.472	.465	.432	.404	.421	.431	.424	1	-	-	-
12. Pow T2	2.700	(1.195)	501	.502	.58	.544	.513	.515	.443	.454	.427	.396	.407	.573	1	-	-
13. Pow T3	2.624	(1.145)	477	.456	.524	.536	.490	.494	.394	.430	.449	.401	.417	.536	.665	1	-
14. Pow T4	2.656	(1.229)	437	.469	.550	.573	.561	.533	.454	.485	.486	.480	.488	.528	.666	.681	1
15. Pow T5	2.618	(1.196)	421	.487	.511	.543	.562	.572	.439	.466	.479	.473	.506	.511	.671	.682	.736

Notes. All correlations are significant at $p < .001$.
VCT=Vaccination Conspiracy Theory Belief (1=*Strongly Disagree*, 5=*Strongly Agree*). VH=Vaccination Hesitancy (1=*Low vaccine hesitancy*; 5=*High vaccine hesitancy*). Pow=Powerlessness (1=*Strongly Disagree*, 6=*Strongly Agree)*.

3.3 Temporal ordering of vaccination conspiracy theory belief, vaccination hesitancy, and powerlessness

The RI-CLPM of belief in vaccination conspiracy theories (T-1), vaccination hesitancy (T-1), and vaccination powerlessness (T-1) to conspiracy theory belief (T), vaccination hesitancy (T), and vaccination powerlessness (T) is presented in Figure 2. The model was an excellent fit with the data, $\chi^2(75)=131.208$, $p<.001$, *CFI*=.992, *SRMR*=.043, *RMSEA*=.036(CI_{90}=.026,.046). The between-person components showed small to moderate associations, suggesting that on average, those who reported higher levels of vaccination conspiracy theories reported higher vaccination hesitancy (*B*=0.382, BC_{95}=[0.323,0.457], $p<.001$) and higher powerlessness (*B*=0.491, BC_{95}=[0.406,0.575], $p<.001$). Higher vaccination powerlessness was associated with higher vaccination hesitancy (*B*=0.353, BC_{95}=[0.291,0.424], $p<.001$). Within-person deviations from these trait-level means (i.e., autoregressive associations) significantly correlated positively over time for vaccination conspiracy theory belief (*B*=0.191, BC_{95}=[0.099,0.281], $p<.001$) and vaccination hesitancy (*B*=0.197, BC_{95}=[0.097,0.313], $p<.001$), but not powerlessness (*B*=0.094, BC_{95}=[-0.009,0.202], $p=.069$). This indicated that increases in belief in vaccination conspiracy theories and vaccination hesitancy, but not powerlessness, predicted even further increases from a person's trait-level mean in each respective measure at the next timepoint.

Of relevance to the aims were the associations that model the within-person dynamics between belief in vaccination conspiracy theories, vaccination hesitancy, and powerlessness. The within-person cross-lagged effect of vaccination conspiracy theory belief on vaccination hesitancy (*B*=0.070, BC_{95}=[0.000,-0.131], $p=.035$) and vaccination powerlessness (*B*=0.220, BC_{95}=[0.051,0.389], $p=.009$) were small and significant. The cross-lagged effects of vaccination hesitancy on belief in vaccination conspiracy theories (*B*=0.078, BC_{95}=[-0.017,0.167], $p=.104$) and powerlessness were nonsignificant (*B*=0.072, BC_{95}=[-

0.124,0.274], p=.484). Finally, the cross-lagged effect of vaccination powerlessness on vaccination conspiracy theory belief (B=-0.017, BC_{95}=[-0.042,0.012], p=.403) and vaccination hesitancy (B=-0.015, BC_{95}=[-0.050,0.020], p=.225) were nonsignificant. This provides some evidence to suggest that belief in vaccination conspiracy theories lead to vaccination hesitancy and vaccine related powerlessness over a short period of time (i.e., 1 month), and it was not feelings of powerlessness or vaccination hesitancy that precede belief in conspiracy theories.

