COVID-19 vaccine: factual reporting, dynamic preferences, and gender hesitancy

Anna Rinaldi (anna.rinaldi@uniba.it)
University of Bari Aldo Moro
Pierfranceso Dellino
University of Bari Aldo Moro

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Abstract

At different rates in different countries, one can observe the phenomenon of COVID-19 vaccine hesitancy. In June 2021, we surveyed 1,068 people in France and Italy to inquire about individual potential acceptance, focusing on time preferences, in a risk-return framework: getting the jab today, in a month, and in 3 months; perceived risks of vaccination and COVID-19; and expected benefit of the vaccine. We conducted a randomized controlled trial to understand the impact of daily stimuli, such as factual news about vaccines, on audience acceptance of vaccination. In the main experiment, participants were asked to read two different articles extracted from two Italian newspapers about vaccine-related thrombosis, one using a more abstract description and language and the other using a more anecdotical description and concrete language.

We find that individual preferences for vaccination are variable and unstable over time, and individual choices of accepting, refusing, or delaying may be affected by the way news is written. To understand these dynamic preferences, we propose a new model based on seven categories of human behaviours that was validated by a neural network.

We observe a treatment effect: participants who red the articles significantly shifted to vaccine hesitancy categories. Furthermore, we detect a peculiar gender effect, showing that the type of language that results in a higher vaccination rate for men is correlated with women's lower vaccination rate and vice versa. This outcome should be taken into consideration for an appropriate gender-based communication campaign to achieve herd immunity.

Introduction

Individual choices of refusing vaccination may jeopardize the achievement of herd immunity and impact the success of campaign rollout[1,2].

"Vaccine hesitancy refers to delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place and vaccines"[3].

As declared by the World Health Organization, the COVID-19 pandemic has been accompanied by a massive infodemic that is an overabundance of information some accurate and some not - that can undermine the public health response to a pandemic.[4,5,6,7]

Misinformation and vaccine hesitancy are hot topics[8,9]. Most research considers the world as polarized between misinformation and factual information. However, in this state of the world, given the sudden spread of the virus and its variants, the most frequent infodemic situation is limited knowledge, i.e., information delivered truthfully, which causes difficulties in understanding reality. It has been noted that acceptance of the vaccine is not static, and it is highly responsive to current information and sentiment

around a COVID-19 vaccine, as well as the state of the epidemic and perceived risk of contracting the disease[2].

The aim of this research is to better understand how and to what extent vaccine hesitancy can change over time at the individual level. For this reason, we designed a survey investigating the individual willingness to accept the COVID-19 vaccine in three different timeframes: getting a jab in three months, in one month and the same day. Since vaccination is not mandatory, the choice of not choosing was also considered to better understand the volubility of the preferences. Therefore, the possible answers consist of a threefold preset option: yes, maybe, not. The questionnaire also investigated COVID-19 perceived risk and probability, vaccine perceived risk and expected benefit.

We also wanted to shed light on how those variables may be affected by stimuli recurring on a daily basis. Therefore, in a randomized controlled trial in France and Italy, we tested the effect of reading two actual newspaper articles reporting factual news. We built a model made up of categories summarizing individuals' dynamic vaccination preferences that was validated by applying neural network analysis and showed high predictive power.

The total sample consists of 1,068 individuals aged 18-64 (49,7% women) from Italy (*n*=530) and France (*n*=538) who had not received even the first jab yet. The two countries were selected to investigate two relatively similar neighbouring western countries that were - at the time of the beginning of the survey, June 26th, 2021- at a similar stage in vaccination campaign rollout (29% of fully vaccinated of the total population, both in Italy and France). Participants were recruited via Qualtrics.

The experiment consisted of 5 different treatments (figure 1). Two groups read different newspaper articles and answer questionnaires; two groups perform abstract vs concrete tasks and answer questionnaires; the control group only answers questionnaires.

