Action bias in the public's clinically inappropriate expectations for antibiotics

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Word count (text only): 6,294 words

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The data, pre-registration protocols, and materials are publicly available on the Open Science Framework at: https://osf.io/5hqfy/

This is a postprint version of the article accepted for publication in Journal Experimental Psychology: Applied; the final version can differ slightly.

Translational Abstract (150 – 250 words)

When people want antibiotics from their physician it encourages the physician to prescribe them, even if it is not clinically appropriate. Clinical guidelines recommend that physicians educate their patients about illnesses and antibiotics to eliminate any inappropriate desires for antibiotics. We tested whether providing clinical information to educate patients can completely eliminate inappropriate desires for antibiotics and whether a set of cognitive biases could explain why some people are not convinced by this information. We conducted four experiments with general adult participants from the United Kingdom. We found that adults who were told about the ineffectiveness and side effects of taking antibiotics for a viral infection were less likely to want antibiotics than those who did not receive this information. However, around 10% of people still wanted to take antibiotics even after being informed they are harmful and offer no benefit. Our findings suggest that this is driven by a strong desire 'to do something' to treat the infection, which can undermine educational efforts to inspire more judicial antibiotic health behaviours.

Public Significance Statement (1 – 3 sentences; approx. 30 to 70 words)

This research finds that although people who are better informed about illnesses and antibiotics are less likely to choose to take antibiotics inappropriately, around 10% of people still want to take antibiotics even though they know they will be harmful and will offer no health benefits. This preference can be explained primarily by a desire to just do something.

Abstract

Clinical guidelines recommend that physicians educate patients about illnesses and antibiotics to eliminate inappropriate preferences for antibiotics. We expected that information provision about illnesses and antibiotics would reduce but not eliminate inappropriate preferences for antibiotics and that cognitive biases could explain why some people resist the effect of information provision. In two experiments, participants ($n_1 = 424$; $n_2 = 434$) either received incomplete information (about the viral aetiology of their infection) or complete information (about viral aetiology and the ineffectiveness and harms of taking antibiotics), before deciding to rest or take antibiotics. Those in the complete information conditions responded to items on four biases: action bias, social norm, source discrediting, and information neglect. In two follow-up experiments ($n_1 = 150$; $n_2 = 732$), we aimed to counteract the action bias by reframing the perception of the resting option as an action. Complete information provision reduced but did not eliminate inappropriate preferences for antibiotics. Around 10% of people wanted antibiotics even when informed they are harmful and offer no benefit and even when the alternative option (i.e., rest) was framed as an active treatment option. Results suggest an action bias underpins this preference but appears challenging to counteract.

Keywords: antibiotics, nonclinical factors, patient decision-making, action bias, cognitive biases

Antibiotic resistance is a major global health threat estimated to be currently responsible for 700,000 deaths a year – a figure forecast to rise to 10 million by 2050 (O'Neill, 2014). Current evidence indicates that overprescribing in primary care is influenced to a large degree by patients with desires for antibiotics prompting physicians to prescribe them without clinical justification (Hamm, Hicks, & Bemben, 1996; Macfarlane, Holmes, Macfarlane, & Britten, 1997; McNulty, Nichols, French, Joshi, & Butler, 2013; Sirota, Round, Samaranayaka, & Kostopoulou, 2017). As the overprescribing of antibiotics fuels the growth and propagation of antibiotic resistance (Goossens, Ferech, Stichele, Elseviers & the ESAC Project Group, 2005), combatting the overprescribing of antibiotics in primary care is one of modern medicine's top priorities (Davies, 2018; Pouwels, Dolk, Smith, Robotham, & Smieszek, 2018).

Numerous studies have shown that the public's knowledge of appropriate antibiotic use and emerging resistance is imperfect (Grigoryan et al., 2007; McCullough, Parekh, Rathbone, Del Mar, & Hoffman, 2016). To correct public misconceptions, clinical guidelines recommend that primary care physicians inform patients about illness aetiologies, the function and side effects of antibiotics, and alternative treatments (Tan, Little, & Stokes, 2008). This educational approach is also adopted by public health campaigns, which distribute pamphlets and posters containing similar content to patients in primary care waiting areas and consultation rooms (Cross, Tolfree, & Kipping, 2017).

Efforts to educate patients reflect the common assumption that imperfect knowledge is responsible for inappropriate desires for antibiotics and that providing information to improve patient knowledge will be effective at eradicating such desires (Eng et al., 2003). However, providing information about illness aetiology and antibiotic efficacy to patients in primary care has resulted in only modest reductions of antibiotic overprescribing (Arnold & Straus, 2006; Haynes & McLeod, 2015; Macfarlane et al., 2002). This suggests that while

information provision may be necessary, it is not sufficient to convince patients that antibiotics are not always helpful (Ancillotti et al., 2018; van Rijn, Haverkate, Achterberg, & Timen, 2019). Hence, researchers have recently been encouraged to consider other factors that might also be important drivers of inappropriate desires for antibiotics (Donald, 2016). To better understand why efforts to eliminate inappropriate desires for antibiotics by providing clinical information about illnesses and antibiotics might not eradicate inappropriate desires for antibiotics, we can draw from the substantive literature on the influence of cognitive processes and biases on medical decision making tendencies (Blumenthal-Barby & Krieger, 2015).

