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Does temporal stability moderate reasoned action approach relations with Covid-19 preventive behaviours?

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Abstract

Background. Preventive behaviours continue to play an important role in reducing the spread of the SARS-CoV-2 virus. *Purpose*. To apply the reasoned action approach (RAA) to predict Covid-19 preventive intentions and behaviour and to test whether temporal stability moderates relations between RAA constructs and behaviour. *Methods*. A representative sample of UK adults ($N = 603$) completed measures of RAA variables (i.e., experiential attitudes, instrumental attitudes, injunctive norms, capacity, autonomy and intention) in relation to six Covid-19 preventive behaviours (i.e., wearing face coverings, social distancing, hand sanitising, avoiding the three Cs, cleaning surfaces, and coughing/sneezing etiquette) at baseline (December 2020) and after one month. Self-reported behaviour was assessed at baseline and after one and two months. *Results*. The RAA was predictive of Covid-19 preventive intentions at time 1 and time 2; instrumental attitudes, descriptive norms and capability were the strongest predictors at each time point. The RAA also predicted subsequent behaviour across time points with intention, descriptive norms and capability the strongest/most consistent predictors. Temporal stability moderated a number of RAA-behaviour relationships including those for intention, descriptive norms and capability. In each case, the relationships became stronger as temporal stability increased. *Conclusions*. Health cognitions as outlined in the RAA provide appropriate targets for interventions to promote Covid-19 preventive intentions and behaviour. Moreover, given that continued performance of Covid-19 preventive behaviours is crucial for reducing transmission of the SARS-CoV-2 virus, the results highlight the need for consistent messaging from governments and public health organisations to promote positive intentions and maintain preventive behaviour.

Key words. Reasoned Action Approach; Intention Stability; Coronavirus; Protection

Does temporal stability moderate reasoned action approach relations with Covid-19 preventive behaviours?

In March 2020 the World Health Organization (WHO) declared Covid-19 to be a global pandemic. To date (1 December 2021), there have been over 260 million confirmed cases of Covid-19 worldwide and over 5 million deaths related to Covid-19 [1]. In an attempt to reduce to spread of the SARS-CoV-2 virus that causes Covid-19, governments across the world instigated local and national lockdowns and advised individuals to adopt a range of preventive behaviours including social distancing, mask wearing, and frequent hand washing [2,3]. With or without the successful rollout of Covid-19 vaccination programmes, these behaviours will continue to play an important role in reducing the spread of the virus and the emergence of new more contagious variants, as evidenced by continuing high numbers of cases in countries, such as the UK, despite high vaccination rates [4]. However, rates of adherence to different Covid-19 preventive behaviours, such as social distancing and the wearing of face coverings, have been found to vary [5]. They have also declined over time [6,7].

Identifying the key modifiable psychological determinants of Covid-19 preventive behaviours is crucial for the development of effective interventions to increase their performance [8]. A growing number of studies have sought to apply social cognition models to explain various Covid-19 preventive behaviours. One such model is the reasoned action approach (RAA) [9], which is an extended version of the theory of planned behaviour (TPB) [10]. According to the RAA, the proximal determinant of behaviour is an individual's intention to perform the behaviour. Intention, in turn, is determined by six independent constructs: experiential (i.e., affective) attitudes (e.g., the belief that engaging in the behaviour would be pleasant), instrumental (i.e., cognitive) attitudes (e.g., the belief that engaging in the behaviour would be beneficial), injunctive norms (i.e., the belief that others would approve of the individual engaging in the behaviour), descriptive norms (i.e., the belief that others engage

in the behaviour), capability (i.e., one's confidence to engage in the behaviour) and autonomy (i.e., perceived control over whether or not to engage in the behaviour). The RAA is proposed to mediate the influence of more distal factors, such as demographics and previous experiences, on intentions and behaviour. A meta-analysis estimated that, on average, the RAA explains 59% and 31% of the variance in health-related intentions and behaviour, respectively [11], thereby indicating that it provides a strong theoretical framework for identifying the proximal, modifiable determinants of behaviour.

A growing number of studies have applied the TPB/RAA to explain Covid-19 preventive intentions and behaviours either at a general level [e.g., 12-17] or for a number of individual behaviours [e.g., 18-20] including physical/social distancing [e.g., 21-25] and the wearing of face coverings [e.g., 26-27]. However, with few exceptions [e.g., 17,19,20] the vast majority of research to date has applied the earlier TPB rather than the RAA. In addition, only a few studies [e.g., 17,20,28-31] have used prospective as opposed to cross-sectional designs. For example, Trifiletti et al. [31] applied the TPB to explain hand washing and social distancing over a one-week period, finding that attitude, subjective norm, and perceived behavioural control were significant predictors of intentions for both behaviours which, in turn, predicted behaviour. Schüz et al. [17] assessed the RAA in relation to eight preventive behaviours. Using within-persons analyses, all of the RAA constructs (with the exception of autonomy) were found to be significant predictors of intention and, in turn, intention predicted behaviour at one-week follow-up.

The above studies confirm the ability of the TPB/RAA to predict Covid-19 preventive intentions and subsequent behaviour. However, to be effective in reducing the transmission of the SARS-CoV-2 virus, it is important that these behaviours continue to be performed over time. To date, few studies have tested relationships between the TPB/RAA and Covid-19 preventive intentions and behaviours over multiple time points [19,30]. This is particularly

relevant to understanding behavioural reactions to the coronavirus pandemic given that it is a constantly evolving public health issue in terms of infection rates, restrictions and behavioural advice. According to Ajzen [32] (p.1115), "as time passes, an increasing number of intervening events can change people's behavioural, normative or control beliefs, modify attitudes, subjective norms or perceptions of control, thus generating revised intentions." However, "changes of this kind will tend to reduce the predictive validity of intentions that were assessed before the changes took place". Therefore, in order to accurately predict behaviour, intentions "must remain reasonably stable over time until the behaviour is performed" [33] (p.389). Thus, temporal stability is hypothesised to moderate the intention-behaviour relationship, such that it should become stronger as the temporal stability of people's intentions increases.

Temporal stability has been found to be a consistent moderator of intention-behaviour relationships across various health behaviours including physical activity [34], healthy eating [35], condom use [36], smoking initiation [37] and attendance at health screening [38]. To date, only one study has tested whether the temporal stability moderates the intention-behaviour relationship for Covid-19 preventive behaviours. Gibson et al. [28] reported that the temporal stability of intentions moderated the relationship between social distancing intentions and behaviour such intentions that remained stable between baseline and follow-up were more predictive of social distancing behaviour at follow-up. However, as noted by Gibson et al., a methodological weakness of this study is that one of the measures used to calculate intention stability (i.e., intention at time 2) was assessed at the same time point as the follow-up measure of behaviour (i.e., also at time 2); therefore, the measure of intention stability was confounded with behaviour. This might lead to consistency biases, especially given that both are self-report measures. Measuring behaviour at a later time point to the intention measures would help to overcome this issue. A stronger design of this moderation

hypothesis would include three waves of data collection in which the temporal stability is assessed between time 1 and time 2 and then tested as a moderator of relations between intention assessed at time 2 (or time 1) and behaviour assessed at time 3.

Although intention is proposed to be the most proximal determinant of health behaviour in the RAA, a number of studies have found that other RAA variables also have direct effects on behaviour over and above the influence of intention. For example, direct effects for experiential attitudes, descriptive norms and capability have been reported in a meta-analytic regression analysis across various health behaviours [11]. Similarly, direct effects have been found for experiential attitudes, descriptive norms, capability and autonomy across eight Covid-19 preventive behaviours [17]. Given these direct effects, it is possible that temporal stability will also moderate relations between other RAA variables and behaviour. Consistent with this idea, recent research has reported that temporal stability moderates relationships between both experiential and instrumental attitudes and various health behaviours [39,40]. Similarly, Cooke and Sheeran [41] reported that, across five studies, stable control perceptions had a significantly stronger average correlation with behaviour than did more unstable control perceptions.

The Present Study

The present study assessed the ability of the RAA to predict Covid-19 preventive intentions and behaviour in a three-wave study. RAA variables were assessed at baseline (time 1) and one month later (time 2) and behaviour was assessed at baseline plus one and two months later (time 3). The study tested whether the RAA predicts Covid-19 preventive intentions and subsequent behaviour at each time point across a set of six Covid-19 preventive behaviours. The study also assessed whether temporal stability moderates RAA-behaviour relations, including the intention-behaviour relationship. In particular, it was hypothesized that stable RAA cognitions would be more predictive of subsequent Covid-19

preventive behaviour. These relationships and moderation effects were assessed using within-persons analyses based on hierarchical linear modeling which accounts for the likely clustering of behaviours within individuals [e.g., 5]. Compared to more commonly used between-persons analyses, which essentially examine rank congruence for each behaviour (e.g., whether those with highest levels of each RAA cognition are also those with the highest levels of the corresponding behaviour), within-persons analyses control for the fact that multiple behaviours (and corresponding RAA determinants) are measured within each person. In doing so, it allows for a more efficient assessment of associations between RAA determinants and behaviour (within persons), consistent with the RAA as a conceptual model of decision making. Such an approach is more appropriate when the determinants of multiple behaviours are considered, and has been used previously to assess relationships between socio-structural factors, health cognitions and Covid-19 preventive behaviours [17] as well as to test attitude stability effects across various health behaviours [e.g., 39,42].