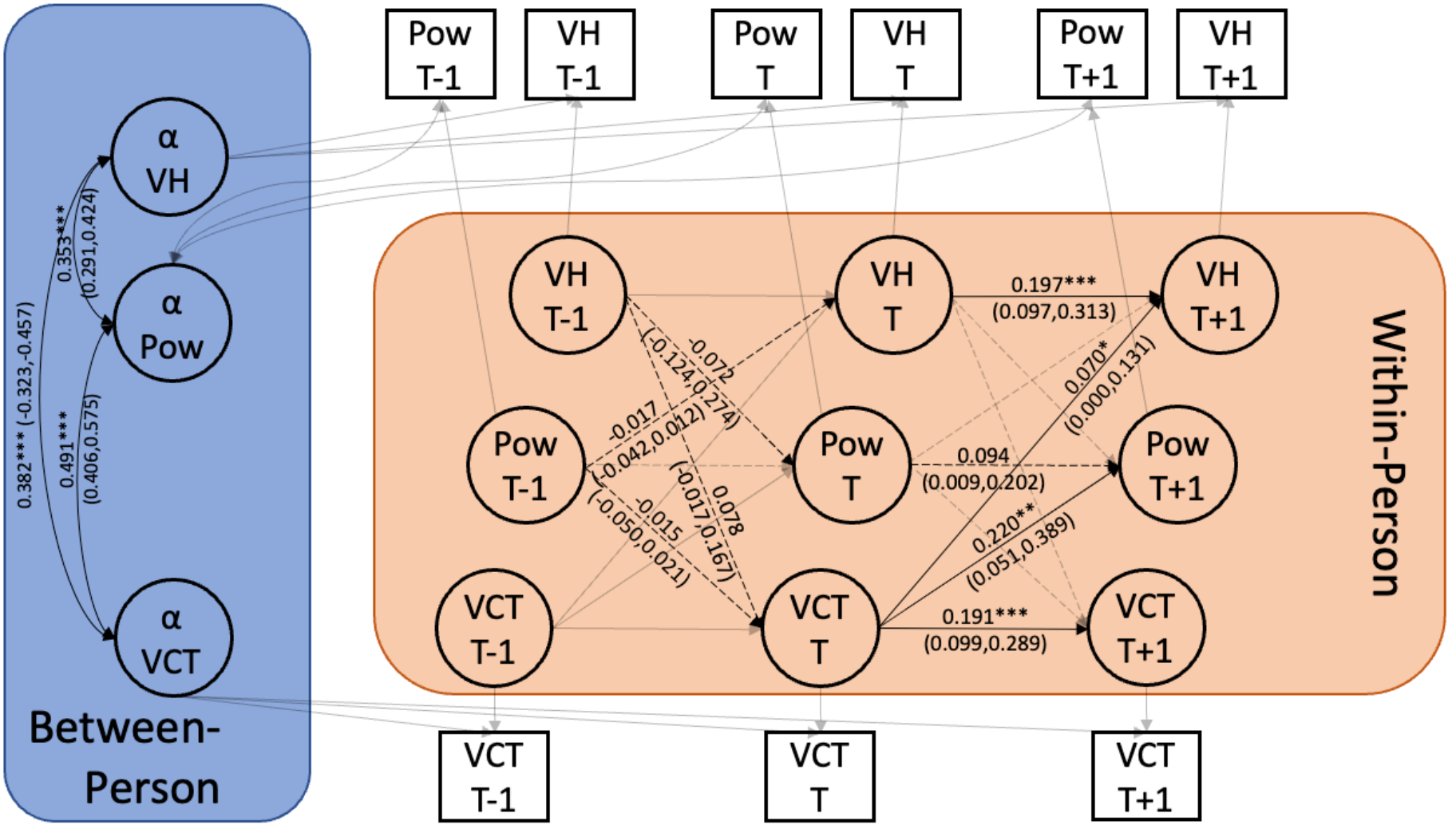

Figure 2. Random intercepts cross-lagged panel model of the associations between vaccination hesitancy (VH), powerlessness (Pow) and vaccination conspiracy theory belief (VCT). Coefficients are unstandardized (with bias corrected 95% confidence intervals). For clarity, the cross-lagged effects of vaccination hesitancy and powerlessness are displayed on the left-hand side only, with the cross-lagged effects of vaccination conspiracy theory belief displayed on the right-hand side. Dashed lines reflect nonsignificant paths. *p<.05, **p<.01, ***p<.001.

