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# Trait reactance as psychological motivation to reject vaccination: Two longitudinal studies and one experimental study

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**Abstract**

Anti-science attitudes can be resilient to scientific evidence if they are rooted in psychological motives. One such motive is trait reactance, which refers to the need to react with opposition when one's freedom of choice has been threatened. In three studies, we investigated trait reactance as a psychological motivation to reject vaccination. In the longitudinal studies ($n = 199$; 293), we examined if trait reactance measured before the COVID-19 pandemic was related to people's willingness to get vaccinated against COVID-19 up to 2 years later during the pandemic. In the experimental study ($n = 398$), we tested whether trait reactance makes anti-vaccination attitudes more resistant to information and whether this resistance can be mitigated by framing the information to minimize the risk of triggering state reactance. The longitudinal studies showed that higher trait reactance before the COVID-19 pandemic was related to lower willingness to get vaccinated against COVID-19. Our experimental study indicated

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that highly reactant individuals' willingness to vaccinate was unaffected by the amount and framing of the information provided. Trait reactance has a strong and durable impact on vaccination willingness. This highlights the importance of considering the role of trait reactance in people's vaccination-related decision-making.

**KEYWORDS**
reactance, state reactance, trait reactance, vaccination, vaccine hesitancy

## INTRODUCTION

The fact that some individuals are unwilling to get vaccinated despite a strong medical consensus for vaccination poses a challenge for public health because preventable infectious diseases may fail to be controlled if vaccine uptake is compromised. It is therefore crucial to understand the factors underlying vaccine hesitancy and how the safety and efficacy of vaccines can be communicated to hesitant individuals.

Vaccination refusal is more likely among individuals who perceive vaccines as unavailable, unaffordable, unnecessary, unsafe, and ineffective (Betsch et al., 2018; MacDonald et al., 2015). A prevailing perspective is that these anti-vaccination attitudes are due to a lack of accurate information (Hornsey et al., 2018; MacDonald et al., 2015). However, the fact that educational interventions have turned out to have only a minor impact on vaccine acceptance, indicates that this explanation may be at least partly incorrect (Brewer et al., 2017). An alternative perspective, the *attitude roots model* (Hornsey, 2020; Hornsey & Fielding, 2017), posits that persistent anti-science attitudes may be rooted in psychological motives, such as fears, worldviews,

ideologies, and identities. These psychological motives, or "roots," make anti-science attitudes resistant to scientific evidence. For example, a person may disagree with the scientific consensus around vaccination because they distrust the sources (e.g. health authorities and scientists) that provide vaccine-related information. Therefore, any attempt by others to change the individual's attitudes by presenting scientific evidence may fail if it does not consider how to align this evidence with the individual's underlying distrust. To make health communication more efficient, it is important to increase our understanding of these underlying psychological roots and the degree to which they make anti-vaccination attitudes resistant to scientific evidence and health communication efforts.

With the attitude roots model (Hornsey & Fielding, 2017) as the starting point, the present study investigates trait reactance as psychological motivation to reject vaccinations. Psychological reactance theory (Brehm & Brehm, 1981) suggests that people react with negative emotions, or oppositional attitudes and behaviors, when they feel that something threatens their personal freedom. This feeling can arise for example in response to persuasion, recommendations, rules, or regulations (Brehm & Brehm, 1981; Rosenberg & Siegel, 2018; Steindl et al., 2015). Reactance is typically measured either as a *state* or a *trait*. State reactance refers to the momentary reaction triggered by a situation that is perceived as freedom-threatening, whereas trait reactance is an individual's proneness to experience state reactance (Quick et al., 2011).

We conducted three studies—two longitudinal and one experimental—to investigate the link between trait reactance and vaccination willingness. We first sought to longitudinally test the premise that reactance is a root that underlies vaccination refusal. More specifically, in two longitudinal studies (Study 1 and Study 2), we examined to what degree people's level of trait reactance measured *before* the COVID-19 pandemic predicted their willingness to get the COVID-19 vaccine up to 2 years later, *during* the pandemic. To the best of our knowledge, there is no earlier longitudinal work that investigates whether trait reactance predicts subsequent vaccination willingness. The only previous study with a longitudinal approach focuses on state reactance (Verpaalen et al., 2023). The results from that study indicated that higher state reactance to government measures during the COVID-19 pandemic in 2021 predicted lower vaccination intentions later the same year. Several cross-sectional studies have shown that people with higher trait reactance are more likely to have negative attitudes to vaccines (Holford et al., 2023; Hornsey et al., 2018; Soveri et al., 2020), lower intentions to get vaccinated (Drążkowski & Trepanowski, 2021; Finkelstein et al., 2020; Salali et al., 2022), and a higher likelihood of having rejected vaccinations in the past (Soveri et al., 2020). The association between reactance and anti-vaccination attitudes has been found also in experimental studies focusing on state reactance (Henkel et al., 2023; Shah et al., 2019; Sprengholz et al., 2021, 2022, 2023). Finally, a recent systematic review and thematic analysis of anti-vaccination arguments identified reactance as one of 11 attitude roots underlying those argument (Fasce et al., 2023).