Articles were extracted from two Italian newspapers that are very different with regard to journalistic style and audience; see in the supplementary material treatment 1 – abstract text, treatment 2 – concrete text. They both have the same number of words and describe an episode of vaccine-related thrombosis. In the first article (abstract text), a more formal, polite and distant language is used, reporting more scientific considerations; in the second article, a more common language forges a more anecdotical description (concrete text). Texts were also weighted according to a concreteness semantic vocabulary[10], controlling for the mean of the total words the articles are composed of (concreteness index = 3.54 for concrete text vs. 2.66 for abstract text; the difference is significant: t-test alpha = 0.05).

Our aim is to understand whether the reading of a newspaper story about vaccines may change individual vaccine hesitancy. And if so, which style of storytelling is more effective and in which direction.

Given that the two newspaper texts manifestly differ in the level of abstraction, we decided to cross-control for the mindset to understand whether this could be a key element influencing vaccination decisions[11,12]. For this reason, we decided to subsample the other two groups and asked participants

(*n*=238) to perform 40 item categories vs example tasks[13,14,15] (see supplementary material treatment 3 – abstract mindset task, treatment 4 – concrete mindset task). The characteristics of the samples are listed in table 1.

The total sample received a questionnaire (main survey) about intentions to get vaccinated in three months, in one month, and the same day (table 2). They were asked about risk perception of COVID-19 in terms of probability and severity and about the perceived risk of the vaccine and its expected benefit. All suggested answers were organized on a 5-point Likert scale.

Results

The two subsamples (France and Italy) are similar in terms of age, income, and education (see supplementary table 1). To acquire information about individual personality traits, such as risk attitude, the DOSPERT psychometric test [16] in the health domain was administered. For the results, see the methods section.

For all subsamples, the revealed preferences for receiving the vaccine increased as the time of inoculation decreased. Answers are consistent from a temporal perspective: from now to 3 months, those intending to be vaccinated increase, and vaccine hesitancy decreases. In absolute terms, vaccine refusal is much higher in France than in Italy, as is vaccine hesitancy.

Globally, 39.7% of Italians refuse the vaccine if administered today, 25.6% in one month, and 19.4% in three months. In France, 63.6% refuse to be vaccinated today, 44.2% in one month, and 35.1% in three months. The higher vaccine hesitancy in France compared to Italy is consistent with previous studies[17].

Instability of individual preferences over time.

Looking deeper into the dynamics of vaccine time preferences at the individual level, one can observe some interesting phenomena. Combining answers about the three times, one can see individuals as polarized between stable and unstable preferences. The three time perspectives that were elicited in the questionnaires are different from actual COVID-19 vaccine inoculation timeframes (now prescribed every five or six months). The questionnaire was designed in this way to better clarify the spectrum of human behavior hidden behind the usual “anti-vaxer” label. Respondents giving the same answer over the three different times (all answers yes vs no vs maybe; Tables 3, 4, 5) are 66.18% of the total sample. Respondents expressing two or three different preferences, namely, the other 24 combinations, represent 33.82%. A few examples are reported in Tables 6, 7, and 8.

Reading newspaper impacts the intended behaviour.

Out of the 27 possible combinations of answers (yes vs. no vs. maybe; three months vs one month vs today), 7 categories were abstracted according to the scheme shown in Table 9 to identify human types among respondents: 3 stable decision-makers (stable pro-vaxers, stable anti-vaxers, stable procrastinators) and 4 unstable.

We then generate the hypothesis that belonging to one of the seven categories is the dependent variable and that the perceived risks and expected benefits the independent risks. The categorization was validated by applying neural networks that showed, for all the treatment groups, a high predictive power, allowing a between-subjects comparison. For details of the neural networks, see the methods section.

The distributions of human behaviour categories in each group are shown in Tables 10 and 11.

In France, in the control group, stable pro-vaxers (category 1) account for 17.3%, and stable anti-vaxers (category 7) account for 29.1%.