The study was conducted at the start of the second wave of the coronavirus pandemic in the UK against a background of rising cases and deaths, as well as changes in restrictions. In the seven days up to and including the date of the time 1 survey (4 December 2020), there had been an average of 14,448 new coronavirus cases and 438 deaths per day. At time 2 (4 January 2021) these figures had risen to an average of 60,746 new coronavirus cases and 617 deaths per day. At time 3 (4 February 2021) the average number of new coronavirus cases per day had fallen to 21,246, although the number of deaths had continued to rise to an average of 1,018 per day [4]. In terms of restrictions, during December 2020, England and Scotland both had a tiered system of restrictions depending on local infection rates, Northern Ireland had a two-week ‘circuit-breaker’ lockdown at the start of the month and then eased restrictions apart from social distancing, and Wales mainly had social distancing restrictions (e.g., only up to 15 people able to meet indoors for organised activities). Thus, the restrictions in all four

nations sought to restrict the number of social contacts in order to reduce the spread of the virus. In addition, the wearing of face coverings (e.g., in shops and on public transport) was mandatory, and social distancing and personal hygiene behaviours were also recommended, in all four nations. National lockdowns were subsequently introduced in all nations of the UK in January 2021.

Method

Participants and Procedure

A representative sample of UK adults (in terms of age, sex, and ethnicity) was recruited from Prolific (www.prolific.co) through stratified sampling. Potential participants from the Prolific participant pool were invited to participate in a study on their beliefs and behaviour in relation to a range of Covid-19 preventive behaviours which involved completing a series of three online surveys hosted on Qualtrics. Before accessing the baseline questionnaire, participants were presented with an information sheet and had to click on a number of statements to indicate that they gave informed consent to participate in the study. Participants completed three surveys, each one month apart, on 4 December 2020 (time 1), 4 January 2021 (time 2) and 4 February 2021 (time 3). Ethical approval for the study was granted by University of Sheffield Research Ethics Committee (ref. 0373410). Some of the current data have been previously reported in Conner et al. [43], which examined whether different properties of attitudes (e.g., attitude certainty) are associated with attitude stability and/or moderate attitude-behaviour relations. Conner et al. [43] did not report on any of the RAA variables (including intention) that form the focus of the current paper.

A total of 603 participants completed the time 1 survey. Of these participants, 535 (88.7%) and 500 (82.9%) completed the time 2 and time 3 surveys, respectively. The characteristics of the baseline sample are presented in Table 1. The sample was broadly representative of the UK adult population in terms of age (18-24: 12.0% vs. 11.6%, 25-34:

17.0% vs. 16.8%, 35-44: 17.7% vs.19.8%, 45-54: 17.6% vs.15.7%, 55+: 35.7% vs. 34.6%), sex (females: 50.6% vs. 51.4%) and ethnicity (ethnic minorities: 15.0% vs. 18.1%) (UK vs. study sample) [44,45]. Of the baseline sample, 517 (86.2%) participants lived in England, 37 (6.2%) in Scotland, 32 (5.3%) in Wales, and 14 (2.3%) in Northern Ireland (missing $n = 3$), which is broadly in line with national population estimates (England 84.3%, Scotland, 8.1%, Wales 4.7%, Northern Ireland 2.8%) [45].

Measures

Demographic data including age, sex (0 = male, 1 = female) and ethnicity (0 = ethnic minorities, 1 = White) were obtained from Prolific records. In addition, participants were asked to provide their postcode in the time 1 survey which was then linked to Index of Multiple Deprivation (IMD) scores using databases for England (http://imd-by-postcode.opendatacommunities.org/imd/2019), Scotland (https://www.gov.scot/publications/scottish-index-of-multiple-deprivation-2020v2-postcode-look-up/), Wales (https://statswales.gov.wales/Catalogue/Community-Safety-and-Social-Inclusion/Welsh-Index-of-Multiple-Deprivation), and Northern Ireland (https://deprivation.nisra.gov.uk/). IMD represents an area-level measure of relative deprivation with lower scores indicating higher levels of relative deprivation. Participants were also asked whether or not they had been diagnosed with Covid-19 (0 = no, 1 = yes) and whether or not they had self-isolated as a result of being in close contact with someone who had Covid-19 (0 = no, 1 = yes).

The time 1 and time 2 surveys included items assessing the RAA variables in relation to performing each of six Covid-19 preventive behaviours recommended by the World Health Organization [46] over the next month: Wearing a face covering in public places; Maintaining social distancing of at least 1 metre, Hand sanitising regularly, Avoiding the 3 ‘Cs’ (Closed spaces, Crowded places, and Close contacts); Cleaning surfaces regularly; and Covering your mouth/nose when coughing/sneezing. The items were constructed in line with current

recommendations [47] and similar to those used in previous studies [e.g., 17,20]. All items were answered on 7-point response scales and coded so that high scores reflected high levels of the variable of interest (e.g., positive experiential attitudes). Two items were used to assess *experiential attitudes* ("My wearing a face covering in public places in the next month would be: Unpleasant–Pleasant"; "Disagreeable-Agreeable"). Responses to the two items were averaged (*r*'s = .56 to .74). Similarly, two items were used to assess *instrumental attitudes* ("My wearing a face covering in public places in the next month would be: Harmful–Beneficial"; "Useless-Useful") which were also averaged (*r*'s = .84 to .89). Single items were used to assess *injunctive norms* ("Most people close to me would disapprove/approve of me wearing a face covering in public places in the next month: Would disapprove–Would approve"), *descriptive norms* ("Of the people close to you, how many will wear a face covering in public places in the next month? None–All"), *capacity* ("How confident are you that you could wear a face covering in public places in the next month? Not at all confident–Very confident"), *autonomy* ("How much control do you have over whether or not you wear a face covering in public places in the next month? No control–Complete control") and *intention* ("Do you intend to wear a face covering in public places in the next month? Definitely don't–Definitely do"). Measures of *temporal stability* across the two assessments were computed for each RAA variable. Similar to previous studies [e.g., 38, 47], temporal stability was assessed as 6 minus the sum of the absolute difference between the time 1 and time 2 items taken for each RAA variable (range 0-6), with high scores indicating greater temporal stability.

Performance of the each of the six Covid-19 preventive behaviours was assessed at each time point with two questions, as used in previous studies [e.g., 17,20]. The first question asked participants how often they had engaged in each of the behaviours over the previous month (i.e., "To what extent have you done each of the behaviours listed below over

the past month?") on a 7-point scale (i.e., "Not at all–All the time"). The second question asked, in the same way, to what extent participants had engaged in the corresponding non-preventive behaviour over the past month (e.g., "Not worn a face covering in public places"). For each behaviour, the two items were combined to produce a dichotomous measure of *behaviour*. Participants who scored 7 for performing the preventive behaviour "all the time" and 1 for performing the non-preventive behaviour "not at all" were coded (1) as being fully compliant with each of the recommended behaviours. All other patterns of responses were coded (0) as being non-fully compliant.

Data analysis

Data were analysed using SPSS (version 24, SPSS Inc.) and HLM (version 7, SSI). Participants who had missing data for the demographic and Covid-19 experience variables or at least one variable missing for each behaviour were excluded from the main analyses (i.e., listwise deletion). The analyses were multi-level (to take account of six behaviours being measured within each participant). A total of 3179 person-behaviour data points spread across 477 individuals were used in the main analysis. Given the complexity of estimating power in multi-level analyses and logistic regressions, we used a 10:1 ratio of cases to predictors 'rule of thumb' [48] to provide an adequate power. With a maximum of 28 predictors (see Table 4), this would require a minimum of least 280 participants. Data analysis was conducted in four phases.

First, Missing Values Analysis within SPSS was used to assess amount of missing data and Little's MCAR test was used to test whether data were missing completely at random or not. Attrition analyses were also conducted to compare those with and without missing data at time 2 and time 3 on the baseline measures in order to explore the nature of the missing data. Multiple imputation techniques were then used to produce five imputed datasets using Missing Values Analysis within SPSS. The main correlation and regression

analyses outlined below were rerun using these imputed datasets. Pooled results from these analyses are reported in Supplementary Tables 5-7 and are presented as sensitivity analyses to assess the robustness of the main findings [49].