For instance, many studies have shown that people are often influenced to a greater extent by the pathway through which an outcome occurs (i.e., by action or inaction) rather than by the information about the risks and benefits associated with the outcome (Baron & Ritov, 2004). The action bias describes occasions where an option is preferred because it is perceived as an action, despite it yielding less optimal outcomes than an alternative option of inaction (Bar-Eli, Azar, Ritov, Keidar-Levin, & Schein, 2007; Patt & Zeckhauser, 2000). This preference for action over inaction has been well documented in the decision making tendencies of both patients and physicians (Ayanian & Berwick, 1991; Fagerlin, Zikmund-Fisher, & Ubel, 2005; Kiderman, Ilan, Gur, Bdolah-Abram, & Brezis, 2013; Scherer, Valentine, Patel, Baker, & Fagerlin, 2018). In a recent demonstration of the bias, Scherer et al. 2018 presented participants with a description of a hypothetical cancer screening test that offered no medical benefits (no chance to save or prolong life), and had potential adverse effects (physical, emotional, and financial harm). They found that around 30% of respondents still viewed taking the screening test as a superior option to not screening at all, even when they were explicitly aware of the lack of benefit and possible harms. Theoretically, explaining inappropriate desires for antibiotics by mapping the desire to take antibiotics onto

the preference for an action with less optimal outcomes (taking antibiotics) over a superior alternative of inaction (resting) is straightforward. But empirical evidence from the general public is lacking. However, though most research has attributed preferences for action over inaction only to an action bias, from the current literature we also pinpoint two other potentially important sources of influence that may account for this preference.

First, people do not always process information in an unbiased manner (Lord, Ross, & Lepper, 1979). The list of ways people might limit how information is processed is a lengthy one. Golman, Hagmann, and Loewenstein (2017) discuss two particular strategies, source discrediting and information neglect, which have been demonstrated in medical settings. For instance, to preserve their prior beliefs, people who are vaccine hesitant often doubt the credibility of physicians that provide positive information about vaccinations (Kata, 2012), while patients with HIV or cancer often eschew important information about their diagnosis and prognosis (Leydon et al., 2000; Sullivan, Lansky, Drake, & Investigators., 2004). Research from these domains has shown that when people are motivated to preserve their prior beliefs, or to avoid potentially unpleasant news about their health, information provision intended to engender more judicious health decisions can lead to limited and even counterproductive outcomes (Leask et al., 2012; Leydon et al., 2000). Source discrediting and information neglect may act as barriers to the effect of information provision aiming to improve people's judgment of when antibiotics are appropriate but have yet to be examined in this context.

Second, people might resist information because it conflicts with their beliefs about what they consider to be the most normal behaviour. It has been well established that the perception of the social norm is an important predictor of people's health behaviours (Conner & Norman, 2015). The work of Kahneman and Miller (1986), recognised that one reason why people are highly motivated to adhere to their perception of the normative behaviour is

because negative events are experienced as worse when the normative behaviour is not followed. Within this framework, it would be expected that the perception that most people take antibiotics for a viral infection would result in a preference to comply with that perception which, in turn, might negate the effect of information provision.

Present Research

The present paper has three key goals. The first goal is to examine the effect of providing information on inappropriate desires for antibiotics. In Experiments 1 and 2 we manipulated information provision from a physician (incomplete vs. complete) and hypothesised that the provision of complete information regarding the effectiveness and costs of taking antibiotics would reduce inappropriate decisions to take antibiotics (Hypothesis 1). The second goal is to test whether some people have a bias for taking antibiotics. We hypothesised that complete information provision would not completely eliminate decisions to take antibiotics (Hypothesis 2). Confirming this hypothesis, that some people will still want to take antibiotics even after receiving complete and unambiguous information that they are not beneficial and potentially harmful, is necessary but not sufficient evidence for demonstrating that an action bias underpins inappropriate desires for antibiotics. This evidence would not exclude the influence of other processes on the bias for taking antibiotics (e.g., people may have not fully processed the information or may perceive some other non-clinical benefit from taking antibiotics). The third goal is to investigate the psychological biases that underpins the preference towards taking antibiotics despite being told they will not be effective and could be harmful. We hypothesised that decisions to take antibiotics in the presence of complete information would be positively associated with respondent's endorsement that their treatment preference was motivated by these four established cognitive biases: action bias, social norm perception, source discrediting, and information neglect (Hypothesis 3). We made no specific a-priori prediction on which of these biases

would be the strongest predictor. Finally, building on the results from Experiment 1 and 2 (showing the prominent role of the action bias), in Experiment 3, we tested whether presenting the alternative to taking antibiotics (resting) as an action would reduce inappropriate desires for antibiotics (Hypothesis 4).

Experiment 1

Method

Participants. Participants were either adults from the general public or first and second year undergraduate students. The general adult participants were recruited using convenience sampling as part of a third-year psychology student's dissertation and completed the experiment voluntarily. Undergraduate students received an invitation to participate via email and completed the experiment as part of their research methods course in exchange for some course credit. All participants accessed the study using an anonymised link. We recorded a total number of 546 attempts to access the online experiment. Two individuals did not consent to participating in the study and thus did not complete the experiment. Following a-priori pre-registered exclusion criteria we excluded 96 participants who did not fully complete the study and 24 participants who completed the study in a very short time, in order to minimise careless responses ($< 1/3$ of median time). Assuming $\alpha = .05$ and $1- \beta = .90$, the final sample size was sensitive enough to detect a small to medium effect size ($\varphi = .16$) for a Pearson's chi-square test to test the effect of information provision on choice of treatment (hypothesis 1), a small effect size ($d = .18$) for a one-sample t-test to test whether the provision of complete information regarding illness aetiology and antibiotic effectivity completely diminishes individuals' decisions to take antibiotics (hypothesis 2), and a small-to-medium effect size ($\rho = .18$) for a point-biserial correlation to test whether the choice to take antibiotics is associated with items relating to action bias, social norm perception, source

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discrediting, and information neglect (hypothesis 3) (Faul, Erdfelder, Lang, & Buchner, 2007).

