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ORIGINAL RESEARCH

Personal and contextual determinants of COVID-19 vaccination intention: a vignette study

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ABSTRACT

Background: This vignette study explores which factors contribute to higher COVID-19 vaccination intentions.

Methods: Between the 4th-11 January 2021, we recruited 15,901 Belgian citizens (M_{age} = 50.11 years, range 18–100) through convenience sampling to participate in a vignette study. In each vignette, we manipulated contextual determinants consisting of different factors. Each participant rated six vignettes in terms of the outcomes 'vaccination intention' and 'recommendation to others.' Finally, we explored the benefits of tailored communication by examining whether these ratings depended upon citizens' initial motives for vaccination.

Results: Participants are most likely to accept a vaccine when they expect no or only small side effects, when the vaccine offers a 95% protection, and when people can no longer infect others ($p < 0.001$). The possibility to receive the vaccine at home or at the GP's office, highlighting that most citizens are willing to get vaccinated, and emphasizing the protective benefits for others yielded additional positive effects ($p < 0.001$). Results showed that tailored communication has a small but significant effect, especially for individuals high on distrust-based amotivation ($p < 0.01$).

Conclusion: In addition to vaccine characteristics, there is room for policymakers to respond to those determinants that fall under their control and can thus be highlighted within communication campaigns.

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Motivation; COVID-19; vaccination attitudes; preference study; Self-Determination Theory

1. Introduction

After the onset of the COVID-19 crisis at the end of 2019, social and preventative measures were rapidly introduced to prevent the circulation of the SARS-CoV-2 virus. These measures were efficient (e.g. national lockdown, mandatory quarantine, etc.), but also intrusive as they disrupted multiple domains of individuals' lives and society as a whole. Because an effective vaccine would help us to control the virus and gradually return to normal life, various pharmaceutical companies, research laboratories, and governmental institutions were stimulated to accelerate the development of a safe and effective vaccine [1,2]. By the end of 2020, many countries had already authorized at least one vaccine against COVID-19. At the same time, it became clear that not all citizens were eager to accept the fast-developed vaccines and vaccination hesitancy became prevalent worldwide [3,4]. For instance, a survey of the Belgian Motivation Barometer showed that in December 2020, 57% of the Belgian population was willing to accept the vaccine as soon as it would be available, but some 9.8% of the participants hesitated and 14.5% said they would refuse it altogether [5]. To examine how to motivate as many people as possible to take a vaccine, we conducted a vignette study to explore which factors would contribute to higher vaccination intention rates.

1.1. Vaccination intention

Vaccination intention is defined as the degree to which a person is willing to get vaccinated, ranging on a continuum from vaccine refusal to vaccine acceptance. To set up a successful vaccination campaign, one must identify and address relevant determinants, taking into account that these determinants differ across time, place, and type of vaccine [6]. Previous research on antecedents of COVID-19 vaccination intention revealed that personal determinants (e.g. socio-demographics, motivation), as well as social and contextual determinants (e.g. confidence, convenience, and complacency), are associated with COVID-19 vaccination intention among adults (see [7–9] for literature reviews). For the

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purpose of the present study, we selected factors relating to those determinants that (a) were found to be relevant factors based on prior research [e.g. 6–10] and (b) seemed most relevant in the situation that prevailed in Belgium around December 2020 (see Table 1 for an overview). The factors selected by us correspond to those in the 3Cs model developed by the World Health Organization's Strategic Advisory Group of Experts. This model categorizes vaccination determinants into confidence, convenience, and complacency [6].

1.2. Contextual determinants

1.2.1. Confidence

A primary determinant that can be considered is *confidence* in the vaccine. Confidence is primarily affected by vaccine properties, such as their safety and effectiveness [10–14]. Various studies have shown that confidence in a vaccine (i.e. against influenza, pneumococcal disease, or shingles) is strongly related to its uptake [15]. Moreover, among health care workers, confidence was not only related to vaccinating oneself, but also to recommending vaccination to others [16]. As it turned out, confidence in the COVID-19 vaccines was a sensitive issue at the time of the current study. The exceptionally rapid development of COVID-19 vaccines triggered a critical attitude and even suspicion among several citizens, resulting in lower vaccination intention [17]. Indeed, a survey of the Belgian Motivation Barometer revealed that the main reason for doubt or refusal was the limited confidence in the vaccine (e.g. fear of possible side effects and low vaccine effectiveness) [5]. Since vaccine characteristics may affect confidence and vaccination intention, the question arose as to which persons would be more trustworthy for citizens to raise their confidence. Recent research shows that confidence in medical (e.g. general practitioners; GPs) and scientific experts is a positive predictor of willingness to receive a COVID-19 vaccine, probably because they come across as reliable sources of information about vaccines, whereas the government or pharmaceutical sector appear less trustworthy [13,18–21].