Second, descriptive statistics were conducted for the study measures (i.e., demographics, Covid-19 experiences, RAA variables, and behaviour) and correlations were computed between the study variables and Covid-19 preventive intentions at times 1 and 2 plus Covid-19 preventive behaviour at times 2 and 3 (see Table 2 and Supplementary Table 1).

Third, multi-level linear regression analyses were used to assess whether the RAA variables predicted Covid-19 preventive intentions at time 1 and time 2. Each analysis was run controlling for demographic variables, Covid-19 experiences and past behaviour (see Table 3). Hierarchical versions of these analyses are reported in Supplementary Table 2 in which the RAA variables were entered in model 1, followed by demographic variables and Covid-19 experiences in model 2, and past behaviour in model 3.

Fourth, given that the measure of behaviour was dichotomous, multi-level logistic regression analyses were used to assess whether the RAA variables predicted Covid-19 preventive behaviours at subsequent time points and whether temporal stability moderated RAA-behaviour relations. Three analyses were conducted to predict time 2 behaviour from time 1 RAA measures, time 3 behaviour from time 2 RAA measures, and time 3 behaviour from time 1 RAA measures. Each analysis was run controlling for demographic variables, Covid-19 experiences and past behaviour (see Table 3). Hierarchical versions of these analyses are reported in Supplementary Table 4 in which in which intention, intention stability and the interaction between intention and intention stability were entered in model 1, followed by other RAA variables, measures of temporal stability and interactions between the RAA variables and measures of temporal stability in model 2, demographic variables and

Covid-19 experiences in model 3, and past behaviour in model 4. Mean-centred variables were used before computing interactions.

The regression analyses were conducted using Hierarchical Linear Modeling using HLM7 [51]. Given that the data were hierarchically clustered under persons (i.e., six Covid-19 preventive behaviours and corresponding RAA determinants per person), a maximal random effects structure was assumed [52]. The RAA variables, measures of temporal stability and past behaviour were level-1 variables, and measures of demographics and Covid-19 experiences were level-2 variables. Model fit (deviance statistic for the linear regressions predicting intention; -2 log likelihood for the Bernoulli regressions predicting behaviour) is reported for each model. For the regression analyses predicting intention, unstandardized coefficients and standard errors, standardized coefficients and significance (based on the population-average model with robust standard errors) are reported for all predictors. For the regression analyses predicting behaviour, unstandardized coefficients, odds ratios, 95%CI and significance (based on the population-average model with robust standard errors) are reported for all predictors. Where an interaction was significant ($p < .05$) the direction of effect was explored with simple slopes using the free software provided by Preacher (Model 1 for interactions between level 1 variables at http://www.quantpsy.org/interact/hlm2.htm).

Results

Missing Data Analyses

There were 4.99% missing values in the dataset used for the main analyses. Little's MCAR test indicated that data were not missing completely at random, χ^2 (66) = 443.66, p = < .001. Attrition analyses indicated that those with missing data at time 2 were younger (M = 36.19, SD = 14.55 vs M = 46.98, SD = 15.24), $t(600) = 5.49$, $p < .001$, and had higher baseline experiential attitude scores (M = 5.95, SD = 1.44 vs M = 5.34, SD = 1.49), $F(1,3595) = 10.11$, $p = .001$, than those without missing data at time 2. Similarly, those with missing data at time

3 were also younger (M = 36.50, SD = 14.83 vs M = 47.67, SD = 14.99), $t(600) = 6.87$, $p <$ .001, and had higher baseline experiential attitude scores (M = 5.55, SD = 1.46 vs M = 5.33, SD = 1.49), $F(1,3595) = 10.33$, $p = .001$, than those without missing data at time 3. Comparisons for all other baseline variables were non-significant.

Bivariate Associations with Covid-19 Preventive Intentions and Behaviour

Means, standard deviations and correlations between the study variables are reported in Table 2. Across behaviours, approximately 48%, 47% and 50% reported full compliance with the Covid-19 preventive behaviours at times 1, 2 and 3, respectively. All of the RAA variables had significant positive correlations with Covid-19 preventive intentions at times 1 and 2 and with subsequent behaviour at times 2 and 3, such that positive experiential and instrumental attitudes, positive injunction and descriptive norms, and strong perceptions of capability and autonomy were associated with positive intentions and greater performance of the Covid-19 preventive behaviours. Of the demographic variables (see Supplementary Table 1), age and (female) sex had significant positive correlations with intention at times 1 and 2 and with subsequent behaviour at times 2 and 3. In addition, (White) ethnicity and lower relative deprivation were significantly associated with intention at times 1 and 2 and with subsequent behaviour at time 2. Having had a Covid-19 diagnosis was negatively associated with intention at time 2 and behaviour at time 3. Having self-isolated had non-significant associations with intention and behaviour. The size and significance of the correlations with intention and behaviour in the original and imputed datasets were virtually identical (see Supplementary Table 5).

Regression Analysis Predicting Covid-19 Preventive Intentions

The multi-level regression analyses predicting intentions at time 1 and time 2 are summarised in Table 3 (Panels A and B). All of the RAA variables were significant predictors of intention at both time points. However, a negative effect was found for autonomy in these

analyses which, given that it had significant positive bivariate associations with intention at both time points, may be due to a suppressor effect and is therefore not interpreted further. Of the RAA variables, instrumental attitude, descriptive norm, and capability were the strongest predictors in both analyses. In addition, age and past behaviour were also significant predictors of time 1 and time 2 intentions. Rerunning the multi-level regression analyses with the imputed datasets produced virtually identical results (see Supplementary Table 6). The only difference was a non-significant beta value for injunctive norms when predicting time 1 intention in the imputed datasets.

Regression Analysis Predicting Covid-19 Preventive Behaviours

The multi-level regression analyses predicting time 2 behaviour from time 1 RAA measures, time 3 behaviour from time 2 RAA measures, and time 3 behaviour from time 1 RAA measures are summarised in Table 4 (Panels A, B and C). Intention was a significant predictor of behaviour in all three analyses. Descriptive norms and capability also had significant direct effects on behaviour in all three analyses. In addition, time 1 autonomy was a significant predictor of time 2 behaviour, time 2 experiential attitude was a significant predictor of time 3 behaviour, and time 1 and time 2 instrumental attitude were significant predictors of time 3 behaviour. Injunctive norm was also found to be a significant predictor in two of the analyses, although in both cases the effect was negative in contrast to corresponding positive bivariate associations and may therefore reflect a suppressor effect. In addition, age was a significant predictor in the two analyses predicting time 3 behaviour and past behaviour was a significant predictor in all of the analyses.

Temporal stability moderated the intention-behaviour relationship when entered in model 1 in all three analyses (see Supplementary Tables 3a-c), although it only remained significant when controlling for other variables in the analysis predicting time 3 behaviour from the time 1 RAA measures. In addition, temporal stability moderated the relationship

between descriptive norms and behaviour in all analyses, and the relationship between capability and behaviour in two of the analyses, with the third moderation effect only becoming non-significant when controlling for past behaviour in the final model. Temporal stability also moderated the relationships between time 1 autonomy and time 2 behaviour and between time 2 instrumental attitude and time 3 behaviour. In addition, the moderating effect of temporal stability on the relationship between time 1 experiential attitude and time 2 behaviour only became non-significant when controlling for past behaviour in the final model. In all cases, positive and significant relationships between the RAA variables and subsequent behaviour became stronger with increasing temporal stability. For example, the relationship between time 1 intention and time 3 behaviour increased in strength from low (M – 1SD; $B = 0.748$, $SE = 0.073$, $p < .001$) to moderate (M; $B = 1.011$, $SE = 0.075$, $p < .001$) and high ($M + 1SD$; $B = 1.274$, $SE = 0.085$, $p < .001$) levels of temporal stability. Details of the simple slopes analyses for all of the temporal stability interactions that were significant in the main analyses (i.e., final models) are presented in Supplementary Table 4. Rerunning the multi-level regression analyses with the imputed datasets produced virtually identical results (see Supplementary Table 7).

Discussion

The present study applied the RAA to predict Covid-19 preventive intentions and behaviours in a three-wave study using within-persons analyses. Regression analyses indicated that the RAA was able to significantly predict Covid-19 preventive intentions at both time 1 and time 2. In both analyses, all of the RAA variables with the exception of autonomy were significant independent predictors of intention such that stronger intentions were associated with positive experiential and instrumental attitudes, positive injunctive and descriptive norms, and high levels of perceived capability. The current findings are in line with Schüz et al. [17] who also found that all RAA variables with the exception of autonomy

were significant independent predictors of Covid-19 preventive intentions. Meta-analytic regression analyses have reported similar results across various health behaviours [11].

