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More-than-Human Geographies of Antibiotic Consumption

Pets, Pet-Owners, and Societal Drugs

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More-than-Human Geographies of Antibiotic Consumption: Pets, Pet-owners, and Societal Drugs

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A dissertation submitted to the University of Bristol in accordance with the requirements of the degree of Ph.D in the School of Geographical Sciences, Faculty of Social Science and Law, September 2020.

Word Count: 85,802

Abstract

Antibiotic resistance is a significant public health challenge arising through a more-than-human geography enrolling multiple species, microbes, institutions, and environments. Antibiotic resistance entangles human, animal, and environmental health(s) because the same antibiotics are utilised in human and veterinary medicine, and resistance to these antibiotics can cross species boundaries through shared environments. Minimal social scientific research has examined the experiences or rationales of pet-owners in relation to antibiotic use and antibiotic resistance, nor whether the experience of utilising veterinary care in addition to medical care has an influence on how pet-owners use antibiotics in the context of their own health.

This thesis deploys mixed-methods to investigate the experiences of pet-owners when navigating multiple healthcare settings in the context of antibiotic use and antibiotic resistance and the extent to which pet-owners resemble petless members of the public in their knowledge and behaviour regarding antibiotics. Through the combination of quantitative and qualitative social research methods, this thesis argues that at the population level pet-owners and petless members of the public exhibit broadly similar levels of responsible behaviour regarding their own health. However, the experiences of accessing medical and veterinary care and following any subsequent treatment regimens are subject to inconsistent perceptions of health and illness across species borders and are productive of differing rationales for antibiotic-related behaviours in different species' care contexts.

This significance of this thesis is that it highlights the complexity of antibiotic stewardship for pet-owners and the role that distinct perceptions of health and illness hold in pet-owners' navigation of veterinary care and antibiotic use. Animal and health geographers, already cognisant of ontological challenges relating to 'knowing' animals and perceiving health, are challenged by this thesis to pursue a deeper integration of these challenges to respond to significant contemporary public health challenges that are interspecies in character and consequence.

Acknowledgements

I would like to thank my supervisors Dr. Maria Fannin, Professor Rich Harris, and Dr. Levi Wolf for their enthusiasm, time, and feedback over these four years as my research was conceived, developed, pursued, and then written up under circumstances that have challenged all involved. I would also like to thank my undergraduate dissertation supervisor, Dr. Merle Patchett, for encouraging me to consider postgraduate research, the staff and students in the School of Geographical Sciences for their intellectual support and friendship, and the players of 'Athletico Geography' past and present for giving me an entertaining way to keep moderately fit.

I owe thanks to Dr. Pru Hobson-West and the Animal Research Nexus Programme for my current gainful employment and my seamless introduction to post-doctoral research in the middle of a national lockdown.

I also owe thanks to my anonymous research participants without whom my research would not have been possible.

I would like to thank my fiancée, Dr. Shannon Khaliq, for not only putting up with me for the duration of my PhD studies but also providing unwavering support and encouragement and helping me to understand my research that much better. I suspect these debts are unrepayable, but I will do my best. I would also like to thank our cat, Treacle, for being the finishing slide in most of my presentations.

I would like to thank my parents, Susan and Gerard, for their depthless support. I would not be in the position I am without their hard work and sacrifices. I also have my sister, Sara, to thank for keeping me grounded.

Finally, I would like to dedicate this thesis to all of the PhD students that are at this moment starting, finishing, pursuing, adapting, struggling through, and living with their research during this global pandemic. Do not lose sight of the journey or the people taking the road with you.

This research was funded by an Economic and Social Research Council 1+3 studentship.

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award.

Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

Signed:  Date: 29/09/2020

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Part 1: Introductory Section

Chapter 1 – Introduction

Section 1.1 – Context and Justification

Section 1.1.1 – Antimicrobial Resistance: Social Scientific Challenges

Antimicrobial resistance is a global public health problem that poses significant challenges to modern medical infrastructure. The World Health Organisation (2019) lists antimicrobial resistance as one of the top ten threats to global public health, alongside issues such as climate change and vaccine hesitancy. In the UK Government Cabinet Office's (2017 p8) National Risk Register, antimicrobial resistance is listed alongside climate change as a long-term trend that is likely "to change the overall risk landscape" making current risks more severe and leading to the emergence of completely new risks.

This thesis focuses specifically on antibiotic resistance – the category of antimicrobial resistance that relates to resistance developed by bacteria. Antibiotic resistance is the social manifestation of a biological process. The biological process at the heart of antibiotic resistance is the evolution of evasion strategies by bacteria to overcome chemical and environmental challenges – such as exposure to antibiotic medication (Wright 2007). Bacteria that survive exposure to antibiotics are then able to grow and spread due to a lack of competition from other strains. Where there is an intersection between this evolution and the failure by humans to treat an infection using an antibiotic medication, the lack of susceptibility becomes 'antibiotic resistance' – in other words the pathogenic bacteria in question is not susceptible to the medication used.

The development of antibiotic resistance poses significant threats to public healthcare and the global economy. The *Review on Antimicrobial Resistance* (2016 p4), chaired by Lord O'Neill of Gatley and published in 2016, estimated that by 2050 10 million lives per year and a cumulative 100 trillion USD of economic output would be at risk if "proactive solutions […] to slow down the rise of drug resistance" are not found. In the healthcare context, antibiotic resistance not only affects the direct treatment of infections but also makes medical procedures such as gut surgeries, caesarean sections, chemotherapy, and joint replacements too dangerous to perform (Smith and Coast 2013; *Review on Antimicrobial Resistance* 2016). In addition – and connected to – these healthcare outcomes, an expert panel concluded in 2019 that based on behaviours exhibited in previous microbial public health events (for example SARS and avian/swine flu outbreaks) there could be decreases in social capital and public trust arising from increased stigmatisation following raised awareness of risk factors, perceptions of antibiotic resistance being unsolvable by governmental and scientific intervention, and a rise in racism linked to international travel and perceptions of risk-laden populations (Council of Canadian Academies 2019). The potential impacts of a rise in antibiotic and other antimicrobial

resistance are diverse, with social, economic, political, and cultural dimensions.