Second, in the experimental study (Study 3) we tested the premise that trait reactance makes individuals' attitudes resistant to information. We did this by examining to what degree people's vaccination willingness was predetermined by their level of trait reactance and independent of the amount of information they had access to. To the best of our knowledge, there are no previous experimental studies that have investigated the latter. We also examined whether information resistance can be mitigated by presenting information in a way that minimizes the risk of state reactance. Previous experimental research has indicated that framing a vaccination as voluntary results in less state reactance and a higher willingness to get vaccinated than framing it as mandatory (Betsch & Böhm, 2016; Sprengholz et al., 2022; see also Sprengholz et al., 2021) Another study consisting of one survey and three experiments, however, showed the opposite:

People considered it more likely that they would get vaccinated against a new disease if vaccination was required than if it were everyone's personal choice (Albarracin et al., 2021). Two of the experiments in that study further showed that the effect was independent of people's level of trait reactance. Previous findings on this topic are hence mixed. Based on the attitude roots model (Hornsey & Fielding, 2017), we formulated the following hypotheses:

1. Individuals with high trait reactance have lower willingness to get vaccinated (Study 1, 2, and 3)
2. Individuals with high trait reactance change their vaccination willingness less after receiving information that goes against their attitudes, than those with lower trait reactance (Study 3)
3. Individuals—including those with high trait reactance—are more willing to get vaccinated if vaccination is framed as voluntary than if it is framed as mandatory (Study 3).

## METHOD: STUDY 1 AND STUDY 2

In Study 1, we investigated whether trait reactance measured a year before the COVID-19 pandemic predicted trust in sources providing information on pandemic-related issues, attitudes to COVID-19 vaccines, and willingness to get vaccinated against COVID-19. In Study 2, we investigated whether trait reactance measured 2 years before the pandemic predicted people's willingness to get vaccinated against COVID-19.

### Study 1: Participants and procedure

In April 2019, we sent out an invitation to an online survey on vaccine acceptance to 5000 18- to 65-year-old individuals living in the Pietarsaari area in Finland. These individuals were randomly selected from the Finnish Population Information System, which is a register with information about all residents in Finland. The sampling frame was stratified based on gender and language (Finnish and Swedish) within each municipality in the area. We targeted the Pietarsaari area because it is a region with lower uptake of several vaccines compared to the rest of Finland (THL, n.d.). Of 1139 respondents (response rate 22.8%), 335 gave us permission to contact them again. Between March 30 and April 12, 2020, those respondents were invited to an online survey about the COVID-19 pandemic. The final sample consisted of 199 participants who responded to the relevant measures at both timepoints (see Table 1). In the final sample, the education level was higher and the youngest age category (18–29 years) was underrepresented, compared to the sample that responded only at time point 1.

### Study 2: Participants and procedure

The participants were recruited from the FinnBrain Birth Cohort Study (Karlsson et al., 2018), which is an ongoing longitudinal project investigating child development. The FinnBrain population consists of parents from three maternal welfare clinics in Finland. The first data collection included in the present study took place before the COVID-19 pandemic, between May and December 2018, and the second one at the beginning of the pandemic, in May 2020. At the first time point, a letter with a link to the online survey was mailed out to 3401 people (all

**TABLE 1** Sample descriptives for Longitudinal Studies 1 and 2 (at Time Point 1) and Experimental Study 3.

| | Study 1 ($N = 199$) | | Study 2 ($N = 293$) | | Study 3 ($N = 398$) | |
|---|---|---|---|---|---|---|
| **Variable** | ***n*** | **%** | ***n*** | **%** | ***n*** | **%** |
| Gender | | | | | | |
| Male | 63 | 31.7 | 61 | 20.8 | 77 | 19.4 |
| Female | 135 | 67.8 | 232 | 79.2 | 307 | 77.1 |
| Other/do not want to report | 1 | 0.5 | | | 14 | 3.5 |
| Age | | | | | | |
| 18–29 | 34 | 17.1 | 18 | 6.1 | 14 | 3.5 |
| 30–39 | 61 | 30.7 | 199 | 67.9 | 43 | 10.8 |
| 40–49 | 44 | 22.1 | 74 | 25.3 | 93 | 23.4 |
| 50–59 | 29 | 14.6 | 2 | 0.7 | 114 | 28.6 |
| 60+ | 31 | 15.6 | 0 | 0.0 | 134 | 33.7 |
| Education | | | | | | |
| Basic/upper secondary | 94 | 47.2 | 69 | 23.5 | 132 | 33.2 |
| Tertiary | 101 | 50.8 | 213 | 72.7 | 254 | 63.8 |
| Other | 4 | 2.0 | 11 | 3.8 | 12 | 3.0 |
| Children | | | | | | |
| Yes | 139 | 70.0 | 294 | 100.0 | | |
| No | 60 | 30.2 | 0 | 0.0 | | |
| Survey language | | | | | | |
| Finnish | 34 | 17.1 | 244 | 83.3 | 398 | 100.0 |
| Swedish | 165 | 82.9 | 49 | 16.7 | | |

*Note*: In Studies 1 and 2, respondents could choose whether to complete the survey in Finnish or Swedish, whereas Study 3 was administered in Finnish only.

parents with children younger than 4.5 years) and altogether 833 responded (response rate 24.5%). At the second time point, the survey was mailed to 5103 people (all parents in the cohort) and 856 responded (16.8%). Our final sample consisted of 293 people who responded to relevant measures at both time points (Table 1). In this final sample, women were overrepresented compared to the gender distribution among the parents who only participated at time point 1. The education level was also lower in the final sample.