The RAA was also predictive of subsequent behaviour at each time point, with intention found to be a significant predictor in all analyses. However, other RAA variables, most notably descriptive norms and capability, were also found to have direct effects on Covid-19 preventive behaviours in all analyses. Schüz et al. [17] found that experiential attitudes, descriptive norms, capability and autonomy also had directs effects across eight Covid-19 preventive behaviours, and Dixon et al. [19] reported that capability was an additional predictor of social distancing, wearing face coverings and hand washing. Meta-analytic regression analyses across various health behaviours have reported similar results [11], with direct effects found for experiential attitudes, descriptive norms and capability. Taken together, these findings suggest that some RAA variables may influence health behaviour in other ways in addition to their effects via intention. For example, the direct effect of descriptive norms on behaviour may reflect modeling processes. In addition, the direct effect for capability is consistent with the original TPB and other models of health behaviour, such as the health action process approach [53], that include self-efficacy as an additional predictor of behaviour.

A number of more distal variables were also found to have direct effects on Covid-19 preventive behaviour, contrary to the proposal that the RAA should mediate the effects of such variables. In particular, increasing age was found to be associated with greater adherence to Covid-19 preventive behaviours, as found in previous studies [17,20]. Such a finding may reflect increased vulnerability to Covid-19 due to age, although risk perceptions have not been found to mediate the effect of age on Covid-19 preventive behaviours [17,20]. Past behaviour was also a significant predictor of intention and behaviour in all analyses, suggesting the RAA is not a sufficient model and that other variables are required to explain further variance

in Covid-19 preventive intentions and behaviour [32]. In particular, the direct effect on behaviour may reflect the influence of more automatic processes, such that when a behaviour is repeated frequently in a stable context it is likely to lead to the formation of strong habits [54]. Accordingly, measures of habit strength have been found to explain additional variance in social distancing over and above that explained by intention [29,30].

The present study also tested whether temporal stability moderated intention-behaviour relations as well as relations between other RAA variables and behaviour. In all analyses, the intention-behaviour relationship became stronger as temporal stability increased, although the moderation effect only remained significant when controlling for other variables when predicting time 3 behaviour from the time 1 RAA measures. Interestingly, this was the longest follow-up period in the present study and suggests that intention stability may be particularly important when predicting behaviour over longer time periods. For example, stable versus unstable intentions have been found to be more predictive of healthy eating behaviour over a six-year follow-up period [35]. The current findings are broadly consistent with previous research that has found that stable intentions are more predictive of social distancing [28] as well as a range of other health behaviours [34, 36-38].

The temporal stability of intentions may be a key feature of strong (i.e., predictive) intentions and may also explain the moderating effects of other variables on the intention-behaviour relationship. For example, intention stability has been found to mediate the impact of other moderators (i.e., past behaviour, self-schemas, anticipated regret and attitudinal versus normative control) on the intention-behaviour relationship for exercise [50]. Rhodes et al. [34] have identified a number of other moderators of the intention-behaviour relationship including goal commitment, goal conflict, affective attitude, and identity. The temporal stability of intentions may also mediate these additional moderators.

Temporal stability also moderated relations between a number of other RAA variables and behaviour, such that (in some but not all analyses) instrumental attitudes, descriptive norms, capability and autonomy were more predictive of subsequent behaviour as temporal stability increased. These findings are consistent with other studies that have reported that stable attitudes [39,40] and perceptions of control [41] are more predictive behaviour, although no previous studies have tested whether temporal stability moderates relationships between norms and behaviour. The moderating effect of temporal stability on RAA-behaviour relations was found even though the moderating effect of intention stability was controlled for, thereby indicating that intention stability does not mediate the moderating effect of temporal stability of other RAA variables. It is noteworthy that the most consistent moderating effects were found for descriptive norms and capability; these variables also had the most consistent direct effects on behaviour, over and above the effect of intention.

Strengths and limitations

The present study had a number of strengths. First, the three-wave design over a two-month period allowed for strong tests of the role of temporal stability as moderator of RAA relations with Covid-19 preventive behaviour. Second, the timing of the three waves of data collection coincided with a marked increase in Covid-19 infections and deaths in the UK as well as changes in the levels of restrictions, thereby providing a changing context in which to assess the predictive utility of the RAA over time and the moderating role of temporal stability. Third, the broadly representative sample of UK adults (in terms of age, sex and ethnicity) increases confidence in the generalizability of the findings.

The present study had a number of limitations that should be noted. First, as with most studies, Covid-19 preventive behaviours were assessed using self-report measures, which might lead to an over-estimation of adherence due to social desirability effects. To partly address this possibility, a strict definition of full adherence was applied as used in previous

studies [17,20]. Moreover, rates of full adherence found at each time point in the present study were less than 50% suggesting that any social desirability effects may have been mitigated. Second, although the study used a prospective design which increases confidence in the proposed direction of effects, experimental work in which RAA cognitions are manipulated and their effects on intentions and behaviour are tested is needed to be able to make causal inferences. In relation to the TPB, Sheeran et al. [55] reported that studies that successfully changed attitudes, norms and self-efficacy were associated with medium sized changes in intentions and small-to-medium sized changes in behaviour. Third, although the sample was broadly representative of UK adults, it was not possible to conduct more fine-grained analysis of specific ethnic groups; instead, participants from all ethnic minority groups (combined) were compared with White participants. It is possible that the beliefs and behaviour of specific ethnic minority groups might differ. Fourth, data were not missing completely at random and attrition analyses indicated that younger participants were more likely to be lost to follow-up, thereby potentially limiting the generalizability of the findings. However, rerunning the main analyses with imputed datasets produced virtually identical results, therefore pointing to the robustness of the current findings. Nonetheless, future research should focus specifically on the beliefs and behaviour of younger adults, given that age was a significant predictor of Covid-19 preventive behaviour.

Conclusions

Covid-19 preventive behaviours, such as social distancing and the wearing of face coverings, are likely to continue to be central to efforts to reduce the spread of Covid-19 and the emergence of new variants as restrictions are lifted. The present findings indicate that health cognitions, as outlined in the RAA, may provide appropriate targets for interventions to promote these behaviours. In particular, in order to engender positive intentions, interventions should seek to strengthen people's attitudes, promote strong social norms and increase

people's confidence in their ability to engage in these behaviours. Positive intentions should then lead to higher rates of adherence, particularly if they remain stable over time. Positive and stable norms and perceptions of capability are also likely to lead to continued adherence. As a result, clear and consistent messaging is needed from governments and public health organisations to promote and maintain positive cognitions and intentions to ensure that engagement in Covid-19 preventive behaviours does not decline over time.

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Table 1. *Participants' characteristics at baseline (N = 603).*

		M	*SD*	*N*	%
Age		45.78	15.53		
Sex	Female			310	51.4
	Male			293	48.6
Ethnicity	White			494	81.9
	Asian/Asian British			51	8.5
	Black/African/Caribbean/Black British			27	4.5
	Mixed/Multiple Ethnic Groups			17	2.8
	Other			14	2.3
IMD Decile		5.65	2.60		
Diagnosed with Covid-19	No			590	97.8
	Yes			13	2.2
Self-Isolated	No			525	87.1
	Yes			78	12.9

Table 2. *Means, standard deviations and intercorrelations between the RAA variables and Covid-19 preventive intentions and behaviour.*

	EA	IA	IN	DN	CAP	AUT	INT	T1B	T2B	T3B	*Mean*	*SD*
Experiential Attitude (EA)	-	.523	.379	.355	.432	.314	.475	.278	.243	.263	5.33	1.49
Instrumental Attitude (IA)	.502	-	.581	.492	.541	.366	.675	.310	.287	.322	6.46	1.07
Injunctive Norms (IN)	.404	.606	-	.512	.466	.298	.518	.254	.217	.224	6.41	1.12
Descriptive Norms (DN)	.341	.515	.542	-	.614	.301	.626	.419	.373	.348	5.94	1.28
Capability (CAP)	.397	.557	.464	.586	-	.490	.768	.477	.441	.398	6.07	1.39
Autonomy (AUT)	.275	.341	.282	.294	.487	-	.346	.218	.299	.231	5.94	1.49
Intention (INT)	.444	.701	.544	.613	.754	.337	-	.428	.391	.391	6.31	1.26
Time 1 Behaviour (T1B)	.238	.269	.246	.387	.440	.314	.367	-	.598	.539	0.48	0.50
Time 2 Behaviour (T2B)	.268	.302	.268	.423	.497	.348	.415	-	-	.558	0.47	0.50
Time 3 Behaviour (T3B)	.257	.305	.254	.372	.412	.267	.397	-	-	-	0.50	0.50
Mean	5.46	6.55	6.50	6.06	6.24	6.11	6.46					
SD	1.42	0.98	0.99	1.15	1.19	1.31	1.11					

Note. Correlations and means/SDs for time 1 RAA variables are reported above the diagonal; those for time 2 RAA variables are below then diagonal. All *rs*, $p < .001$.