Indeed, preference studies conducted during the COVID-19 pandemic concluded that citizens prefer vaccines that carry a less than 1% risk of minor side effects, are over 90% effective, and are recommended by one's GP [12,22,23]. Therefore, in our vignettes, we included both vaccine characteristics (i.e. vaccine effectiveness, side effects) and the specific source of communication that encourages the population to get vaccinated (i.e. GPs, scientific experts) as factors shaping *confidence*.

1.2.2. Convenience

Convenience can be considered a second important determinant affecting vaccination intention [6]. Convenience is the ease with which one can get a vaccine and the effort that may or may not be required. Specifically, the effort that people have to make (for instance in terms of costs, time investment, travel to a location, …) as well as the extent to which the services in this regard are perceived as efficient and comfortable in lowering people's effort-expenditure, may influence the decision to get vaccinated [6]. At the time governments in most countries announced that a vaccine against COVID-19 would be available and free of charge, it was not yet clear how and where the vaccines would be administered (e.g. at home, GP's office, local hospital, or newly established vaccination center). A second ambiguity for citizens was the number of doses they should receive. Some vaccines required one dose (e.g. Johnson & Johnson) and others two doses (e.g. Pfizer/BioNTech). Because previous experience with vaccination (e.g. against measles) indicates that the coverage of a second dose is often substandard, the number of doses may impact vaccination intention because it influences the amount of effort for a citizen to get (fully) vaccinated [24]. Finally, at that time, people were unsure as to whether vaccinated people would remain infectious after vaccination and whether they would have to keep following the preventative measures after vaccination. The latter aspect would change the cost-benefit ratio of vaccination considerably, thus leading people to experience their vaccination as less convenient or relatively more effortful.

Results of preference studies during the COVID-19 pandemic are somewhat inconsistent regarding the role of convenience. For instance, results of a choice-based experiment in the U.S. found that the location and number of doses did not significantly influence participants' vaccination willingness, whereas the vaccination intention of Chinese respondents decreased with a higher frequency of injections [23,25]. Since these three uncertainties (i.e. location, number of doses, and infectiousness) were hot topics in the media at the time we conducted the present study and since we considered them potentially decisive in determining vaccination intention, we included them as three factors possibly affecting *convenience*.

1.2.3. Complacency

Finally, a third category is complacency [6,9]. Complacency means that one does not consider vaccination as a necessary preventative measure, for instance, because vaccination rates are sufficiently high in one's environment [26]. Such reasoning is probably more common among self-oriented individuals (i.e. with rather egoistic motives) compared to more other-oriented people (i.e. with rather altruistic motives) [27,28]. From a self-oriented point of view, vaccination may become unnecessary, whereas, for other-oriented people, vaccination remains important to protect others and to achieve the collective goal of fighting COVID-19 [29]. Indeed, several studies concluded that altruistic motives and perceived community benefits are associated with higher vaccination intentions [30–33]. Although the idea behind complacency assumes that a high vaccination standard decreases vaccination intention, the opposite could also be true [34]. According to Social Identity Theory, high vaccination rates in a group with which one identifies may lead to a higher willingness to get vaccinated, suggesting that explicit information about the high vaccination willingness of other citizens may encourage other citizens to get vaccinated as well [35,36]. Indeed, previous research revealed that vaccination uptake may be increased by promoting social norms supportive of vaccination [37].

Table 1. Overview of the three contextual determinants consisting of different factors and levels which were included in the vignettes as predictors of vaccination intention and recommendation.

Determinants	Factors	Level 1	Level 2	Level 3
Confidence	Vaccine effectiveness	The vaccine offers 95% protection against COVID-19.	The vaccine offers 70% protection against COVID-19.	
	Side effects	After vaccination, you may experience no or perhaps some discomfort for a few hours or days.	After vaccination, you have a very small chance of an intense reaction in the next few days.	After vaccination, it is currently uncertain as to whether future health problems will occur.
	Communication source	According to your GP, …	According to the scientific experts, …	
Convenience	Location	You will be invited to get vaccinated at your home or your GP's office.	You will be invited to get vaccinated at your local hospital.	
	Number of doses	The vaccine consists of 1 dose.	The vaccine consists of 2 doses.	
	Infectiousness	After vaccination, you can still transmit the virus to others.	After vaccination, you can no longer transmit the virus to others.	
Complacency	Social orientation	By getting vaccinated, you help protect yourself.	By getting vaccinated, you help protect your loved ones (family and friends) and the entire population.	
	Social norm	/	75% of the population already indicated that they want to be vaccinated.	

The full factorial combination of these eight factors with two or three levels each resulted in 384 possible vignettes.

Also, a preference study using a discrete choice experiment on vaccination intention among health care workers showed that the most motivating factor was the protection of family, together with a high uptake among colleagues [38]. Therefore, we considered (a) emphasizing a self- or other-oriented motive for being vaccinated and (b) highlighting a prevailing social norm as two factors of a vaccination campaign potentially shaping complacency.