## Measures at time point 1

### Trait reactance

Trait reactance was measured with the 14-item Hong Psychological Reactance Scale (HPRS; Hong & Page, 1989) in Studies 1 and 2. The participants responded on a scale from 1 (*completely disagree*) to 5 (*completely agree*). A higher HPRS score indicates higher trait reactance.

## Measures at time point 2

### Vaccination willingness

Vaccination willingness was measured in Study 1 with the question "Imagine a hypothetical scenario where the authorities recommend a new vaccine against COVID-19 free of charge. How likely do you consider it to be that you would accept such a vaccine?," and in Study 2 with the question "How likely do you consider it to be that you would take a vaccine against COVID-19, if such a vaccine was available, free of charge, and recommended to everyone by the authorities?" The participants responded on a scale from 1 (*very unlikely*) to 5 (*very likely*).

### COVID-19 vaccine attitudes

Attitudes to COVID-19 vaccines were measured in Study 1 with four statements (e.g. "If a vaccine against COVID-19 were available, it would be important that as many as possible got vaccinated"; Table A1). The response scale ranged from 1 (*completely disagree*) to 6 (*completely agree*). Higher values indicate more positive attitudes.

### Trust in Information Sources

Trust in sources of pandemic-related information was measured in Study 1 in relation to four sources: authorities, medical doctors, scientists, and news media (e.g. "I trust the information provided by authorities about the coronavirus pandemic"; Table A1). The respondents responded on a scale from 1 (*completely disagree*) to 6 (*completely agree*). Higher values indicate higher trust.

## RESULTS

The distribution of responses to all measures are reported in Tables A2–A4. We conducted structural regression (SR) analyses to investigate whether the respondents' trait reactance measured before the pandemic predicted their trust in information sources, attitudes to COVID-19 vaccines, and willingness to get vaccinated against COVID-19. Multi-item constructs (trait reactance, trust in information sources, and vaccine attitudes) were represented by latent factors in the SR models. Before specifying the structural models, we assessed the fit of each latent factor with separate confirmatory factor analyses (CFAs). All final models fit the data well (supporting information, pp. 11–12). All analyses were conducted in R (version 4.2.2) (R Core Team, 2022), and the lavaan package (Rosseel, 2012) was used for SR and CFA analyses. The WLSMV estimator was used, and missing data was handled with pair-wise deletion.

In Study 1, the SR model fit the data well ($\chi^2[128] = 277.58$, CFI = .990, TLI = .987, RMSEA = .043; 90% CI[.025, .058], SRMR = .060) and showed that higher trait reactance significantly predicted lower trust in information sources, more negative attitudes to COVID-19 vaccines, and lower willingness to get vaccinated against COVID-19 (Table 2). In Study 2, the SR model included only one of the outcome measures—willingness to get vaccinated against COVID-19—together with trait reactance as a predictor. The model showed good fit to the data

**TABLE 2** Results from SR analyses on the relationship between trait reactance and the outcomes in studies 1 and 2.

| Study | Outcome | *β* | *SE* | *Z* | *p* |
|---|---|---|---|---|---|
| Study 1 | Trust in information sources | −0.34 | 0.06 | 5.44 | <.001 |
| | Vaccine attitudes | −0.45 | 0.08 | 5.62 | <.001 |
| | Vaccination willingness | −0.33 | 0.08 | 4.12 | <.001 |
| Study 2 | Vaccination willingness | −0.16 | 0.07 | 2.32 | .020 |

($\chi^2[26] = 62.07$, CFI = .960, TLI = .944, RMSEA = .069; 90% CI[.047, .091], SRMR = .055). Higher trait reactance was a significant predictor of lower willingness to get vaccinated against COVID-19. See supporting information for post hoc power analyses (p.11).

## METHOD: STUDY 3

In Study 3, we examined whether trait reactance makes anti-vaccination attitudes more resistant to corrective scientific information and whether this resistance can be mitigated by giving information in a way that minimizes the risk of state reactance. The study design and statistical analyses were preregistered (https://osf.io/e8w2v).

### Participants and procedure

Participants were recruited February 14–16, 2023, via a Facebook post marketed to Finnish adults (≥18 year olds). A priori power analysis (with an α-level of .05 and power of .8) indicated that a sample size of approximately 300 was required to detect small to medium effect sizes ($f = .2$). Our aim was, therefore, to collect a sample of at least 300 participants to ensure that each group consisted of a minimum of 100 participants. The post reached 13,560 Facebook users and the survey was viewed by 889. Of the 412 respondents who completed the survey (46.3% of those who viewed the post), we included 398 who responded correctly to the attention checks (Table 1).

After giving informed consent, participants were asked to provide demographic information (i.e. gender, age, and level of education). They then filled out questionnaires that measured trait reactance and vaccination attitudes and completed the experimental task described below. The order of the questionnaires and the experimental task was randomly counterbalanced, so that half of the participants received the questionnaires before the experimental task.