To mitigate antibiotic resistance, and antimicrobial resistance more broadly, a variety of systemic, institutional, and individual responses are required to address complex and interwoven problem areas. The *Review* (2016 p9) identified ten "fronts" on which antimicrobial resistance needs to be tackled:

1. Public awareness
2. Sanitation and hygiene
3. Antibiotics in agriculture and the environment
4. Vaccines and alternatives
5. Surveillance
6. Rapid diagnostics
7. Human capital
8. Drugs
9. Global Innovation Fund
10. International coalition for action

Public health interventions addressing antibiotic resistance are implemented in settings that are enmeshed with political, economic, and cultural contexts that can make their efficacy challenging. For example the report of the House of Commons Health and Social Care Committee's (2018 p17) Inquiry into Antimicrobial Resistance found that 20 years on from the implementation of electronic issuing of prescriptions, low-cost interventions such as delayed prescriptions that have proven efficacy in safely reducing antibiotic use are still "very difficult to put into practice on standard GP prescribing systems". In another example, rapid diagnostic tests that are recommended by NICE for certain infections are often not used because the cost of the test (which is higher than the financial cost of antibiotics) falls on individual GP practices rather than Clinical Commissioning Groups (House of Commons Health and Social Care Committee 2018). This can be problematic if and when patients demand antibiotics from their doctor when antibiotics are not indicated, as 'care' often takes the form of 'action' in this scenario as shall be further discussed in Chapter 2 (Hall *et al* 2018). Antibiotic resistance is a complex socio-technical problem, in which technical fixes, economic marginalities, social pressures, and cultural perceptions are interwoven into a "wicked problem" (Cabral & Lambert 2016 np).

The overuse of antibiotic medications and the underexposure of bacteria to antibiotics when they are used are anthropogenic drivers of antibiotic resistance. The same antibiotics are used in humans and animals, with 36% of antibiotics used in 2017 being sold for use in animals and 64% being prescribed for use in humans (80% in the community sector and 20% in the hospital sector) (HM Government 2019a). Sales of antibiotics for use in companion animals account for around 8% of total UK antibiotic sales (House of Commons Health and Social Care Committee 2018). The conditions that underly problematic utilisations of antibiotic medicines and promote antibiotic resistance, and the conditions that militate against antibiotic resistance, are "deeply social, shaped by cultural, political, and economic processes" (Smith 2015 p.1). In recent years there has been a significant push for the

social sciences to have greater involvement in researching the drivers, consequences, and conditions in and through which antibiotic resistance becomes a problem, and in the generation of sustainable solutions to promote antimicrobial stewardship (Knight *et al* 2018; Haenssgen *et al* 2018; Lorencatto *et al* 2018; Smith 2015; Economic and Social Research Council 2014). These conditions include the behaviour of prescribers such as general practitioners (GPs) or veterinarians, the settings in which they are prescribed (such as in highly time-pressured free-at-point-of-use GP practices or finance-conscious veterinary practices), as well as the behaviour of consumers such as patients, parents, pet-owners, and farmers.

The complexity of antibiotic resistance requires a coalition of research across the health and biomedical sciences, engineering disciplines, humanities, and arrayed social sciences. The work of this thesis is social scientific but as shall be evidenced in Chapter 2 draws upon not only upon interdisciplinary work in the social sciences and humanities, but also the work of microbiologists, epidemiologists, and veterinary scientists.

Section 1.1.2 – Justification

To date, minimal research has addressed the complexity of antibiotic stewardship in the social context of companion animal care. It is unclear for example the extent to which companion animal owners face distinct challenges or hold novel understandings regarding antibiotic use and antibiotic resistance, or the extent to which these may relate to existing perceptions or challenges in the context of human healthcare. These could be significant oversights, as around 40% of the UK population are pet-owners (Pet Food Manufacturers' Association 2019).

This thesis is predominantly concerned with the area of "public awareness", examining how the beliefs and practices of pet-owners across human and animal healthcare settings are entangled with (or distinct from) awareness about antibiotic resistance and the uses of antibiotic medicines. Following the *Review*, three co-authors of the report highlighted survey findings that most people in the UK believed that taking too many antibiotics could cause their own body to become resistant (Hall *et al* 2018). A consequence of this is that "people often do not realize that their use of antibiotics can have an effect on other people, and conversely, that other people's misuse could also have a negative effect on them" (Hall *et al* 2018 p151). This presents one example of disconnection in the awareness of the potential role of individual actions as part of the larger public health problem of antibiotic resistance that may implicate healthcare contexts incorporating the bodies of multiple species.

If this disconnection affects pet-owners' perceptions of their and their pets' health(s) as part of a more-than-human family, any effect of this disconnection on the development of resistance through misuse of antibiotics in the community could be being compounded by inter-species intimacy and intimately shared local microbial environments. There is growing evidence that companion animals are reservoirs of pathogens for humans, including antibiotic resistant pathogens, and that these

bacteria are able to move between human and non-human species as well as transfer resistance (Marques *et al* 2019a; Marques *et al* 2019b; Drougka *et al* 2016; Montgomery *et al* 2018; Weese *et al* 2006; Ishihara *et al* 2010; Strommenger *et al* 2006; Stenske *et al* 2009; Loeffler & Lloyd 2010; van Duijkeren *et al* 2019; Pomba *et al* 2017). A 118-case outbreak of multidrug resistant *Campylobacter* among humans in the United States between 2016 and 2018 for example was traced to contacts with puppies in a group of pet stores (Montgomery *et al* 2018). Pet-ownership has also been associated with larger households and the presence of children (Murray *et al* 2010; Westgarth *et al* 2007; 2010), suggesting that the number of routes through which pathogens or bacterial genetic material could be transferred tend to be multiplied in pet-owning households compared to petless households. Both of these areas – microbial and demographic – point towards pet-owners as a group of interest for social scientific research into community antibiotic stewardship as their antibiotic-related behaviours may have amplified societal effects on antibiotic resistance. These rationales are further discussed in Chapter 2.

At the commencement of this doctoral research in September 2016, there was no research published explicitly focusing on the antibiotic stewardship behaviours or perceptions of pet-owners. Since the commencement of this doctoral research in September 2016, there have been some contributions made to qualitative (Smith *et al* 2018; Dickson *et al* 2019; Redding & Cole 2019a) and quantitative (Stallwood *et al* 2019) social research in this area. Where this thesis extends these contributions is in situating pet-owners as one public among multiple rather than treating them in isolation from the broader public by engaging with antibiotic use and antibiotic resistance in the context of pet-owners' own narratives of health and illness across different species contexts rather than as a singular and separate issue.

