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RESEARCH

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# Are psychological attitudes towards vaccination an expression of personality? A cross-sectional study on COVID-19 vaccination in France

Gaëlle Lièvre<sup>1</sup>, Jonathan Sicsic<sup>2</sup>, Simon Galmiche<sup>1</sup>, Tiffany Charmet<sup>1</sup>, Arnaud Fontanet<sup>1</sup> and Judith Mueller<sup>1,3\*</sup>

## Abstract

**Background** The capacity of the 7C model's psychological antecedents, which include confidence in vaccines, complacency, convenience, calculation, collective responsibility, confidence in the wider system, and social conformism, to explain variance in COVID-19 vaccine intentions and behaviours has been documented. However, it remains unclear whether the attitudes represented by the 7C psychological antecedents are specific to vaccination or if they are, in fact, an expression of underlying personality traits.

**Methods** From February to June 2022, French adults completed self-administered questionnaires assessing COVID-19 vaccination history, the 7C antecedents, and personality traits ("ComCor" and "Cognitiv" studies). Vaccination behaviours were studied through three outcomes: at-least-one-dose vaccination status by 2022 ( $N=49,019$ ), up-to-date vaccination status ( $N=46,566$ ), and uptake speed of first dose ( $N=25,998$ ). Personality traits were evaluated using the French version of the Big Five Inventory (BFI-Fr). Multivariable logistic regressions and Cox models predicting vaccine behaviours were run with the 7C antecedents, both with and without personality traits.

**Results** Among the 49,019 participants, 95.0% reported receipt of at least one dose and 89.8% were up to date with recommendations. All 7C antecedents were significantly associated with the outcomes. The inclusion of personality traits did not substantially alter the effect estimates of the association between the 7C antecedents and vaccination behaviours, with differences between effect sizes of models with and without personality traits being < 5%.

**Conclusions** Our results suggest that the 7C psychological antecedents of vaccination are not the mere expression of personality and that their impact on vaccine behaviours is independent of personality traits. As such, the 7C antecedents may be modifiable by appropriate information and vaccine promotion.

**Trial registration** The "ComCor" study received ethical approval by the Comité de Protection des Personnes Sud Ouest et Outre Mer 1 on 21/09/2020. The addition of the "Cognitiv" questionnaire received ethical approval by the Comité de Protection des Personnes Sud Ouest et Outre Mer 1 on 01/02/2022. The data protection authority Commission Nationale de l'Informatique et des Libertés (CNIL) authorised the processing of data on 21/10/2020. The study is registered with ClinicalTrials.gov under the identifier NCT04607941.

**Keywords** Vaccination, Health behavior, Personality, Psychological attitudes, 7C antecedents

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## Background

Vaccination is globally recognised as an essential strategy for improving health outcomes [1]. The success and effectiveness of vaccination campaigns depend not only on vaccine efficacy and safety, but also on vaccine acceptance among the population. Vaccine hesitancy is the term used to describe refusal, delay, or doubt regarding the acceptance of recommended and accessible vaccinations [2]. This phenomenon is multifaceted and is associated with socio-demographic, cultural, and psychological factors [3, 4]. It is encountered to varying degrees in most populations, with different vaccines and a variable set of contributing factors [5]. Despite efforts to produce safe and effective COVID-19 vaccines and to make them easily accessible to all population groups, vaccine hesitancy has posed a significant challenge to the rollout of COVID-19 vaccination campaigns in many countries, with difficulties for public health systems to understand the phenomenon and respond with adapted vaccine promotion strategies [6].

Initially, the three antecedents of vaccine hesitancy—confidence in vaccines, complacency, and convenience—formed the 3C model [2]. This model was expanded to include the calculation of vaccination's benefit-risk balance and collective responsibility, resulting in the 5C model [7].

This 5C model has been found to predict vaccination intentions for various vaccines, including those against influenza, pneumococcal disease, shingles, HPV, and COVID-19 [8, 9].

More recently, a more comprehensive 7C model, which includes confidence in the wider system (reactance) and social conformism, has been shown to explain population variance in COVID-19 and HPV vaccine intention and status [10, 11]. Using data from a large sample of adults in France, we found that a simple questionnaire on the 7C psychological antecedents explained 58.9% and 23.4%, respectively, of the variance in at-least-one-dose and up-to-date vaccination status during the COVID-19 vaccination campaign in France [12]. This extended 7C model refers to the framework of vaccine hesitancy [2] or vaccine readiness [13]. These models aim at representing the various dimensions of psychological factors that are associated with and even appear to determine individuals' intention to get vaccinated and their likelihood of being vaccinated [13].

Despite this substantial evidence, two weaknesses surround the concept of psychological antecedents. First, there is no prospective evaluation available. As such, the possibility of an inverse association cannot be excluded, where vaccine intention or decisions would influence responses to questionnaire items regarding vaccination. Secondly, it remains unclear whether an

individual's attitudes captured by the 7C psychological antecedents are specific to vaccination or actually an expression of underlying personality traits. This distinction is crucial because personality traits are difficult to influence or consider in individual or official communications, as discussed by several studies and reviews on the stability of personality traits in adulthood [14, 15]. Personality traits have been associated with a range of preventive health behaviours, including vaccination [16]. While both personality traits and the 7C antecedents are important concepts that have been related to health behaviours and vaccination, no study to date has explored the how the 7C model may be tied to personality traits.