1.3. Personal determinants

1.3.1. Socio-demographic characteristics

Importantly, in addition to these contextual determinants, personal determinants may account for differences between citizens in terms of vaccination behavior even before the start of the vaccination campaign. For instance, previous studies showed that one's socio-demographic characteristics are related to one's vaccination intention. Several studies revealed that men and (highly) educated individuals report higher vaccination intention compared to, respectively, women and low-educated people [10,20,34,39]. However, results on other socio-demographics (e.g. age, chronic disease) are not always consistent. For instance, some studies showed that younger age was positively associated with vaccine acceptance, while other studies found that younger age predicted vaccination hesitancy and older age was associated with a higher COVID-19 acceptance rate [10,20,39]. Similarly, although some studies indicated that willingness to receive a COVID-19 vaccination is high among high-risk individuals, other studies found that having an underlying chronic disease reduced vaccination acceptance [10,40].

1.3.2. Vaccination motivation

Next to socio-demographic characteristics, people may also differ a priori in terms of their motivation to get vaccinated. Although various theoretical frameworks have proven useful to predict health-related behaviors, one motivational theory that has garnered increasing interest is Self-Determination Theory (SDT [41–43];). Within SDT, a distinction exists between autonomous or controlled types of motivation [44,45]. *Autonomous motivation* occurs when citizens perceive vaccination behavior to be relevant and congruent with their personal values (e.g. solidarity, health). On the other hand, *controlled motivation* occurs when citizens experience internal (e.g. feelings of guilt) or external (e.g. criticism) pressure to get vaccinated. Previous studies concerning vaccination against influenza and the human papillomavirus revealed that autonomous motivation positively influenced vaccination intention, whereas controlled motivation was unrelated to vaccination intention [46,47]. Finally, some citizens may also lack motivation to get vaccinated. SDT states that such *amotivation* can stem from different sources [48]. Citizens could, for example, be amotivated because vaccination is too effortful (i.e. effort-based amotivation), or because they have little confidence in the efficacy and safety of the vaccine (i.e. distrust-based amotivation) [49]. The scant research on the role of amotivation in the context of vaccination shows that (effort-based) amotivation plays no or minimal role, whereas distrust-based amotivation is negatively related to vaccination intention [50–52].

Although (a)motivation has been examined in previous research as an antecedent of vaccination intention, no studies to our knowledge investigated whether segmentation according to this initial motivational orientation is meaningful. For example, a vaccination campaign may be more effective if it aligns its communication strategy with people's initial motivational orientation. For instance, one could develop the argument that individuals high in distrust-based amotivation may be especially sensitive to efficiency- and side-effects-related information as these contextual determinants may fuel their distrust. Along similar lines, one could argue that individuals high on effort-based amotivation would show lower vaccination intention, especially when they need to get two doses or go to an unfamiliar location to receive the vaccine. Therefore, in this study, we want to explore the possibilities of a tailoring

approach, looking at the interaction between citizens' initial motivation and induced contextual factors.

1.4. The present study

At the time of the approval of the first vaccines against COVID-19, a large number of countries launched national vaccination campaigns to achieve maximum vaccination coverage. Still, it quickly became clear that vaccine availability did not guarantee vaccine uptake [53]. In the Belgian case, the vaccination intention rate as of December 2020 was rather low [5,54]. As previous work showed that most effective vaccination campaigns are multifactorial we included both personal and contextual determinants that might hinder or contribute to citizens' intended vaccination behavior [55]. We surveyed the personal determinants (i.e. socio-demographics and vaccination motivation) through questionnaires, while, in a second part of the survey, we combined different factors of three contextual determinants (i.e. confidence, convenience, and complacency) into hypothetical but realistic vignettes. We asked participants to read and imagine these vignettes and subsequently report on their intention to get vaccinated and to recommend vaccination to others. We included both vaccination intention and recommendation to others as outcomes, as recommendation may be important in establishing a positive cascading cycle by which citizens stimulate each other to accept a vaccine.

To examine the relative contribution of each factor to the outcomes, we relied on a vignette methodology [56]. The aim of a vignette study is to identify and assess the importance of the manipulated factors that affect people's responses to the contextualized but hypothetical vignette. Although we expected each contextual factor to significantly hinder or contribute to vaccination behavior, we had no a priori hypotheses regarding the relative contribution of each factor.

Moreover, we considered the contribution of the contextual determinants (i.e. confidence, convenience, and complacency) on top of citizens' personal determinants (i.e. socio-demographics and motivation). Based on previous literature, we expected men, (highly) educated individuals, individuals high on autonomous motivation, and individuals low on amotivation to report higher vaccination intentions [e.g. 10,20,52]. Given the inconsistency within the literature, we had no a priori hypotheses regarding other background variables (e.g. age) and controlled motivation. Finally, we explored whether a tailored approach was desirable by examining whether contextual characteristics differentially had an impact on the outcomes as a function of citizens' motivation for vaccination.

2. Data and method

Data were analyzed using R [57].

