

The public uptake of information about antibiotic resistance in the Netherlands

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Abstract

In this study, we test to what extent an educational video on the intricacies of antibiotic resistance affects public attitudes towards antibiotic resistance and how such information is absorbed by the most likely targets of public health campaigns. We use a representative sample of 2037 individuals (from 2016) to test how people respond to a video educating them about antibiotic resistance. Our results show that receiving information does increase the general awareness of antibiotic resistance among our respondents. Yet, these effects are most profound for those who are the most likely targets of such information: the least knowledgeable group and those who have a more apathetic worldview. Our results are in line with suggestions made by the knowledge deficit model and show that the influence of cultural predispositions on the uptake of information about antibiotic resistance should not be ignored in future campaigns.

Keywords

antibiotic resistance, cultural predispositions, knowledge deficit, media representations, risk communication, risk perception, uptake of information

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I. Introduction

Antimicrobial resistance is a serious public health threat (Coast et al., 1998; Mayer, 2000; Thomas and Depledge, 2015; Viens and Littmann, 2015). To deal with the containment of antimicrobial resistance, the World Health Organization (WHO) has formulated several strategies. These include educating the prescribers and users about the prudent use of antibiotics, developing policies that focus on lowering the use of antibiotics in the veterinary sector, and developing new sorts of antibiotics and preventing the transmission of resistant microorganisms (WHO, 2001). As part of educating the lay public, interventions that target the nonprudent use of antibiotics are advised to be implemented.

Targeting people by providing information is a common strategy in public health campaigns. However, a closer look at the rather complex interrelationship of media and manner in which people deal with information about public health threats is needed, because mass media does not necessarily raise the perceived severity of emerging infectious diseases (Washer and Joffe, 2006). The information provided is often characterized by a technical and informative framing of messages. For example, the message used in public health campaigns that focus on promoting the prudent use of antibiotics often include the information about why misuse of antibiotics and antibiotic resistance are important public health problems (Huttner et al., 2010). Although the ‘clinician-patient’ encounter is the front line of the fight between humans and bacteria (Avorn and Solomon, 2000), we will focus on how people and specific groups of individuals, that is, the most likely targets of health communication, deal with information about antibiotic resistance.

Past and present public health campaigns about antimicrobial resistance mirror a key assumption in the so-called ‘information deficit literature’ (see Sturgis and Allum, 2004), that is that low levels of public acceptance on proper use of antibiotics are a reflection of low levels of awareness of and knowledge about the possibly disastrous effects of improper use. Against this background, our research focuses on two issues with regard to the uptake of information. Both issues resolve around the most likely targets of such persuasive communication: (1) those who are the unknowledgeable and (2) those who are culturally predisposed to reject all information that is meant to change their minds. The first issue addresses the relevance of the ‘information deficit literature’. The varying degree of success of interventions used to promote the prudent use of antibiotics (Huttner et al., 2010) could hint towards a disturbance with regard to the public uptake of information. The question here is whether information provision works to increase the awareness of the public health problem. The second issue deals with the relevance of cultural predispositions with regard to the uptake of information. Communication research has, time and again, shown that people use cultural predispositions to evaluate information that is new to them (Nisbet et al., 2002; Wynne, 2013). These predispositions can also hinder the public uptake of information (Achterberg, 2014; Chong and Druckman, 2007; Festinger, 1962).

Taking the two issues into account, we aim to contribute to the literature by studying the uptake of information about antibiotic resistance. We will test the effect of an informational video on antibiotic resistance among the public in general and among samples of the most likely targets of public health communication. Using data from a national survey deployed in the Netherlands, our study examines how different groups in society, based on their worldview or on their level of knowledge about the public health threat, deal with information about antibiotic resistance. This is relevant because more knowledge is needed on how to present information so that culturally diverse groups are all exposed to the information, and how to structure the debate to avoid cultural polarization (Kahan, 2010). Therefore, the guiding research question in this article asks ‘does the provision of information on the threat of antibiotic resistance work to increase the general awareness of antibiotic resistance and how is it absorbed by the most likely targets of public health campaigns?’

The structure of this article is as follows: in ‘Information deficits, cultural predispositions and information about the prudent use of antibiotics’ section, the theoretical framework describes the ‘knowledge deficit model’ and framing theory on which our hypotheses are inspired. This is followed by ‘Study design, measures and analytical strategy’, ‘Results’ and lastly, ‘Conclusion and discussion’.

2. Information deficits, cultural predispositions and information about the prudent use of antibiotics

The public uptake of information about antibacterial resistance

There are multiple ways by which people can be exposed to information on antimicrobial resistance. For example, news articles can spread the word of the dangerous hazard of the public health threat. In accordance with the increase of newspaper articles on a specific antibiotic-resistant bacterium,¹ methicillin-resistant *Staphylococcus aureus*, the framing of the public health threat has been subject to change over time. While in the past the information about antibiotic resistance focused on a medical scientific framing, recently, it concerns a discourse in which the ‘end of the golden age of antibiotics’ is predicted (Washer and Joffe, 2006). Another example is the use of noncommercial materials to educate physicians and lay persons about the importance of prudent antibiotic use (Avorn and Solomon, 2000; Bauchner et al., 2001). This is one of the goals of the WHO (2001) to raise awareness about the problems of antimicrobial resistance.