### Experimental task

In the experimental task (supporting information pp. 3–6), participants were first asked to imagine that a novel virus that can cause severe symptoms is spreading around the world. They were then presented with a short text (Text 1) that notified them that a vaccine has been developed and that everyone will be given a vaccination appointment. This text was framed in three ways—to mitigate state reactance (by stating that vaccination is voluntary), to elicit state

reactance (by stating that vaccination is mandatory), or to be neutral (by not mentioning voluntariness or mandate)—and participants were randomly presented with one of these versions of the text. After this, participants completed an attention check, and answered questions about their emotional response to the text, as well as their willingness to get the vaccine and to receive more information. Participants then proceeded to another text (Text 2) that was the same for everyone and provided more information on the safety and efficacy of the vaccine and the severity of the disease. In this information, the risks of the fictitious disease were clearly greater than the risks of the vaccine. The vaccine thus resembled existing vaccines in the national vaccination program. After reading Text 2, participants again completed an attention check and were asked to report their willingness to receive the vaccine.

## Measures

### Trait reactance

We again measured participants' trait reactance with the 14-item HPRS (Hong & Page, 1989), but here the participants responded on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (strongly *agree*).

### Vaccine attitudes

We used the short 5-item 5C scale (Betsch et al., 2018) to measure attitudes to vaccines. The participants responded on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

### State reactance

We measured state reactance by asking participants how frustrated, angry and irritated they felt after reading the texts (Pekrun et al., 2016). Participants responded on a scale from 1 (*not at all*) to 5 (*very strong*). The mean of the three emotions was used in the analyses.

### Willingness to get vaccinated

After Texts 1 and 2, we asked participants' how willing they would be to get the made-up vaccine mentioned in the text. The answers were given on a scale from 1 (*not at all willing*) to 5 (*very willing*). Henceforth, t1 refers to the question administered after Text 1, and t2 to the one administered after Text 2.

### Willingness to receive more information

After Text 1, we asked how willing the participants were to receive more information about the vaccine and the disease. Participants responded on a scale from 1 (*not at all willing*) to 5 (*very willing*).

## Attention checks

Attention checks in the form of multiple-choice questions were presented after Texts 1 and 2 (supporting information p. 7).

# RESULTS

The distribution of responses to all measures are reported in Tables A6–A7. There were no statistically significant differences in HPRS scores or 5C scores between those who had received the questionnaires before the experiment and those who had received them after. The responses for these variables were therefore pooled across counterbalanced groups.

A CFA showed that the fit of the one-factor solution of the HPRS to the data was acceptable and one-way ANOVAs showed that the framing groups (Neutral; Voluntary; Mandatory) were statistically equal on trait reactance and vaccine attitudes (Table A8). To test our hypotheses, we conducted a series of linear regression analyses for different outcome measures, with trait reactance (factor scores retrieved from the CFA) and framing group (simple contrasts with Neutral as the reference group), as well as their interaction term, as predictors.

We started by investigating whether the framing in Text 1 was successful in inducing different levels of state reactance. For this purpose, we included state reactance as the outcome in the regression analysis with trait reactance and framing group as predictors. The results showed a significant main effect of trait reactance, indicating that individuals with higher trait reactance reported more state reactance (Table 3). The analysis further revealed a significant main effect of framing: the message with mandatory vaccination elicited more state reactance than the neutral framing. However, a significant interaction between framing and trait reactance indicated that the mandatory framing elicited higher state reactance than the neutral framing only among participants with higher trait reactance (Figure 1). There was no significant difference between the voluntary framing and the neutral one. Taken together, the results of this analysis suggested that stating that vaccination was mandatory successfully elicited state reactance among those prone to experiencing reactance, whereas stating that vaccination was voluntary did not induce less state reactance than the neutral framing.

Next, we examined whether trait reactance and framing predicted the participants' willingness to get the vaccine upon reading Text 1. The regression analysis showed a significant main effect of trait reactance (Table 3), indicating that individuals with higher trait reactance were significantly less willing to accept vaccination, and this relationship was strong, as it predicted 44% of the variance in willingness to get vaccinated ($\beta = -.66$). T1 vaccination willingness was not affected by framing, and the interaction between trait reactance and framing was not significant.

We also investigated whether trait reactance and framing predicted the participants' willingness to receive more information after reading Text 1. Individuals with higher trait reactance were significantly less willing to receive more information, whereas there was no effect of framing and no significant interaction (Table 3).

After this, we examined whether receiving more information about the vaccine and disease in Text 2 changed participants' willingness to get vaccinated, and whether this change depended on their level of trait reactance and how Text 1 had been framed to them