Table 3. *Multi-level regression analyses predicting intentions from RAA variables, demographic and Covid-19 experience variables, and past behaviour at time 1 and time 2*.

	Panel A: Predicting time 1 intention from time 1 RAA measures			Panel B: Predicting time 2 intention from time 2 RAA measures		
	B	*SE*	*β*	*B*	*SE*	*β*
Experiential Attitude	0.051	0.011	0.060***	0.034	0.013	0.043**
Instrumental Attitude	0.353	0.028	0.300***	0.405	0.034	0.358***
Injunctive Norms	0.038	0.019	0.034*	0.049	0.022	0.044*
Descriptive Norms	0.150	0.020	0.152***	0.126	0.023	0.131***
Capability	0.451	0.025	0.498***	0.441	0.031	0.445***
Autonomy	-0.078	0.013	-0.092***	-0.073	0.016	-0.086***
Age	0.003	0.001	0.038**	0.003	0.001	0.042***
Sex	-0.005	0.024	-0.002	0.030	0.026	0.014
Ethnicity	-0.016	0.035	-0.005	-0.050	0.036	-0.018
Deprivation	-0.004	0.005	-0.008	-0.004	0.005	-0.009
Covid-19 Diagnosis	0.138	0.088	0.016	0.009	0.084	0.001
Self-isolated	0.044	0.032	0.012	0.005	0.042	0.001
Past Behaviour	0.101	0.028	0.040***	0.055	0.028	0.025*

Note. B = unstandardized coefficient; SE = standard error; *β* = standardized coefficient. Panel A, Deviance = 7438.51; Panel B, Deviance = 5892.21; Panel C, Deviance = 7169.77; * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 4. *Hierarchical multi-level regression analyses predicting behaviour from RAA variables, temporal stability, RAA x temporal stability interactions, demographic and Covid-19 experience variables, and past behaviour.*

Predictor	Panel A: Predicting time 2 behaviour from time 1 RAA measures			Panel B: Predicting time 3 behaviour from time 2 RAA measures			Panel C: Predicting time 3 behaviour from time 1 RAA measures		
	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI
Intention (INT)	0.284	1.328***	1.132, 1.557	0.482	1.620***	1.320, 1.988	0.273	1.313***	1.126, 1.531
Experiential Attitude (EA)	-0.018	0.982	0.902, 1.070	0.128	1.136**	1.047, 1.234	0.069	1.071	0.991, 1.158
Instrumental Attitude (IA)	0.018	1.019	0.865, 1.199	0.240	1.271*	1.031, 1.567	0.395	1.485***	1.251, 1.762
Injunctive Norms (IN)	-0.160	0.852*	0.730, 0.994	-0.078	0.925	0.795, 1.077	-0.154	0.857*	0.741, 0.991
Descriptive Norms (DN)	0.305	1.356***	1.202, 1.531	0.208	1.231***	1.096, 1.382	0.158	1.171**	1.048, 1.308
Capability (CAP)	0.443	1.557***	1.342, 1.806	0.203	1.225**	1.052, 1.426	0.311	1.364***	1.199, 1.552
Autonomy (AUT)	0.157	1.170***	1.073, 1.275	-0.002	0.998	0.910, 1.095	-0.039	0.962	0.888, 1.042
INT Stability	0.142	1.153	0.959, 1.385	0.254	1.289***	1.109, 1.498	0.310	1.364***	1.171, 1.589
EA Stability	-0.075	0.928	0.826, 1.043	-0.036	0.964	0.861, 1.080	-0.071	0.932	0.836, 1.038
IA Stability	-0.037	0.963	0.785, 1.182	0.059	1.061	0.883, 1.276	-0.162	0.850	0.708, 1.022
IN Stability	-0.018	0.982	0.863, 1.119	-0.001	0.999	0.894, 1.116	0.034	1.035	0.925, 1.158
DN Stability	0.037	1.038	0.916, 1.175	0.069	1.071	0.963, 1.192	0.076	1.079	0.963, 1.209
CAP Stability	0.210	1.234**	1.075, 1.417	-0.082	0.921	0.821, 1.033	-0.047	0.954	0.840, 1.083

AUT Stability	0.047	1.048	0.934, 1.176	-0.066	0.936	0.848, 1.033	-0.001	0.999	0.894, 1.116
INT x INT Stability	-0.002	0.998	0.913, 1.091	0.057	1.059	0.939, 1.194	0.103	1.109***	1.048, 1.174
EA x EA Stability	0.060	1.062	0.994, 1.135	0.004	1.004	0.936, 1.077	0.036	1.037	0.976, 1.101
IA x IA Stability	0.057	1.059	0.947, 1.184	0.148	1.160*	1.013, 1.327	0.078	1.080	0.966, 1.209
IN x IN Stability	-0.006	0.994	0.929, 1.064	-0.022	0.978	0.932, 1.026	-0.022	0.979	0.922, 1.038
DN x DN Stability	0.186	1.204***	1.138, 1.274	0.106	1.112*	1.015, 1.219	0.098	1.103***	1.040, 1.170
CAP x CAP Stability	0.149	1.160***	1.092, 1.234	0.047	1.048	0.954, 1.151	0.091	1.095***	1.037, 1.156
AUT x AUT Stability	0.060	1.062**	1.015, 1.112	0.010	1.010	0.947, 1.078	0.010	1.010	0.967, 1.055
Age	0.003	1.003	0.995, 1.011	0.014	1.014**	1.005, 1.023	0.013	1.013**	1.004, 1.022
Sex	0.213	1.238	0.975, 1.571	0.141	1.151	0.899, 1.474	0.132	1.142	0.900, 1.449
Ethnicity	-0.196	0.822	0.572, 1.181	-0.100	0.905	0.628, 1.305	-0.177	0.838	0.607, 1.157
Deprivation	0.032	1.033	0.987, 1.080	-0.033	0.967	0.919, 1.017	-0.017	0.983	0.935, 1.034
Covid-19 Diagnosis	0.003	1.003	0.534, 1.884	-0.262	0.770	0.416, 1.423	-0.229	0.795	0.436, 1.452
Self-isolated	0.328	1.389	0.972, 1.983	-0.254	0.776	0.545, 1.105	-0.085	0.919	0.647, 1.305
Past Behaviour	1.810	6.133***	4.937, 7.570	1.649	5.201***	4.157, 6.508	1.464	4.324***	3.494, 5.353

Note. B = unstandardized coefficient; OR = odds ratio; CI = confidence interval. Panel A, -2LL = -4.299E +003; Panel B, -2LL = -4.039E+003; Panel C, -2LL = -4.042E+003; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 1. *Correlations between participants' characteristics and intentions at time 1 and time 2 and behaviour at time 2 and time 3.*

	Intention		Behaviour	
	Time 1	Time 2	Time 2	Time 3
Age	.094***	.085***	.073***	.108***
Sex	.079***	.106***	.102***	.092***
Ethnicity	-.037*	-.050**	-.044*	-.030
IMD Decile	.053**	.060***	.055**	.014
Diagnosed with Covid-19	-.016	-.051**	-.024	-.038*
Self-Isolated	.033	-.013	.033	-.019

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

Supplementary Table 2a. *Hierarchical multi-level regressions of time 1 intention on time 1 RAA variables, demographic and Covid-19 experience variables, and past behaviour*.

Predictor	Model 1			Model 2			Model 3		
	B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Experiential Attitude	0.050	0.011	0.059***	0.053	0.011	0.063***	0.051	0.011	0.060***
Instrumental Attitude	0.355	0.028	0.301***	0.353	0.028	0.300***	0.353	0.028	0.300***
Injunctive Norms	0.037	0.019	0.033♯	0.037	0.019	0.033♯	0.038	0.019	0.034*
Descriptive Norms	0.160	0.020	0.163***	0.158	0.020	0.161***	0.150	0.020	0.152***
Capability	0.462	0.024	0.510***	0.461	0.024	0.509***	0.451	0.025	0.498***
Autonomy	-0.073	0.014	-0.086***	-0.076	0.014	-0.090***	-0.078	0.013	-0.092***
Age				0.003	0.001	0.038***	0.003	0.001	0.038**
Sex				0.002	0.024	0.001	-0.005	0.024	-0.002
Ethnicity				-0.019	0.035	-0.006	-0.016	0.035	-0.005
Deprivation				-0.004	0.005	-0.008	-0.004	0.005	-0.008
Covid-19 Diagnosis				0.134	0.088	0.016	0.138	0.088	0.016
Self-isolated				0.044	0.032	0.012	0.044	0.032	0.012
Time 1 Behaviour							0.101	0.028	0.040***

Note. B = unstandardized coefficient; SE = standard error; *β* = standardized coefficient. Model 1, Deviance = 7420.52; Model 2, Deviance = 7445.19; Model 3, Deviance = 7438.51; ♯ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 2b. *Hierarchical multi-level regressions of time 2 intention on time 2 RAA variables, demographic and Covid-19 experience variables, and past behaviour*.

