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Short Communication

"Beauty contest" indicator of cognitive ability and free riding strategies. Results from a scenario experiment about pandemic flu immunization

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ABSTRACT

High immunization coverage rates are desirable in order to reduce total morbidity and mortality rates, but it may also provide an incentive for herd immunity free riding strategies. The aim of this paper was to investigate the link between cognitive ability and vaccination intention in a hypothetical scenario experiment about Avian Flu immunization. A between-subject scenario experiment was utilized to examine the willingness to undergo vaccination when the vaccination coverage was proclaimed to be 36, 62 and 88%. Respondents were later assigned to a "Beauty contest" experiment, an experimental game commonly used to investigate individual's cognitive ability. Results show that there was a significant negative effect of the proclaimed vaccination uptake among others on the vaccination intention. However, there were no significant association between the "Beauty contest" indicator of cognitive ability and the use of herd immunity free riding strategies.

1. Introduction

Immunization is one of the most cost-efficient medical treatments available, but the potential for societies to secure the public health benefits generated by vaccinations can be limited by the social dilemma of immunization (Bauch, 2005). A communicable disease is subject to transferability, which implies that one individual's health can affect the health of others. By means of herd immunity, individual immunization will confer protection to other people and contribute to a reduction of disease prevalence in society. However, high immunization coverage in society may stimulate herd immunity free-riding strategies, defined as attempts by individuals benefit from a public good without contributing themselves. If most other people are immune, individuals can benefit from the herd immunity without being exposed to any potential side effects of the vaccination. As a consequence, free riding may result in suboptimal immunization coverage rates from a societal perspective, and so increase total morbidity and mortality (Bauch, 2005; Hershey et al., 1994; Vietri et al., 2012).

Game-theoretical simulations show that free riding reduces the possibility of attaining socially optimal immunization coverage rates. In classical game-theoretical predictions, individuals are assumed to be fully rational and have perfect knowledge about the individual's probability of infection. Under such assumptions, immunization coverage rates converge towards Nash equilibrium, the point at which no one could be better off by individually changing their strategy. Even though every individual guides his or her behaviour according to self-interest, this will lead to suboptimal outcomes in a societal perspective (Bauch, 2005; Fu et al., 2011).

The overall objective of this paper is to explore underpinning assumptions of game theory approaches to herd immunity free riding strategies. In game theory approaches it is assumed, among other things, that individuals act strategically and respond to other people's vaccination behaviour. Empirical studies of vaccination behaviour – for example, surveys and scenario experimental studies – have confirmed that the possibility to free ride often plays a role in the individual's decision-making about immunization (Bauch, 2005; Betsch et al., 2013; Hershey et al., 1994; Ibuka et al., 2014; Vietri et al., 2012; Zijtregtop et al., 2009). However, this is far from being a golden rule. In fact, these studies also found that some people seem to be indifferent to the prevalence of herd immunity and don't use herd immunity strategies.

This paper is an attempt to account for this puzzling heterogeneity, by exploring the role of cognitive ability in the vaccination decision. The aim is to investigate the way in which an indicator of cognitive ability associates with vaccination intention in a hypothetical scenario experiment about immunization. The investigation is carried out in two steps. Firstly, the paper investigates whether individuals respond to the possibility to use herd immunity free riding strategies. Using a survey experimental procedure, the paper investigates the way in which proclaimed immunization uptake among other people influence on the individual willingness to vaccinate. Hypothetically, the willingness to vaccinate is higher if immunization coverage rates are lower. Secondly, the paper investigates the link between an indicator of cognitive ability and herd immunity free riding strategies. In this part of the investigation, respondents of the hypothetical scenario experiment were assigned to a web-based "Beauty contest" experiment

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(Bosch-Domenech et al., 2002; Duffy and Nagel, 1997; Nagel, 1995). The "Beauty contest" experiment is an experimental game commonly used to investigate individual's cognitive ability. Hypothetically, cognitive ability is associated with individual herd immunity free riding strategies, because it is supposed to be necessary for the detection of the possibility of using such strategies.

It is well known that cognitive ability is linked to economic decisions making (Frederick, 2005). But despite that studies have found cognitive ability to be linked to free riding behaviour (Nielsen et al., 2014) and that immunization clearly has a free riding component, very few studies, if any, have investigated the link between cognitive ability and herd immunity free riding behaviours. It is therefore interesting to investigate if such a link could be observed in relation to herd immunity strategies.

2. Methods and materials

2.1. Step 1: scenario experiment

In the first step, a total of 400 individuals participating in a survey scenario experiment were asked to assess their willingness to vaccinate against a hypothetical outbreak of Avian Influenza. Respondents were randomly drawn from a web-based panel of Swedish citizens called the Citizen Panel, which was made available by the Multidisciplinary Opinion and Democracy Research (MOD) group at the University of Gothenburg in Sweden. The scenario experiment was in field between March 26th and April 12th, 2012. Participators were self-recruited via Internet advertising and exclusively included people living in Sweden. In total, 341 respondents out of the 400 returned the survey.