4. Discussion

The aim of this study was to determine the temporal ordering of vaccination conspiracy theory beliefs, powerlessness, and hesitancy in a prospective sample of adults over a 4-month period using a RI-CLPM. The findings suggest that higher levels of belief in vaccination conspiracy theories precede increases in vaccination hesitancy and powerlessness, and not the other way around.

Research has suggested that conspiracy theories may be appealing to some individuals to restore order and control following feelings of powerlessness (Douglas et al., 2017). While belief in vaccination conspiracy theories increase vaccination hesitancy and reinforce a negative state of feeling powerlessness in vaccination related decisions, there was no evidence that these feelings were the cause of either vaccination hesitancy or conspiracy theory belief (Stojanov and Halberstadt, 2020). There was also evidence that increases in conspiracy theory beliefs predicted even further increases in these beliefs one month later (Liekefett et al., 2021). This pattern was also found for vaccination hesitancy, but not for powerlessness. Taken together this suggests that vaccination hesitancy and conspiracy beliefs lead to increases beyond an individual's trait level at the next time point, while feelings of vaccination related powerlessness do not. Findings also suggest that increases in vaccination conspiracy theory beliefs result in future increases in feelings of vaccination powerlessness and hesitancy.

There are several implications of these study findings. First, the psychological experience of powerlessness appears to be a consequence of changes in belief in vaccination conspiracy theories, and not a cause. Second, vaccination conspiracy theory beliefs are a driver of increases in these beliefs over time as well as generalized vaccination hesitancy (Razai et al., 2021). In our study it is unclear what is driving the changes in conspiracy theory belief, aside from the congeneric increases over time. However, the small increases in

generalized vaccination hesitancy were a result of changes in belief in conspiracy theories from approximately 4-weeks prior. The present research finds support for the harmful consequences of beliefs in vaccination conspiracy theories (Oleksy et al., 2021; Romer and Jamieson, 2020) on generalized vaccination hesitancy using an adult sample, consistent with previous experimental research relating to childhood vaccination (Jolley and Douglas, 2014).

A strength of our RI-CLPM analysis in separating between and within person variance, suggesting that there was a substantial amount of within-person change over time. Separating out the trait-like stability from the time-variant changes reduced the risk of confounding estimated parameters by the relationship at the between-person level found in traditional CLPMs. This approach also allowed for the examination of the temporal ordering of our variables of interest in a naturalistic setting over time, moving beyond important but artificial snapshot experimental studies.

4.1 Limitations

Despite these strengths, as with any single study there are some limitations. We operationalized vaccination hesitancy using a general measure that assessed trust, and the 3 C's of vaccination hesitancy (Quinn et al., 2019) rather than a measure of hesitancy towards a specific vaccination (e.g., COVID-19). Other frameworks explaining vaccination uptake also consider behavioural and social drivers of vaccination by considering thoughts and feelings (e.g., perceived disease risk, vaccine confidence) as well as social processes (e.g., social norms) that influence hesitancy or motivation (Brewer et al., 2017). Finally, we measured change in the variables 4-weeks apart over 4-months during the second year of the COVID-19 pandemic in Australia throughout marked social and economic upheaval. These specific conditions may have affected the stability or change in feelings of powerlessness, vaccination hesitancy and belief in conspiracy theories. These factors may limit the generalizability of

these findings and future studies may wish to replicate our findings to other populations, and to other specific adult vaccinations.