Predictor	Model 1			Model 2			Model 3		
	B	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Experiential Attitude	0.032	0.012	0.041***	0.036	0.013	0.046**	0.034	0.013	0.043**
Instrumental Attitude	0.406	0.034	0.358***	0.404	0.034	0.357***	0.405	0.034	0.358***
Injunctive Norms	0.048	0.022	0.043*	0.049	0.022	0.045*	0.049	0.022	0.044*
Descriptive Norms	0.135	0.022	0.140***	0.131	0.022	0.136***	0.126	0.023	0.131***
Capability	0.448	0.030	0.480***	0.448	0.030	0.480***	0.441	0.031	0.445***
Autonomy	-0.067	0.016	-0.079***	-0.070	0.016	-0.083***	-0.073	0.016	-0.086***
Age				0.003	0.001	0.042***	0.003	0.001	0.042***
Sex				0.033	0.026	0.014	0.030	0.026	0.014
Ethnicity				-0.051	0.036	-0.018	-0.050	0.036	-0.018
Deprivation				-0.004	0.005	-0.009	-0.004	0.005	-0.009
Covid-19 Diagnosis				0.009	0.085	0.001	0.009	0.084	0.001
Self-isolated				0.008	0.042	0.002	0.005	0.042	0.001
Time 1 Behaviour							0.055	0.028	0.025*

Note. B = unstandardized coefficient; SE = standard error; *β* = standardized coefficient. Model 1, Deviance = 5866.53; Model 2, Deviance = 5889.37; Model 3, Deviance = 5892.21; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 3a. *Hierarchical multi-level regression analyses predicting time 2 behaviour from time 1 RAA variables, temporal stability, RAA x temporal stability interactions, demographic and Covid-19 experience variables, and past behaviour.*

Predictor	Model 1			Model 2			Model 3			Model 4		
	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI
Intention (INT)	1.156	3.178***	2.824, 3.577	0.423	1.526***	1.305, 1.785	0.420	1.522***	1.296, 1.787	0.284	1.328***	1.132, 1.557
INT Stability	0.423	1.529***	1.264, 1.849	0.222	1.249*	1.026, 1.521	0.216	1.240*	1.021, 1.508	0.142	1.153	0.959, 1.385
INT x INT Stability	0.315	1.370***	1.287, 1.459	0.023	1.023	0.930, 1.126	0.020	1.021	0.926, 1.124	-0.002	0.998	0.913, 1.091
Experiential Attitude (EA)				0.013	1.013	0.939, 1.093	0.017	1.017	0.941, 1.099	-0.018	0.982	0.902, 1.070
Instrumental Attitude (IA)				0.019	1.020	0.860, 1.208	0.007	1.007	0.848, 1.197	0.018	1.019	0.865, 1.199
Injunctive Norms (IN)				-0.194	0.823*	0.694, 0.977	-0.192	0.825*	0.694, 0.981	-0.160	0.852*	0.730, 0.994
Descriptive Norms (DN)				0.429	1.535***	1.368, 1.723	0.434	1.543***	1.374, 1.734	0.305	1.356***	1.202, 1.531
Capability (CAP)				0.706	2.026***	1.753, 2.342	0.702	2.019***	1.745, 2.336	0.443	1.557***	1.342, 1.806
Autonomy (AUT)				0.198	1.219***	1.113, 1.335	0.192	1.212***	1.106, 1,328	0.157	1.170***	1.073, 1.275
EA Stability				-0.041	0.960	0.777, 1.186	-0.042	0.958	0.777, 1.182	-0.037	0.963	0.785, 1.182
IA Stability				-0.071	0.931	0.834, 1.040	-0.070	0.932	0.834, 1.041	-0.075	0.928	0.826, 1.043
IN Stability				-0.029	0.971	0.863, 1.094	-0.033	0.967	0.857, 1.092	-0.018	0.982	0.863, 1.119
DN Stability				0.010	1.011	0.893, 1.144	0.012	1.102	0.894, 1.147	0.037	1.038	0.916, 1.175

CAP Stability	0.243	1.275***	1.117, 1.456	0.245	1.279***	1.121, 1.459	0.210	1.234**	1.075, 1.417
AUT Stability	0.558	1.057	0.952, 1.174	0.052	1.053	0.948, 1.170	0.047	1.048	0.934, 1.176
EA x EA Stability	0.035	1.035	0.916, 1.170	0.034	1.035	0.916, 1.169	0.057	1.059	0.947, 1.184
IA x IA Stability	0.072	1.075*	1.011, 1.143	0.072	1.075*	1.010, 1.144	0.060	1.062	0.994, 1.135
IN x IN Stability	-0.018	0.983	0.919, 1.051	-0.016	0.984	0.919, 1.055	-0.006	0.994	0.929, 1.064
DN x DN Stability	0.223	1.249***	1.174, 1.329	0.224	1.251***	1.177, 1.330	0.186	1.204***	1.138, 1.274
CAP x CAP Stability	0.245	1.277***	1.198, 1.361	0.244	1.276***	1.198, 1.359	0.149	1.160***	1.092, 1.234
AUT x AUT Stability	0.074	1.077***	1.034, 1.123	0.074	1.077***	1.033, 1.123	0.060	1.062**	1.015, 1.112
Age				0.005	1.005	0.998, 1.013	0.003	1.003	0.995, 1.011
Sex				0.253	1.288*	1.027, 1.616	0.213	1.238	0.975, 1.571
Ethnicity				-0.208	0.812	0.576, 1.144	-0.196	0.822	0.572, 1.181
Deprivation				0.024	1.024	0.980, 1.070	0.032	1.033	0.987, 1.080
Covid-19 Diagnosis				-0.048	0.953	0.475, 1.914	0.003	1.003	0.534, 1.884
Self-isolated				0.218	1.244	0.859, 1.801	0.328	1.389	0.972, 1.983
Past Behaviour							1.810	6.133***	4.937, 7.570

Note. B = unstandardized coefficient; OR = odds ratio; CI = confidence interval. Model 1, -2LL = -4.358E+003; Model 2, -2LL = -4.391E+003; Model 3, -2LL = -4.392E+003; Model 4, -2LL = -4.299E+003; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 3b. *Hierarchical multi-level regression analyses predicting time 3 behaviour from time 2 RAA variables, temporal stability, RAA x temporal stability interactions, demographic and Covid-19 experience variables, and past behaviour.*

Predictor	Model 1			Model 2			Model 3			Model 4		
	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI
Intention (INT)	1.322	3.750***	3.161, 4.450	0.679	1.972***	1.587, 2.451	0.660	1.936***	1.551, 2.415	0.482	1.620***	1.320, 1.988
INT Stability	0.387	1.473***	1.272, 1.706	0.289	1.336***	1.148, 1.555	0.296	1.344***	1.154, 1.566	0.254	1.289***	1.109, 1.498
INT x INT Stability	0.315	1.371***	1.277, 1.472	0.105	1.110	0.976, 1.264	0.105	1.111	0.974, 1.266	0.057	1.059	0.939, 1.194
Experiential Attitude (EA)				0.126	1.135***	1.051, 1.225	0.145	1.156***	1.069, 1.251	0.128	1.136**	1.047, 1.234
Instrumental Attitude (IA)				0.166	1.180	0.969, 1.438	0.164	1.178	0.962, 1.442	0.240	1.271*	1.031, 1.567
Injunctive Norms (IN)				-0.091	0.913	0.784, 1.062	-0.083	0.920	0.788, 1.074	-0.078	0.925	0.795, 1.077
Descriptive Norms (DN)				0.340	1.405***	1.250, 1.578	0.335	1.400***	1.243, 1.572	0.208	1.231***	1.096, 1.382
Capability (CAP)				0.475	1.609***	1.377, 1.879	0.488	1.629***	1.389, 1.911	0.203	1.225**	1.052, 1.426
Autonomy (AUT)				0.063	1.065	0.972, 1.167	0.057	1.059	0.966, 1.161	-0.002	0.998	0.910, 1.095
EA Stability				-0.050	0.951	0.855, 1.058	-0.043	0.958	0.860, 1.067	-0.036	0.964	0.861, 1.080
IA Stability				0.044	1.044	0.877, 1.244	0.032	1.032	0.865, 1.232	0.059	1.061	0.883, 1.276
IN Stability				-0.018	0.983	0.872, 1.107	-0.026	0.974	0.861, 1.103	-0.001	0.999	0.894, 1.116
DN Stability				0.057	1.059	0.956, 1.172	0.052	1.054	0.950, 1.168	0.069	1.071	0.963, 1.192