With public health campaigns that target the public-at-large as being one of the strategies to contain antibiotic resistance (WHO, 2001), the mechanism addressed by various national public health campaigns aims to increase the awareness of antibiotic resistance and prudent use of antibiotics (Huttner et al., 2010). The assumption is that by educating both experts and lay public, an increase in the level of knowledge on antimicrobial resistance will follow as a result from the exposure to such information. Health communication also rests upon knowledge deficit assumptions, assuming a knowledge gap that may be filled using public health communication (Bauchner et al., 2001; Sørensen et al., 2012). In line with the justification of providing information according to the ‘knowledge deficit’ model (Sturgis and Allum, 2004), the assumption in these public health campaigns is that people lack the knowledge they should have. And because knowledge is used as the key for success, the messages used in such public health campaigns focus on enhancing knowledge on antimicrobial resistance. For example, information containing that antibiotics are not effective against viral infections is a commonly used approach in such campaigns (Huttner et al., 2010).

The deficit model rests upon the assumption that there is a difference, or deficit, in the level of knowledge that people should have and the level of knowledge that people do have. Individuals who are least knowledgeable are considered as the most likely targets of public health campaigns. When a supportive attitude towards science and/or new technologies is desired, the public could be educated about the topic to reduce scepticism and accordingly increase a supportive attitude (Allum et al., 2008; Etchegary et al., 2010). By this logic, it can, therefore, be assumed that providing information leads to an equilibrium, a state in which the general public is sufficiently knowledgeable on the public health threat.

However, while providing information is necessary, it is not sufficient. A factor crucial for the success of public health campaigns is the exposure of the public to the informational provision (Huttner et al., 2010). To ensure that a large share of the target public is reached, a combination of media outlets can be used. One study on the combination of media sources that contain information

about antibiotic resistance shows that a multifaceted approach increases the chances of success (Bauchner et al., 2001). However, it is not the medium as such that matters, it is the content of the news that is most important (De Vreese and Boomgaarden, 2006c). In a study on media exposure on political knowledge and participation, De Vreese and Boomgaarden (2006c) found a positive effect between a positive framing and the level of knowledge. However, the media effect is diminished when news provided is two-sided, for example, when it focuses both on the pros and cons of a certain political issue (De Vreese and Boomgaarden, 2006a). This finding is in line with the two-sided information flow hypothesis from Zaller (1992) that states that mixed messages are likely to cancel each other out.

To solve the issue of a knowledge deficit, a common approach is to flood the public with information. As Brunk (2006) ironically puts it: ‘If only this deficit in knowledge could be erased (by education or persuasive communication), all of us, expert and lay, could ride together into the sunset of rational consensus on controversial matters’ (p. 179). By taking into account the one-sided hypothesis from Zaller (1992), which assumes that a consistent and pervasive directional news bias may shift public opinion, we develop our first hypothesis: (H1a) *one-sided information about antibiotic resistance helps to increase the general awareness of antibiotic resistance*. This hypothesis focuses on the effect of information that highlights the negative consequences of antibiotic resistance and nonprudent use of antibiotics.

However, the level of knowledge can also moderate the effect of information (De Vreese and Boomgaarden, 2006b). It is also possible that the effect of information does not always follow the expected positive direction towards a supportive attitude (Allum et al., 2008). In addition, we expect that the effect of information differs between levels of knowledge about the public health threat and that the effect is stronger for the most likely targets of public health campaigns. As such, we expect that (H1b) *the effect of one-sided information about antibiotic resistance on the general awareness of antibiotic resistance is stronger for those with lower levels of knowledge compared to those with a higher level of knowledge*. Summarizing our hypotheses with regard to the knowledge deficit model, we expect that information provision helps to increase general awareness of the public health threat and the effect of information on awareness is strongest for the most likely targets – the low knowledgeable.

Moderating the uptake of information

Yet, the idea that there is an equal uptake of information among the members of the public is not shared by most researchers, as cultural values, or predispositions, influence what and whom we believe (Kahan, 2010). The uptake of information is not uniform among all individuals, because some individuals will be culturally predisposed to accept or reject information (De Koster et al., 2016). While some people neglect information and take a negative stance towards a specific issue or topic because they are culturally predisposed to do so, others see their worldviews and values in line with the provided information, which will lead to acceptance and a positive stance (De Koster and Achterberg, 2015; De Koster et al., 2016). This finding in cultural–sociological research refers to the second issue we will address in this article.

Framing theory acknowledges the effect of cultural predispositions on the uptake of information (Festinger, 1962). The process of forming an opinion on an issue is a ‘marriage of information and predisposition’ (Zaller, 1992: 6). Awareness on an issue can be raised by providing information. Once exposed to it, information is processed and filtered by people’s predispositions, which leads to the formation of an opinion (Zaller, 1992). In addition to individuals basing their judgement on knowledge, they rely on their cultural predispositions in forming an attitude towards an issue. Hence, not only are cultural predispositions important

predictors in forming attitudes towards various issues, they also moderate the effect of information (Achterberg, 2014; Achterberg et al., 2015; De Koster and Achterberg, 2015; De Koster et al., 2016; Nisbet, 2005).

Therefore, the assumption that the same stimulus or information produces a universal reaction among all individuals is heavily criticized in recent research. In a recent paper, Drummond and Fischhoff (2017) found that more knowledgeable people (i.e. the higher educated) are more polarized over contested scientific issues (see also the results of Gauchat (2012) which point to similar polarization over science in general among the most highly educated). These findings seem to suggest that more information more or less implies more polarization instead of more agreement. Achterberg et al. (2010) note that there are several objections to the use of 'one-way' provision of information to the public. Two of their critiques referred to the inadequate empirical evidence in favour of the deficit model hypothesis and the moderating effect of cultural predispositions in the uptake of information. As a consequence, the uptake of one-sided or one-way provision of information is expected to differ among culturally diverse groups. Hence, the role of culture is one of the drivers between differences in antibiotic resistance rates between countries (Harbarth et al., 2001).