Section 1.2 – Methodology and Research Questions

Section 1.2.1 – Overarching Research Questions

The goals of this thesis can be outlined through four overarching research questions that break down into specific methodological goals, questions, and hypotheses. The four overarching questions may be stated as follows:

1) How do pet-owners perceive the health(s) of themselves and their companion animals in relation to antibiotic use?
2) What impact do these perceptions have on beliefs about how antibiotics should be consumed?
3) Are there differences in reported personal antibiotic use between pet-owners and people who do not have companion animals?
4) What role does online health information have in shaping the understanding of information relating to antibiotics and their use?

The first two questions are linked together as the first progresses into the second. These questions explore pet-owners' conceptions of health and healthcare and the extent to which pet-owners make associations between these conceptions with antibiotic use and antibiotic resistance. These questions are explored through both the qualitative and quantitative aspects of the research. The third question is comparative and quantitative, drawing on the human medical side of the primary research questionnaire to compare responses between petless and pet-owning respondents in this study, contextualised with results reported from high-quality such as the Wellcome Trust Monitor. The fourth question addresses the role of the Internet relative to professional sources in shaping the understanding of antibiotics and their use, and will be primarily but not exclusively explored through the quantitative aspects of this thesis.

Section 1.2.2 – Mixed-Methods

Mixed-methods were used in order to more completely address the questions at the heart of the thesis and to begin to address the dearth of scholarship in the social sciences on the topic of pet-owner antibiotic stewardship and integrate quantitative and qualitative framings of social attitudes around antibiotics. The combining, and importantly the *integration*, of quantitative and qualitative methods can generate inferences beyond the individual methods themselves (O'Cathain *et al* 2007; O'Cathain 2012). Rather than simply use multiple methods, the quantitative and qualitative approaches in this thesis are integrated through connection in sampling, through "building" with the results from different methods informing the data collection of other approaches, and through the interpretation of results following analysis (Fetters *et al* 2013 p2139). For example, cognitive interviews were used in the design of the primary survey questionnaire instrument, material from these cognitive interviews and quantitative analyses complemented the analyses of qualitative material later on, with some qualitative interviews being recruited from the primary survey.

The use of mixed-methods is important for this research topic due to the lack of research in this area in either qualitative or quantitative modes. The thesis exploits the benefits presented by mixed-methods, as quantitative survey research allows for the observation of regularity at the population level whilst the qualitative interview research acknowledges that individuals have their own unique interpretations of the world (Morgan 2007). To borrow Howe's (2012 p92) example, observing the regularity with which drivers stop at red lights "does not provide an explanation of why humans *stop* when traffic lights are red" because "stopping is an action that can only be understood in terms of traffic laws and humans' reasons for obeying them, and it is this that underlies and explains the observed regularity." The chosen methods in this thesis facilitated population comparisons between petless members of the public and pet-owners alongside the development of understandings of pet-owners' own narratives around health and illness within the resource limitations and timeframe of a PhD. Each method is generative of inferences in its own right, however the added "yield" (O'Cathain *et al* 2007 p147) from deploying mixed-methods in this research project comes from situating the

individual narratives of pet-owners around health and healthcare in a population context relative to people who do not share the experiences of pet-owners.

The four central questions of the thesis in Section 1.2.1 were broken down into a specific set of quantitative hypotheses and guiding qualitative questions in order to provide a clear image of how the different methods were to be used to respond to the central questions.

Section 1.2.3 – Quantitative Hypotheses

The quantitative aspects of this research focus on examining evidence for differences. These differences are examined between groups (for example between pet-owners and petless survey respondents) as well as between outcomes (for example between models explaining trust levels in doctors and models explaining trust levels in veterinarians). In designing the primary survey research, Chapter 3 also examines differences between two random probability sample survey datasets to establish key correlates to adjust for in the weighting procedure for the non-probability sample used in Chapter 5.

The primary research survey in this project responds to six hypotheses that delineate the differences being examined in response to the central questions posed above:

H_1: Pet-owners report greater responsibility with antibiotics than people with no companion animals.

$H_{1/a}$: Pet-owners report less responsibility with antibiotics than people with no companion animals.

$H_{1/0}$: Pet-owners report no more nor less responsibility with antibiotics than people with no companion animals.

H_2: Pet-owners are more aware of the multispecies nature of antibiotic use than people with no companion animals.

$H_{2/a}$: Pet-owners are less aware of the multispecies nature of antibiotic use than people with no companion animals.

$H_{2/0}$: Pet-owners are no more nor less aware of the multispecies nature of antibiotic use than people with no companion animals.

H_3: Pet-owners' antibiotic-related behaviour towards themselves reflects their antibiotic-related behaviour towards their companion animals.

$H_{3/0}$: Pet-owners' antibiotic-related behaviour towards themselves does not reflect their antibiotic-related behaviour towards their companion animals.

H_4: The type of companion animal has a differential association with an owner's antibiotic-related behaviour.

$H_{4/0}$: The type of companion animal has no relationship with an owner's antibiotic-related behaviour.

H_5: There is an association between levels of knowledge around antibiotics and antibiotic resistance, and attitudes and behaviours regarding antibiotic use.

$H_{5/0}$: There is no association between levels of knowledge around antibiotics and antibiotic resistance, and attitudes and behaviours regarding antibiotic use.

H_6: Use and trust in the Internet as a source of health information has an association with knowledge, attitudes, and behaviours relating to antibiotics.

$H_{6/0}$: Use and trust in the Internet as a source of health information has no association with knowledge, attitudes, and behaviours relating to antibiotics.

These hypotheses are addressed in Chapters 3 and 5, and the discussion section of Chapter 5 explicitly responds to each hypothesis in turn based on the quantitative evidence presented in those Chapters.