In the scenario experiment, one third of the participants were given a scenario where immunization coverage rates among other people were proclaimed to be 36%, as compared to 62 and 88 respectively in the two remaining thirds (see Appendices A and B for proof of random assignment and the scenario vignette).

After the scenario experiment, the survey participants were asked to answer how willing they would be to vaccination against the Avian Influenza, on a scale from 1 to 7, where low numbers represent low willingness to be vaccinated and high numbers high willingness (mean 5.08, SD 2.17, skewness −0.775, min/max 1–7).

2.2. Step 2: "Beauty contest" experiment

Approximately one year after the hypothetical scenario experiment, between February 27th and March 31th, 2013, respondents of the scenario experiment were assigned to a web-based "Beauty contest" experiment. The "Beauty contest" experiment is a well-studied dominance solvable experimental game (Bosch-Domenech et al., 2002; Duffy and Nagel, 1997; Nagel, 1995). Prior research shows that, in "Beauty contest" experiments, an entry closer to Nash equilibrium or closer to the winning choice is strongly associated with cognitive ability (Burnham et al., 2009).

Beauty contest entries argued to be linked to cognitive ability for two reasons. Firstly, subjects with lower cognitive ability might have difficulties in calculating the equilibrium. Secondly, the link between cognitive abilities and Beauty contest entries might be due to that higher ability subjects are more equipped to form non-equilibrium beliefs about the entries of co-players (Burnham et al., 2009). In other words, respondents of the Beauty contest need to figure out that the Nash equilibrium is zero, but also adjust their answer to the possibility that other respondents might not realise this.

In this web-based "Beauty contest" experiment, respondents were simultaneously instructed to pick a number between 0 and 100. As winner of the "Beauty contest" was to be selected the person whose chosen number was closest to 2/3 of the average of all the choices. In order to increase participators' motivation, respondents were told that the winner of the Beauty contest experiment was to receive movie gift vouchers. Respondents were not informed about the number of respondents participating in the "Beauty contest" experiment. Out of 341 respondents assigned to the experiment (all respondents who previously answered the vaccination question), 275 returned the survey and selected a number in the "Beauty contest", resulting in a response rate of about 81%. Two respondents having selected numbers above 100 were removed from the analysis.

In total, 273 participants answered the question according to instructions. The mean entry in the "Beauty contest" was 48.88 (SD 20.87, skewness −0.083, min/max 0,100) and the Standard Deviation 20.87. According to the instructions given in the "Beauty contest", the winning number was to be the integer closest to 2/3 of the average, which turned out to be 33.

In comparison with similar experiments carried out on a population of students or self-selected participants through "Beauty contest" experiments in newspapers, the mean number found in this web-based experiment was substantially higher (Bosch-Domenech et al., 2002; Duffy and Nagel, 1997; Nagel, 1995). It was closer, compared to the result of the same experiment conducted with a population drawn from a population-based registry (Burnham et al., 2009). In the distribution of responses, peaks may be noticed at 33 and 22), indicating steps of reasoning also registered in prior "Beauty contest" experiment research (Nagel, 1995).

The number (0−100) selected by each participator was used as the Beauty contest indicator of cognitive ability. An alternative indicator could have been based on the amount of deviation from the winning number, but the former of these alternatives is somewhat more strongly related to cognitive ability (Burnham et al., 2009).

2.3. Statistics

In the statistical analysis, using the SPSS 21 software package, ANOVA analysis was carried out to investigate the association between proclaimed immunization uptake and immunization willingness. To measure the effect of the coverage rate stimuli, significant tests, 95% confidence intervals (C.I.) and the effect size measure η^2 was calculated. To investigate the link between the indicator of cognitive ability and herd immunity free riding strategies, ANCOVA analysis (95% C.I.) was used.

3. Results

Among the participants of the scenario experiment, mean willingness to vaccinate was 5.59 (95% C.I. 5.20–5.99) when 36% were reported to vaccinate, but 4.99 (C.I. 4.53–5.44) when 62% were reported to do so (see Fig. 1). And when as many as 88% were proclaimed

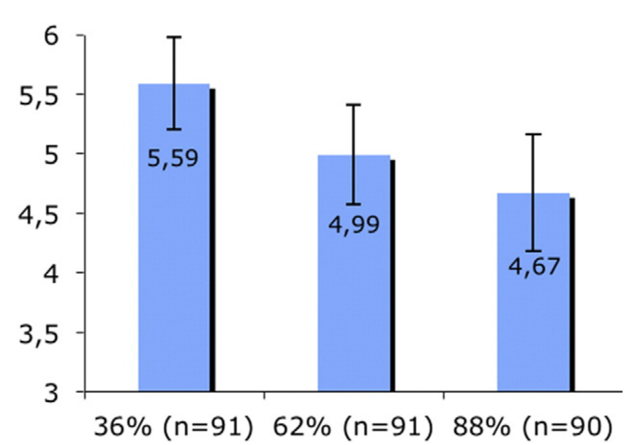

Fig. 1. Mean immunization intent and 95% C.I. Mean immunization intent, and 95% confidence intervals.
Source: The Citizens Panel (IV), 2012.