On the other hand, knowledge and attitude factors related to vaccination, rather than personality, may be easier to influence and more accessible for optimised health education and vaccine promotion, as suggested by previous studies [17, 20].

The five-factor model of personality, commonly known as the Big Five, has been extensively employed in psychological research to assess and compare personality traits. It categorises an individual's personality into five key dimensions: Neuroticism (as opposed to emotional stability), Extraversion, Openness to experience, Agreeableness, and Conscientiousness. Since its formulation by American psychologist Donald W. Fiske in 1949 [19] and empirical work by Lewis Goldberg (1981) [20] and Costa and McCrae (1985–1992) [21], the “Big Five” framework has been and is still widely used for characterising individuals' personalities and studying behaviours. Personality traits, as measured by the Big Five, tend to be relatively stable in adulthood [22–24], with little average changes over time and across different age groups. Evolutions in intraindividual personality are generally unrelated to specific experiences or adverse life events, such as disease [23].

Personality traits, assessed by the Big Five questionnaire, have been associated with a range of health outcomes and preventative behaviours. In longitudinal studies, these traits have been identified as predictors of all-cause mortality risk [25] and risk factors of many diseases, including stroke and coronary heart disease [26]. Among these traits, low conscientiousness appears as the most robust personality correlate of poor health, linked to several diseases and unhealthy behaviours [27, 28]. High extraversion and high neuroticism are also associated with unhealthy behaviours, but less so with chronic diseases [29]. Moreover, there is some evidence that low agreeableness and low openness predict health outcomes in longitudinal studies, such as reduced physical activity frequency [30] and increased risk of Alzheimer's disease [31].

Despite existing research that has primarily focused on the relationship between the Big Five personality traits and health behaviours, there has been relatively limited investigation into the association between personality traits and vaccination acceptance and uptake. Existing studies have yielded mixed results about the connections between personality traits and vaccination. While some investigations have suggested negative associations with vaccine behaviours (e.g., for high extraversion [32]), others have found positive correlations (e.g., for high agreeableness [33]), and some have reported no significant associations [34]. In the United States, results from a nationally representative sample indicated that individuals with higher levels of agreeableness, conscientiousness, and emotional stability (i.e., lower neuroticism) were more likely to agree that vaccination is beneficial [35].

Nonetheless, the field of research on personality and vaccination has recently been accelerated by public discussions during the COVID-19 pandemic. A 2024 systematic review and meta-analysis presented a convincing picture of notable, although modest, effects of personality traits on vaccination [16]. Individuals with higher levels of agreeableness [36] and extraversion, and lower levels of neuroticism were found to have more positive attitudes towards vaccination. Those high in openness showed stronger intentions to vaccinate. Additionally, open and agreeable people had more positive views on novel COVID-19 vaccines [39]. Another 2024 study suggested that vaccination status, number of vaccine doses, and vaccination timing may be predicted from personality traits [37].

Vaccine uptake and attitudes might predict other health outcomes (beyond the specific disease the vaccine prevents) and general health, as health literacy is related to both vaccination and other health outcomes. Associations have been found between low health literacy and more hospitalizations, increased use of emergency care, lower rates of mammography screening and influenza vaccination, and poorer ability to correctly take medications and interpret labels and health messages [38]. In addition, research has explored the link between personality traits and health outcomes, suggesting that traits like conscientiousness can influence both vaccination behaviour and general health [39].

Based on existing research, we expected the following associations between personality traits and vaccination behaviours:

1. A positive, albeit small, association between conscientiousness, openness, agreeableness, extraversion and vaccination behaviours.
2. A negative association between neuroticism and vaccination behaviours.

We expected conscientiousness to be positively associated with vaccination behaviours, as it encompasses traits such as self-discipline, reliability, and diligence [40]. Conscientious individuals may also be better at anticipating and preparing for future adversities and more organised. These qualities may make them more likely to decide on receiving COVID-19 vaccination and to attend their vaccine appointment.

Openness to experience refers to cognitive and behavioural flexibility, cultured tendencies, and an awareness of internal and external events and experiences [41]. These factors likely contribute to the prevention of avoidable health problems and enhance adaptive disclosure of health concerns, health decision-making, and problem management [39]. They may also make individuals more likely to accept novel vaccinations such as COVID-19 vaccines.

Extraversion includes inclinations towards positive mood, sociability, and an active lifestyle characterised by engagement and busyness [42]. As such, individuals with higher levels of extraversion may be more likely to vaccinate to enjoy sociable activities, especially in a period when movement and leisure restrictions applied to non-vaccinated individuals.

We expected agreeableness to be positively associated with vaccination behaviours, as it combines traits that contribute to fostering interpersonal harmony, including trust, honesty, compliance, deference, altruism, and compassion for others [23]. Given the prosocial nature of COVID-19 vaccination, individuals with higher agreeableness levels might be more likely to vaccinate.