Section 1.2.4 – Qualitative Research Questions

The qualitative aspects of this research are less structured, allowing research participants a greater role in driving the research process. For example, the 'failure' of a qualitative interview question to gain traction with a participant or capture data desired by the researcher could be productive and generative rather than unhelpful or a hindrance. Qualitative approaches allow for data generation to be a more interactional process, with participants more routinely able to challenge or disrupt the researcher's thinking. For these reasons, the qualitative research questions derived from the central questions were starting guides rather than specific evaluative statements:

1) How is antimicrobial resistance perceived and articulated by pet-owners in relation to the health of themselves and their companion animals?
2) Through what conditions are these perceptions generated?
3) To what extent do pet-owners narratives about antibiotic resistance encompass both humans and non-human animals?
4) What role (if any) does the Internet play in challenging or supporting existing healthcare institutional structures and the maintenance of the conception of a moral antibiotic consumer?

Chapters 6 and 7 present and discuss the qualitative analyses of this research, with the format of the Chapters developed out of the qualitative analysis process guided by the coding approach. Chapter 6 discusses participants' conceptions of health and illness, their perceptions of doctors and veterinarians, and their use of online health information, and Chapter 7 discusses their reflections on antibiotic use and antibiotic resistance in light of the findings presented in Chapter 6.

Section 1.3 – Contributions

Section 1.3.1 – More-than-human geographies of antibiotic consumption

Antibiotic resistance is a public health problem that entangles humans with non-human animals, microbes, institutions, practices, and infrastructures. These entanglements are geographic, bringing into focus "the most enduring of geographical concerns – the vital connections between the geo (earth) and the bio (life)" (Whatmore 2006 p601). Pet-owners must navigate this nexus of relations in the context of their own healthcare and their companion animals' healthcare. I argue in this thesis that in the UK these navigations are significantly different propositions in which lay accounts of human and non-human health are also accounts of space-making. How pet-owners understand health, illness, and antibiotic use in these contexts explicitly enrols sites of care such as the home, GP surgery, and veterinary clinic, and also implicitly relate to the shared environments of pet-ownership in the milieu of microbial movements such as parks, gardens, workplaces, and schools.

The more-than-human geography of antibiotic consumption presented through this thesis is not of a significant differentiation between pet-owners and petless members of the public, but rather of the centrality of differences in the way that infrastructures around human and companion animal health have to be navigated. Veterinary care in the UK brings into visibility the costs of healthcare in a way that medical care does not for most people, and from these costs arise different perceptions of professionals, affective relations with sites of care, and occasionally different understandings of health and illness. The weight of evidence in this thesis points to the different contexts navigated in understanding and securing health in different species as being generative of a more-than-human geography of antibiotic consumption that draws together institutions, sites and spaces of care, affective relations, and multispecies encounters. There is minimal evidence however that this geography leads to any systemic differences in terms of perceptions or behaviours regarding antibiotics and antibiotic resistance between members of the public who have to make varied navigations between medical and veterinary care and people who do not have to do so.

Section 1.3.2 – 'One Health' and companion animal antibiotic stewardship

'One Health' has been a cornerstone of policy development regarding antibiotic resistance in the UK (HM Government 2019a) and among international institutions (e.g. European Commission 2017). This approach emphasises the interconnection of human, animal, and environmental healths and the integration of policies addressing health in different spheres. An illustrative example of 'One Health' policy in practice is a collaborative case study in Salford involving the PDSA (a charity veterinary clinic) and the NHS Health Check programme that aims to tackle preventable death and disability. The PDSA and Salford Health Improvement Service partnered with their own bespoke health check vehicles and toured local parks together, successfully leveraging people's interest in their dog's

wellbeing to increase uptake of NHS Health Checks by offering them whilst their dog received a PDSA "PetWise MOT" health check (British Veterinary Association 2019a).

The evidence of this thesis however suggests that the understanding of antibiotic resistance as a policy issue entangling disparate healths into 'One' is not necessarily the lived understanding of pet-owners regarding different species' healths nor antibiotic resistance. By drawing out pet-owners' own accounts of 'health' and their perceptions of antibiotic resistance and antibiotic use, the research of this thesis points to a more proactive role for the public health interventions involving the companion animal-focused veterinary practice and a reworking of existing efficacious educational interventions to emphasise and normalize not only that antibiotic resistance is a public health issue but that not all of the 'healths' at stake are human.

Section 1.3.3 – Online health information

Online health information plays an increasingly prescient role in modern patient-hood. This is an area of interest that has engaged both medical and veterinary professions as well as social scientists. The research of this thesis highlights the divide in information provision between medical and veterinary contexts, calling back to the uneven implementation of 'One Health' as a policy orientation and the disconnected infrastructures that shape the more-than-human geography of antibiotic consumption for pet-owners.

This thesis makes additional contributions in examining trust and frequency of use of online health information and their relationship to the public's levels of understanding and stewardship behaviour. Specifically, quantitative evidence suggests that individuals that very frequently use the Internet as a source of health information are less trusting of medical and veterinary professionals, with lower levels of good stewardship behaviour. Interventions in this area, this research suggests, need to be cognisant of the varied reasons members of the public have for turning to the Internet as a source of health information.

Section 1.3.4 – Survey methodological contributions

The key methodological contributions of this thesis are in the field of survey research relating to antibiotic stewardship. These contributions are located in Chapters 3 and 4, and whilst they inform the research design of the thesis they also hold relevance for social research into antibiotic resistance beyond companion animal care, and for social research examining the parallel contexts of medical and veterinary care navigated by pet-owners.

Through the use of existing random-probability survey datasets (the Wellcome Monitor and Eurobarometer series) focusing on the general public, the thesis provides evidence that previously unconsidered variables such as geographic and political attitudinal variables are potential areas for investigation in relation to antibiotic stewardship within and beyond the thesis.

Using cognitive interviews, the thesis also examines the performance of survey questions relating to human and companion animal antibiotic consumption, attitudes towards healthcare professionals, and the use of online health information. This is a novel application of this qualitative method to a questionnaire exclusively focusing on antibiotic stewardship, and the findings highlight clear differences not only between the performance of questions in terms of recall-related error but also in the rationalisations of responses to identical questions about personal and pet-orientated antibiotic use, and trust in doctors and veterinarians.

Section 1.4 – Structure of the thesis

Section 1.4.1 – Chapter Sequence

This thesis is composed of eight Chapters including this introduction. These Chapters are divided across four sections, show in Table 1.