2.1. Participants and procedure

On 18 December 2020, the first person in Belgium received a vaccine against COVID-19. Between the 4th and 11th of January 2021, we conducted an online vignette study among the Belgian adult population. As we wanted some 250 participants to appraise each vignette (i.e. 384 different vignettes with 6 vignettes per participant; see Plan of Analyses section), we aimed for a total sample size of 16,000 participants. We recruited participants through cooperation with online newspapers and magazines, and by using a paid advertising campaign on Facebook. The survey was available in Dutch and French, the two main national languages in Belgium. After completing an online built-in informed consent, as many as 15,901 citizens (M_{age} = 50.11 years, range 18–100, SD = 14.58) participated (50.3% female, 60% Dutch speakers). Overall, 75.8% reported having a partner, 30.7% obtained at most a secondary education degree, 37.7% had a bachelor's degree, and the remaining 31.6% had a master's degree. A minority of participants (31.3%) suffered from one (23.6%) or more (7.7%) chronic diseases, putting them at higher risk for COVID-19 complications. A minority of 12.9% of the respondents indicated that they had already experienced a SARS-CoV-2 infection.

After providing these socio-demographic characteristics, participants indicated their motivations for (not) being vaccinated. Next, we presented the hypothesized vignettes about a vaccination campaign. The full factorial combination of all eight factors with two or three levels (see Table 1 for an overview of the included factors) resulted in $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 3 = 384$ possible vignettes (see Table 2 for the instructions and two examples). This total vignette population, which required a large sample size, was partitioned by randomly selecting sets of six vignettes (in a random sequence) for each respondent. Participants had to imagine that the vignette depicted a real vaccination campaign. After each vignette, participants had to indicate whether, under the described circumstances, they would be willing to get vaccinated and whether they would encourage others to get vaccinated. The procedure was approved by the ethical committee of Ghent University (reference number 2020/174).

2.2. Materials

2.2.1. Vaccination motivation (Pre-vignette)

Participants had to indicate the extent to which they agreed with different reasons for (not) getting vaccinated. Three items tapped into autonomous reasons (e.g. 'Getting vaccinated aligns with my personal values,' α =0.93) and three items tapped into controlled reasons (e.g. 'I feel pressured to get vaccinated,' α =0.63). Likewise, participants indicated the extent to which reasons people might have for *not* getting vaccinated applied to them. Distrust (e.g. 'I am concerned about possible side effects of the vaccine,' α =0.90) and effort (e.g. 'I can't make the effort to get vaccinated,' α =0.77) were assessed with three items each. Participants answered all items on a 5-point Likert-type scale ranging from 1 (totally disagree) to 5 (totally agree).

2.2.2. Vaccination behavior (Post-vignette)

After reading each hypothetical vignette, participants answered one item to report their vaccination intention ('If these are the circumstances under which you are invited to be

Table 2. Instructions that were given to the participants with two vignette examples.

The government is planning a vaccination campaign in the coming weeks. In this study, we explore what such a campaign might best look like. You will be shown six hypothetical scenarios. These scenarios are hypothetical because several factors are uncertain today. We will ask you to read each scenario and imagine that this is a vaccination campaign that will be launched by the government. After each scenario, we will ask you to answer two questions. Answer these questions for each scenario separately, ignoring what you have read in previous scenarios.	
Imagine this situation:	
You are invited to get vaccinated at **your home or your GP's office**. According to **your GP**, the vaccine offers **95%** protection against COVID-19. After vaccination, **it is currently uncertain as to whether future health problems will occur**. The vaccine consists of **1 dose**. After vaccination, you **can still transmit** the virus to other people. By getting vaccinated, you help protect **yourself.**	You are invited to get vaccinated **at your local hospital**. According to **scientific experts**, the vaccine offers **70%** protection against COVID-19. After vaccination, **you may experience no or maybe some discomfort for a few hours or days**. The vaccine consists of **2 doses**. After vaccination, you **cannot transmit** the virus to other people. By getting vaccinated, you help protect **your relatives (family and friends), as well as the general population.**

vaccinated against COVID-19, what would you decide?') on a 5-point Likert-type scale ranging from 1 (I would refuse without any hesitation) to 5 (I would accept without any hesitation). In addition to the question about vaccination intention, participants indicated if they would encourage others to get vaccinated under these circumstances on a 5-point Likert-type scale ranging from 1 (totally disagree) to 5 (totally agree).

2.3. Plan of analyses

As for the preliminary analyses, we began by assessing the role of the socio-demographic variables in relation to the outcome variables by using multivariate analyses of variance (i.e. MANOVA) and subsequent univariate analyses (i.e. ANOVA) for the categorical variables gender (male/female), region (Dutch/French), civil status (partner/single), educational status (secondary/Bachelor/Master), chronic diseases (zero/one/more than one), and past infection with SARS-CoV-2 (yes/no). For the categorical variables with more than two groups (i.e. education and chronic diseases), we conducted post hoc comparisons using the Tukey HSD test. Finally, for age, a continuous socio-demographic variable, we computed Pearson correlations with the study variables.