We expected neuroticism to be negatively associated with vaccination behaviours, as it refers to instability [43] and focuses on chronic experiences of negative emotions like anxiety, depression, and anger [23]. Neuroticism also relates to vulnerability, with feelings of being unable to effectively cope with life's challenges. It is considered to have broad public health significance due to its association with numerous negative outcomes [44, 45]. However, some studies have also reported negative findings [46] or even a positive association between neuroticism and health outcomes [47]. To resolve these seemingly conflicting findings, Friedman has proposed a theory distinguishing between "healthy" and "unhealthy" neuroticism [48]. "Healthy" neuroticism includes tendencies which may encourage engagement in preventive health behaviours, such as vaccination, to alleviate concerns about developing chronic health issues. This may be true of individuals with higher levels of anxiety but without significant issues of poor self-esteem, vulnerability, or depressive moods.

In addition, a strong and consistent associations have been documented between the 7C psychological

antecedents and vaccination intentions [11] and behaviours [14], while associations between personality traits and vaccination remain small. Therefore, we expected the relationships between the 7C antecedents and COVID-19 vaccination behaviours to only be modestly explained by underlying personality traits.

In this article, we evaluate the association between personality traits and COVID-19 vaccine behaviours among the adult population in France in 2022. We also investigate whether the association between the 7C psychological antecedents and COVID-19 vaccination behaviours is explained by underlying personality traits.

Our study introduces a hypothetical model in which personality traits, as evaluated by the Big Five questionnaire, precede the 7C antecedents of vaccination readiness. Consequently, personality traits may serve as confounders in the documented association between the 7C antecedents and vaccine behaviours [13]. This constellation is based on the hypothesis that personality traits impact or are the cause of both vaccine behaviours and the 7C antecedents (Fig. 1). Thus, we investigate the potential association between personality traits and vaccination behaviours, as well as the hypothetical confounding role of personality traits in the association between the 7C antecedents and vaccine behaviours.

**Methods**

**Study design, participant enrolment and data collection**

We analysed data of the “ComCor” case–control study, the methods of which have been previously described [49]. Briefly, between 2020 and 2022, adults with recent SARS-CoV-2 infection were recruited as cases by the French national health insurance agency. Controls were recruited from a national panel as non-infected adults matched to cases by age, sex, region, population density, and calendar week. Additional participants were recruited as cases’ relatives. For all participants, the

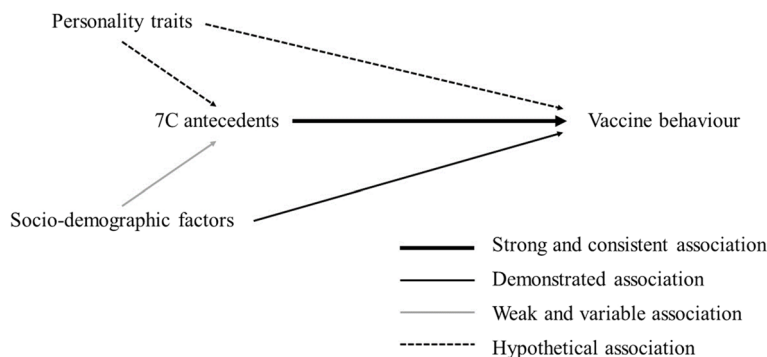
“ComCor” questionnaire collected information on sociodemographic factors, SARS-CoV-2 infection history, and detailed self-reported COVID-19 vaccination history, including vaccination dates and dose numbers. Between 24 February 2022 to 19 June 2022, upon completion of the “ComCor” questionnaire, participants were invited to complete a self-administered “Cognitiv” questionnaire, which assessed personality traits using the Big Five questionnaire and current 7C attitudes towards COVID-19 vaccination (Appendix 1).

The “ComCor” study received ethical approval by the Comité de Protection des Personnes Sud Ouest et Outre Mer 1 on 21 September 2020. The addition of the “Cognitiv” questionnaire received ethical approval by the Comité de Protection des Personnes Sud Ouest et Outre Mer 1 on 1 February 2022. The data protection authority Commission Nationale de l’Informatique et des Libertés (CNIL) authorised the processing of data on 21 October 2020. The study is registered with ClinicalTrials.gov under the identifier NCT04607941.

**Questionnaires**

Individuals’ attitudes towards COVID-19 vaccination were assessed using a short form of the 7C questionnaire previously described by Moirangthem and colleagues (2022) [11]. This questionnaire was adapted to the general adult population and the COVID-19 vaccination context in 2022, with each antecedent domain reduced to a single item. Response modalities were mostly coded on 5-point Likert scales (Completely disagree to Completely agree), with an indecision option as the central modality. In addition, participants could refuse to respond to individual items.