The final sample consisted of 424 participants (148 were male, 273 female, and 3 other; age ranged from 18 to 68 years old, $M = 25.9$, $SD = 10.3$ years). The majority of participants (90%) indicated that they are registered with a family physician, are residents of the United Kingdom (83%) and identified as white (80%). Most participants were students (51%) or in full time employment (41%), with only a few unemployed (8%). Level of education varied among those with less than an undergraduate degree (57%), those with an undergraduate degree (29%), and those with a masters or doctoral degree (14%).

Design. In a between-subjects design participants decided whether to take antibiotics or rest in two information conditions (incomplete information condition: viral nature of the illness only vs. complete information condition: viral nature of the illness and antibiotic ineffectiveness information). Participants were randomly allocated to one of the two conditions with a 1:3 ratio, with 107 participants in the incomplete information condition and 317 participants in the complete information condition. As we aimed to explain any preferences participants may have for taking antibiotics despite having complete information, the 1:3 ratio was selected in order to maximise statistical power in the complete information condition where we would run correlation and regression analyses to examine the relationship between the cognitive biases and antibiotic preference. The incomplete information condition featured a vignette describing cold-like symptoms with the results of a blood test confirming the viral nature of the infection (Cooke et al., 2015; Meili, Muller, Kulkarni, & Schutz, 2015). In the complete information condition, a sentence was added: "She tells you not to worry and goes on to assure you that in this case, antibiotics will not work and will not help you recover any sooner than doing nothing. She adds that if you were

to take antibiotics you may experience side effects such as diarrhoea, vomiting and rash" (see the full cold vignette in the supplementary materials).

Materials and procedure. All research presented in this paper was approved by the university ethics committee. After providing consent, participants read a hypothetical medical scenario of a consultation with a physician for cold-like symptoms before expressing their treatment choice: "Take antibiotics" or "Rest only (without taking antibiotics)". The scenario was modelled on the vignettes employed by Sirota et al., (2017) and describes a situation in which a patient suffers from an illness for which antibiotics should not be prescribed according to the guidelines from the National Institute for Health and Care Excellence (Tan et al., 2008). Participants in the complete information condition then answered four questions on what motivated their treatment decision, one question for action bias "I would rather do something that may have side effects (i.e., take antibiotics), when I have a cold like this, rather than do nothing (i.e., rest only)"; for the social norm perception "Because other people like me would take antibiotics in this situation"; for source discrediting "Because I would not change my beliefs about taking antibiotics, when I have a cold like this, based only on the opinion of one GP"; and for information neglect "Because I did not consider the information about antibiotics not working, when I have a cold like this, when making my decision". Participants rated their level of agreement to these four cognitive bias items on a six-point scale ranging from 1 to 6 (1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Somewhat disagree*, 4 = *Somewhat agree*, 5 = *Agree*, 6 = *Strongly agree*).

Lastly, participants were asked to provide some information regarding their typical medical behaviour and some general demographic questions.

Statistical analyses. We ran a Pearson's chi-squared test for association with Yates' continuity correction to test whether the provision of complete information regarding antibiotic effectivity would reduce decisions to take antibiotics by examining any differences

between the proportion of individuals who choose to take antibiotics in the incomplete information condition and the proportion of individuals who choose to take antibiotics in the complete information condition (Hypothesis 1). We originally pre-registered to run a binomial test but realised that this analysis would not provide a sufficient test of the hypothesis.

We ran a one-sample *t*-test to test whether the provision of complete information regarding antibiotic effectivity completely diminishes individuals' decisions to take antibiotics by examining any differences between the proportion of individuals who chose to take antibiotics in the complete information condition and zero (Hypothesis 2). Again, we originally pre-registered to run a binomial test, but realised that this analysis was not appropriate.

We ran zero-order point-biserial correlations to analyse whether the choice to take antibiotics is associated with items indicating their endorsement of action bias, social norm perception, source discrediting, and information neglect (Hypothesis 3). To complement this analysis, we ran a multiple logistic regression to see which cognitive biases best predicted treatment choice[1].

Results

Consistent with the first hypothesis, a greater proportion of participants chose to take antibiotics in the incomplete information condition (40.19%) compared to the complete information condition (15.46%). Providing information about the efficacy and side effects of antibiotics significantly reduced inappropriate decisions to take antibiotics $\chi^2 (1) = 27.36$, $p <$ .001. This difference corresponded to a medium effect size $(\varphi) = .25$. However, consistent

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[1] Originally we pre-registered different analysis, but we realised that the pre-registered analysis plan was not appropriate to test the pre-specified hypotheses and so ran the analyses reported here.

with the second hypothesis, the provision of complete information was not enough to completely eliminate desires for antibiotic treatment. The proportion of people who said they would take antibiotics in the complete information condition was significantly higher than the 0%, which we would expect if respondents heeded all the information provided, $t(316) = 7.601$, $p < .001$. This difference corresponded to a medium effect size, Cohen's $d = 0.43$. Lastly, consistent with the third hypothesis, decisions to take antibiotics were positively associated with all four cognitive biases (black circles in Figure 1 show the correlation coefficients) and most strongly so with an action bias $r_{pb} = .68$, $p < .001$, 95% CI [0.62, 0.74]. In a multiple logistic regression with endorsed biases as predictors and preferred treatment decision as the binary criterion, the action bias significantly increased preference for taking antibiotics, $B = 1.20$, $OR = 3.31$, 95% CI [2.34, 4.97], $z = 6.27$, $p < .001$, as did agreement with the social norm perception bias, $B = 0.44$, $OR = 1.55$, 95% CI [1.11, 2.19], $z = 2.58$, $p = .010$ (see Table 1). While the same directional pattern was observed for source discrediting and information neglect, these predictors did not reach significance ($B = 0.29$, $OR = 1.34$, 95% CI [0.95, 1.89], $z = 1.67$, $p = .095$; $B = 0.22$, $OR = 1.25$, 95% CI [0.88, 1.77], $z = 1.24$, $p = .214$, respectively). One reason for this could be due to the correlations between these predictors (see Table 1).