Because each participant saw six vignettes, we analyzed our vignette data using a crossed random (multilevel) model. The estimated coefficients associated with the factors express the degree to which one unit of the factor increases or decreases the outcome. In line with the goals of the current study, we used a hierarchical approach to assess the predictive validity of the factors (Model 1) above and beyond socio-demographic variables and citizens' vaccination motivation (Model 0). Moreover, we calculated the importance weight (expressed in a percentage) for each factor. The importance weight depicts the relative importance of each factor, based on the strength of the estimated coefficients for the factors' levels. More specifically, the importance weight of a factor results from the span of its levels divided by the sum of all levels' spans.[1]

Finally, we explored whether a tailoring approach was desirable by testing the interactions between the manipulated contextual factors and the types of motivation. The interaction terms were created by multiplying the dummy-coded factor level with the standardized types of motivation. For each of the two vaccination behaviors, we ran a separate model for each contextual factor, resulting in 72 possible interaction effects (= 2 outcomes x 4 motivation types x 9 dummy-coded factor levels).

3. Results

3.1. Preliminary analyses

MANOVAs indicated significant multivariate effects for all categorical socio-demographic variables (see supplementary material, Table S1). Male participants (compared to females), French-speakers (compared to Dutch-speakers), participants with a partner (compared to singles), participants with a bachelor's degree (compared to those with a secondary or master's degree), those with more than one chronic disease (compared to those with none or one chronic disease), and those with no previous SARS-CoV-2 infection (compared to those who experienced a previous infection) scored higher on the two vaccination behaviors (i.e. intention and recommendation). Pearson correlations showed that age was positively related to both vaccination intention and recommendation (Table 3).

3.2. Primary analyses

In a first step, we included the socio-demographic variables and vaccination (a)motivation types in the model (Table 4, Model 0). It should be noted that the results were similar to those of the preliminary analyses, such that mainly older people and people with no previous SARS-CoV-2 infection reported higher scores on both vaccination behaviors (i.e. intention and recommendation). However, when compared to the preliminary analyses, simultaneously considering the socio-demographic characteristics along with the motivational types reduced the predictive validity of several socio-demographic characteristics for at least one of the two vaccination behaviors. Moreover, autonomous motivation was positively related to vaccination behaviors, whereas controlled motivation had no predictive value. Because the inclusion of both types of amotivation (distrust- and effort-based amotivation) caused multicollinearity resulting in a positive value for effort-based amotivation, we created a composite scale of these two amotivation types. This composite scale was negatively related to both vaccination behaviors.[2]

In a second step, we added all factors' levels as predictors to the model (Table 4, Model 1). The results were comparable for both outcomes. Importance weights show that

Table 3. Descriptive statistics and Pearson correlations on both between- and within-subject levels between continuous personal determinants and the two outcome measures.

Variables	Mean	Standard Deviation	Age	AM	CM	DA	EA	VI	VR
Personal determinants									
Age	50.11	14.58							
Autonomous motivation (AM)	4.11	1.17	.10***						
Controlled motivation (CM)	2.43	1.00	−.21***	−.30***					
Distrust-based amotivation (DA)	2.53	1.21	−.16***	−.74***	.38***				
Effort-based amotivation (EA)	1.46	.67	−.08***	−.39***	.24***	.45***			
Outcome measures									
Vaccination intention (VI)	3.88	1.31	.15***	.83**	−.29***	−.72***	−.34***		**.73*** **
Vaccination recommendation (VR)	3.74	1.23	.11***	.75***	−.26***	−.69***	−.33***	.84***	

***$p < 0.001$.
Correlation coefficients under diagonal refer to between-subject correlations. The one **bold** value above the diagonal refers to the within-subject correlation.

Table 4. Output of the multilevel models testing the impact of personal (i.e. socio-demographics and vaccination motivation) and contextual (i.e. confidence, convenience, and complacency) determinants on vaccination intention and recommendation.