Taking into account the expected filtering process of cultural predispositions, we explore the possibility that cultural worldviews moderate the effect of information provision. Since research on the association between cultural predispositions and health beliefs on antibiotic resistance is lacking, we argue that some worldviews are, to a more or lesser extent, associated with health beliefs and health behaviour. As will be further described in 'Measures' section, we included anomie, utilitarian individualism, environmental concern, institutional (dis)trust and holism on the following empirical findings.

Anomie is the experienced separation of the individual self from other individuals in society (Merton, 1938). This cultural predisposition is considered to be an important predictor for bad health maintenance because anomic individuals are more likely to be the nonprudent users of medicines (Kramer, 1993). Anomic individuals typically distrust society and its institutions (Carlisle et al., 2010), and therefore the cultural predisposition *institutional (dis)trust* (cf. Achterberg et al., 2015) is also relevant. Research shows that individuals generally expect and trust the government to eradicate the problem of antibacterial resistance (Washer and Joffe, 2006). Therefore, we expect that individuals who distrust societies' institutions are more likely to reject information about the prudent use of antibiotics. Another cultural predisposition that is related to health beliefs is *holism*. This predisposition views nature and humanity as one interconnected entity. Holistic individuals perceive their health as a reflection of religious or spiritual well-being (Astin, 1998). Some people view antibiotic resistance as a process that occurs naturally and is, therefore, beyond human control (Brooks et al., 2008). However, the human component in wrong or excessive use of antibiotics in the veterinary sector is indisputable (WHO, 2001). Antibiotic resistance can, therefore, also be seen as a public health threat, which can still be within some form of human control. Furthermore, *utilitarian individualism* (Derks, 2004) as the belief that individuals' actions and beliefs are purely based on their self-interest (Bellah et al., 2007; Mascini et al., 2013) can also be linked to health beliefs. Research shows that some individuals have a low concern about the negative consequences of resistant bacteria on society as a whole and blame others for this problem (Brooks et al., 2008). Another related cultural predisposition is *environmental concern*, the believe that humans endanger the natural environment in combination with a strong willingness to protect nature (Franzen and Meyer, 2009). Both the more environmentally concerned and holistic individuals are more positive towards the use of complementary and alternative medicine (Astin, 1998; Hildreth and Elman, 2007). It is for this reason that environmental concern also might be related to beliefs about antibiotic use and antibiotic resistance. Based on this information, we consider people

with an apathetic worldview, that is, those with low levels of environmental concern and institutional trust and high levels of anomie, holism and utilitarian individualism are the most likely targets of public health communication.

Our second hypothesis (H2) is *the effect of one-sided information about antibiotic resistance on the general awareness of antibiotic resistance is less strong for those who are culturally predisposed to reject such information*. This hypothesis is formulated somewhat tentatively, as empirically we first define three clusters of individuals embracing the same set of cultural predispositions, and then test this information effects for each cluster independently.

3. Study design, measures and analytical strategy

Study design

We used the services of Flycatcher² to gather data in the Netherlands in Week 20 and 21 of 2016. To generate a representative sample of 2000 individuals, they used a stratified sampling procedure on their web panel members for age, gender, educational level and region. Before the closure date of the web survey, a reminder was sent to those who did not yet complete the questionnaire and this resulted in the completion by 2037 respondents. The survey, designed by Tilburg University and the National Institute for Public Health and the Environment (hereafter RIVM), was tested by Flycatcher with an internal pretest and by a convenience sample of 10 lay people. Respondents at the start of the survey noted that completion of the questionnaire would take approximately 30 minutes. We excluded respondents who completed the survey in 10 minutes or less from the analyses, as we expect they did not devote the reasonably needed time to provide reliable answers. The same strategy in cultural–sociological research was applied by Achterberg et al. (2015) and resulted in a sample size of 1780.

Measures

The survey was designed to assess individuals' knowledge on antibiotics and antibiotic resistance, beliefs about antibiotics and antibiotic resistance, and intentional behaviours regarding the prudent use of antibiotics. Furthermore, questions that measure cultural worldviews were included to analyse the association between these views and health beliefs on antibiotic resistance. In total, the survey consisted of 103 questions, comprising 5-point Likert-type scales, multiple-choice and open questions, distributed over four sections.

Within the first section, we assessed the degree of importance of several cultural predispositions for the respondents. As indicated above, we included measures for anomie, utilitarian individualism, environmental concern, institutional (dis)trust and holism. For measuring anomie, we used the adapted scale designed by Srole (1956) as used by Achterberg et al. (2015). The measures for *institutional (dis)trust* and *holism* were retrieved from Achterberg et al. (2015) and Achterberg et al. (2010), respectively. The measure for *utilitarian individualism* was retrieved from Derks (2004). The last cultural predisposition, *environmental concern*, was measured using a scale from the International Social Survey Program Module 2 on the environment (Franzen and Meyer, 2009; ISSP, 2012). The items for all these cultural predispositions have been factor analysed. Measurement information of the cultural predispositions is displayed in Table 1 and additional information regarding the wordings of the items are displayed in Appendix 2 (online supplemental files).³

In the second section, we focused on assessing the level of knowledge and the use of antibiotics. The level of knowledge on antibiotic resistance was measured with 10 'true–false–don't-know' items. Four of these items were retrieved from the Eurobarometer survey 79.4, which included

Table 1. Results of factor and reliability analyses on cultural predispositions and health beliefs.