We used the French version of the Big Five Inventory (BFI-Fr) to evaluate personality traits [19, 50, 51, 23]. The BFI-Fr is a reliable and effective tool for assessing individual differences in the five major dimensions of personality



**Fig. 1** Associations between the 7C psychological antecedents, personality traits, and COVID-19 vaccination behaviours. Dotted arrows represent hypothetical associations

[52], that are neuroticism (mean of 8 items, including 3 reversed), extraversion (mean of 8 items, including 3 reversed), conscientiousness (mean of 9 items, including 4 reversed), openness (mean of 10 items, including 2 reversed), and agreeableness (mean of 10 items, including 5 reversed). “Following the example of previous studies [26, 53], personality traits were recoded into three categories based on terciles to obtain categories of low, medium, and high levels of these variables” Cronbach’s alpha coefficients, which measure the internal coherence, have been described as, respectively, 0.82, 0.75, 0.80, 0.82, and 0.74 for the five dimensions of extraversion, agreeableness, conscientiousness, neuroticism, and openness [55].

Socio-demographic factors included age category (18–28, 29–38, 39–48, 49–58, 59–68, and 69+), sex (male or female), diploma category (below Bacculaureate, Bacculaureate or equivalent, 2 to 4 years of study after Bacculaureate, and 5+ years of study after Bacculaureate), professional category (employee, independent profession, senior executive, intermediate profession, farmer, blue-collar worker, pensioner, student, and inactive), country of birth (France, abroad, and not answered), and comorbidity (no comorbidity, 1+ comorbidity, and not answered). The description of participant characteristics (sociodemographic, comorbidities, the 7C psychological antecedents, and personality traits), by outcome status is provided in Supplementary Table 3.

### Statistical analyses

In our analyses, grounded in epidemiological theory, we developed three regression models predicting vaccine behaviours. Model 0 included the five domains of the Big Five personality traits as independent variables. Model 1 comprised the seven domains of the 7C antecedents as independent variables. Model 2 integrated both the 7C antecedents and the Big Five personality traits. We examined two aspects: 1) in Model 0, the effect size of each domain of the Big Five personality traits, and 2) the comparison between Models 1 and 2 coefficients to determine if the effect estimates of the 7C antecedents substantially decreased in Model 2, which would suggest a confounding constellation. These models were not adjusted for socio-demographic characteristics or the presence of comorbidities. However, in sensitivity analyses, we explored potential confounding roles by including age category, sex, diploma category, professional category, country of birth, and comorbidities.

We defined three outcomes based on COVID-19 vaccination history: at-least-one-dose vaccination status was coded as a binary variable with No dose (0) and One dose or more (1); up-to-date vaccination status was coded as a binary variable with One or two doses without

infection (0) and Two doses with infection, three doses or more (1); and “uptake speed” referred to the time to vaccination, that is, the delay between the date of age- and comorbidity-specific vaccine eligibility and the date of the first dose receipt (if not previously infected). Eligibility dates varied for different ages and comorbidities (see Appendix 2).

We assessed the determinants of at-least-one-dose and up-to-date vaccination status using multivariable logistic regression models, and the determinants of uptake speed using Cox proportional hazard models. To investigate the association between personality traits and vaccine behaviours, we built Models 0, with personality traits as independent variables and vaccine behaviours as dependent variables. To evaluate whether the associations between the 7C antecedents and vaccination behaviours were confounded by personality traits, we established base models with the 7C psychological antecedents (Models 1) and subsequently introduced personality traits (Models 2).

As shown in Lièvre and colleagues (Submitted for publication) [13], the Odds Ratios (OR) were not significantly different between models incorporating only the 7C antecedents and models encompassing both the 7C antecedents, sociodemographic factors, and comorbidities. We conducted sensitivity analyses involving sociodemographic factors and comorbidities to explore the differences between models that included or excluded these variables. Initially, participants recruited as cases, controls, and relatives were analysed separately. However, because the determinants of vaccine uptake showed similar associations across cases, controls, and relatives, we present results that combine the three groups.

We show exact *P*-values and use  $P < 0.05$  as the definition of statistical significance for the narrative presentation of results. All statistical analyses were performed using Stata 17.0 (StataCorp, College Station, TX, USA).

### Results

A total of 49,200 (30.4%) eligible “ComCor” participants completed the “Cognitiv” questionnaire, including 44,881 cases, 3,099 controls, and 1,220 relatives. COVID-19 vaccine coverage was 95.0% for at-least-one-dose and 87.8% for up-to-date vaccination status. Supplementary Table 3 shows the description of participant characteristics (sociodemographic factors, comorbidities, the 7C psychological antecedents, and personality traits) by outcome status.

The associations between personality traits and vaccination behaviours were initially analysed without adjustment on sociodemographic factors and comorbidities. Neuroticism (high vs. low levels), agreeableness (high and intermediate vs. low levels), and conscientiousness (high vs. low levels) were significantly

and moderately associated with at-least-one-dose vaccination status (OR=1.32, OR=1.20, and OR=1.22, respectively; Table 1). Openness and extraversion were not associated with at-least-one-dose vaccination status. Openness was the only personality trait to be significantly associated with up-to-date vaccination status (OR=0.89; Supplementary Table 4). Extraversion and agreeableness were significantly and weakly associated with uptake speed (OR=0.94 and OR=0.96, respectively; Supplementary Table 5).