**TABLE 3** Results from regression analyses in study 3.

| Outcome | Predictor | *β* | *SE* | *t* | *p* |
|---|---|---|---|---|---|
| State reactance | Trait reactance | −.49 | 0.04 | 11.48 | <.001 |
| | Framing: Voluntary | −.06 | 0.10 | 0.54 | .592 |
| | Framing: Mandatory | .44 | 0.10 | 4.20 | <.001 |
| | Trait reactance*framing: Voluntary | .10 | 0.11 | 0.90 | .367 |
| | Trait reactance*framing: Mandatory | .27 | 0.10 | 2.55 | .011 |
| T1 vaccination willingness | Trait reactance | −.66 | 0.04 | 16.81 | <.001 |
| | Framing: Voluntary | .02 | 0.10 | 0.24 | .810 |
| | Framing: Mandatory | .02 | 0.10 | 0.24 | .814 |
| | Trait reactance*framing: Voluntary | .04 | 0.10 | 0.41 | .683 |
| | Trait reactance*framing: Mandatory | .02 | 0.10 | 0.19 | .847 |
| Willingness to receive info | Trait reactance | −.54 | 0.04 | 12.64 | <.001 |
| | Framing: Voluntary | −.12 | 0.10 | 1.12 | .263 |
| | Framing: Mandatory | .04 | 0.11 | 0.36 | .716 |
| | Trait reactance*framing: Voluntary | −.13 | 0.11 | 1.20 | .232 |
| | Trait reactance*framing: Mandatory | −.08 | 0.11 | 0.75 | .453 |
| Change in willingness to vaccinate | Trait reactance | −.01 | 0.05 | 0.28 | .782 |
| | Framing: Voluntary | −.05 | 0.12 | 0.38 | .703 |
| | Framing: Mandatory | .14 | 0.13 | 1.15 | .253 |
| | Trait reactance*framing: Voluntary | −.11 | 0.13 | 0.87 | .386 |
| | Trait reactance*framing: Mandatory | −.24 | 0.13 | 1.88 | .061 |

*Note*: Reference: Neutral framing. The * indicates an interaction between the variables.

(i.e. hypotheses 1 and 2). A paired samples *t*-test showed that, on average, participants' willingness to get vaccinated increased significantly after having read Text 2, $t(397) = 3.89$, $p < .001$. A regression analysis with the change in willingness to get vaccinated (calculated as t1 vaccination willingness subtracted from t2 vaccination willingness) as the outcome showed no significant associations (Table 3). This indicated that the change in willingness to get vaccinated was similar for both high- and low-reactant individuals and was unrelated to framing.

However, as the individuals whose willingness to get vaccinated after Text 1 was at ceiling (i.e. already 5 on the 1–5 scale) could not have increased their willingness score, we conducted a post hoc regression analysis with only those 282 individuals whose t1 vaccination willingness was below 5. The results showed two significant main effects: one suggesting that participants with lower trait reactance showed a larger change toward being willing to get vaccinated than the participants with higher trait reactance, and another one suggesting that those who received the mandatory framing showed a larger change toward being willing to get vaccinated than those who received the neutral framing (Table 4). However, a significant interaction effect revealed that the mandatory framing had an effect only among low-reactant participants. Their willingness to get vaccinated increased the most when their Text 1 stated that vaccination is mandatory (Figure 2).