Scale	Eigen value	KMO	Cronbach's α	M	SD
<i>Cultural predispositions</i>					
Anomie	2.203	0.746	0.727	2.80	0.69
Institutional trust	2.584	0.788	0.777	3.09	0.72
Environmental concern	3.413	0.810	0.794	3.09	0.60
Holism	2.203	0.688	0.671	3.40	0.66
Utilitarian individualism	2.083	0.722	0.634	2.25	0.46
<i>Health beliefs</i>					
Perceived severity	2.836	0.787	0.770	4.12	0.49
Perceived susceptibility	2.388	0.776	0.774	2.87	0.79
Awareness on risk of nonprudent use	2.783	0.643	0.793	3.91	0.58
Proxy on prudent use	2.255	0.757	0.684	4.23	0.54
<i>Dependent variable</i>					
General awareness about antibiotic resistance	1.917	0.644	0.708	4.09	0.43

KMO: Kaiser-Meyer-Olkin measure of sampling adequacy.

questions on antibiotic use and antimicrobial resistance (Borg, 2011; European Commission, 2013). The respondents were also asked whether and why they ever used antibiotics.

After assessing the level of knowledge, we implemented an intervention. We used an educational video with a duration of 1.30^ominute that was developed by the RIVM (2013) that explained what antibiotics are, how bacteria become resistant to antibiotics and the importance of prudent use of antibiotics to study the effect of this particular information on the general awareness of antibiotic resistance.⁴ While originally two-third of the respondents were randomly assigned to the test group, after setting the demarcation line of 10 minutes, 68.5% ($N=1220$ out of 1780) of the respondents were included in the test group. These respondents were allowed to proceed with the survey only after watching the video.

The third section was used to assess individual health beliefs on antibiotic resistance. The health belief model as described by Champion and Skinner (2008) served as the inspiration to develop the health belief questions. Following this model, we assessed four relevant health beliefs. The first health belief captures the perceived severity of antibiotic resistance. This was measured with six items that focused on beliefs towards the threat of antibiotic resistance, the framing/reporting about the risks of antibiotic resistance and nonprudent use of antibiotics. The second health belief captures the perceived susceptibility to become a carrier of antibiotic-resistant microorganisms. This was measured with four items that focused on the likelihood of attracting an antibiotic-resistant bacterium as a result of hospitalization, bad hand hygiene, and physical contact with an animal or with someone who is already infected. A third health belief was measured with five items and mirrored the awareness of the consequences of nonprudent use of antibiotics. A fourth health belief was measured with five items that resembled beliefs on actual prudent use of antibiotics. Factor and reliability analyses resulted in the use of four reliable scales to measure the health beliefs. In addition, a factor and reliability analysis of these four scales showed that the perceived susceptibility scale did not measure the same underlying component as the other three scales and did not contribute to the validity of the scale when it was included. As such, we constructed our dependent variable as the mean score on the three health belief scales: perceived severity of antibiotic resistance, awareness of the risk of nonprudent use of antibiotics and a proxy on the prudent use of antibiotics.

The fourth and last section of the survey included two questions on the religion - if any - of the respondent and the frequency of attending religious services. Additional socioeconomic background

information was post hoc provided by Flycatcher. Whereas gender, age, educational level, religiosity, gross income per year and history of antibiotic use either are related to awareness about antibiotic resistance and/or the cultural predispositions, we decided to include these variables as statistical controls in our regression tables. For gender, females are the reference category. Age was added as a continuous variable. Educational level was measured with three categories: low, middle, high. Religion was measured with the following categories: not religious, Catholic, Protestant, and other religion. The category 'other religion' is a mix of Evangelic, Humanistic, Islam, and other religious orientations. We have combined this category as a result of severe underrepresentation of any of these religious denominations. The history of antibiotic use was measured with four categories: never, within the last 12 months, longer than 12 months ago and a dummy category for those who could not recall. Gross income per year was measured with multiple categories: lower than €12,900, between €12,900 and €27,000, between €27,000 and €40,000, between €40,000 and €67,000, higher than €67,000 and refusing to answer.

Analytical strategy

A central strategy in our research was to identify whether the respondents in our sample cluster around a set of cultural predispositions. Because we expected that the influence of information on antibiotic resistance varied among different groups who each rely differently on their cultural predispositions, we first identified these clusters. The cluster analysis showed that although we argued that five cultural predispositions could be related to health beliefs on antibiotic resistance, four of them could be used to identify sufficient clusters. Including holism as a predictor variable for the clusters showed a nonsubstantial difference between the means on holism when two clusters were found ($M=3.36$ vs. $M=3.43$). Therefore, we excluded holism from the cluster analysis and performed the two-step cluster analysis again on the remaining four cultural predispositions: institutional (dis)trust, anomie, utilitarian individualism and environmental concern. Based on these variables, we found that the respondents cluster around three profiles.⁵ The Silhouette measure of cohesion and separation is .3, giving the cluster analysis a fair quality (Sarstedt and Mooi, 2014). The ratio of distance between measures was 1.792 and the ratio of sizes between the largest and smallest cluster was 1.37. Of the respondents, 37.9% ($N=675$) were assigned to Cluster 1 (Trusting), 34.3% ($N=610$) to Cluster 2 (Apathetic), and 27.8% ($N=494$) to Cluster 3 (Worried). Although the three clusters, or profiles, showed on average a comparable general awareness of antibiotic resistance, there is a statistical significant difference ($F(2, 1776)=76.79, p < .001$) between the trusting ($N=675, M=4.19, SD=0.37$), apathetic ($N=610, M=3.92, SD=0.44$), and worried individuals ($N=494, M=4.14, SD=0.42$).