Experiment 2

Results of Experiment 1 showed that providing more complete information does reduce inappropriate preferences for taking antibiotics. Some people, however, still wanted to take antibiotics even when they were informed that they had a viral infection, that antibiotics are not beneficial for people with viral infections, and that they can cause harm; out of the four predictors considered this preference was most strongly associated with agreement that an action bias and social norm perception motivated their decision. In Experiment 2, we set out

to provide a conceptual replication of Experiment 1 and retest the hypotheses in the context of a different illness (Lindsay, 2015). We also made slight changes to the scenario to address a few methodological shortcomings present in Experiment 1. First, we changed the wording in the scenario so that respondents were asked to think about the two treatment options rather than being suggested them by the physician as that may have endorsed the option to take antibiotics. Second, we developed and employed multi-item measures for the cognitive biases to enhance reliability and validity.

Method

  Participants. Participants from the general adult population were invited via a recruitment panel (Prolific: https://www.prolific.co/) to take part in an experiment paid at a rate of £5.04 per hour. In order to reach 400 participants while accounting for an expected 10% attrition rate, we set an a-priori stopping rule of 440 participants. We recorded a total number of 441 attempts to access the online experiment; all individuals consented to participating in the study. Following a-priori pre-registered exclusion criteria, we excluded one participant who did not fully complete the study and six participants who did not respond to an attention check question as instructed. The attention check question consisted of a hypothetical medical scenario of a consultation with a physician for cold-like symptoms. To show they had read the text participants were instructed to type the word 'SURVEY' in the response box.

  Assuming $\alpha = .05$ and $1- \beta = .90$, the final sample size was sensitive enough to detect a small-to-medium effect size ($\varphi = .16$) for a Pearson's chi-square test to test the effect of information provision on choice of treatment (hypothesis 1), a small effect size ($d = .18$) for a one-sample t-test to test whether the provision of complete information regarding illness aetiology and antibiotic effectivity completely diminishes individuals' decisions to take

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antibiotics (hypothesis 2), and a small-to-medium effect size ($\rho = .18$) for a point-biserial correlation to test whether the choice to take antibiotics is associated with items relating to the action bias, social norm perception, source discrediting, and information neglect (hypothesis 3) (Faul et al., 2007).

The final sample consisted of 434 participants (180 were male, 251 female, and 3 other; age ranged from 18 to 74 years old, $M = 37.18$, $SD = 12.09$ years). All participants were residents of the United Kingdom and the majority of participants identified as white (92%). Most participants were in full time employment (70%) and level of education varied among those with less than an undergraduate degree (43%), those with an undergraduate degree (43%), and those with a masters or doctoral degree (15%).

Design. The experimental design was the same as Experiment 1, but with a different illness vignette (acute otitis media). Again, participants were randomly allocated to one of the two conditions with a 1:3 ratio, with 108 participants in the incomplete information condition and 326 participants in the complete information condition.

Materials and procedure. With the exception of three improvements, the materials and procedure were the same as in Experiment 1. First, in our previous study, some participants may have believed that the physician endorsed both rest and antibiotics as treatment options because they were mentioned by the physician. To avoid this, we reworded the vignette so that the treatment options were not generated in discussion with the physician. (i.e., "After the examination she explains that for such symptoms there are two potential treatment options"). The new wording was changed as follows: "At this point in the examination you start thinking about two potential treatment options".

Second, in the complete information condition, participants responded to six items to measure each of the four biases (instead of one item per bias; see the supplemental materials): *Action bias* (e.g., "I preferred to do something, rather than just do nothing")*, Social norm*

perception (e.g., "Other people like me would have taken antibiotics"), *Source discrediting*[2] (e.g., "I would not change my beliefs about antibiotics based only on the opinion of one GP"), and *Information neglect* (e.g., "I did not fully consider the information about antibiotics"). Participants expressed their agreement on a six-point scale ranging from 1 to 6 (1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Somewhat disagree*, 4 = *Somewhat agree*, 5 = *Agree*, 6 = *Strongly agree*). Principal axis factoring with direct oblimin rotation revealed that the items for each bias loaded well onto the four theoretically predicted factors (see the full details in the supplemental materials). All scales displayed excellent internal consistency – with Cronbach's α ranging from .81 to .88 (see Table 1) and hence for each bias, responses were averaged for analysis. Third, participants in the complete information condition who chose to take antibiotics were also given the opportunity to report other reasons for their treatment decision as an open response.

Statistical analyses. The implemented statistical analyses for this experiment were identical to those run in Experiment 1. The analyses did not diverge from the pre-registration.