CAP Stability	-0.014	0.986	0.881, 1.103	-0.017	0.983	0.876, 1.103	-0.082	0.921	0.821, 1.033
AUT Stability	-0.049	0.952	0.868, 1.045	-0.055	0.946	0.861, 1.040	-0.066	0.936	0.848, 1.033
EA x EA Stability	0.001	1.001	0.939, 1.068	0.005	1.005	0.941, 1.073	0.004	1.004	0.936, 1.077
IA x IA Stability	0.089	1.093	0.965, 1.237	0.081	1.084	0.955, 1.230	0.148	1.160*	1.013, 1.327
IN x IN Stability	-0.026	0.975	0.925, 1.027	-0.025	0.975	0.925, 1.029	-0.022	0.978	0.932, 1.026
DN x DN Stability	0.146	1.157***	1.060, 1.262	0.150	1.162***	1.062, 1.271	0.106	1.112*	1.015, 1.219
CAP x CAP Stability	0.147	1.159**	1.055, 1.272	0.150	1.162**	1.056, 1.278	0.047	1.048	0.954, 1.151
AUT x AUT Stability	0.023	1.023	0.966, 1.083	0.020	1.020	0.964, 1.080	0.010	1.010	0.947, 1.078
Age				0.013	1.013**	1.004, 1.022	0.014	1.014**	1.005, 1.023
Sex				0.213	1.237	0.971, 1.575	0.141	1.151	0.899, 1.474
Ethnicity				-0.129	0.879	0.616, 1.254	-0.100	0.905	0.628, 1.305
Deprivation				-0.017	0.983	0.934, 1.034	-0.033	0.967	0.919, 1.017
Covid-19 Diagnosis				-0.229	0.800	0.444. 1.427	-0.262	0.770	0.416, 1.423
Self-isolated				-0.203	0.816	0.569, 1.172	-0.254	0.776	0.545, 1.105
Past Behaviour							1.649	5.201***	4.157, 6.508

Note. B = unstandardized coefficient; OR = odds ratio; CI = confidence interval. Model 1, -2LL = -4.901E+003; Model 2, -2LL = -4.107E+003; Model 3, -2LL = -4.077E+003; Model 4, -2LL = -4.039E+003; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 3c. *Hierarchical multi-level regression analyses predicting time 3 behaviour from time 1 RAA variables, temporal stability, RAA x temporal stability interactions, demographic and Covid-19 experience variables, and past behaviour.*

Predictor	Model 1			Model 2			Model 3			Model 4		
	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI
Intention (INT)	1.011	2.747***	2.440, 3.094	0.382	1.465***	1.258, 1.705	0.368	1.445***	1.236, 1.689	0.273	1.313***	1.126, 1.531
INT Stability	0.384	1.468***	1.227, 1.729	0.350	1.420***	1.203, 1.675	0.356	1.428***	1.208, 1.687	0.310	1.364***	1.171, 1.589
INT x INT Stability	0.306	1.358***	1.289, 1.431	0.116	1.123***	1.061, 1.189	0.111	1.117***	1.054, 1.184	0.103	1.109***	1.048, 1.174
Experiential Attitude (EA)				0.064	1.066	0.990, 1.148	0.081	1.084*	1.006, 1.169	0.069	1.071	0.991, 1.158
Instrumental Attitude (IA)				0.367	1.443***	1.220, 1.707	0.358	1.430***	1.205, 1.697	0.395	1.485***	1.251, 1.762
Injunctive Norms (IN)				-0.176	0.839*	0.772, 0.975	-0.176	0.838*	0.717, 0.980	-0.154	0.857*	0.741, 0.991
Descriptive Norms (DN)				0.263	1.301***	1.170, 1.447	0.264	1.302***	1.169, 1.450	0.158	1.171**	1.048, 1.308
Capability (CAP)				0.524	1.689***	1.489, 1.917	0.530	1.699***	1.495, 1.931	0.311	1.364***	1.199, 1.552
Autonomy (AUT)				0.012	1.012	0.936, 1.094	0.005	1.005	0.929, 1.088	-0.039	0.962	0.888, 1.042
EA Stability				-0.073	0.929	0.838, 1.030	-0.068	0.934	0.842, 1.036	-0.071	0.932	0.836, 1.038
IA Stability				-0.170	0.844	0.696, 1.023	-0.177	0.838	0.691, 1.016	-0.162	0.850	0.708, 1.022
IN Stability				0.023	1.023	0.917, 1.141	0.022	1.022	0.914, 1.143	0.034	1.035	0.925, 1.158
DN Stability				0.068	1.070	0.959, 1.195	0.061	1.063	0.951, 1.188	0.076	1.079	0.963, 1.209

CAP Stability	-0.002	0.998	0.881, 1.130	-0.001	0.999	0.882, 1.132	-0.047	0.954	0.840, 1.083
AUT Stability	0.015	1.015	0.909, 1.133	0.008	1.008	0.902, 1.126	-0.001	0.999	0.894, 1.116
EA x EA Stability	0.036	1.037	0.978, 1.099	0.042	1.043	0.984, 1.106	0.036	1.037	0.976, 1.101
IA x IA Stability	0.059	1.060	0.941, 1.195	0.056	1.057	0.937, 1.193	0.078	1.080	0.966, 1.209
IN x IN Stability	-0.030	0.970	0.919, 1.025	-0.029	0.972	0.917, 1.029	-0.022	0.979	0.922, 1.038
DN x DN Stability	0.135	1.144***	1.076, 1.217	0.133	1.142***	1.074, 1.215	0.098	1.103***	1.040, 1.170
CAP x CAP Stability	0.165	1.180***	1.123, 1.240	0.170	1.185***	1.126, 1.247	0.091	1.095***	1.037, 1.156
AUT x AUT Stability	0.028	1.028	0.987, 1.071	0.026	1.026	0.984, 1.069	0.010	1.010	0.967, 1.055
Age				0.014	1.014***	1.006, 1.303	0.013	1.013**	1.004, 1.022
Sex				0.190	1.210	0.953, 1.535	0.132	1.142	0.900, 1.449
Ethnicity				-0.182	0.833	0.593, 1.171	-0.177	0.838	0.607, 1.157
Deprivation				-0.016	0.984	0.937, 1.034	-0.017	0.983	0.935, 1.034
Covid-19 Diagnosis				-0.286	0.751	0.396, 1.425	-0.229	0.795	0.436, 1.452
Self-isolated				-0.109	0.896	0.617, 1.303	-0.085	0.919	0.647, 1.305
Past Behaviour							1.464	4.324***	3.494, 5.353

Note. B = unstandardized coefficient; OR = odds ratio; CI = confidence interval. Model 1, -2LL = -4.082E+003; Model 2, -2LL = -4.070E+003; Model 3, -2LL = -4.085E+003; Model 4, -2LL = -4.042E+003; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 4. *Simple slopes analyses for significant RAA × temporal stability interactions predicting time 2 and time 3 behaviour.*

	Temporal Stability								
	Low (M – 1 SD)			Moderate (M)			High (M + 1 SD)		
RAA Predictor	*B*	*(SE)*		*B*	*(SE)*		*B*	*(SE)*	
<u>Predicting Time 2 Behaviour</u>									
Time 1 Descriptive Norms	0.653	(0.041)	***	0.895	(0.045)	***	1.137	(0.059)	***
Time 1 Capability	0.827	(0.057)	***	1.132	(0.068)	***	1.437	(0.075)	***
Time 1 Autonomy	0.333	(0.033)	***	0.545	(0.041)	***	0.757	(0.057)	***
<u>Predicting Time 3 Behaviour</u>									
Time 1 Intention	0.748	(0.073)	***	1.011	(0.075)	***	1.274	(0.085)	***
Time 1 Descriptive Norms	0.511	(0.041)	***	0.693	(0.044)	***	0.875	(0.056)	***
Time 1 Capability	0.648	(0.054)	***	0.879	(0.057)	***	1.110	(0.067)	***
Time 2 Instrumental Attitude	0.747	(0.081)	***	0.917	(0.084)	***	1.087	(0.096)	***
Time 2 Descriptive Norms	0.595	(0.055)	***	0.796	(0.054)	***	0.997	(0.068)	***

Note. *** $p < .001$.