Furthermore, trusting individuals had the highest level of institutional trust and lowest level of anomie. They were on average more equal to worried individuals with regard to their levels of environmental concern. Worried individuals were on average the least utilitarian individualist and compared to apathetic individuals had a similar level of institutional trust. Apathetic individuals had the highest average level of anomie and lowest average level of environmental concern. Considering these profiles, we expected that the apathetic individuals were more likely than the trusting and worried individuals to reject information about the prudent use of antibiotics and the problems of antibacterial resistance. Therefore, we regarded them as the most likely targets of public health campaigns. In other words, we expected that individuals with a profile of having relatively the lowest average level of institutional trust and environmental concern and highest average levels of anomie and utilitarian individualism are not affected by the educational video.

In addition, following the suggestion from Hanel and Mehler (2018) we will provide informative effect sizes to increase the transparency of our scientific communication. Therefore, we choose to both

Table 2. Level of knowledge on antibiotics and antibiotic resistance among the Dutch public.

Statements									
(1) Antibiotics kill viruses. (False)									
(2) Antibiotics are effective against the cold and flu. (False)									
(3) Unnecessary, too much or wrong use of antibiotics makes them ineffective. (True)									
(4) Using antibiotics often lead to side effects such as diarrhoea. (True)									
(5) A person can become resistant to antibiotics due to the wrong use of antibiotics. (False)									
(6) Antibiotic resistance is transmissible from one human to another. (True)									
(7) Reusing leftovers from a previous antibiotic course does not form a risk for antibiotic resistance. (False)									
(8) You can carry antibiotic-resistant bacteria without getting sick. (True)									
(9) Antibiotic resistance implies that antibiotics lose their efficiency to cure bacterial infections. (True)									
(10) Antibiotic resistance is a problem that only occurs within hospitals. (False)									
Results									
Statement	Whole sample (N = 1780)	Clusters			Gender		Educational level		
		Trusting (N = 675)	Apathetic (N = 610)	Worried (N = 494)	Men (N = 898)	Women (N = 882)	Lower (N = 561)	Middle (N = 784)	Higher (N = 435)
	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
(1)	49.3	60.7	37.9	47.8	45.8	68.7	33.2	52.2	64.8
(2)	75.2	80.1	69.3	75.5	68.7	81.7	68.8	76.5	80.9
(3)	95.1	97.2	92.1	96	94.5	95.7	92.2	96.2	97
(4)	52	50.4	49.5	57.3	44.1	60	48.5	55	51
(5)	7.1	9.2	4.9	6.9	8	6.1	4.5	6.5	11.5
(6)	12.6	14.5	11.6	11.1	14.6	10.5	9.4	12	17.7
(7)	64.8	73.2	54.6	65.8	63.3	66.3	56.3	65.2	74.9
(8)	80.2	86.7	72.8	80.4	81.7	78.6	70.9	82.5	87.8
(9)	83.4	88.1	76.9	84.8	83.4	83.3	76.3	84.4	90.6
(10)	87.1	93.5	79.2	88.3	86.5	87.8	79	88.6	94.9

Correct answer category is given after the statement (false/true). Scores are in percentages.

mention the Cohen's *d* and Cohen's *U*₃, which can be used to measure the practical significance of interventions (Cohen, 1988; Hanel and Mehler, 2018).

Next to the analytical strategy to find clusters of respondents based on their scores on the cultural predisposition questions, we identified the level of knowledge about the prudent use of antibiotics and antibiotic resistance. Table 2 shows the results on the knowledge items as measured within the second section of the survey. Of the 1780 respondents, a large proportion knew that nonprudent use of antibiotics makes them ineffective (95.1%) and that the ineffectiveness of antibiotics to cure bacterial infections refers to antibiotic resistance (83.4%). Although the results show that the respondents knew what antibiotic resistance implies, only a few of them knew that antibiotic resistance is transmissible between persons (12.6%) and that the human body itself cannot become resistant to antibiotics (7.1%). Furthermore, almost half of the respondents thought that antibiotics are effective against viral infections (43.1%). Nevertheless, 75.2% knew that antibiotics are not effective against the cold and flu.⁶

For each respondent, the total of the correct answers on the knowledge items was computed. The scores on the knowledge items were summed up and accordingly three groups were formed to

Table 3. Regression estimates on the general awareness of antibiotic resistance.

Variable	Model 1		Model 2		Model 3	
	B	SE	B	SE	B	SE
Intervention	0.050*	0.022	0.042*	0.019	0.039*	0.019
<i>Knowledge (high reference)</i>						
Low			-0.485***	0.028	-0.466***	0.030
Middle			-0.216***	0.022	-0.210***	0.022
<i>Profile (trusting reference)</i>						
Apathetic			-0.195***	0.022	-0.192***	0.023
Worried			-0.021	0.023	-0.021	0.023
<i>Male (female reference)</i>					0.049*	0.019
Age					0.001	0.001
<i>Religiosity (atheist reference)</i>						
Catholic					-0.039	0.024
Protestant					-0.005	0.027
Other religion					-0.051	0.029
<i>Education (lower reference)</i>						
Middle					0.010	0.022
Higher					0.002	0.028
<i>Income (< €12,700 reference)</i>						
€12,900–€27,000					0.081	0.043
€27,000–€40,000					0.064	0.041
€40,000–€67,000					0.079	0.042
> €67,000					0.126**	0.048
Income refuse					0.082*	0.040
<i>Antibiotic use (never reference)</i>						
Within 12 months					-0.014	0.038
Longer than 12 months ago					0.017	0.035
Do not know when					-0.042	0.047
Constant	4.052***	0.018	4.346***	0.025	4.143***	0.070
Explained variance R ²	0.30%		21.09%		22.16%	
Adjusted R ²	0.24%		20.86%		21.28%	
F	5.257*		94.372***		24.931***	

N = 1772. Regression coefficients are unstandardized.