4.2 Conclusions

This research provides important new evidence for the antecedents and consequences of belief in vaccination conspiracy theories. Not only does it appear that vaccination hesitancy and belief in conspiracy theories reinforce themselves over time, but feelings of powerlessness and hesitancy are heightened following increased belief in vaccination conspiracy theories. This appears to suggest that belief in vaccination conspiracy theories are pernicious and increase, rather than satisfy, specific unmet needs that make them alluring for some individuals.

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Supplementary Materials

Table S1
Sample, Response Rate, and Retention Information for Five Timepoints of Data Collection During 2021.

	T1 (18-19 June)	T2 (16-20 July)	T3 (13-20 August)	T4 (10-17 September)	T5 (8-15 October)
Sample	500	506	478	437	421
Booster Samples	–	70	–	–	–
Retention T-1	–	436	385	315	389
Retention Rate T-1	–	87.2%	76.09	65.90%	89.02%

Table S2.
Demographic Characteristics Across Each Timepoint.

	T1 (n = 500)	T2 (n = 506)	T3 (n = 478)	T4 (n = 437)	T5 (n = 421)
	Percentage	Percentage	Percentage	Percentage	Percentage
Gender					
Female	53.20	51.98	52.93	5.57	53.92
Male	45.40	46.25	45.61	47.83	44.42
Nonbinary	1.40	1.78	1.46	1.60	1.66
Education					
High school not completed	2.20	1.79	1.89	1.83	2.14
High school graduate, or the equivalent	24.20	22.66	22.22	2.14	2.43
Advanced Diploma	6.20	6.56	7.34	7.32	6.41
Bachelors degree, Graduate Diploma and Certificate	37.40	37.97	38.78	39.36	4.62
Postgraduate Diploma and Certificate, Bachelor Honours Degree	11.40	11.53	12.16	12.36	11.88
Masters degree	13.00	13.92	12.37	13.50	13.30
Doctorate degree	5.00	4.97	4.82	5.03	4.51
Other	.60	.60	.42	.46	.71
Location					
Metropolitan / Urban	87.60	88.07	89.10	88.56	88.84
Rural	12.20	11.53	1.48	11.21	1.93
Remote	.20	.40	.42	.23	.24
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Age	33.68 (12.35)	34.35 (12.18)	34.44 (12.23)	34.80 (12.25)	35.23 (12.46)
Importance of religion/spirituality	2.82 (1.99)	2.87 (1.99)	2.86 (2.20)	2.88 (2.02)	2.88 (2.01)
Political Ideology					
Economic	4.79 (1.30)	4.78 (1.27)	4.81 (1.27)	4.77 (1.27)	4.76 (1.29)
Social	5.19 (1.27)	5.18 (1.25)	5.18 (1.25)	5.15 (1.24)	5.14 (1.26)

Note. Demographics were only assessed at the first timepoint (T1 or T2 booster). All percentages reported are valid percentages. Range for age is 18–81years. Range for importance of religion/ spirituality is 1 = Not at all to 7 = Extremely. Political ideology is 1 = Extremely Conservative, 2 = Very Conservative, 3 = Somewhat Conservative, 4 = Neither Conservative nor Progressive, 5 = Somewhat Progressive, 6 = Very Progressive, 7 = Extremely Progressive.

Intraclass correlations and Exploratory Factor Analyses calculated in R (R Core Team, 2021) using the psych (Revelle, 2021) and GPARotation packages (Bernaards and Jennrich, 2005).

Table S3

Intraclass correlation coefficients for Vaccination Conspiracy Theories, Vaccination Hesitancy, and Vaccination Powerlessness.

	ICC	F (*df*)	*p*
Vaccination Conspiracy Theories	.83	9.3 (569,2280)	<.001
Vaccination Hesitancy	.83	26.0 (569,2280)	<.001
Vaccination Powerlessness	.62	10 (569,2280)	<.001

Notes. Number of subjects = 57. Single-raters (absolute).