	Vaccination intention					Vaccination recommendation				
	Model 0		Model 1		Importance weight	Model 0		Model 1		Importance weight
Variables	β	95% CI	β	95% CI		β	95% CI	β	95% CI	
Personal determinants										
Socio-demographics										
Age	.04***	[.03, .05]	.04***	[.03, .05]		.01**	[.00, .02]	.01*	[.00, .02]	
Gender [female]	−.02*	[−.03, −.00]	−.01	[−.03, .00]		−.02	[−.04, .00]	−.02	[−.03, .00]	
Region [French]	−.01	[−.02, .01]	−.00	[−.02, .01]		.05***	[.04, .07]	.06***	[.04, .08]	
Civil status [single]	−.00	[−.02, .02]	−.00	[−.02, .02]		−.02*	[−.04, -.00]	−.02*	[−.04, -.00]	
Education [bachelor]	−.03**	[−.05, -.01]	−.03**	[−.05, -.01]		−.02	[−.04, .01]	−.02	[−.04, .01]	
Education [master]	−.04***	[−.06, -.02]	−.04***	[−.06, -.02]		.01	[−.02, .03]	.01	[−.02, .03]	
Chronic disease [one]	.00	[−.03, .04]	−.01	[−.03, .04]		−.01	[−.05, .03]	−.01	[−.05, .03]	
Chronic disease [zero]	−.01	[−.04, .02]	−.01	[−.04, .02]		−.02	[−.05, .02]	−.02	[−.05, .02]	
Previous infection [no]	.04**	[.01, .06]	.03**	[.01, .05]		.03*	[.00, .06]	.02	[−.00, .05]	
Vaccination motivation										
Autonomous motivation	.63***	[.62, .64]	.63***	[.62, .64]		.52***	[.51, .53]	.52***	[.51, .53]	
Controlled motivation	−.00	[−.01, .00]	−.00	[−.01, .00]		.00	[−.01, .01]	.00	[−.01, .01]	
Amotivation	−.14***	[−.15, -.13]	−.14***	[−.15, -.13]		−.19***	[−.20, -.17]	−.19***	[−.20, -.17]	
Contextual determinants										
Confidence										
Vaccine effectiveness [95%]			.19***	[.18, .19]	21.3%			.19***	[.18, .20]	21.1%
Side effects [uncertain]			−.31***	[−.32, -.31]	46.2%			−.32***	[−.33, -.32]	47.7%
Side effects [no/some]			.08***	[.07, .09]				.09***	[.08, .10]	
Communication source [expert]			−.01*	[−.01, -.00]	0.0%			−.00	[−.01, .00]	1.1%
Convenience										
Location [home/GP]			.02***	[.01, .02]	1.2%			.01***	[.01, .02]	1.3%
Dose [two]			.00	[−.00, .01]	0.7%			.00	[−.00, .01]	1.3%
Infectiousness [yes]			−.19***	[−.20, -.18]	21.7%			−.19***	[−.20, -.18]	21.0%
Complacency										
Social orientation [others]			.05***	[.04, .05]	5.2%			.04***	[.03, .05]	4.1%
Social norm [no]			−.02***	[−.03, -.02]	3.7%			−.02***	[−.02, -.01]	2.4%
Random effects										
ICC	.40		.46			.48		.53		
Marginal R^2/Conditional R^2	.552/.730		.597/.780			.451/.714		.499/.765		

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$
Note. β = standardized regression coefficients, 95% CI = 95% credible interval, ICC = intraclass correlation coefficient

respondents' vaccination behavior was predominantly determined by the vaccine's side effects (46.2% for intention and 47.7% for recommendation), the degree of infectiousness after vaccination (21.7% for intention and 21.0% for recommendation), and the vaccine's effectiveness (21.3% for intention and 21.1% for recommendation). The possibility to receive the vaccine at home or at the GP's office (versus in a hospital), highlighting that most citizens are willing to get vaccinated (instead of not reporting a social norm), and highlighting the protective benefits for others (instead of for oneself), yielded additional but small positive effects, with importance weights ranging from 1.2% to 5.2%. The predictive roles of the source of communication and the number of doses were negligible.

Finally, we explored all possible interaction effects between the different types of motivation and the contextual factors (see supplementary material Table S2). Again, the inclusion of both types of amotivation caused multicollinearity resulting in a positive value for effort-based amotivation. Therefore, after running a model with the composite score of amotivation, we ran each model two more times for each type of amotivation separately. Results showed that, in general, the largest number of significant interaction effects appeared to exist between

contextual factors and distrust-based amotivation. For example, the vaccine effectiveness of 95% had a stronger positive impact on the vaccination intentions of individuals high, compared to those low, in distrust-based amotivation. Also, both the vaccine effectiveness and the expected side effects were most likely to differently affect people's vaccination behavior across all motivation types (see supplementary material Figure 1Sa and 1Sb for two examples). However, it should be noted that although significant, the interaction effects can be considered small ($\eta_p^2 = 0.01$) [58].

4. Discussion

The current study sought to examine how different personal and contextual determinants hinder or contribute to people's vaccination intention and their willingness to encourage others to get vaccinated. Identifying the most critical factors is crucial for the development of an effective vaccination campaign to maximize vaccination coverage within the population.

When considering different types of motivation as possible predictors of vaccination behavior, results showed that autonomous motivation (i.e. getting vaccinated based on a good understanding of why vaccination is important and aligns with one's personal values) was the strongest positive predictor of intended vaccination behavior. On the other hand, controlled motivation (i.e. getting vaccinated to avoid criticism, because one experiences feelings of pressure) did not contribute to vaccination behavior. This is in line with previous studies on vaccination and other health-related behaviors in the context of the COVID-19 pandemic, which shows that autonomous motivation positively predicts health-related behaviors, whereas controlled motivation is often unrelated [46,59].