***p < .001; **p < .01; *p < .05.

test Hypothesis 1b. The first group, the ‘low knowledgeable’ had a maximum of four correct answers (N = 332, 18.7%), the second group, the ‘moderate knowledgeable’ had up to seven answers correct (N = 1024, 57.5%) and the third, the ‘highest knowledgeable’ had more than seven answers correct (N = 424, 23.8%).

4. Results

One-sided information on antibiotic resistance

To test the knowledge deficit hypothesis (H1a), we use to the information provided by the multivariate regression results as shown in Table 3. With the variables included, we can explain 21.3%

of the variance in our dependent outcome. *Ceteris paribus*, the educational video used in the survey helps to increase the general awareness of antibiotic resistance ($p=.048$ in Model 3). The effect size of the video was determined with an independent samples t test. The test group ($M=4.10$, $SD=0.42$) had a significantly different mean score on the general awareness of antibiotic resistance than the control group ($M=4.05$, $SD=0.44$), $t(1778)=-2.351$, $p=.019$. The Cohen's d and Cohen's U_3 values are 0.1188 and 54.73%, respectively. Thus, the effect of the video among our respondents is barely statistically significant and is practically very small. Of the control group, 54.73% has a lower general awareness of antibiotic resistance than the test group. Still, we accept Hypothesis 1a. However, both the level of knowledge and the worldviews are included in the analysis. Table 3 shows that the lower knowledgeable of all knowledge-level profiles and those with a more apathetic worldview have the lowest general awareness of antibiotic resistance. In addition, we found that apathetic worldview is negatively correlated with knowledge ($r=-.225$) and additional analyses showed that knowledge is a stronger predictor than the worldviews of attitudes towards antibiotic resistance.

To test Hypothesis 1b, we performed a regression analysis on three groups of respondents, according to their level of knowledge, which is shown in Table 4. Using the ANOVA, we found that variances among these three groups are equal as we found a nonsignificant Levene statistic of 0.809 ($p=.445$). The lowest knowledgeable group, ($M=3.78$, $SD=0.40$), middle knowledgeable group ($M=4.09$, $SD=0.40$), and the high knowledgeable group ($M=4.32$, $SD=0.37$) differed significantly from each other with regard to their general awareness of antibiotic resistance ($F(2, 1777)=177.48$, $p<.001$). Furthermore, the educational video was found to be significantly effective only among the lowest knowledgeable group ($p<.001$). In addition, an independent samples t test was used to determine the effect size of the video among the low knowledgeable group. Among them, those who saw the educational video ($M=3.84$, $SD=0.39$, $N=226$) had a significantly higher mean score on the general awareness of the threat of antibiotic resistance than those who belonged to the control group ($M=3.67$, $SD=0.40$, $N=106$), $t(330)=-3.780$, $p<.001$. The Cohen's d effect size value ($d=0.44$) suggests a medium effect. The corresponding Cohen's U_3 value is 67.1%, indicating that among the low knowledgeable group, 67% of the control group had a lower general awareness of antibiotic resistance than the test group. These results suggest that the intervention has a positive relationship with the general awareness about the risk of antibiotic resistance. Hence, we found evidence that the effect of one-sided information about antibiotic resistance on the general awareness of antibiotic resistance is stronger for those with lower levels of knowledge compared to those with a higher level of knowledge. Thus, the knowledge deficit assumption is confirmed for the least knowledgeable sample. We, therefore, accept Hypothesis 1b. In addition, with regard to Hypothesis 2, we discovered the possible varying effect of the informational video on the clusters based on the cultural predispositions. In all three models of Table 4, apathetic individuals had a lower awareness level compared to the trusting individuals. Among the least knowledgeable, the worried individuals also had a lower awareness level than the trusting individuals.

The expectation that the effect of one-sided information about antibiotic resistance on the general awareness of antibiotic resistance is less strong for those who are culturally predisposed to reject such information (H2) is tested with the multivariate regression analysis displayed in Table 5. Information used in our intervention did work for the apathetic individuals ($b=0.10$, $SE=0.04$, $p<.01$). While we found evidence that one-sided information works (H1a), and in particular for the lowest knowledgeable people (H1b), we reject Hypothesis 2 because we expected that the apathetic individuals would reject the information given in our intervention because they were culturally predisposed to do so. Yet, we find that for apathetic individuals, the educational video apparently increased the general awareness of antibiotic resistance. In addition, an independent samples t test was used to test the effect of the video for among individuals who belonged to the

Table 4. Regression estimates on the general awareness of antibiotic resistance per knowledge profile.