Supplementary Table 5. *Means, standard deviations and intercorrelations between the RAA variables and Covid-19 preventive intentions and behaviour using imputed data.*

	EA	IA	IN	DN	CAP	AUT	INT	T1B	T2B	T3B	*Mean*	*SD*
Experiential Attitude (EA)	-	.521	.387	.362	.441	.318	.483	.282	.217	.242	5.36	1.49
Instrumental Attitude (IA)	.504	-	.579	.475	.542	.368	.673	.312	.267	.305	6.45	1.08
Injunctive Norms (IN)	.397	.605	-	.521	.491	.311	.533	.265	.209	.222	6.40	1.13
Descriptive Norms (DN)	.335	.501	.542	-	.620	.312	.626	.417	.356	.337	5.93	1.29
Capability (CAP)	.389	.547	.468	.584	-	.493	.770	.477	.412	.381	6.06	1.39
Autonomy (AUT)	.274	.336	.292	.306	.488	-	.353	.305	.271	.222	5.94	1.49
Intention (INT)	.439	.703	.547	.602	.748	.347	-	.433	.369	.374	6.30	1.26
Time 1 Behaviour (T1B)	.241	.265	.240	.375	.422	.292	.353	-	.553	.498	0.47	0.50
Time 2 Behaviour (T2B)	.270	.312	.287	.437	.506	.353	.426	-	-	.562	0.45	0.50
Time 3 Behaviour (T3B)	.254	.310	.264	.377	.420	.272	.404	-	-	-	0.48	0.50
Mean	5.42	6.49	6.45	6.00	6.15	6.03	6.37					
SD	1.40	0.96	0.98	1.14	1.17	1.30	1.10					

Note. These results are based on pooled analyses from five imputed datasets each with 603 respondents and 3618 person-behaviour pairs. Correlations and means/SDs for time 1 RAA variables are reported above the diagonal; those for time 2 RAA variables are below the diagonal. All *rs*, $p < .001$.

Supplementary Table 6. *Multi-level regression analyses predicting intentions from RAA variables, demographic and Covid-19 experience variables, and past behaviour at time 1 and time 2 using imputed data*.

	Panel A: Predicting time 1 intention from time 1 RAA measures			Panel B: Predicting time 2 intention from time 2 RAA measures		
	B	*SE*	*β*	*B*	*SE*	*β*
Experiential Attitude	0.052	0.011	0.061***	0.032	0.012	0.051**
Instrumental Attitude	0.357	0.028	0.306***	0.400	0.031	0.353***
Injunctive Norms	0.034	0.019	0.030	0.053	0.020	0.047*
Descriptive Norms	0.148	0.020	0.152***	0.124	0.020	0.129***
Capability	0.451	0.024	0.498***	0.437	0.028	0.469***
Autonomy	-0.079	0.013	-0.093***	-0.067	0.015	-0.079***
Age	0.003	0.001	0.037**	0.003	0.001	0.042***
Sex	-0.005	0.024	-0.002	0.028	0.024	0.013
Ethnicity	-0.012	0.035	-0.004	-0.048	0.033	-0.017
Deprivation	-0.004	0.005	-0.008	-0.003	0.004	-0.007
Covid-19 Diagnosis	0.132	0.089	0.016	0.034	0.082	0.005
Self-isolated	0.053	0.033	0.014	0.014	0.039	0.004
Past Behaviour	0.106	0.028	0.042***	0.057	0.026	0.026*

Note. B = unstandardized coefficient; SE = standard error; *β* = standardized coefficient. Panel A, Deviance = 7535.06; Panel B, Deviance = 6614.91; * $p < .05$; ** $p < .01$; *** $p < .001$.

Supplementary Table 7. *Hierarchical multi-level regression analyses predicting behaviour from RAA variables, temporal stability, RAA x temporal stability interactions, demographic and Covid-19 experience variables, and past behaviour using imputed data.*

Predictor	Panel A: Predicting time 2 behaviour from time 1 RAA measures			Panel A: Predicting time 3 behaviour from time 2 RAA measures			Panel A: Predicting time 3 behaviour from time 1 RAA measures		
	B	OR	95% CI	B	OR	95% CI	B	OR	95% CI
Intention (INT)	0.239	1.270***	1.094, 1.474	0.466	1.594***	1.333, 1.904	0.262	1.300***	1.129, 1.496
Experiential Attitude (EA)	-0.024	0.976	0.905, 1.053	0.115	1.122**	1.041, 1.209	0.055	1.057	0.986, 1.132
Instrumental Attitude (IA)	-0.001	0.999	0.859, 1.162	0.205	1.228*	1.025, 1.470	0.339	1.404***	1.209, 1.629
Injunctive Norms (IN)	-0.182	0.834*	0.718, 0.968	-0.084	0.919	0.799, 1.059	-0.154	0.857*	0.751, 0.979
Descriptive Norms (DN)	0.213	1.237***	1.113, 1.376	0.193	1.213***	1.093, 1.346	0.157	1.170**	1.063, 1.288
Capability (CAP)	0.420	1.522***	1.332, 1.738	0.201	1.223**	1.068, 1.399	0.295	1.343***	1.196, 1.508
Autonomy (AUT)	0.129	1.138***	1.052, 1.230	0.005	1.005	0.926, 1.091	-0.037	0.964	0.898, 1.035
INT Stability	0.252	1.287**	1.083, 1.528	0.232	1.261**	1.100, 1.446	0.361	1.435***	1.244, 1.655
EA Stability	-0.054	0.947	0.849, 1.058	-0.023	0.977	0.881, 1.084	-0.001	0.999	0.904, 1.104
IA Stability	0.007	1.007	0.823, 1.232	0.039	1.040	0.876, 1.234	-0.099	0.906	0.763, 1.075
IN Stability	0.012	1.012	0.898, 1.141	0.002	1.002	0.907, 1.107	0.029	1.029	0.922, 1.149
DN Stability	0.077	1.080	0.958, 1.218	0.037	1.038	0.937, 1.149	0.076	1.079	0.972, 1.197

CAP Stability	0.310	1.363***	1.194, 1.557	-0.059	0.943	0.846, 1.050	0.046	1.047	0.931, 1.178
AUT Stability	0.078	1.081	0.974, 1.200	-0.063	0.939	0.851, 1.036	0.016	1.016	0.923, 1.119
INT x INT Stability	0.007	1.007	0.920, 1.102	0.058	1.060	0.951, 1.181	0.107	1.113***	1.053, 1.176
EA x EA Stability	0.062	1.064	0.999, 1.133	0.016	1.016	0.952, 1.084	0.051	1.052	0.994, 1.114
IA x IA Stability	0.056	1.058	0.945, 1.183	0.128	1.137*	1.010, 1.279	0.032	1.033	0.944, 1.130
IN x IN Stability	0.009	1.009	0.946, 1.077	-0.020	0.980	0.935, 1.027	-0.018	0.982	0.931, 1.036
DN x DN Stability	0.199	1.220***	1.155, 1.289	0.103	1.108**	1.023, 1.201	0.107	1.113***	1.055, 1.174
CAP x CAP Stability	0.175	1.191***	1.126, 1.260	0.036	1.037	0.959, 1.121	0.108	1.111***	1.067, 1.163
AUT x AUT Stability	0.065	1.067**	1.024, 1.112	0.018	1.018	0.969, 1.069	0.016	1.016	0.979, 1.055
Age	0.006	1.006	0.998, 1.014	0.013	1.013***	1.005, 1.021	0.015	1.015***	1.007, 1.023
Sex	0.197	1.218	0.979, 1.514	0.080	1.083	0.873, 1.344	0.083	1.087	0.884, 1.335
Ethnicity	-0.157	0.855	0.616, 1.185	-0.080	0.923	0.680, 1.254	-0.123	0.884	0.670, 1.168
Deprivation	0.032	1.033	0.981, 1.076	-0.041	0.960	0.919, 1.002	-0.026	0.974	0.933, 1.017
Covid-19 Diagnosis	0.116	1.123	0.638, 1.978	-0.090	0.914	0.508, 1.645	-0.002	0.998	0.567, 1.757
Self-isolated	0.267	1.306	0.940, 1.815	-0.171	0.843	0.616, 1.154	-0.049	0.952	0.698, 1.298
Past Behaviour	1.614	5.023***	4.096, 6.160	1.704	5.496***	4.491, 6.726	1.277	3.586***	2.954, 4.354

Note. B = unstandardized coefficient; OR = odds ratio; CI = confidence interval. Panel A, -2LL = -4965.5; Panel B, -2LL = -4935.9; Panel C, -2LL = -4944.5; * $p < .05$; ** $p < .01$; *** $p < .001$.