to vaccinate, the mean willingness to accept vaccination went down to 4.67 (C.I. 4.18–5.15). The difference between the three groups is significant and η^2 is 0.032 (F (2269) 4.383, $p = 0.013$, $\eta^2 = 0.032$). However, the results from the ANCOVA analysis indicate that there was no significant interaction between the "Beauty contest" entry and proclaimed vaccination uptake among other people (F = 0.762, $p = 0.782$).

4. Discussion

The results of the empirical investigation indicate that mean willingness to vaccinate is significantly lower, when the stated vaccination uptake among others is higher. It is likely that this is due to that respondents exploit the possibility of adopting herd immunity free riding strategies. The prior litterateur about vaccination behaviour have confirmed that the possibility to free ride sometimes play a role for the individual's decision-making about immunization (Hershey et al., 1994; Vietri et al., 2012; Zijtregtop et al., 2009). However, there were no significant association between the "Beauty contest" indicator of cognitive ability and the use of herd immunity free riding strategies.

Despite that cognitive ability has been linked to economic free riding behaviour (Nielsen et al., 2014) this study failed to found a similar link with regard to immunization. To some extent, this may signify that decision-making in relation immunization is not directly comparable to economic free riding behaviour. Instead of implementing policies to incentivise immunization behaviour, policy maker may rather pay attention to the role of social norms for vaccination behaviour (Rönnerstrand, 2013) and communicate the social benefit of vaccinations (Betsch et al., 2013).

To my best of knowledge, this is the first study to investigate the link between "Beauty contest" entry and vaccination intention. However, this study has several limitations. First, survey participators were self-recruited via Internet advertising. Politically interested, more highly educated males are over-represented in the panel as compared to what is the case in surveys of a representative sample of the Swedish population. However, since random selection to the stimuli groups was used, the effect of immunization coverage on vaccination intent at least cannot be attributed to the sample characteristics. Secondly, the mean number found in the "Beauty contest" experiment was quite high. This may indicate that participators did not pay sufficient attention to the instructions, which might have negative consequences for the validity of the "Beauty contest" indicator of cognitive ability. Thirdly, using the Beauty contest as a single indicator of cognitive ability is a limitation. Although this measure is strongly linked to certain kinds of cognitive ability, it may not overly generalize to cognitive ability more broadly. Finally, a within subject design – in which respondents report immunization intent in relation to several different levels of immunization uptake – would have allowed for a more direct investigation of the link between strategic reasoning and free riding. However, between subject investigations of herd immunity strategies tend to trigger variation in responses and hence potentially overestimate free riding behaviour (Vietri et al., 2012).

Appendix A. Control of randomization

	Different groups (mean values)					
Experimental groups	36%	62%	88%	All	F value	*p* value
Sex (1 = w, 2 = m)	1.59	1.67	1.62	1.63	0.541	0.583
Age	50.4	49.9	48.9	49.7	0.240	0.787
Left-right scale (1–5)	2.93	3.10	3.11	3.05	0.470	0.625

Comment. ANOVA showed no significant differences between the experimental groups when it comes to sex, age, and political orientation from left to right.

Appendix B. Scenario

A new global epidemic is being spread

Imagine the following scenario:

In the spring of 2012 a new global epidemic has broken out and authorities expect the spread of contagion to culminate in Sweden early in the summer. The epidemic, which has its origin in South East Asia, is a new variant of the Avian influenza. Through a virus mutation the disease is now transmissible between humans and highly infectious. The particular composition of this virus has the effect that symptoms only affect (women/men), but both males and females can transmit contagion.

In the on-going outbreak the symptoms of the bird flu include sudden fever, cough and shortness of breath, muscle ache, and a general sense of illness. In seriously affected humans the dominating symptom has been serious respiratory troubles often requiring intensive care medicine, using medical ventilators, and even a heart-lung machine (CPB pump). The virus is transmitted through direct contact in the same way as that of ordinary seasonal influenza is. When an infected person is coughing or sneezing, particles are spread by means of aerosols containing the virus, which will infect anybody that inhales them. Since earlier known variants of the H5N1 virus are distinct from the new virus, most people cannot be expected to have built any immunity against the new virus.

During the spring of 2012 the healthcare system will be providing vaccine free of charge. Besides offering protection to the individual, vaccination reduces the risk of spread in the population at large. In other words, the risk of contracting the bird flu is reduced also for unvaccinated persons. Well-documented scientific studies show that the part of the Swedish population that will have vaccinated amounts to around XX (36, 62, or 88) percent.

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