	Low knowledge (N=331)		Moderate knowledge (N=1020)		High knowledge (N=421)	
	B	SE	B	SE	B	SE
Intervention	0.181***	0.045	0.009	0.026	0.019	0.039
<i>Profile (trusting reference)</i>						
Apathetic	-0.283***	0.054	-0.168***	0.030	-0.164***	0.049
Worried	-0.135*	0.061	0.006	0.031	-0.007	0.043
<i>Male (female reference)</i>	0.032	0.045	0.063	0.026	0.046	0.039
Age	0.001	0.001	0.002	0.001	-0.001	0.001
<i>Religiosity (Atheist reference)</i>						
Catholic	-0.017	0.051	-0.015	0.032	-0.147**	0.05
Protestant	0.045	0.065	-0.007	0.037	-0.049	0.053
Other religion	-0.120	0.070	-0.006	0.039	-0.102	0.059
<i>Education (lower reference)</i>						
Middle	-0.063	0.047	0.035	0.029	-0.038	0.059
Higher	-0.070	0.073	0.034	0.037	-0.380	0.059
<i>Income (< €12,700 reference)</i>						
€12,900–€27,000	0.126	0.085	0.061	0.061	0.063	0.087
€27,000–€40,000	0.151	0.082	0.054	0.058	0.021	0.082
€40,000–€67,000	0.208*	0.094	0.097	0.059	-0.063	0.081
> €67,000	0.184	0.129	0.144*	0.067	0.028	0.090
Income refuse	0.185*	0.081	0.078	0.058	0.009	0.08
<i>Antibiotic use (never reference)</i>						
Within 12 months	-0.070	0.075	0.027	0.054	-0.055	0.078
Longer than 12 months ago	-0.002	0.066	0.047	0.051	-0.022	0.070
Do not know when	-0.038	0.078	-0.031	0.068	-0.089	0.131
Constant	3.633***	0.151	3.823***	0.094	4.410***	0.133
Explained variance R ²	17.74%		6.76%		8.02%	
Adjusted R ²	13.00%		5.10%		3.90%	
F	3.739***		4.029***		1.947*	

Regression estimates are unstandardized.

*** $p < .001$; ** $p < .01$; * $p < .05$.

cluster of apathetic individuals. The test group ($M=3.95$, $SD=0.43$, $N=409$) had a significantly higher general awareness of the risk of antibiotic resistance than the control group ($M=3.86$, $SD=0.46$, $N=201$), $t(608)=-2.581$, $p=.01$. The corresponding Cohen's d (0.219) and Cohen's $U3$ (58.69%) value for effect sizes show a small effect of the video among the apathetic individuals between the test and control group. Thus, while we find statistical significant results using the multivariate linear regression analysis, the effect sizes are small, implying a lower practical significance of the results.

5. Conclusion and discussion

This research has brought forward three main findings. First, one-sided information does affect the general awareness of antibiotic resistance. Two, one-sided information is stronger for those with low levels of knowledge. And, third, one-sided information on antibiotic resistance actually increases

Table 5. Regression estimates on the general awareness of antibiotic resistance per cultural profile.

	Trusting (N = 674)		Apathetic (N = 606)		Worried (N = 492)	
	B	SE	B	SE	B	SE
Intervention	-0.001	0.030	0.102**	0.035	0.022	0.038
<i>Knowledge (high reference)</i>						
Low	-0.354***	0.050	-0.489***	0.054	-0.522***	0.056
Middle	-0.205***	0.031	-0.211***	0.047	-0.200***	0.042
<i>Male (female reference)</i>	-0.025	0.03	0.112**	0.035	0.078*	0.037
Age	0.001	0.001	0.004***	0.001	-0.001	0.001
<i>Religiosity (atheist reference)</i>						
Catholic	-0.048	0.036	0.007	0.042	-0.090	0.047
Protestant	0.050	0.039	0.001	0.053	-0.094	0.054
Other religion	-0.002	0.048	-0.035	0.055	-0.093	0.050
<i>Education (lower reference)</i>						
Middle	0.039	0.039	0.040	0.036	-0.056	0.042
Higher	0.039	0.043	0.032	0.055	-0.073	0.053
<i>Income (< €12,700 reference)</i>						
€12,900–€27,000	0.015	0.072	0.053	0.073	0.179*	0.082
€27,000–€40,000	-0.030	0.065	0.054	0.073	0.211**	0.076
€40,000–€67,000	-0.020	0.066	0.105	0.075	0.162*	0.081
> €67,000	0.065	0.070	0.012	0.101	0.301**	0.098
Income refuse	0.014	0.063	0.057	0.072	0.220**	0.076
<i>Antibiotic use (never reference)</i>						
Within 12 months	0.038	0.059	-0.044	0.067	-0.036	0.073
Longer than 12 months ago	0.031	0.051	0.013	0.063	0.001	0.068
Do not know when	-0.002	0.072	-0.062	0.081	-0.086	0.094
Constant	4.346***	0.101	3.669***	0.135	4.126***	0.141
Explained variance	12.91%		20.09%		21.23%	
Adjusted R ²	10.50%		17.60%		18.20%	
F	5.392***		8.200***		7.084***	

Regression estimates are unstandardized.

*** $p < .001$; ** $p < .01$; * $p < .05$.

the general awareness of this public health threat among those who are culturally predisposed to reject it. With regard to our first and second main finding, it appears that flooding people with information increases the general awareness of the negative consequences of antibiotic resistance. However, one must note that the uptake of information is not uniform across the population.