In Italy, in the control group, category 1 represents 39.8% of the subsample, while category 7 represents 14.6%.

Categories 1 and 7 rapidly change after reading texts.

After reading the abstract text, anti-vaxers shift to 36% in France and 21% in Italy. Category 1 decreases to 12% in France and to 30% in Italy.

After reading concrete text, category 7 arrives at 35% in France and 17% in Italy, while category 1 arrives at 11% in France and 36% in Italy.

Both texts increase vaccine hesitancy, but the abstract text surprisingly affects readers more than the concrete text. It is worth noting that the increase in the anti-vaxers category is coupled with a decrease in the pro-vaxers category (category 1) and a slight decrease in the unstable categories.

Grouping together the unstable categories (2-3 and 5-6), one can observe a similar trend in both nations. In Italy they are 36.9% in the control; 33.5% in the abstract text; 30.7% in the concrete text; in France respectively 40%, 39.9%; and 37.2%.

Category 4, respondents choosing maybe for three times, in France, represents 14% of the control group, 12% in the abstract text group, and 16% in the concrete text group; in Italy respectively 9%, 15% and 17%.

No significant differences in vaccine-revealed preferences were detected among the control group and the two groups performing tasks.

Ordinary least square (OLS) multivariate analysis was applied to find the functional relationship among the 8 independent variables of the questionnaires and the category (dependent variable). The results are shown in Tables 12 and 13. The linear model, for all groups, is significant (based on an F test, a=0.05). After treatments, a change in the relative importance of the independent variables in all treatment groups

is observable. The relevance of demographic variables recedes after reading the texts or performing tasks.

In regard to texts and tasks, vaccine expected benefit and perceived risk become the most relevant independent variables. Vaccine hesitancy increases after reading newspaper articles, and vaccine acceptance decreases. This phenomenon in our model based on human behavior categories appears to be driven by vaccine risk-return individual assessment.

Trade-off between male and female vaccine hesitancy.

In both nations, gender matters to the control group as an independent variable. The distribution per gender of stable pro-vaxers and stable anti-vaxers is shown in Tables 14 and 15. In the control group, in Italy, women accept vaccination more than men and are more likely to be in category 1 – pro-vaxers: 48.2% of women total sample (TS); 29.8% of men TS. In category 7 - anti-vaxers - 7.1% of women and 23.4% of men occur. In France, in category 1, women accounted for 21% of TS, and males accounted for 13.2%. In category 7, women accounted for 22.8%, and men accounted for 35.8%.

In contrast, in the abstract text group, in Italy, women accept the vaccine less than men: category 1 is made up of 23.1% of TS of women and 36.4% of men. In category 7, 38.5% of the TSs were women, and 3.9% were men. In Italy, in concrete text, 39.5% of females belong to category 1. Males in the same category were 29.3%. In category 7 (anti-vaxers), females are 15.1% of TS and 20% males.

Symmetrically, in the French abstract text group, in category 1, females account for 10.4% and males for 13.2%. Anti-vaxers of category 7 were 40.3% females and 31.6% males. In France, in the concrete text in category 1, the females were 13.8%, and the males were 7.8%. The prevalence of anti-vaxers was 7.9% in cats and 32.5% in males.

Discussion

Questions about different timeframes of inoculation allowed us to create categories shedding light on vaccine acceptance and anti-vaxers' complex phenomenon.

Individuals appear to be voluble because decisions are volatile and can easily change when they are exposed to common stimuli, recurring on a daily basis, such as reading a newspaper article. We also understand that moving time perspectives, a remarkable quote of the sample, expresses internally inconsistent preferences: the same individual could declare to be a pro-vaxer today, an anti-vaxer in one month and a procrastinator in three months.

If the trend, in terms of vaccine hesitancy, is similar in both countries, in France it is always greater than in Italy and this confirms/denies the data in the literature. There is a difference between the two countries for the whole sample in terms of DOSPERT risk perception in the health field.