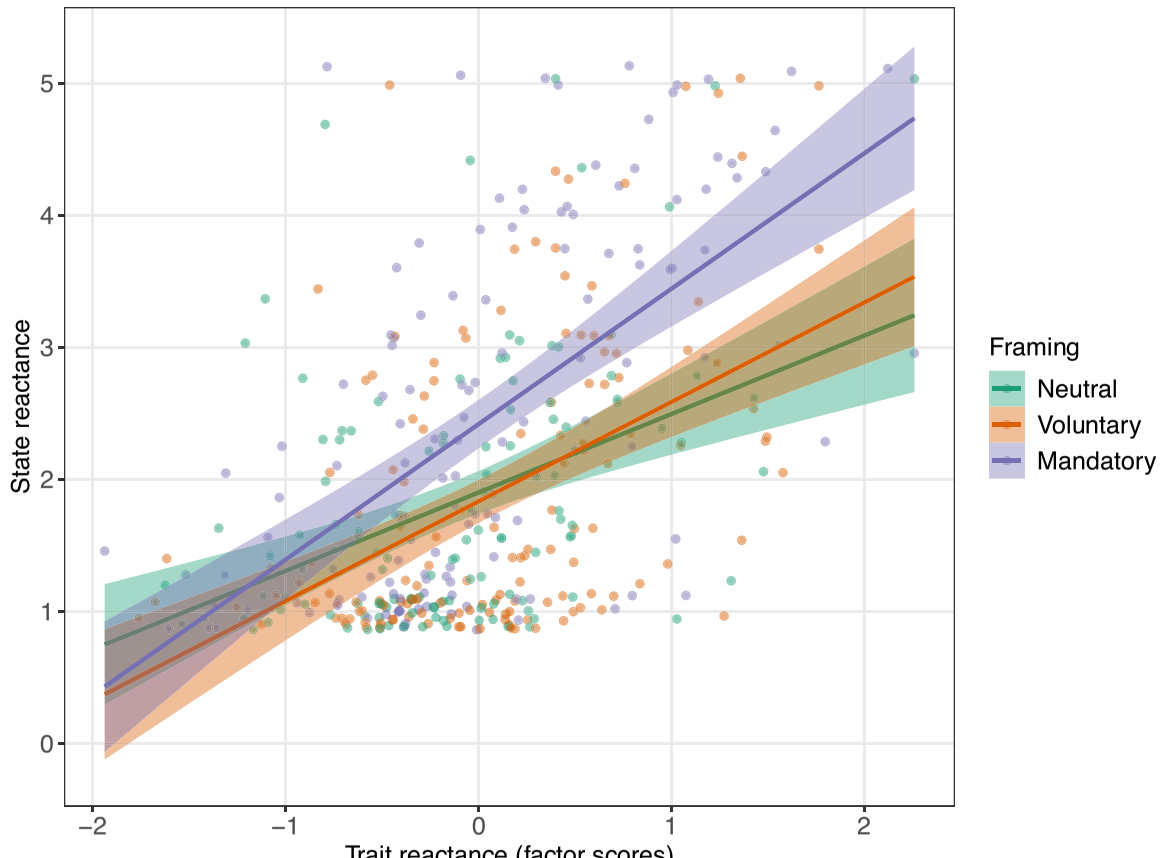


**FIGURE 1** The interaction between trait reactance (factor scores; higher number indicates more reactance) and framing on state reactance (higher number indicates more state reactance). Responses have been vertically jittered to facilitate interpretation.

**TABLE 4** Results from post hoc analysis with change in willingness to vaccination as outcome variable.

| Predictor | *β* | *SE* | *t* | *p* |
|---|---|---|---|---|
| Trait reactance | −.23 | 0.06 | 3.52 | <.001 |
| Framing: Voluntary | −.04 | 0.15 | 0.24 | .815 |
| Framing: Mandatory | .39 | 0.16 | 2.50 | .013 |
| Trait reactance*framing: Voluntary | −.17 | 0.17 | 1.05 | .296 |
| Trait reactance*framing: Mandatory | −.42 | 0.16 | 2.69 | .008 |

*Note*: Reference: Neutral framing. The * indicates an interaction between the variables.

## GENERAL DISCUSSION

In two longitudinal and one experimental study, we drew on the attitude roots model (Hornsey & Fielding, 2017) to investigate trait reactance as a psychological motivation to reject vaccination. In brief, the results indicated that trait reactance has a strong and durable impact on peoples' vaccination willingness. It maintains vaccination refusal intentions in the face of evidence that supports vaccination. In fact, our experimental study indicated that it did not matter how much information the highly reactant people had about the vaccine, or if getting vaccinated was voluntary or compulsory—their vaccination willingness still stayed fairly the same.

Our first step was to test if the link between high trait reactance and anti-vaccination attitudes observed in cross-sectional studies (Drążkowski & Trepanowski, 2021; Finkelstein et al., 2020; Holford et al., 2023; Hornsey et al., 2018; Salali et al., 2022; Soveri et al., 2020) exists also when trait reactance is assessed up to 2 years before the vaccination decision. Indeed, our two longitudinal studies (Studies 1 and 2) consistently indicated that people who scored high on trait reactance before the COVID-19 pandemic had lower willingness to get vaccinated against COVID-19 years later, which was a novel disease and vaccine they knew nothing about at the time when their trait reactance was assessed. These results advance the understanding of trait reactance as a strong and stable motivator that maintains anti-vaccination attitudes. The association was found also in our experimental study, where the effect of trait reactance was particularly strong, as it explained almost half (44%) of people's vaccination willingness. The link between trait reactance and vaccination willingness in our three studies and previous research (Drążkowski & Trepanowski, 2021; Finkelstein et al., 2020; Hornsey et al., 2018; Salali et al., 2022; Soveri et al., 2020) emphasizes the fact that when health communicators are communicating with people who have negative attitudes to vaccines, they are also likely to frequently deal with individuals who have a predisposition to react negatively to their message.

We sought to experimentally test (Study 3) to what degree high-reactant people's willingness to get vaccinated is resistant to information about the vaccine and the disease. The analysis revealed that low-reactant people were more willing to get vaccinated after having received more information, whereas most individuals with high trait reactance did not change their vaccination willingness at all. This can be explained by greater resistance to change among high-reactant individuals. It could, nevertheless, also be a result of the fact that the information was vaccine-positive and less likely to contradict the opinions of the low-reactant individuals, who had more pro-vaccination opinions to begin with. However, visual inspection of the mean change in vaccination willingness reveals that low-reactant individuals became more willing to get vaccinated even when their initial willingness was low (Figure 3). People with high trait reactance, on the other hand, stuck to their initial opinion. This provides