Table S4a

Exploratory Factor Analysis of Vaccination Hesitancy, Vaccination Conspiracy Beliefs, and Vaccination Powerlessness at Time 1

	Factor 1	Factor 2	Factor 3
VC1T1	**.778**	-.060	.042
VC2T1	**.608**	-.184	.045
VC3T1	**.803**	-.007	.020
VC4T1	**.850**	-.005	-.007
VC5T1	**.862**	-.027	.049
VC6T1	**.956**	.082	-.043
VC7T1	**.648**	-.130	.059
VH1T1	-.049	**.571**	-.030
VH2T1	-.025	**.666**	-.144
VH3T1	.063	**.775**	-.015
VH4T1	-.246	**.652**	.005
VH5T1	.050	**.857**	.049
VH6T1	-.029	**.807**	.041
VH7T1	-.218	**.594**	-.066
VH8T1	-.182	**.529**	-.080
VH9T1	.095	**.604**	-.041
VH10T1	.096	**.543**	.005
POW1T1	-.022	.034	**.616**
POW2T1	.065	.090	**.616**
POW3T1	-.006	-.002	**.913**
POW4T1	-.046	-.004	**.919**
POW5T1	.065	-.038	**.834**
SS loadings	4.600	4.545	3.182
Proportion of Variance	.209	.207	.145

Notes. N=5. VC=Vaccination Conspiracy Belief. VH=Vaccination Hesitancy. POW=Vaccination Powerlessness. Principal Axis Factor extraction method with Oblimin rotation. Optimal solution of 3 factors deemed sufficient from Parallel Analysis. **Bolded** values > .3.

Table S4b

Exploratory Factor Analysis of Vaccination Hesitancy, Vaccination Conspiracy Beliefs, and Vaccination Powerlessness at Time 2

	Factor 1	Factor 2	Factor 3
VC1T2	**.946**	.068	-.043
VC2T2	**.646**	-.197	-.015
VC3T2	**.738**	-.095	.068
VC4T2	**.778**	-.029	.070
VC5T2	**.929**	-.004	-.018
VC6T2	**.852**	.014	.072
VC7T2	**.682**	-.096	-.021
VH1T2	-.006	**.673**	-.011
VH2T2	-.144	**.552**	-.098
VH3T2	-.095	**.624**	-.084
VH4T2	-.196	**.649**	-.071
VH5T2	.016	**.796**	.044
VH6T2	.037	**.868**	.058
VH7T2	-.114	**.666**	-.084
VH8T2	-.072	**.654**	-.007
VH9T2	.177	**.682**	-.041
VH10T2	.033	**.494**	.052
POW1T2	.107	.031	**.590**
POW2T2	.065	-.059	**.605**
POW3T2	-.068	-.024	**.957**
POW4T2	-.017	.029	**.945**
POW5T2	.105	-.013	**.769**
SS loadings	4.679	4.604	3.171
Proportion of Variance	.212	.209	.144

Notes. N=503. VC=Vaccination Conspiracy Belief. VH=Vaccination Hesitancy. POW=Vaccination Powerlessness. Principal Axis Factor extraction method with Oblimin rotation. Optimal solution of 3 factors deemed sufficient from Parallel Analysis. **Bolded** values > .3.

Table S4c

Exploratory Factor Analysis of Vaccination Hesitancy, Vaccination Conspiracy Beliefs, and Vaccination Powerlessness at Time 3

	Factor 1	Factor 2	Factor 3
VC1T3	**.812**	-.037	.032
VC2T3	**.579**	-.217	.019
VC3T3	**.817**	-.003	.019
VC4T3	**.856**	.011	.020
VC5T3	**.923**	.006	-.019
VC6T3	**.901**	.042	.011
VC7T3	**.606**	-.135	.022
VH1T3	-.045	**.572**	.012
VH2T3	-.089	**.600**	-.131
VH3T3	-.089	**.572**	-.037
VH4T3	-.298	**.562**	-.009
VH5T3	.026	**.844**	.024
VH6T3	.065	**.840**	.010
VH7T3	-.252	**.539**	-.042
VH8T3	-.092	**.630**	-.040
VH9T3	.134	**.614**	-.036
VH10T3	.080	**.503**	.014
POW1T3	.133	.005	**.553**
POW2T3	.039	-.052	**.520**
POW3T3	-.039	-.018	**.956**
POW4T3	-.034	.014	**.955**
POW5T3	.059	.011	**.860**
SS loadings	4.660	4.138	3.169
Proportion of Variance	.212	.188	.144