Overall, these findings suggest that fostering autonomous motivation can be a focus for health policy and messaging. This is in line with a growing literature within SDT that is detailing motivating strategies to foster greater autonomous motivation [60]. For instance, it is essential to provide meaningful explanations about the importance of vaccination and to keep following the rhythm of vaccine doubters so they can come to their own informed decision. In contrast, controlling messaging, involving the threats of sanctions, the use of guilt trips (e.g. by reminding them of their duty of solidarity), minimizing or even invalidating the concerns of hesitating or refusing citizens should best be avoided.

Although most research on the role of amotivation in the context of vaccination behavior shows that amotivation plays no or minimal role, the current study showed that amotivation yielded a negative contribution to intended vaccination behaviors [50,51]. Especially when people indicated they distrust the effectiveness of the vaccine or the person recommending vaccination, they reported lower vaccination intention [52]. Moreover, those who considered vaccination as a behavior that would require too much effort were less likely to recommend vaccination to others. A potential reason why other studies did not find associations between amotivation and vaccination behavior may be because they made use of more general amotivation items that were less context-responsive (e.g. 'It is easier to do what I'm told than to think about it' [51]), whereas our amotivation items well-reflected the precarious situation at the end of the year 2020. For instance, the vaccine was developed at a rapid pace, which created some doubt (distrust) about its effectiveness and safety [17]. Citizens were flooded with information regarding the virus and vaccine, which made it more difficult to distinguish reliable from unreliable information [61]. Finally, there was still much uncertainty regarding the organizational approach that would be used to vaccinate as many citizens as possible as quickly as possible, which made it difficult to estimate the effort that each citizen would have to make in order to be vaccinated.

Next to the different types of motivation, we also considered some socio-demographic variables as personal determinants of vaccination behaviors. Results showed that the values of age and whether or not having experienced a COVID-19 infection were robust predictors when considered simultaneously with one's type of motivation to get vaccinated. More specifically, older people and people with no previous SARS-CoV-2 infection reported higher scores on both vaccination outcomes. When considered in isolation, men, French-speakers, people with a bachelor's degree, and those with more than one chronic disease reported higher intended vaccination behaviors, although these contributions disappeared when they were simultaneously considered together with the motivation types.

With regard to the contextual determinants, the ideal vaccination campaign to increase vaccination intention and recommendation would be one in which it is scientifically accurate to state that people would experience no or only small side effects for a few hours or days (as opposed to intense side effects within days or unknown side effects in the future), when the vaccine offers a high (95%) effectiveness against COVID-19 (versus a lower (70%) effectiveness), and when people cannot infect or spread the virus to others after vaccination (versus are still infectious). Although these factors appeared to be the most decisive in predicting vaccination intention, these are features of the vaccine itself over which the government has little impact as such and about which the government should provide correct information.

This study also shows that, in addition to these vaccine characteristics, there is room for governments to leverage those determinants that fall under their control and can thus be manipulated within communication campaigns and policies. In line with previous research, when it was highlighted that the majority of the population is willing to get vaccinated (versus not reporting a social norm) and that by being vaccinated one also protects one's loved ones (rather than merely referring to individual benefits), participants indicated they were more willing to accept a vaccine and to recommend the vaccine to others [38]. These are clearly factors that governments and policymakers can respond to. As for the logistical organization of the vaccination campaign, it is desirable to consider whether individuals can receive their vaccine at home or at their GP's office (versus in a hospital) as results showed that this contributed significantly to vaccination behavior.

The above findings suggest that the percentage of vaccinated individuals by age group could be presented on a regular basis at the beginning of the vaccination campaign.

If vaccinating becomes the norm within an age group, this encourages reluctant individuals to follow their immediate peers. Likewise, vaccinated individuals can be asked to testify about their prosocial motivation to get vaccinated, which may encourage peers to also get vaccinated. In the invitation letter to get vaccinated, the importance of a collective and prosocial mind-set can be addressed, for example by emphasizing the importance of vaccination in protecting the elderly and vulnerable citizens. At the same time, because vaccines reduce but do not eliminate the risk of infection and infectiousness, one should not posit the vaccine as the ultimate solution to protect society. For example, the statement made by a Belgian Minister at the beginning of the vaccination campaign that vaccination would open the door to the 'land of freedom' created false expectations and feelings of disappointment months later [62]. Moreover, we must take into account the fact that healthy young adults have a low probability of becoming seriously ill or dying from COVID-19. Research in the context of the COVID-19 pandemic showed a positive association between risk perception, a concept reflecting the estimation of the probability and the severity of a future COVID-19 infection for oneself and others, and vaccination intention and uptake [e.g. 52]. This means that the lower people assess the risk of (severe) infection, the less likely they are to get vaccinated [52].