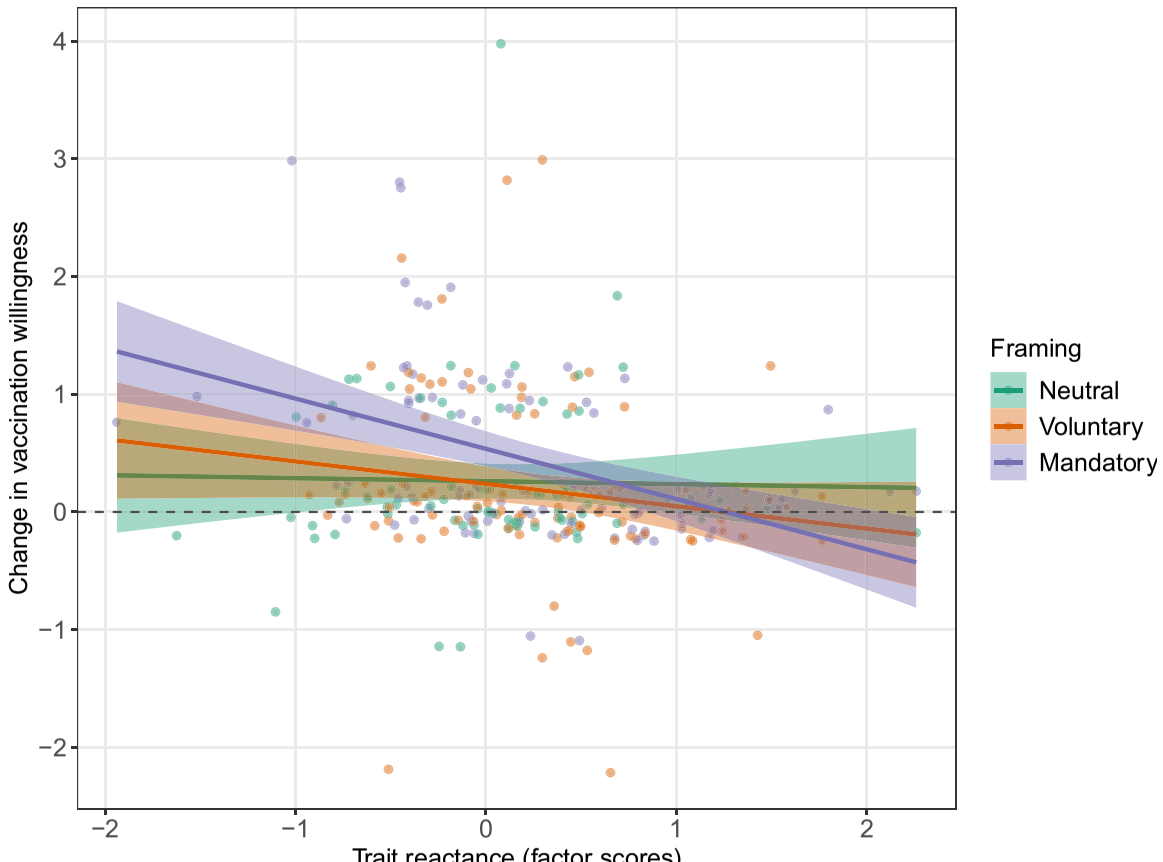


**FIGURE 2** The interaction between trait reactance (factor scores; higher numbers indicate more reactance) and framing on the change in vaccination willingness from t1 to t2 (positive numbers indicate increase in willingness) in the post hoc analysis including those participants whose t1 vaccination willingness was below 5. Responses have been vertically jittered to facilitate interpretation.

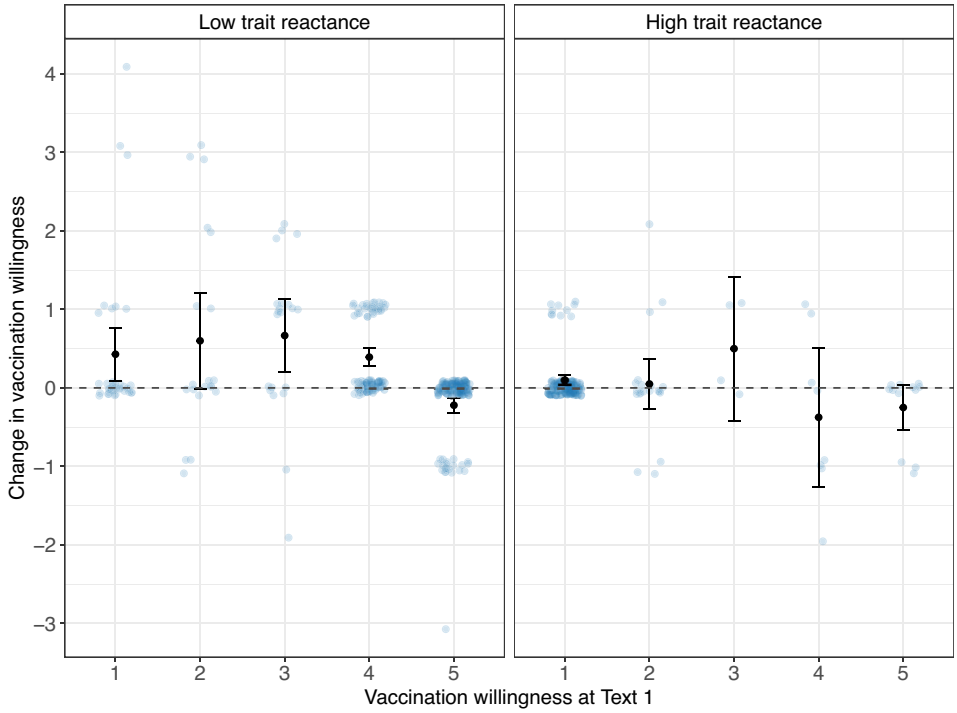


**FIGURE 3** Change in vaccination willingness from t1 to t2 (*y*-axis; positive numbers indicate increase in willingness) plotted against t1 vaccination willingness (*x*-axis), separately for participants with low (mean response to HPRS < 4) and high (mean response to HPRS ≥ 4) trait reactance. Black dots represent mean change and bars 95% CIs. Responses have been jittered to facilitate interpretation.

empirical support for the attitude roots model (Hornsey & Fielding, 2017) that stipulates that trait reactance makes anti-vaccination attitudes survive even when they are challenged by evidence. In other words, trait reactance is one likely explanation for why public health interventions that focus purely on providing facts have had limited success (Brewer et al., 2017).