Table 1. Section and Chapter Sequence

Section	Chapter
Introductory Section	1 – Introduction
	2 – Background Context
Methodological Research	3 – Secondary Survey Analysis
	4 – Cognitive Interview Testing
Empirical Research	5 – Primary Survey Analysis
	6 – Qualitative Analysis 1: The Plural Dynamics of Human and Companion Animal Care
	7 – Qualitative Analysis 2: Consuming Antibiotics and Situating Resistance
Concluding Section	8 – Conclusion

Part 1: Introductory Section

The first section provides introductory background material for the thesis and includes this introductory Chapter and Chapter 2. Chapter 2 provides a discussion of background literature in health and animal geographies, the social science of antibiotic resistance, and an in-depth rationale for the thesis' focus on the substantive areas of pet-owners and online health information. Together, the Chapters in this section situate the thesis in relation to the problem addressed by the research and the contextual literature that supports the research.

Part 2: Methodological Research

This second section includes two Chapters that provide a methodological grounding for the Empirical Research section. Whilst these Chapters contain empirical research, within this thesis they have a methodological purpose and the empirical work they contain is directed towards evidencing the variable selection for the primary survey research based on analysis of secondary datasets and evidencing the development of survey questions used in the primary survey research questionnaire. Chapter 3 presents the analysis of two secondary survey datasets: the third wave of the Wellcome Monitor and the 2016 and 2018 waves of the Eurobarometer series. These datasets contain multiple common variables, and their parallel and exploratory analyses provide clear direction and robust context for the survey design and analyses reported in Chapter 5. The analyses in Chapter 3 have been published in *PLoS ONE* and the *Journal of Antimicrobial Chemotherapy* (Anderson 2018; 2019a). Chapter 4 presents the use of a qualitative technique – cognitive interviewing – for the refinement of a survey questionnaire that extends the research of Chapter 3 into the territory of antibiotic stewardship in companion animal care. Chapter 4 provides a methodological contribution both to the thesis and the broader field of social research into antibiotic stewardship, and the data collected for this aspect of the research is additionally used alongside further qualitative interviews in Chapters 6 and 7. A version of this Chapter has been published as an unrefereed preprint on *SocArXiv* (Anderson 2019b).

Part 3: Empirical Research

This section contains the key empirical contributions of this thesis building upon the research of Chapters 3 and 4 which, whilst be empirical in character, serve a methodological purpose within the thesis. Drawing upon material in Sections 1 and 2, Section 3 extends social research into antibiotic resistance into the area of companion animal care. This is achieved firstly using an online panel survey reported in Chapter 5, with analysis and discussion of methodological and substantive contributions that this research makes in the contexts of survey research and antibiotic stewardship. Following this, the substantive qualitative aspects of this thesis are presented and discussed in Chapters 6 and 7. Chapter 6 covers companion animal care and speaks to issues raised in recent sociological and anthropological literature in this area. Chapter 7 then builds upon the themes presented in Chapter 6 to engage specifically with research participants' narratives around antibiotic use and antibiotic resistance as an issue. Together these chapters provide a novel and interconnected contribution to social research on antibiotic resistance, and individual contributions to the methodological or conceptual literatures that they engage with.

Part 4: Concluding Section

This section includes the final chapter. Chapter 8 refreshes the questions articulated in this introductory chapter and provides a synthesis of the thesis responding to these questions. The limitations of the thesis and future directions for this research are also discussed.

Chapter 2 – Background and Context

Section 2.1 – Introduction

This Chapter presents and discusses the literature within which this thesis is situated.

The first section of the Chapter (2.1) situates the thesis within human geography. More specifically, it draws out work in health and medical geography and links to animal geographies to place the later discussed empirical areas of antibiotic resistance, pet-ownership, and use of online health information within the empirical and theoretical spaces of geographic enquiry. This section argues that a more-than-human health geography of antibiotic consumption by pet-owners is both relevant and timely.

The second section (2.2) discusses the ways in which antibiotic resistance has been multiply constructed as an issue of interconnectedness between humans and non-humans (such as animals and infrastructures) alongside an issue of individualisation or risk and behaviour. The discussion here is critical of the concept of 'One Health', engaging with the one-world metaphysics that this concept suggests in order to raise critical questions regarding the 'oneness' of health in the context of pet-owners' antibiotic use. Issues around antibiotics as infrastructures of care, the role of experiential and biomedical knowledges, and how 'rational' behaviour is enacted are also discussed with relevance to the behaviour of the general public.

The third section (2.3) discusses specific aspects of pet-ownership and the use of online health information that make them relevant and timely areas to study in the context of antibiotic resistance.

Section 2.2 – Geographies of Health, Companion Species, and the Politics of Life around Antibiotic Resistance

Section 2.2.1 – Health Geography: Context, Information, and Normality

Health geography, Kearns & Collins (2010 p18) argue, has a broader focus than simply considering health as the "absence of medically defined ailments". Health geography has followed the growth of population health perspectives in policy and public health practice to encompass "sustaining the health-maintaining potential of the environment at large [with] attentiveness to social/cultural, political, built and natural components of place-based communities", including consideration of patterns of health-related behaviour that are often coordinated outside of the formal health care sector (Kearns & Collins 2010 p18; Twigg & Cooper 2010). The construction of risk has become central to the regulation of everyday life such that symptomatic individuals remain within the domain of medicine whilst the public health imperative is to manage the behaviour of asymptomatic populations who may experience disease sometime in the future (Kearns & Collins 2010). For significant global health challenges like antibiotic resistance, risk constructions enact geographies produced and lived in

the name of pre-empting, preparing for, and preventing threats to a present that is both on the verge of disaster and incubating disaster within itself (Anderson 2010). The life that is threatened in the present is "understood in terms of its irreducible complexity" characterised by transnational flows and connections (Anderson 2010 p781), with further complexity underpinned by different scales of vitality as precarious bodies are displaced "within wider molecular fields" in a global biological cauldron (Braun 2007 p7) – or as Hinchliffe (2015 p30) puts it in interspecies terms, "a chicken can splutter in Indonesia and a cytokine storm can be triggered in a hospital bed in the UK". The work of geographers is not simply to study the spatial correlates of disease, but to embrace and consider the complexity of social, cultural, political, and geographic contexts that underlie and give rise to disease and disease-causing behaviours and the geographies that are produced and lived in the name of mitigation.