Notes. N=478. VC=Vaccination Conspiracy Belief. VH=Vaccination Hesitancy. POW=Vaccination Powerlessness. Principal Axis Factor extraction method with Oblimin rotation. Optimal solution of 3 factors deemed sufficient from Parallel Analysis. **Bolded** values > .3.

Table S4d

Exploratory Factor Analysis of Vaccination Hesitancy, Vaccination Conspiracy Beliefs, and Vaccination Powerlessness at Time 4

	Factor 1	Factor 2	Factor 3
VC1T4	**.850**	.008	.035
VC2T4	**.619**	-.259	-.011
VC3T4	**.791**	-.081	.012
VC4T4	**.823**	-.001	.022
VC5T4	**.917**	.031	.019
VC6T4	**.896**	.063	.031
VC7T4	**.624**	-.160	-.061
VH1T4	-.067	**.539**	-.018
VH2T4	-.154	**.486**	-.159
VH3T4	-.111	**.549**	-.141
VH4T4	**-.361**	**.435**	-.111
VH5T4	-.036	**.794**	.048
VH6T4	-.030	**.772**	.054
VH7T4	**-.310**	**.467**	-.096
VH8T4	-.190	**.565**	-.045
VH9T4	.139	**.705**	-.115
VH10T4	.130	**.618**	.009
POW1T4	.010	-.024	**.578**
POW2T4	.153	.097	**.632**
POW3T4	-.065	-.035	**.960**
POW4T4	-.019	.013	**.941**
POW5T4	.082	-.018	**.832**
SS loadings	4.818	3.778	3.325
Proportion of Variance	.219	.172	.151

Notes. N=437. VC=Vaccination Conspiracy Belief. VH=Vaccination Hesitancy. POW=Vaccination Powerlessness. Principal Axis Factor extraction method with Oblimin rotation. Optimal solution of 3 factors deemed sufficient from Parallel Analysis. **Bolded** values > .3.

Table S4e

Exploratory Factor Analysis of Vaccination Hesitancy, Vaccination Conspiracy Beliefs, and Vaccination Powerlessness at Time 5

	Factor 1	Factor 2	Factor 3
VC1T5	**.770**	-.036	.112
VC2T5	**.748**	-.106	-.052
VC3T5	**.811**	-.057	.039
VC4T5	**.813**	-.023	.038
VC5T5	**.968**	.042	-.014
VC6T5	**.893**	.064	.034
VC7T5	**.757**	-.088	-.075
VH1T5	-.092	**.529**	.029
VH2T5	-.124	**.435**	-.170
VH3T5	-.134	**.594**	-.050
VH4T5	-.222	**.514**	-.197
VH5T5	-.058	**.785**	.062
VH6T5	-.013	**.829**	.028
VH7T5	**-.338**	**.421**	-.109
VH8T5	-.096	**.680**	-.054
VH9T5	.211	**.687**	-.064
VH10T5	.136	**.601**	-.007
POW1T5	-.041	-.046	**.644**
POW2T5	.025	-.016	**.632**
POW3T5	-.010	-.002	**.943**
POW4T5	-.019	.006	**.950**
POW5T5	.068	.010	**.839**
SS loadings	5.068	3.897	3.429
Proportion of Variance	.230	.177	.156

Notes. N=42. VC=Vaccination Conspiracy Belief. VH=Vaccination Hesitancy. POW=Vaccination Powerlessness. Principal Axis Factor extraction method with Oblimin rotation. Optimal solution of 3 factors deemed sufficient from Parallel Analysis. **Bolded** values > .3.

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