Results

Consistent with the first hypothesis, a greater proportion of participants chose to take antibiotics in the incomplete information condition (41.67%) compared to the complete information condition (7.98%). Providing information about the efficacy and side effects of taking antibiotics again significantly reduced inappropriate decisions to take antibiotics, χ^2 (1) = 64.86, *p* < .001, φ = .39. However, consistent with the second hypothesis that complete information provision would not completely eliminate decisions to take antibiotics, the proportion of people who said they would take antibiotics in the complete information

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[2] Labelled in the pre-registration as "source credibility" we renamed this measure to be more congruent with the direction of the items within the measure.

condition was significantly higher than the 0%, which we would expect if participants heeded all the information provided, $t(325) = 5.307$, $p < .001$, $d = 0.29$. Finally, consistent with the third hypothesis, decisions to take antibiotics were positively associated with all four cognitive biases (grey triangles in Figure 1 show the correlation coefficients) and most strongly with an action bias, $r_{pb} = .56$, $p < .001$, 95% CI [0.48, 0.63]. In a multiple logistic regression with biases as predictors and preferred treatment decision as the binary criterion, the action bias significantly increased decisions to take antibiotics, $B = 2.94$, $OR = 18.89$, 95% CI [7.02, 71.04], $z = 5.08$, $p < .001$, as did agreement with the social norm perception bias, $B = 1.65$, $OR = 5.21$, 95% CI [1.98, 17.27], $z = 3.04$, $p = .002$ (see Table 1). While the same directional pattern was observed for source discrediting and information neglect these predictors again did not reach significance ($B = 0.81$, $OR = 2.25$, 95% CI [0.87, 6.51], $z = 1.61$, $p = .108$; $B = 0.63$, $OR = 1.88$, 95% CI [0.78, 4.73], $z = 1.40$, $p = .161$, respectively), which again could be due to the correlations between these predictors (see Table 1). The results were thus very similar to those observed in Experiment 1.

Experiment 3a

In the previous two experiments we found that an action bias was the most prominent reason motivating decisions to take antibiotics. In Experiment 3a we had two goals: first, to show that the options "take antibiotics" and "rest" differ in terms of being perceived as an action or inaction; and second, to see if we could change the perception of "rest" by framing it differently without losing the meaning.

Method

  Participants. Participants from the general adult population were invited via a recruitment panel (Prolific) to take part in an experiment paid at a rate of £5.04 per hour. A total of 150 participants completed the study. This sample size was determined in order to

provide estimates with reasonable precision given the funding that was available for participant recruitment. Participation was restricted to individuals who were residents of the United Kingdom and at least 18 years of age. We did not collect any further demographic information (e.g., age, gender, or employment).

Design. In a completely within-subjects design, all participants were sequentially presented with two differently framed antibiotic treatment options and six differently framed rest options. The dependent variable was the perception of the treatment options as inaction or action.

Materials and procedure. After providing informed consent, participants were told to "*imagine a consultation with a GP during which they were offered one of the eight treatment options (e.g., fight the infection by taking three days rest, see Table 2):*" Participants then categorised the eight treatment options (presented in random order) by indicating whether they would consider the treatment option to be inaction or action (0 = *inaction*, 1 = *action*). Randomization was carried out using the Question Randomization function in Qualtrics.

Results

Ratings of the treatment options are shown in Table 2. Consistent with the action bias account, the option "Take antibiotics" was overwhelmingly rated as an action (97%), while the rest-as-inaction option, used in Experiments 1 and 2, "Rest only (without taking antibiotics)" was perceived as inaction by a majority (61%). We tried several variations for wording the option to rest (full items available in the supplemental materials) and the option most perceived as an action was "Action: The GP prescribes that you go and take three days rest" with 57% of participants rating it as an action. Thus, we were not able to reframe the option "to rest" to be perceived as equivalent to the "Take antibiotics" option as an action.

Experiment 3b

In Experiments 1 and 2 we found that some people prefer to take antibiotics even if they know they are not effective for their illness and that they have potential side effects. An action bias was the most prominent reason motivating these decisions in both experiments. In Experiment 3a, we found that taking antibiotics was more perceived as an action than the "rest" option however it was framed. To find a way of framing "rest" as an action we conducted a short pre-test ($n = 27$). This study had the exact same design as Experiment 3a, but also included three additional treatment option wordings ("Take painkillers and rest", "Action: Take painkillers and rest for three days", and "Rest (with antibiotics)"). While the overall pattern of results was similar to those in Experiment 3a, we found that the treatment option "Take painkillers and rest" was perceived as an action by the majority of participants (85%). Therefore, in Experiment 3b we set out to inform participants about antibiotics and try to counteract the action bias and its effect on antibiotic desires by presenting the option 'to rest' alongside this medicating action (taking painkillers). We hypothesized that presenting the choice of 'rest' alongside an action would reduce the proportion of people who would decide to take antibiotics in a scenario of a viral infection compared to presenting the option of 'rest' alone as inaction (Hypothesis 4).

Method.

Participants. We conducted a-priori power analysis using G*Power (Faul et al., 2007) to determine the number of participants needed, assuming $\alpha = .05$ and $1-\beta = .95$, to detect a 10% deviation from an expected 20% baseline proportion ($\varphi = .14$), for a Pearson's chi-square test (testing hypothesis 4). This resulted in a minimum sample size of 658 participants (329 in each condition). Participants were from the general adult population and invited to take part via a recruitment panel (Prolific) and paid at a rate of £5.01 per hour. To

account for expected attrition rate due to a-priori exclusion criteria (estimated around 10%), we collected a total of 740 participants. Two people did not consent to participating in the study and thus did not complete the experiment. Following a-priori exclusion criteria we excluded a further six participants who did not fully complete the study. As in Experiment 2, an attention check, which question consisted of a hypothetical medical scenario of a consultation with a physician for cold-like symptoms was employed. To show they had read the text participants were instructed to type the word 'SURVEY' in the response box. All remaining participants responded to an attention check question as instructed.

The final sample consisted of 732 participants (268 were male, 463 female, and 1 other; age ranged from 18 to 75 years old, $M = 35.75$, $SD = 12.60$ years). All participants were residents of the United Kingdom and the majority of participants identified as white (87%). Most participants were in full time employment (69%) and level of education varied among those with less than an undergraduate degree (39%), those with an undergraduate degree (45%), and those with a masters or doctoral degree (16%).