One area in which such consideration of behaviour by health geographers has manifested is the "rise of a new sort of spatialization of Foucault's medical gaze" through the virtual space of the Internet (Parr 2002 p86). Seeking information in cyberspace, Crooks (2006 p64) argues, is a "necessary component of negotiating patient-hood in the information age", creating relational connections between disparate spaces of care and cyberspace that mediate the power relations and communication flows between doctors and patients. Whilst health geographies have yet to comprehensively engage with the digital, there has been a broader digital turn within geography in recent years. This turn is not productive of a singular digital geography, but rather indicates a range of engagements with the digital and how new cultural meanings (Rose 2016) and geographies (Ash *et al* 2018) are being produced through, by, and of the digital. Scholarship in the social sciences has highlighted problematic digital divides that have material impacts, for example recently illustrated by the complexities of reaching underserved populations for COVID-19 screening using telehealth (Ramsetty & Adams 2020). These divides can stem from a number of possible causes, such as deficiencies in physical access to the Internet, skills to access the Internet, and the availability of beneficial content (Tranos & Sitch 2020). The work of this thesis does not substantively engage with the digital turn within geography, focusing instead on how the use of the Internet as a means to access health information features in relation to public behaviour with antibiotics and participants' narratives regarding this behaviour and their relationships with health professionals.

Members of the general public are increasingly encouraged to turn this 'gaze' upon themselves to regulate their behaviour for the good of the population, for example through "sneezing etiquette, social isolation and other measures deemed to be necessary in times of public health emergency" that represent "appeals to self-subjectification/objectification which draw on and intensify immune-political address to the volitional and responsible embodied self" (Davis *et al* 2015 p20). In the context of antibiotic resistance, such behaviours may include not pressuring one's physician or veterinarian for antibiotics, ensuring that one adheres to the course of antibiotics prescribed by the

physician or veterinarian, and not sharing or self-administering antibiotics without direction from a physician or veterinarian. Antibiotic resistance is somewhat unique here in that these behaviours are both for the benefit of the individual patient in that antibiotics should be used in such a way as to be therapeutically effective whilst minimizing the commonly experienced side-effects, and for the benefit of the general population to avoid unnecessarily exacerbating the development of resistance by bacteria to antibiotics.

One of the apparent tensions within the relationship between patients and healthcare professionals in the context of antibiotic use is miscommunication and misunderstanding of expectations between healthcare professionals and patients or clients – a point that will be examined in specific detail in the later section discussing existing social science research on antibiotic resistance itself. The point being made here is that this kind of tension concerns geographers as part of the social context of antibiotic resistance and as a relational aspect of the gaze patients turn upon themselves as it relates to both positive information-seeking and more anxious belief-development. This is exemplified in Philo's (2007) discussion of the work of Georges Canguilhem, specifically the distinction between that which is physiologically 'normal' and by contrast what is 'pathological'. Canguilhem's sociology of medicine "ultimately rests on what everyday people take as a normal state of bodily and mental functioning relative to the demands of their immediate circumstances" according to Philo (2007 p85), where an individual's health is judged relative to what individuals require of themselves or is required of them by others. Canguilhem illustrates this understanding of health with the example of a farmhand whose tibias broke and became fused at an unsightly angle. On visiting a hospital after denunciation by neighbours, doctors rebroke the tibias and set them 'properly' – "it is clear", Canguilhem (1991 p127) states, "that the head of department who made the decision had another image of the human leg than that of the poor devil and his master". Canguilhem (1991) further suggests that medicine exists not because there are doctors to tell someone that they are sick but because people actually do feel sick. Extending this to veterinary medicine, it could be argued that companion animal veterinary medicine in particular came into existence because economically viable numbers of pet-owners felt that their pets were sick and not because there was a professionalized veterinary practice to tell them that their pets were sick, with equivalent emergence of veterinary medical norms alongside commonplace norms of medical perception and intervention (Gardiner 2014; Philo 2000).

Lay publics' understandings of infectious diseases and their symptoms, and how they relate to perceptions of health and illness, are key areas of interest for the development of public health measures to address such contagious health problems. In the context of upper respiratory tract infections such as the flu or common cold for example, Prior *et al* (2011 p922) note that whilst these illnesses have been taken into the laboratory and systematically 'Jennerized' the main site for their diagnosis is in the world of everyday life, a world in which "the understanding of respiratory infections is mediated through a web of concerns – about the origins and interconnection of

symptoms, the maintenance of personal health and the distribution of illness among relatives, friends, and neighbours". What 'health' is, in this perspective, cannot be separated from the social or cultural milieu in which it is experienced by individuals and their surrounding populations either for people and their personal experience or pet-owners and their perceptions of their companion animals' state of being. How knowledge and experience about illness is acquired, structured, and mobilized by the general public is important for public health intervention, and for geographic research into 'health', 'illness', and connected behaviour.

Philo's (2007) argument contends that there is an integral sense of geography to Canguilhem's reasoning. Beyond explicitly noting that the supposed averages of human bodily form and functioning can only be derived from measuring particular people in particular places, Canguilhem paints a picture of "a regional geography of human bodies-in-transition, of humans making and remaking their own bodies, their own bodily norms included, rather than these bodies and norms being nailed down in advance by nature (as akin to divine diktat)" (Philo 2007 p89). Pathology is not then simply a "quantitatively varied extension of the physiological state", but it relates also to the opinion of the sick person who knows that they feel different and consequently "thinks he also knows in what and how he is different" (Canguilhem 1991 p89). Whilst the person may be mistaken on the second point, it does not follow for Canguilhem that they are mistaken on the first. This is an important line of argument for the consideration of behaviour with antibiotics in both medical and veterinary spheres – the prescription and use of antibiotics is enmeshed within social, cultural, and political contexts that include patients' perceptions of their and their companion animals' physiological normality, which may be informed by "a generalised medical consciousness, diffused in time and space" (Foucault 1973 in Parr 2002 p79) that includes online health information. To put it another way: "medical activity, through clinical questioning and therapeutics, has a relationship with the patient and his value judgements" (Canguilhem 1991 p122).This will be further examined through the literatures on clinical 'ritual' and lay use of online health information later in this chapter, the key point here however is that health geographers should consider not only the patterns of behaviours relating to antibiotic consumption and potential resistance, but also the social, cultural, political, and geographic factors that underly perceptions of health, the relation of these perceptions to different spaces of information acquisition, and the behaviours that arise from these interconnected areas of consideration.