Two other findings deserved further mentioning. First, although previous research showed that the coverage of a second vaccine is often lower, the number of doses did not make a difference in participants' intentions to get vaccinated or to encourage others to do so [24]. This is encouraging because most COVID-19 vaccines require two doses to be optimally protected, and additional so-called 'booster' doses have been recommended [63]. Second, results showed that the benefits of tailoring contextual factors to interpersonal differences in motivation are significant in the case of distrust-based amotivation. Specifically, maximizing the convenience with which people can get vaccinated (e.g. by providing the ability to receive a vaccine at home or at their GP's office) and maximizing people's confidence in the vaccine (e.g. by providing correct information regarding its effectiveness and side effects) is especially important for people high on distrust-based amotivation. Although significant, the interaction effects were rather small. This could suggest that in the first phase of the vaccination campaign, a general approach rather than a fine-grained one (which would allegedly be more complex and costly) would be appropriate. In a second phase, where doubters or refusers remain as non-vaccinated people who are most likely to show a higher degree of amotivation, it would then be preferable to switch to an individualized, tailored approach.

4.1. Limitations and recommendations for future research

The large vignette population made us choose to work with a random selection instead of an experimentally driven selection of the vignettes for each participant. This procedure may have caused uncontrolled confounding effects. As such, estimated effects should be interpreted with caution. Future research would do well to experimentally plan a selection of the vignette population, with a predetermined confounding of main effects with higher-order interaction effects [56].

Given that the number of possible vignettes increased exponentially with the number of factors and levels, we also had to be selective in choosing our factors and levels. Although the literature describes several other factors that contribute to vaccination intention (e.g. risk perception, previous experience with other vaccines and diseases, etc; [see [7,8,9] for literature reviews]), we tried to select the factors that seemed most relevant for the Belgian COVID-19 situation at the time of the study. Since then, more information about the vaccines (e.g. vaccination reduces the severity of illness after infection rather than the risk of being infected or transmitting the virus to others, the documentation of some rare but serious adverse events following immunization) became available to the wider public. Such new information somewhat reduces the validity of some of the operationalized levels of certain factors in our study. For instance, it is less meaningful nowadays to include a level that alludes to the fact that one is no longer infectious after vaccination. Future research would do well to maximally align the operationalized factors and levels with emerging new scientific insights to maximize the ecological validity of the vignettes and allow participants to empathize with the vignette.

Another limitation is that this study was conducted in the Belgian population and, as such, cannot simply be generalized to other countries without caution. Moreover, our non-probability sampling method resulted in an unrepresentative sample. For instance, the mean age within the current study was 50.11 years compared to 41 years within the Belgian population. Having said this, the gender (50.3% female) and language distribution (60% Dutch speakers) within this study was similar to that of the Belgian population (50.72% female, 57.75% Dutch Speakers) [64].

On a more optimistic note, the data revealed extremely small differences between the results for vaccination intention and vaccination recommendation. This is a promising finding, because vaccination recommendation may be important in establishing a positive cascading cycle in which citizens stimulate each other to accept a vaccine (e.g. thereby emphasizing the social norm), which may result in a higher vaccination coverage rate. However, and this limitation holds for both outcomes, the participants were required to report their hypothetical *intended* behavior, which does not necessarily reflect their actual behavior related to vaccine uptake and recommendation.

4.2. Conclusion

The current study shows that Belgian citizens are most likely to accept a vaccine when they experience no or only small side effects for a few hours or days, when the vaccine offers a 95% effectiveness against COVID-19, and when people cannot infect others after vaccination. However, in addition to these sheer vaccine characteristics, there is also room for governments and policymakers to respond to those factors that fall under their control and can thus be highlighted within communication campaigns and policies. Indeed, the

findings suggest that organizing vaccination in familiar places (i.e. home or GP's offices), highlighting that most citizens are willing to get vaccinated, as well as underlining the protective benefits for others are important in promoting higher vaccination intention. By building upon these features in their vaccination campaigns, authorities better rely on motivating strategies that maximize citizens' autonomous motivation.

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Notes

1. Unlike effect sizes that are traditionally used (e.g. Cohen's d), a factor's importance weight is relative to the importance weights of other factors included in the study, with the sum of all importance weights reaching 100%. Therefore, a factor's importance weight provides a more intuitive measure of its relevance compared to more typical measures of effect sizes [65]. Although we can more easily compare the importance of one factor to another within a single study, the disadvantage of an importance weight relative to other effect sizes is that we cannot compare a factor's importance weight between studies that combine different factors [66].
2. When including both types of amotivation separately in the model, distrust-based amotivation was negatively related to both vaccination behaviors ($\beta_{intention} = -.20$, $\beta_{recommendation} = -.25$, $p < 0.001$), whereas effort-based amotivation only showed a significant negative relation with vaccination recommendation ($\beta_{recommendation} = -.04$, $p < 0.001$), but not with vaccination intention ($\beta_{intention} = -.01$, $p > 0.05$).

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Author contribution statement

All authors have (1) substantially contributed to the conception, study design, execution, acquisition of data, data analysis, and interpretation, and (2) drafted or written, or substantially revised or critically reviewed the article.

Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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Data availability statement

All de-identified data, analysis code, and research materials are available at Zenodo. The study was not preregistered.

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