Design. In a between-subjects design (rest-as-inaction vs. rest-as-action), participants chose between either taking antibiotics or rest only (without taking antibiotics). In the rest-as-inaction condition the option to rest was presented alone as inaction "**Treatment option:** Rest (without taking antibiotics)" and the alternative option was presented as "**Treatment option:** Take antibiotics". In the rest-as-action condition the option to rest was presented alongside an action "**Treatment option:** Take painkillers and rest (without antibiotics)" as was the alternative option "**Treatment option:** Take painkillers and antibiotics". We decided to present the rest and antibiotic options alongside taking painkillers in the rest-as-action condition based on the results of a pre-test (Table 2), with the same design as Experiment 3a, in which we found that pairing the option to rest with a medicating action ("Take painkillers and rest") led to the option being perceived as an action (inaction = 15%, action = 85%).

Materials and procedure. After providing informed consent, participants read a vignette describing symptoms of acute otitis media. All participants received complete information about the viral nature of the infection and that antibiotics will not work, will not help them recover any sooner than doing nothing, and may cause side effects. Within the vignette, participants were then asked to think about the two treatment options. After reading the vignettes, all participants made their final choice of treatment (Take antibiotics vs. Rest only (without taking antibiotics)) and then provided some general demographic information.

Statistical analyses. As pre-registered, we ran a Pearson's chi-squared test for association to test whether presenting the option to rest alongside an action would reduce decisions to take antibiotics by examining any differences between the proportion of individuals who choose to take antibiotics in the rest-as-action condition and the proportion of individuals who choose to take antibiotics in the rest-as-inaction condition.

Results

In these complete antibiotic information conditions, a smaller proportion of participants chose to take antibiotics in the rest-as-action condition (9.81%) compared with the rest-as-inaction condition (12.33%). This small difference was in the predicted direction, but it was not statistically significant, χ^2 (1) = 0.94, p = .333, φ = .04. Thus, our hypothesis was not confirmed. These findings indicate that counteracting the action bias by presenting the alternative "rest" option alongside an action does not diminish the bias.

General Discussion

The present research establishes three important findings. First, most people responded well to information from a physician that an objective point-of-care test indicates an infection is viral and that antibiotics are not necessary and may have harmful side effects if taken. We

find that information provision can reduce the proportion of inappropriate preferences for antibiotics from 40% to 10%. Our findings support clinical recommendations for physicians to educate patients about illness aetiology and the ineffectiveness of antibiotic treatment for viral infections, as well as the side effects for self and others (Tan et al., 2008) as this information provision appears to play an important role in reassuring patients when antibiotics are not necessary.

Second, a proportion of people (around 1 in 10) still preferred to take antibiotics even when they had complete and unambiguous information from a physician that they will provide no benefit and possible harms. This finding violates a key assumption of normative decision-making theory (that people should choose the option that yields the greatest utility) and suggests the presence of an action bias for taking antibiotics in spite of complete information. The scenarios in experiments 1 and 2 were void of any diagnostic or treatment uncertainty as participants were offered clinical certainty of the viral aetiology of the infection from a blood test alongside the physician's clinical diagnosis. These tests are not always available in primary care, but their inclusion was necessary to establish clearly that in those situations, antibiotics could not treat the infection and so taking them was not a good decision.

Third, the bias for taking antibiotics despite complete information was positively associated with a set of four known cognitive biases. We find that people who were biased towards taking antibiotics were aware and willing to admit that their penchant for action and their social norm perception motivated their preference for sub-optimal treatment in this context.

The experiments presented here advance current understanding of the cognitive processes underpinning such desires and why efforts to educate patients are often not as successful as intended. A key implication of the present findings is that information provision

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from a primary care physician can substantially reduce inappropriate desires to take antibiotics, but some people are resistant to this information and efforts to address them should focus on counteracting the influence of cognitive biases such as the action bias.

Our findings are consistent with current research, which suggests that a proportion of people have an action bias to receive cancer screenings, which appears to be insensitive to information provision about the clinical benefits and harms (Fagerlin et al., 2005; Gavaruzzi, Lotto, Rumiati, & Fagerlin, 2011; Scherer et al., 2018), but extends it in an important and novel way as the first to establish the presence of this bias in the context of inappropriate antibiotic desires. In addition, supplementing the indirect evidence of an action bias (preference for antibiotics when they risk side effects and offer no benefit) with direct post-hoc self-report measures notably strengthens the evidence supporting the presence of the action bias. It is important to acknowledge that wanting antibiotics in the complete information condition could potentially have been because of different reasons, which were not assessed directly including failing to pay attention to the information provided or failing to update their belief (e.g., because of not reading the information, or because of holding personal views too strongly).

Aligned with the norm theory account (Bar-Eli et al., 2007; Kahneman & Miller, 1986), the perception that the social norm is to take antibiotics also significantly predicted inappropriate decisions to take antibiotics. Given the positive impact of attempts to leverage social norm on antibiotic behaviour of physicians (Hallsworth et al., 2016) and the general public (Ronnerstrand & Andersson Sundell, 2015), considerable efforts should be made to maintain momentum in fostering the perception that most people do not take, or even want, antibiotics for viral infections. The bivariate correlation analyses from Experiments 1 and 2 also revealed positive relationships between inappropriate decisions to take antibiotics and both the source discrediting measures and the information neglect measures. Aligned with

insights from other health domains (e.g., vaccination research), this provides tentative evidence that patients may attempt to protect their desire to take antibiotics by dismissing the objectivity and competence of the physician (Kata, 2012) or neglecting the information (Leydon et al., 2000). Based on the current findings, further research might explore whether strategies to help physicians emphasise the pertinent information or to reassure patients of their medical credibility might prove effective in promoting acceptance of antibiotic information.