All 7C antecedent items were significantly associated with at-least-one-dose vaccination status in Model 1 (Table 2): the strongest effect sizes (most vaccine-favourable vs. least vaccine-favourable attitude level) were observed for collective responsibility (perception of COVID-19 vaccination as a collective action, OR=14.44), calculation (perception of more benefits than risks with COVID-19 vaccination, OR=10.29), and confidence in systems (positive perception of

the government's incitation to get vaccinated against COVID-19, OR=8.94; Table 1). Weaker effect sizes were observed for confidence in vaccines (absence of fear of vaccination side effects, OR=3.70) and low complacency (fear of severe forms of COVID-19, OR=1.87). Two antecedents showed particular associations with at-least-one-dose vaccination status: first, indecision regarding access convenience (perception of no practical difficulties to get an appointment) was associated with lower vaccine uptake (OR=0.06). Secondly, describing a favorable majority opinion towards COVID-19 vaccination in one's close social environment (antecedent item referring to social conformism) was negatively associated with at-least-one-dose vaccination status (OR=0.69).

In Models 2, the inclusion of all five personality traits did not substantially alter the magnitude of the effect estimates of the association between the 7C antecedents and vaccination outcomes, with differences between effect sizes of Models 1 and 2 being < 5% (Table 2 for at-least-one-dose vaccination status, Supplementary Table 6 for up-to-date vaccination status, and Supplementary Table 7 for uptake speed). Sensitivity analysis excluding socio-demographic characteristics and comorbidities yielded similar results (Supplementary Table 8 for at-least-one-dose vaccination status, Supplementary Table 9 for up-to-date vaccination status, and Supplementary Table 10 for uptake speed). The inclusion of personality traits individually did not either substantially alter the effect estimates of the association between the 7C antecedents and vaccination outcomes (Supplementary Table 11 for at-least-one dose vaccination status, data for up-to-date vaccination status and uptake speed not shown).

In Models 2, two personality traits significantly contributed to the explanation of at-least-one-dose vaccination status (highest vs. lowest category): neuroticism (OR=1.68) and openness (OR=0.77; Table 2). Similar results were observed for up-to-date vaccination status (Supplementary Table 6), with neuroticism (highest vs. lowest category, OR=1.36) and openness (highest vs. lowest category, OR=0.68) significantly contributing to the explanation of up-to-date vaccination status. Agreeableness (highest vs. lowest category, HR=0.92) and openness (highest vs. lowest category, HR=0.94) significantly contributed to the explanation uptake speed (Supplementary Table 7).

## Discussion

In this study, conducted in a large sample of adults in France in early 2022, we found that the strong association between the 7C antecedents and vaccine behaviours was not confounded by personality traits. Personality traits showed a weak-to-moderate and variable association

**Table 1** Associations between personality traits and at-least-one-dose COVID-19 vaccination status among 49,019 adults. Non-adjusted for sociodemographic factors and comorbidities. Cognitiv study. France, 24 February 2022—19 June 2022 (N=49,019 adults)

At-least-one-dose vaccination status				
	N	OR	95% Confidence Interval	p-value
<b>Neuroticism</b>				
Low neuroticism	15,497	1.00	-	-
Intermediate neuroticism	18,430	1.08	0.98–1.19	0.138
High neuroticism	15,092	1.32	1.18–1.47	<0.001
<b>Agreeableness</b>				
Low agreeableness	15,133	1.00	-	-
Intermediate agreeableness	13,750	1.24	1.11–1.37	<0.001
High agreeableness	20,136	1.20	1.09–1.33	<0.001
<b>Openness</b>				
Low openness	17,555	1.00	-	-
Intermediate openness	14,523	1.08	0.97–1.19	0.147
High openness	16,941	1.04	0.94–1.14	0.489
<b>Extraversion</b>				
Low extraversion	15,430	1.00	-	-
Intermediate extraversion	19,610	0.94	0.85–1.04	0.226
High extraversion	13,979	0.90	0.80–1.00	0.060
<b>Conscientiousness</b>				
Low conscientiousness	18,944	1.00	-	-
Intermediate conscientiousness	12,223	1.09	0.99–1.21	0.088
High conscientiousness	17,852	1.22	1.10–1.34	<0.001

Reading grid: The OR of the association between neuroticism and at-least-one-dose vaccination status was 1.08 (n.s.) for individuals with intermediate levels of neuroticism

**Table 2** Associations between the 7C antecedents and at-least-one-dose COVID-19 vaccination status among 49,019 adults without (Model 1) and with (Model 2) adjustment on personality traits. Both models are adjusted for sociodemographic factors and comorbidities. Cognitiv study, France, 24 February 2022—19 June 2022 (N = 49,019 adults)