It is usually difficult to define people's behavior in practice when it concerns choices under risk and uncertainty. In the present work, the categorization effort well summarizes both the preferences of the Italians and the preferences of the French and allows us to observe, at the individual level, the change in the dependent and independent variables following the treatments, which turns out to be symmetrical in the two countries for both texts and tasks.

If preferences have such a high degree of volatility under common stimuli (texts), it is reasonable to affirm that it is possible to affect individuals' vaccine hesitancy through adequate measures.

It is worth noting that the abstract text more than the concrete one increases vaccine hesitancy, and this is surprising because in the abstract text, a more scientific language is used, while in the concrete text, a more anecdotal language is used.

Another remarkable result is how different genders react to treatments. Gender differences in preferences and specifically in the risk domain are largely documented in both the economic and psychological experimental literature[16]. Confirming this general statement, our findings add something new to this literature, allowing us to zoom in on opposite reactions to common stimuli. Women are more willing to get vaccinated at baseline, but after reading the abstract text, a significant number change their mind and become more anti-vax. By contrast, after reading the concrete text, men become less willing to get vaccinated. This imposes us a reflection about gender differences in reactions to factual news. Our findings of this decision-making mechanism suggest that gender-oriented specific communication could play a crucial role in nudging vaccination decisions, thus achieving herd immunity.

Methods

Respondents were recruited via Qualtrics and provided written informed consent at the beginning of each survey.

The study was conducted in accordance with the ethical principles of the Helsinki Declaration and approved by the Ethics Committee of the Behavioral Economics and Risk Lab of University of Bari Aldo Moro (2021-BERL-R001).

DOSPERT

To gain information about individual personality traits such as risk attitude (risk perception, expected benefit, risk taking), the DOSPERT psychometric test[14] in the health domain was administered. DOSPERT questionnaire analysis (table 16) revealed that there was a notable difference between Italy (M=30) and France (M=19) in risk perception in the health domain but not in risk taking (M between 15 and 17 in Italy; 15 and 16 in France) at baseline.

A t test analysis (see table 17) revealed that there is a significant difference in all subgroups between Italy and France in risk perception, while for risk taking, it is significant only for the concrete text.

Neural network

Neural network analysis was used to validate the grouping of human behaviour categories as a function of the 8 independent variables of the questionnaires. We consider these categories to describe the universe of possible choices with respect to vaccine acceptance. A deep learning scheme with 3 hidden layers, consisting of 7, 5 and 2 nodes, was used. In fig. 2, the result of the abstract task in Italy is shown as an example. The blue lines show the intercept of the layers, while the black lines show the weight of the nodes. A configuration with 7 categories of human behaviour as the dependent variable resulted in the best predictions, as shown in table 18, where only two cases out of 54 observations were predicted in the wrong category (residual higher than 0.5).

Ordinary Least Square Analysis

The seven categories defined by the neural network analysis constitute the dependent variable used in the OLS multivariate analysis, which served to show how the significance of the independent variables changes in the vaccine acceptance/hesitancy choice in the different treatment groups. The general model of the OLS is:

$$Human\ behaviour\ category = \alpha + \beta gender + \gamma age + \delta education + \vartheta income + \lambda C19\_PR + \mu C19\_Prob + \nu vaccine\_PR + \xi vaccine\_EB + \pi DOSPERT\_RT + \rho DODPERT\_RP + \varrho DOSPERT\_EB;$$

where α is the intercept and β, γ, δ ... are the coefficients of the independent variables, as shown in Tables 12 and 13.

Declarations

Data Availability

The datasets used and analysed during the current study is available from the corresponding author on reasonable request.

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Tables

Tables are only available as a download in the Supplemental Files section.

Figures

Figure 1

Schematic representation of the experimental design.

Figure 2

Neural network analysis structure

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Tables.docx
- Supplementaryinfo.docx