Patients frequently report desires for antibiotics (McNulty et al., 2013), and this pressure is a strong and independent predictor of whether a physician will prescribe antibiotics (Little et al., 2004; Sirota et al., 2017). The use of delayed prescriptions has been shown to effectively reduce antibiotic use (Arnold & Straus, 2006) as can the implementation of multi-faceted educational interventions (Gonzales et al., 2005). Psychological research is well placed to complement existing strategies to reduce antibiotic overprescribing by developing an arsenal of quick and effective strategies for primary care physicians to convince patients with inappropriate desires for antibiotics to manage self-limiting viral infections without them (Tonkin-Crine, Walker, & Butler, 2015).

In Experiment 3, we aimed to illustrate how a simple intervention might convince individuals who are resistant to information to exhibit more judicious antibiotic desires. Contrary to our hypothesis, we did not find an effect of the intervention on inappropriate decisions to take antibiotics. In order to provide a strong theoretical assessment of the role of the action bias it was important that the manipulation in Experiment 3b was specifically targeted at countering the action bias. In this context, we found the action bias was difficult to counteract as presenting an over the counter form of treatment (painkillers) alongside the rest option did not significantly reduce the proportion of people who wanted to take antibiotics which provides some insight into the potential steadfast nature of the preference for taking

antibiotics. The lack of significant effect we observed might have been due to the possibility that this proportion of participants have such a strong representation of taking antibiotics as an action that they are more difficult to convince that taking antibiotics is not the most 'active' response. Given that only a small proportion chose to take antibiotics, it is also possible that a floor effect may be masking the full effect of the intervention. Future work could examine the combined effect of manipulations that target more than one of the cognitive biases identified here (e.g., both action bias and social norm perceptions), which might yield more effective results. Research exploring the effectiveness of such of multi-faceted educational manipulations would have significant practical value. An alternative possibility is that these participants may have been worried about future bacterial complications and perceived that choosing the rest option would exclude the possibility of having antibiotics in the future if the infection were to worsen (Gavaruzzi et al., 2011).

A few limitations of the present research need to be discussed. First, although we found evidence of an action bias for taking antibiotics, our present sample does not allow to generalise our findings beyond the United Kingdom. The importance of the social norm variable on participant's preferences to take harmful antibiotics suggests that people exposed to different cultures regarding antibiotics might display more or less of the action bias. Further research testing whether a similar proportion of people display an action bias across different cultural contexts (e.g., with residents from a country where antibiotics can be purchased over the counter) would be beneficial in determining the boundary conditions of the action bias on inappropriate preferences for antibiotics (Simons, Shoda, & Lindsay, 2017).

Second, in all the experiments presented here, participants were only given a choice between resting or taking antibiotics (or resting and taking painkillers in Experiment 3), which limits generalisability to clinical settings. During an actual primary care consultation

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patients and physicians can discuss other options. However, the forced choice paradigm was required to provide the conditions for a clear demonstration of action bias as a preference of an action (taking antibiotics) over inaction (resting). Further investigation of patients' decisions in clinical settings where patients have the chance to discuss other options (e.g., delayed prescriptions) could shed further light on the influence of the cognitive processes found here.

Finally, participants' decisions in our research were based on reading hypothetical vignettes about illnesses. The vignettes, commonly used in other studies (Gavaruzzi et al., 2011; Scherer et al., 2018) allowed us to control for important potentially confounding elements (e.g., symptom severity/duration and physician behaviour) and assess the causal influence of other elements (e.g., information provision and treatment presentation). It is therefore possible that the actual decisions will be more consequential. As a consequence, we would possibly observe a higher rate of endorsing the option of having antibiotics. Despite its hypothetical nature, we can be reassured that our participants engaged with the task. First, participants were only eligible to take part if they had an approval rating of at least 90%, based on their successful completion of previous online studies. Second, eligible participants were all rewarded (either financially or with course credit) for their engagement in the experiments. Finally, those who did not respond as instructed to attention checks were excluded.

Conclusion

The reported experiments identify important processes underlying inappropriate antibiotic preferences in the general public. People who were better informed were less likely to choose antibiotics when they were inappropriate. However, information provision did not fully eradicate inappropriate desires for antibiotics. We encourage future research to focus on counteracting the influence of cognitive biases on inappropriate desires for antibiotics.

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Cognitive biases associated with inappropriate preference to take antibiotics