At-least-one-dose vaccination status		Model 1 without adjustment			Model 2 adjusting for personality traits		
N		OR	95% Confidence Interval	p-value	OR	95% Confidence Interval	p-value
3,070	Completely disagree	1.00	-	-	1.00	-	-
2,509	Rather disagree	2.14	1.81–2.53	<0.001	2.15	1.86–2.62	<0.001
6,328	Does not know	4.53	3.81–5.38	<0.001	4.45	3.80–5.40	<0.001
10,598	Rather agree	14.88	11.06–20.01	<0.001	14.66	11.14–20.27	<0.001
25,712	Completely agree	10.29	7.53–14.05	<0.001	10.32	7.75–14.53	<0.001
802	Not answered	3.37	2.25–5.05	<0.001	3.50	2.31–5.24	<0.001
2,778	Completely disagree	1.00	-	-	1.00	-	-
2,153	Rather disagree	1.27	1.07–1.50	0.006	1.26	1.10–1.55	0.003
2,858	Does not know	2.08	1.74–2.49	<0.001	2.09	1.83–2.65	<0.001
8,875	Rather agree	4.25	3.47–5.21	<0.001	4.31	3.73–5.67	<0.001
31,427	Completely agree	14.44	10.72–19.45	<0.001	14.58	11.59–21.28	<0.001
928	Not answered	2.66	1.82–3.87	<0.001	2.66	2.00–4.32	<0.001
<b>Confidence in systems (positive perception of the government's incitation to get vaccinated against COVID-19)</b>							
3,026	Deters from vaccination	1.00	-	-	1.00	-	-
21,029	No effect	1.35	1.19–1.54	<0.001	1.37	1.20–1.57	<0.001
24,964	Encourage vaccination	8.94	6.51–12.27	<0.001	8.89	6.23–11.95	<0.001
<b>Confidence in vaccines (absence of fear of COVID-19 vaccination side effects)</b>							
4,895	Completely disagree	1.00	-	-	1.00	-	-
7,390	Rather disagree	1.72	1.48–2.00	<0.001	1.75	1.51–2.04	<0.001
7,960	Does not know	2.65	2.18–3.21	<0.001	2.73	2.25–3.32	<0.001
12,657	Rather agree	3.77	2.96–4.80	<0.001	3.95	3.09–5.04	<0.001
15,803	Completely agree	3.70	2.95–4.64	<0.001	3.87	3.08–4.85	<0.001
314	Not answered	1.49	1.01–2.21	0.046	1.50	1.00–2.23	0.048
<b>Social conformism (majority opinion towards COVID-19 vaccination in one's close social environment)</b>							
1,815	Very skeptical	1.00	-	-	1.00	-	-
3,379	Rather skeptical	0.84	0.69–1.02	0.075	0.83	0.71–1.05	0.152
9,331	Equal share of skeptical and favourable	0.69	0.57–0.82	<0.001	0.69	0.61–0.87	<0.001



**Table 2** (continued)

At-least-one-dose vaccination status		Model 1 without adjustment			Model 2 adjusting for personality traits		
N	OR	95% Confidence Interval	p-value	OR	95% Confidence Interval	p-value	
Rather favourable	20,073	0.72	0.59–0.88	0.001	0.71	0.61–0.92	0.005
Very favourable	14,421	0.69	0.52–0.93	0.013	0.69	0.54–0.98	0.036
<b>Convenience (perception of no practical difficulties to get an appointment for COVID-19 vaccination)</b>							
Completely disagree	1,098	1.00	-	-	1.00	-	-
Rather disagree	3,506	1.90	1.03–3.50	0.041	1.88	1.02–3.49	0.044
Does not know	2,383	0.06	0.04–0.10	<0.001	0.06	0.04–0.10	<0.001
Rather agree	11,049	0.60	0.37–0.98	0.040	0.60	0.36–0.98	0.040
Completely agree	30,318	0.40	0.25–0.64	<0.001	0.40	0.25–0.65	<0.001
Not answered	665	0.05	0.03–0.08	<0.001	0.05	0.03–0.08	<0.001
Completely disagree	9,051	1.00	-	-	1.00	-	-
Rather disagree	11,966	0.98	0.83–1.16	0.836	0.97	0.85–1.19	0.907
Does not know	7,511	1.30	1.08–1.56	0.005	1.26	1.05–1.52	0.015
Rather agree	11,620	1.60	1.32–1.94	<0.001	1.51	1.29–1.91	<0.001
Completely agree	8,470	1.87	1.49–2.34	<0.001	1.72	1.40–2.21	<0.001
Not answered	401	1.17	0.75–1.82	0.501	1.13	0.73–1.79	0.570
<b>Personality traits</b>							
<b>Neuroticism</b>							
Low neuroticism	15,497	-	-	-	1.00	-	-
Intermediate neuroticism	18,430	-	-	-	1.17	1.02–1.35	0.028
High neuroticism	15,092	-	-	-	1.68	1.43–1.98	<0.001
<b>Agreeableness</b>							
Low agreeableness	15,133	-	-	-	1.00	-	-
Intermediate agreeableness	13,750	-	-	-	0.94	0.81–1.10	0.439
High agreeableness	20,136	-	-	-	0.88	0.76–1.02	0.091
<b>Openness</b>							
Low openness	17,555	-	-	-	1.00	-	-