Section 2.2.2 – Animal Geographies: Companion Species and More-than-Human Relations

So far, the actions and perceptions of humans have been the main focus of this discussion of health geographies: how does social context affect humans' perceptions of health? How might the information age and engagements in cyberspace affect humans' perceptions of health? How might these connect together relationally and productively in the perceiving of 'health'? In a general sense,

these questions form the central thrust of this thesis bounded by the specific context of antibiotic resistance and the more specific context of pet-owners' navigation of healthcare spaces of relevance to different non-microbial species. This next section considers the enrolment of companion species in the development and enactment of these perceptions and behaviours as a focus for geographers working in a more-than-human health geographic context.

The role of microbial life in health-related geographic enquiry has taken many forms within many contexts, ranging from the body to the house, and from the laboratory to geopolitics (for example Greenhough 2012; Hinchliffe 2015; Lorimer 2017a; 2017b; 2019; Beck 2019; Wakefield-Rann 2019). For example, Greenhough (2012) notes that in the 'Common Cold Unit', viruses used for research became domesticated and less virulent than their wild cousins, whilst Lorimer (2017a p553) traces an argument that "no microbe is essentially pathogenic; pathogenesis is the outcome of political and ecological relations". In a more embodied example, Beck (2019) develops a conception of 'corporeal communication' to describe faecal microbiota transplantation users' mode of relating with their microbiomes, whilst Wakefield-Rann (2019) provides another context of engagement and entanglement in her research into the embedded assumptions about microbial agency within domestic practices in Australian households. These examples, along with the work of other geographers such as Hinchliffe *et al* (2013; 2018) and Braun (2007) on questions of biosecurity and geopolitics, provide evidence that geographic engagements with microbial life function at a variety of scales from the human body to the laboratory space, and from political and ecological relations defining the pathogenicity of an organism through to relationships between pigs and their farmers or chickens and casualised labour forces. Spatially, this thesis' research engages with the experience of pet-owners in spaces of care (such as the home, the GP surgery or hospital, and the veterinary practice) and with the healthcare professionals that inhabit them, linking the experiences of these spaces and individuals' underlying conceptions of 'health' and microbial agency to develop an understanding of the pet-owning public's behaviour with antibiotic medicines. The tone of this thesis' engagement with microbial life in the context of pet-owners' antibiotic use will be set further on in this chapter through a discussion of the conceptualisation of antibiotic resistance as a 'One Health' problem in the literature and further again in the discussion of 'Companion Animals, Antibiotic Resistance, and Microbial Ecologies'.

In addition to considering the microbial liveliness that sits at the heart of 'antibiotic resistance' as relations between companion species (Haraway 2008; Beck 2019), this thesis of course engages with companion animals as companion species. As Haraway (2003 p12) argues, "there cannot be just one companion species" and the relating between companions is never "done once and for all". This is exemplified in the context of antibiotic use in recent research on the behaviour of pet-owners, with Dickson *et al* (2019) relaying that some of their Glaswegian interviewees expressed different decision-making around their own and their pets' antibiotic consumption. In this relationship we can

consider the companion animal relationship between human and pet, but also the companion species of the microflora that make up not only pet-owners' and their pets' internal microbiota and the environmental microbiota of their household and local environment. This will be discussed in depth later in this review when examining pet-ownership in the context of health, but here the point is that in the context of antibiotic consumption the relating between companions is never done once and for all since companion animals shape antibiotic-related decision making and live within the same 'molecular field' that is itself shaped by antibiotic consumption.

More-than-human family relations have distinctly geographical dimensions, for example in terms of domestication as a historical context and relations of care and spatial access. Pet-ownership and its relations of domestication is a "profoundly geographical project" that centralises 'where' as much as 'when' species meet (Power 2012 p373). 'Home' is a "key space and powerful imaginary shaping human-dog relatings" in which ideal dogs embody the expectations of home and perform the domestic well, creating in the process more-than-human families that are distinct in experience from those involving only people (Power 2012 p377; 2008; Urbanik & Morgan 2013). This is not to simply craft two categories of families with and without companion animals, but rather to present the social, cultural, and geographical negotiations that pet-owners must navigate which have no experiential equivalent for families without pets. Pets have a dual status within more-than-human families as both 'person' and possession that must be negotiated in everyday decisions about welfare and treatment (Fox 2006 p529). This status is itself culturally and historically contingent as pet-ownership itself is a relatively recent phenomena tied to the emergence of middle-classes and the transition of, for example, dogs from working animals to active co-organizers of family lives and human-pet relationships (Power 2012; Gaunet *et al* 2014). Whilst the domestic space of the home provides a central point around which the status and relationships of a companion animal can develop, within public (and particularly urban) space companion animals have a more contested status, for example leading Urbanik & Morgan (2013 p301) to argue that more-than-human families require more-than-human public spaces to claim as their own "just like families with children or those who want to play tennis or picnic". Gorman (2019 p11) further argues that not only is health experienced and co-produced "with more-than-human others" including companion animals, but following from earlier discussion in this review "place is affected by health, and health is affected by place; both are affected by human-animal relations". This is true of human-pet relationships in several ways that are discussed later in this review, such as the exercise and companionship benefits of pet-ownership on physical and mental health, as well as the co-production of microbial ecologies between humans and their companion animals at the household level. This thesis extends this line of argument to health-related behaviour around antibiotics, with various behaviours emerging from distinct experiences and perceptions of medical and veterinary spaces and the professionals within them for more-than-human families.