(Point-Biserial Correlation)
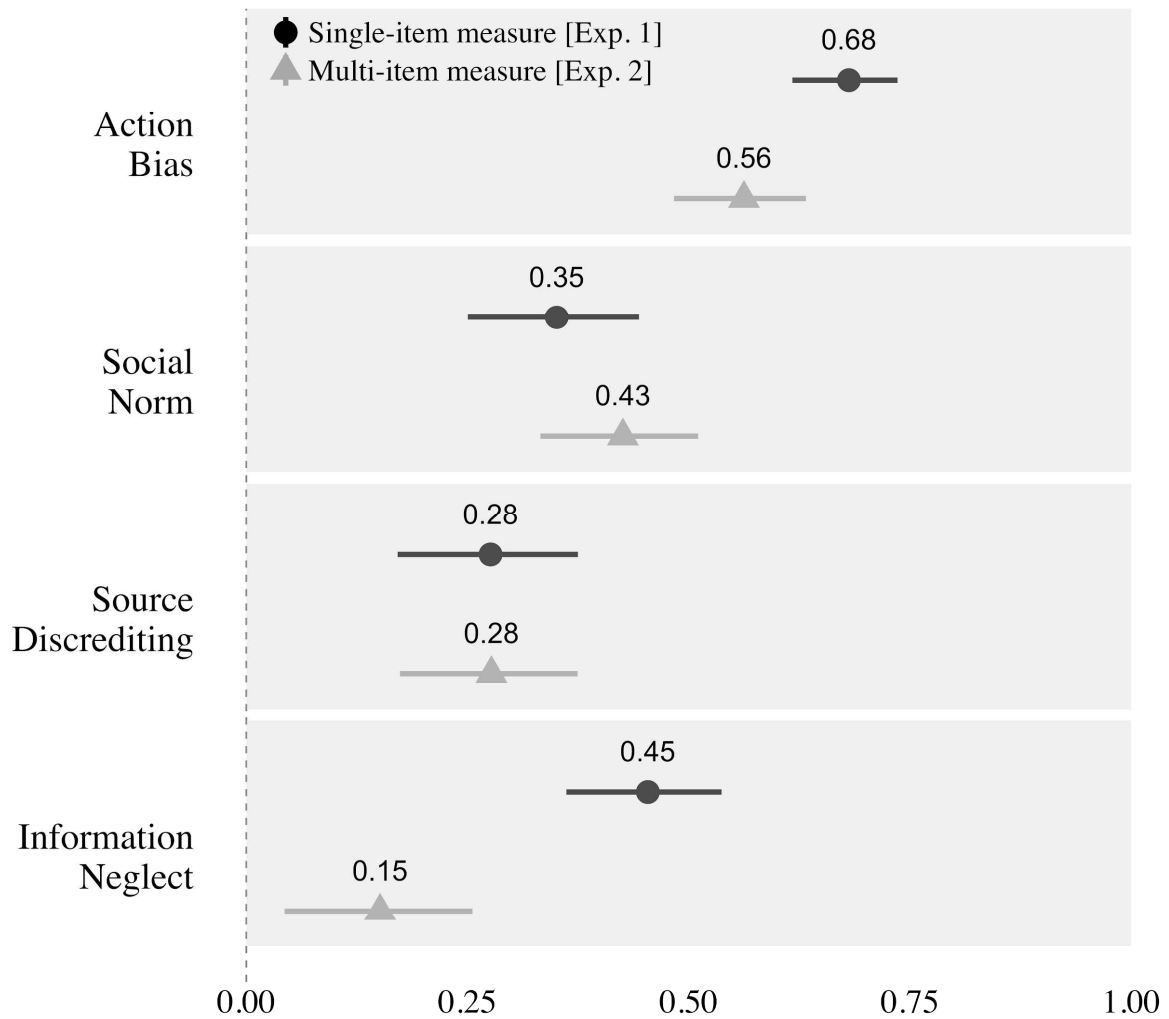
Figure 1. Showing correlation coefficients for the cognitive bias measures with decisions to take antibiotics across both viral scenarios [Experiment 1 and Experiment 2]. The point symbols represent zero-order point-biserial correlation coefficient estimates and the error bars represent 95% confidence intervals.

Table 1. Pearson correlation coefficients, descriptive statistics, reliability (α) and multicollinearity diagnostics for the cognitive bias items.

	1	2	3	4	Mean ± SD	VIF	Cronbach's α
Experiment 1 (Single-item)							
1 Action Bias	-	.41	.34	.59	2.13 ± 1.36	1.15	-
2 Social Norm Perception	-	-	.21	.38	2.22 ± 1.30	1.01	-
3 Source Discrediting	-	-	-	.36	2.87 ± 1.57	1.02	-
4 Information Neglect	-	-	-	-	2.36 ± 1.47	1.17	-
	1	2	3	4	Mean ± SD	VIF	Cronbach's α
Experiment 2 (Multi-item)							
1 Action Bias	-	.43	.29	.18	2.94 ± 0.97	1.39	0.82
2 Social Norm Perception	-	-	.34	.19	3.29 ± 0.95	1.07	0.81
3 Source Discrediting	-	-	-	.37	2.22 ± 0.85	1.33	0.86
4 Information Neglect	-	-	-	-	1.94 ± 0.27	1.29	0.88

Table 2. Participant responses from Experiment 3a of whether the various treatment options were perceived as either inaction or action.

Experiment 3a	Inaction (*n*)	Action (*n*)
Treatment option (Antibiotics)		
Take antibiotics	3% (5)	97% (145)
Action: Take antibiotics	1% (1)	99% (149)
	Inaction (*n*)	Action (*n*)
Treatment option (Rest)		
Action: Go and rest	51% (77)	49% (73)
Rest only (without taking antibiotics)	61% (91)	39% (59)
Action: The GP prescribes that you go and take three days rest	43% (65)	57% (85)
Fight the infection by taking three days rest	49% (74)	51% (76)

	Inaction (n)	Action (n)
Take three days to look after yourself	51% (76)	49% (74)
Go and take three days to overcome the infection	56% (84)	44% (66)

Pre-test (Experiment 3b)	Inaction (*n*)	Action (*n*)
Treatment option (Antibiotics)		
Take antibiotics	0% (0)	100% (27)
Action: Take antibiotics	4% (1)	96% (26)
Rest (with antibiotics)	15% (4)	85% (23)
	Inaction (*n*)	Action (*n*)
Treatment option (Rest)		
Action: Go and rest	59% (16)	41% (11)
Rest only (without taking antibiotics)	67% (18)	33% (9)
Action: The GP prescribes that you go and take three days rest	44% (12)	56% (15)
Fight the infection by taking three days rest	48% (13)	52% (14)
Take three days to look after yourself	56% (15)	44% (12)
Go and take three days to overcome the infection	74% (20)	26% (7)
	Inaction (*n*)	Action (*n*)
Treatment option (Painkillers and Rest)		
Take painkillers and rest	15% (4)	85% (23)
Action: Take painkillers and rest for three days	18% (5)	82% (22)