**Table 2** (continued)

	N	Model 1 without adjustment		Model 2 adjusting for personality traits		
		OR	95% Confidence Interval	OR	95% Confidence Interval	p-value
Intermediate openness	14,523	-	-	0.81	0.70–0.94	0.004
High openness	16,941	-	-	0.77	0.66–0.89	<0.001
<b>Extraversion</b>						
Low extraversion	15,430	-	-	1.00	-	-
Intermediate extraversion	19,610	-	-	1.11	0.96–1.28	0.154
High extraversion	13,979	-	-	1.21	1.03–1.42	0.020
<b>Conscientiousness</b>						
Low conscientiousness	18,944	-	-	1.00	-	-
Intermediate conscientiousness	12,223	-	-	1.09	0.94–1.26	0.275
High conscientiousness	17,852	-	-	1.16	1.01–1.34	0.041

Reading grid: The OR of the association between calculation and at least-one-dose vaccination status was 2.14 for individuals who rather disagreed with the proposal “vaccination has more benefits than risks for me” in a simple model with only the 7C antecedents, sociodemographic factors, and comorbidities. This OR did not substantially change in a model with the 7C antecedents, sociodemographic factors, comorbidities, and personality traits (OR = 2.15)

with COVID-19 vaccination behaviours. Our results suggest that the influence of the 7C antecedents on vaccine behaviours is independent of personality traits (Fig. 2).

### The 7C antecedents, more than an expression of personality

All 7C antecedent items were significantly associated with at-least-one-dose vaccination status. Previous studies have also documented a strong association of the 7C psychological antecedents, all of which significantly contribute to the intention and uptake of various vaccines [11, 13]. In particular, we found an outstanding role of confidence in system, collective responsibility, and calculation in vaccine decisions, for all three outcomes [12]. While it is intuitive that the fear of side effects impacts vaccine acceptance, the finding that seven different dimensions play a role is surprising, underscoring the complexity of vaccine decision-making. Therefore, the development and evaluation of interventions to enhance vaccine promotion must be based on a comprehensive model that incorporates, at a minimum, the seven domains of the 7C antecedents.

The primary result of this study is that personality traits are not involved in the strong association between the 7C antecedents and COVID-19 vaccination behaviours. This implies that attitudes related to the 7C antecedents exert a direct and independent effect on COVID-19 vaccination behaviours, regardless of individuals' personality traits. Personality traits are considered to be relatively stable within individuals over time [18, 54] and are resistant to change through interventions [55]. The fact that they exhibit little association with vaccine behaviours is, therefore, an encouraging finding, as it suggests potential opportunities for interventions. Conversely, the 7C antecedents may exhibit more variability over time, although no longitudinal observations are currently available to confirm how they evolve over time, and whether increased knowledge translates into improved attitudes. Nonetheless, attitudes and knowledge related to the 7C antecedents could potentially be influenced by appropriate interventions. Further psychometric analyses of data on personality traits, the 7C antecedents, and vaccine intention or behavior should delve into the intricate mechanisms at play. This exploration could offer valuable insights to guide the development of effective interventions.

### Personality traits and vaccination

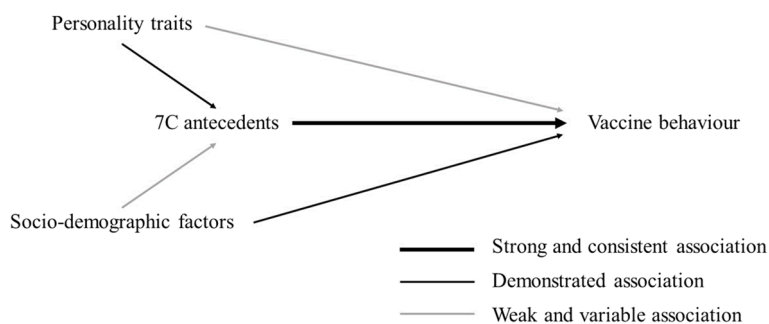
Our findings, which reveal weak-to-moderate associations between personality traits and vaccine behaviours, indicate that personality traits play a more distal role in vaccination behaviours compared to the 7C antecedents. This is consistent with two recent studies that reported

weak associations between higher levels of neuroticism and increased COVID-19 vaccination rates (ecological level) or vaccine intention (individual level) [56, 57]. Interestingly, we observed the association between neuroticism and vaccination behaviours even after adjusting for the 7C antecedents. For individuals with neurotic tendencies, characterised by a relatively stable inclination towards experiencing negative emotions, anxiety, and low stress tolerance [58], the fear of contracting COVID-19 may outweigh concerns about potential vaccine side effects.