A one-size-fits-all solution is common for ‘filling’ knowledge deficits among members of the public in order to raise public support for science (Simis et al., 2016: 404). Although empirical evidence often refutes the knowledge deficit model, it is still used as a legitimation for filling knowledge deficits of public audiences (Simis et al., 2016). Moreover, Weber and Schell Word (2001) argue that adherence to the deficit model is a product of underestimating how complex the decision-making process is for publics as they form attitudes towards science topics. Nonetheless, our results do suggest that some knowledge deficits can be taken away as we found that the intervention increased the general awareness of antibiotic resistance only among the lowest knowledgeable individuals in the Netherlands. Hence, the middle- and higher knowledgeable individuals already had a substantial general awareness of antibiotic resistance. Furthermore, as the analysis on

the knowledge items showed, the Dutch are generally literate on what antibiotic resistance implies. Once levels of knowledge pass a certain threshold, information that provides such knowledge cannot increase the level of knowledge anymore. Therefore, it appears that among the middle- and higher knowledgeable individuals, a certain saturation point was reached. Our findings do, however, suggest that these more educated and knowledgeable people are less polarized in their response to the educational video than their less knowledgeable counterparts (cf. Drummond and Fischhoff, 2017).

Concerning our third main finding, we found that people with a certain cultural profile were not affected by the educational video. This might be due to the fact that the trusting and worried individuals already have a substantial knowledge and awareness level. Contrary to what we expected, the information increased the general awareness of antibiotic resistance among the apathetic individuals. Individuals with a worried or trusting profile were not affected by the educational video. However, this is still in line with the expectation that cultural predispositions act as a filter that determine the uptake of information (Achterberg, 2014; Achterberg et al., 2010; Festinger, 1962; Nisbet, 2005). In addition, with regard to Washer and Joffe (2006) who stated that a question left unanswered is whether the media picture on antimicrobial resistance is accepted and shared by its audience, we find that individuals in the Netherlands accept the information about the risk of nonprudent antibiotic use. In other words, the information is absorbed by the most likely targets and increases the general awareness of antibiotic resistance. However, as the practical significance of our results show, the effect of the educational video we used is small to medium. Summarizing our main findings, the information works for the most likely targets – the low knowledgeable – and those who are culturally predisposed to reject such information – the apathetic individuals.

Future research could check whether the respondents who were excluded from our analysis indeed provided unreliable answers on the scales and to what extent the video affects the dependent outcome for this group of respondents. Another recommendation for future research is to test the effect of politicized messages on antibiotic resistance since we used a nonpoliticized framing of the message (cf. Kahan, 2010).

As for recommendation for future health communication interventions aimed at increasing awareness, we argue that the framing of the message should include the overall threat of antibiotic resistance on an individual- and societal level. According to Washer and Joffe (2006), it is believed that only a strong arm of the government can help in containing the public health threat. In addition to educational recommendations, we argue that a focus on the noneffectiveness of antibiotics on viral infections is needed. There is still a substantial proportion unknowledgeable on the fact that antibiotics are not effective against viral infections, such as the cold or flu. Future health campaigns could benefit from framing the message more specifically on the effective use of antibiotics. Hence, the Dutch were mostly unaware that bacteria get resistant to antibiotics instead of their physical body.

Considering the limitations of our study, the first is that although our sample is representative for age, gender, educational level and region, our sample is not representative for ethnical background. Instead, our sample contains an overrepresentation of native Dutch individuals with a native Dutch parental background. A second limitation is the use of a perceived value measure on the negative consequences of antibiotic resistance. With our study, we are not able to investigate whether the educational intervention actually prevents individuals from nonprudent use of antibiotics. A fruitful approach for future research could be to focus on the effect of educational intervention to promote the prudent use of antibiotics on the actual behavioural component of antibiotic use by individuals. Another limitation is that our study does not discriminate between the prescribers and users of antibiotics. It could be relevant too, to compare general practitioners with the lay public on their awareness of the negative consequences of antibiotic resistance.

This study contributes to the emerging body of knowledge on how people deal with information about antibiotic resistance. Our findings can be used to improve future educational interventions, in order to increase the success rate of a public health campaign that promotes the prudent use of antibiotics.

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Supplemental Material

Supplemental material for this article is available online at <https://journals.sagepub.com/home/pus>

Notes

1. Washer and Joffe (2006) studied news articles on MRSA published in the United Kingdom between 1995 and 2005.
2. For more information about Flycatcher, please visit their website: <https://www.flycatcher.eu/en>. The data have been made publicly available via the data-sharing platform Open Science Framework. The DOI of the project 'The public uptake of information about antibiotic resistance in the Netherlands' is 10.17605/OSF.IO/74ABR
3. A correlation matrix between the variables of cultural predispositions, knowledge and health beliefs can be found in Appendix 3 (online supplemental files).
4. The text of the video is written out in Appendix 1 (online supplemental files). The video can be seen on YouTube: https://www.youtube.com/watch?v=TJFWo_utkaE and contains the title '*Hoe ontstaat resistentie tegen antibiotica*'
5. The results of the cluster analysis are provided in Appendix 4 (online supplemental files).
6. The results on the knowledge items that were retrieved from the Eurobarometer survey are comparable to the study of Borg (2011), one of the scholars who utilized the Eurobarometer to show the level of knowledge on antibiotics in multiple European countries. With regard to that antibiotics do not kill viruses and the use of antibiotics can lead to side effects, the difference between the percentages of correct answers is less than 5%. A substantial difference in the percentages of correct answers was found on 'antibiotics are effective against the cold and flu' (our study=75.2% correct, Borg's study=93% correct) and 'Unnecessary, too much or wrong use of antibiotics makes them ineffective' (our study=95.1% correct, Borg's study=66% correct).

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