We experimentally tested (Study 3) if vaccination willingness could be increased by providing people with information about the vaccine in a way that does not cause state reactance. Against our expectations, the message that was designed to mitigate state reactance by emphasizing that vaccination was voluntary did not elicit less state reactance than the neutral framing did. The text that was framed to trigger state reactance with mandatory vaccination, however, produced the expected effect among individuals with high trait reactance. That only high-reactant individuals reported state reactance suggests that a proneness to experience reactance was a precondition for a negative reaction toward the mandatory vaccination text. This did, nevertheless, not translate into lower vaccination willingness, as initial vaccination willingness upon reading the first text did not differ between framing groups. Furthermore, in line with previous research (Albarracin et al., 2021), willingness to get vaccinated increased the most in the group that had been told that vaccination is mandatory. In the present study, however, this was true only among individuals with low trait reactance. It is important to note here that there was no difference between the groups when it comes to trait reactance and vaccine attitudes.

The fact that the voluntary vaccination text did not result in lower state reactance than the neutral text might be due to the way the texts were framed. It is possible that the neutral and

voluntary texts were more similar than the neutral and mandatory texts. Another possible reason brought up in previous research is that communication that has been designed to mitigate reactance might actually induce it in highly trait reactant individuals (Richards et al., 2021). Even though the results were not statistically significant in the present study, the participants' reactions (level of state reactance and change in vaccination willingness) to the reactance-mitigating message were closer to those of the reactance-triggering message than to the neutral one.

Vaccination mandate policies are a controversial topic as they increase vaccination rates (Vaz et al., 2020) but also restrict people's freedom of choice (Maneze et al., 2023). Evidence against the use of mandates also comes from experimental studies that have shown that telling people that a hypothetical/fictitious vaccination is mandatory results in lower willingness to get vaccinated against other existing diseases (Betsch & Böhm, 2016; Sprengholz et al., 2022). The present results rather indicate the opposite, that is, that mandatory vaccinations can have positive effects on the informed decision to get vaccinated in people who are not reactant. In reactant individuals, by contrast, mandatory vaccination does not have a negative impact on the vaccination willingness, even if it evokes state reactance in them. Similar conclusions have been made in previous research (Albarracin et al., 2021). Important to note, however, is that the present experiment was based on a made-up disease and vaccine, which should be kept in mind when generalizing the results to existing vaccines. We did not investigate the effects of mandatory vaccinations on people's vaccine attitudes or willingness to get vaccinated against other diseases.

The magnitude of the effect of trait reactance on vaccination willingness observed in the present studies, the resistance to evidence-based information in individuals who exhibit high trait reactance, and the fact that trait reactance was not a marginal phenomenon, stress the importance of finding efficient ways to mitigate reactance when communicating with vaccine hesitant individuals. Future studies should therefore continue to explore and test the efficiency of vaccine communication strategies in decreasing the risk of reactance (see, e.g. Reynolds-Tylus, 2019; Rosenberg & Siegel, 2018, for an overview of potential communication approaches).

There are limitations to the generalizability of the results in all three studies. In Studies 1 and 2, there is a risk of selection bias due to the drop-off in participants between the two time points. Comparisons between the final sample and the sample that dropped out after time point 1, indeed, revealed some differences in age, gender, and level of education. It is, furthermore, possible that those who were willing to take part at both time points had lower reactance and higher trust in science than those who decided not to stay in the study. The participants in the final samples in Studies 1 and 2, in fact, demonstrated lower trait reactance than the participants in the cross-sectional Study 3, as approximately 18% of the participants in the two longitudinal studies and 36% in the experimental study responded in the upper half of the trait reactance scale. In Study 3, the sample consisted of people who decided to take part in a study that was marketed on Facebook. This recruitment strategy may have led to sampling bias as it may have attracted individuals with certain characteristics, such as higher trait reactance and lower willingness to get vaccinated. In intervention studies, however, this can be considered an advantage as it helps to avoid ceiling effects.

## CONFLICT OF INTEREST STATEMENT

No authors have any conflicts of interest.

## DATA AVAILABILITY STATEMENT

Because we did not include information about making data openly available in the informed consent in Study 1, the data will be shared only upon request (anjoso@utu.fi). Due to Finnish federal legislation on personal data protection in medical research, the original research data in Study 2 cannot be made available online, but data can potentially be shared with Material Transfer Agreement. Requests and collaboration initiatives can be directed to the Board of the FinnBrain Birth Cohort Study. In Study 3, the data set that underlies the results reported in this article, without demographic information, has been made available in the OSF repository https://osf.io/3q2dm/. The data is accompanied by a file including information on the variables.

## ETHICS STATEMENT

Ethical approval for Study 1 was obtained from the Board for Research Ethics at Åbo Akademi University, for Study 2 from the Ethics Committee of the Hospital District of Southwest Finland, and for Study 3 from the Ethics Committee for Human Sciences at the University of Turku. In all studies, the respondents gave their informed consent to participate and received no compensation.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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