The association between agreeableness and conscientiousness and being up to date with vaccinations aligns with a 2016 nationally representative survey on individual perceptions of vaccination among school-age children in the US. This survey found that higher levels of conscientiousness and agreeableness were significantly correlated with positive attitudes towards vaccination, even after controlling for demographic factors [35]. Lee and colleagues (2017) also reported that individuals with higher levels of conscientiousness and agreeableness, but lower levels of openness, displayed stronger confidence in vaccines [59]. In the Big Five model, low conscientiousness appears as the most robust personality correlate of poor health [24]. Regarding the specific case of SARS-CoV-2, higher agreeableness scores were associated with a higher probability of adhering to the COVID-19 vaccination program [60]. Recent studies have also documented associations between lower levels of conscientiousness and COVID-19 vaccine hesitancy [61], as well as conscientiousness-related traits and attitudes and behaviours related to COVID-19 vaccination [62].

### Public health implications

The results of our study have notable implications for public health. They show that the 7C psychological antecedents are independently associated with various vaccine behaviors, including the speed of vaccine uptake during an epidemic-response vaccine campaign. This finding holds particular relevance for epidemic preparedness plans, in situations where rapid vaccine uptake is essential. As the impact of the 7C psychological antecedents on vaccine behaviours is not the expression of personality traits, these antecedents may be amenable to modification through appropriate information and vaccine promotion efforts. Specifically, efforts aimed at improving knowledge and attitudes related to collective responsibility, calculation, and confidence in systems may yield valuable results. Previous research suggested that interventions could indeed be effective for individuals who engage in calculated decision-making [63]. Explaining the concept of herd immunity can also increase



**Fig. 2** Associations between the 7C psychological antecedents, personality traits, and COVID-19 vaccination behaviour

people’s willingness to vaccinate by emphasizing collective responsibility [64].

However, changing such attitudes can be challenging, especially in emergency situations, and may necessitate broader, long-term approaches to enhance vaccine-related literacy, attitudes, and trust within society before epidemics emerge. Our study focuses on vaccine uptake within the context of strong incentives imposed by the COVID-19 health pass requirement in France, and future research should also investigate the long-term effects of such incentive policies on vaccine antecedents.

**Limitations**

This study has several limitations. Firstly, the sample is not representative of the adult population in France in 2022, despite the large sample size of the study. Infected participants were recruited nationwide among all persons with social security undergoing testing, and non-infected participants were selected from a panel by a market and public opinion research company, matched to infected participants on age, sex, region, population size of area of residence, and calendar week. In consequence, participants characteristics such as willingness to participate in a study, computer literacy, and access to a computer differed between our study population and the source population. Previous analyses of the study population have shown that both infected and non-infected respondents tended to be younger, included a higher proportion of women, and were wealthier compared to the source population [65]. In addition, 95% of our sample had received at least one dose of COVID-19 vaccine, which is higher than vaccine coverage in the general French adult population (92.4%). In consequence, prevalence estimates (e.g., vaccination rates) are prone to selection bias and should be interpreted with caution. Associations between determinants and vaccine behaviour are usually less biased by such selection, but their extrapolation to the entire population should recognise a limited generalisability. Secondly, the data collection was cross-sectional, and we

cannot exclude that individuals’ vaccine experience influenced their responses to the 7C attitude items. Thirdly, the Big Five personality assessment is self-reported. As such, responses might be influenced by the respondents’ social desirability biases. In addition, the Big Five personality assessment may capture pathological conditions, as neuroticism has frequently been associated with pathology and mental health conditions, including depression and anxiety disorders [66]. Lastly, the large sample size of this study can lead to statistically significant results even when the practical significance of the effects is limited.

**Conclusions**

The current research indicates that the 7C psychological antecedents of vaccination impact vaccine behaviours independently from personality traits, and therefore, they may be amenable to appropriate interventions. Further research should explore how psychological antecedents – or their association with vaccine behaviours – can be positively influenced to increase and accelerate vaccine uptake during epidemics.

**Supplementary Information**

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-21364-9>.

Supplementary Material 1.

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**Authors’ contributions**

GL, JEM, AF, SG, TC, and JS designed the study. SG, TC, and AF developed the “ComCor” questionnaire on vaccination history and sociodemographic factors. GL, JEM, and JS developed the “Cognitiv” questionnaire including psychological antecedents of vaccination. GL performed the statistical analyses. GL drafted the first version of the manuscript. All authors read and approved the final manuscript.

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#### Data availability

The data that support the findings of this study are available from Institut Pasteur. Restrictions apply to the availability of these data, which were used under authorised agreement for this study from the data protection authority, the Commission Nationale de l'Informatique et des Libertés (CNIL). Access to these pseudonymized data would therefore require prior authorisation by the CNIL.

#### Declarations

##### Ethics approval and consent to participate

All protocols were approved. The "ComCor" study received ethical approval by the Comité de Protection des Personnes Sud Ouest et Outre Mer 1 on 21/09/2020. The addition of the "Cognitiv" questionnaire received ethical approval by the Comité de Protection des Personnes Sud Ouest et Outre Mer 1 on 01/02/2022. The data protection authority Commission Nationale de l'Informatique et des Libertés (CNIL) authorised the processing of data on 21/10/2020. The study is registered with ClinicalTrials.gov under the identifier NCT04607941. Informed consent was obtained from all participants.

##### Consent for publication

Not applicable.

##### Competing interests

The authors declare no competing interests.

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