The effects of antibiotic resistance do not only affect humans. Whilst current 'One Health' policy approaches retain a distinctly anthropomorphic focus (Kamenshchikova *et al* 2019), animal geographies engaging with antibiotic resistance should not lose sight of the fact that 'interspecies' cuts both ways. Buller (2014 p310) outlines the ontological challenge posed by animal geographies as follows:

> *"With what (scientific) legitimacy do we 'speak' for, to and with animals or demand a radically different biopolitical or cosmopolitical engagement with human and non-human experience alike? Have we, following Wolch and Emel's (1995) call, merely 'let the animals back in' to accounts of our own space-making, or is this something more profound, some broader acknowledgement of an altogether different, less one-sided ontology of both (human and non-human) knowing and being?"*

This challenge gives rise to certain political ramifications in geographic research (Mol 1999), for example differing conceptions of the status of the non-human companion animal and their consequent place in public space (Urbanik & Morgan 2013) or the hierarchisation of species in laboratory-based knowledge-making in animal research (Message & Greenhough 2019; Hobson-West & Davies 2019). In the context of interspecies health, such ramifications may take a trans-biopolitical turn when zoonotic associations "have lethal consequences for nonhuman others […] in gross disproportion to the human deaths that ensue from animal-sourced infections" (Blue & Rock 2010 p354). In the context of antibiotic resistance for example, animal geographers should be cognisant of such biopolitical implications as the privileging of certain species over others within the struggling supply chain of new antibiotics, nationally-varying regulation of the relationship between animal welfare and antibiotic use in agriculture, or the local financial limitations imposed upon companion animal healthcare compared to human healthcare.

In veterinary medicine and clients' perceptions of veterinary medical practice, the communication barrier between species is a key component of the relationship between professional veterinary surgeon and lay pet-owner that tracks another pair of central challenges for animal geographies diagnosed by Buller (2015 p374): "what can we know of animals, and what might we do with that knowing?". The increased sophistication and technologization of companion animal veterinary medicine and care brings new spaces for novel ethical practices and moral agencies (Haraway 2008; Buller 2016) – including new (animal) health inequalities and diagnostic or exploratory emphases. Donald (2018 p2) underscores the spatiality that has accompanied the development of professional veterinary medicine, highlighting that "a vet's jurisdiction can involve clients' homes, laboratories, operating theatres and courts of law", going on to acknowledge "what connects the scales of care, and forms the primary point of concern, is the non-human animal." In particular for veterinary care, and

perhaps beginning to bridge the challenges posed by Buller (2014; 2015), Donald (2018 p6) contends that "when affective relations between animal and human bodies are valued as communication, animals are no longer just the object of care". Doing research on pet-owners' behaviours regarding themselves and their pets should take seriously these challenges – rather than just 'let the animals in' to the account, the research should embrace and contend with an inability to speak dog as a generative space for understanding, and consider the companion animal as a point of concern with affective dimensions rather than simply a contextual feature. What do pet-owners do in the context of antibiotic use when they cannot 'speak' their companions' language? How are behaviours and perceptions mediated by affective differences relating to personal health and pet 'personhood'? Pet-owners' behaviour with antibiotics is likely to not only affect themselves but their companion animals, the broader public of dog-walkers, cat-owners, and indeed petless familial formations. How companion animals enter rationalisations of behaviours is consequently important, as is the recognition that the consequences are interspecies in both directions and a consideration of social normalisation and regularisation that influence such rationalisation.

Section 2.2.3 – Biopolitics: A Departure Point for the Politics of Life Around Antibiotic Resistance and Pet-owners

Biopolitics is an analytical conceptual perspective employed by geographers to understand how life enters the realm of political calculation, drawing on the work of Foucault (2003) which Philo (2012 p507) argues is "profoundly geographical" in its grappling with historical analyses of the control of relations within society to manage the vital characteristics, behaviours, and norms of populations. Braun (2007; 2013 p46) for example employs this conceptual toolbox to consider biosecurity's enactment of divisions between human and nonhuman populations in the context of a "biological world [that is] unruly, prolific, mutable, [and] fluid" continuously incubating within life threats *to* life as a "political and ethical issue, not merely a technical or logistical one". Other geographers have employed these concepts in relation to the governance of companion animals life, for example in Lorimer *et al*'s (2019a p38) initial examination of animals' atmospheres considering "the biopolitical means through which some dogs have emerged as discerning consumers in the pet care and pet food industries of late capitalism, and made subject to affective atmospheres of taste and wellbeing" and Srinivasan's (2013 p114) engagement with dog control and care in the UK and India highlighting the "biopolitical characteristics of euthanasia" such as the practice of euthanasia in the name of the wellbeing of the dogs themselves. These examples highlight that geographic engagements with biopolitical thought consider the spatialization of "making live and letting die" through the "power of regularization" (Foucault 2003 p247) on a variety of scales and in a variety of geographic contexts – from public health arising through the management of agriculture and food chains, through to canine consumerism and welfare arising through the management of affective atmospheres or the legal geographies of euthanasia.

Biopolitics is not just about "institutions, ethical committees, or even citizen groups" but also occurrences within "people's concrete embodied everyday practices" (Bellacasa 2017 p137). Contemporary biopolitical life is characterised by Rose (2001 p18) as 'ethopolitical' in which "the sentiments, moral nature or guiding beliefs of persons, groups, or institutions […] have come to provide the 'medium' within which the self-government of the autonomous individual can be connected up with the imperatives of good government [and] life itself, as it is lived in its everyday manifestations, is the object of adjudication". This characterisation of contemporary biopolitics has not been received uncritically, for example with Raman & Tutton (2010) criticising the separation of molecular truth discourses and discourses of the population in the work of Rose and his collaborations with Rabinow following their specific focus on the role of the life sciences in defining contemporary biopolitics (e.g. Rabinow & Rose 2006). Contemporary biopower, Raman & Tutton (2010) argue, retains population-level characteristics such as the production of social statistics illustrated by the example of the adoption of self-identified racial and ethnic categories from censuses to monitor the inclusion of population groups in biomedical studies. In the politics of life around climate change, Raman & Tutton (2010 p728) go on to argue, "we see the potential for a coalescence of individualizing 'ethopolitics' and collectivising 'biopolitics' as people are asked to grapple with their personal carbon footprints in the context of moral claims about their impacts on the lives of other people in distant lands and on the biosphere." This case for the coalescence of individualising and collectivising forms of biopolitics can be transplanted into the politics of life around antibiotic resistance – people are asked to grapple with the lively pathology of their own bodies and bodies that they care for in the context of moral claims about their impacts on the lives of other people in society.

Biopolitics itself is not an objectively defined concept however, and it can be traced through a variety of genealogies to consider a plethora of issues that take life – however 'life' is defined – as the object of politics. The meaning and employment of biopolitics in any given situation is consequently not a value-free exercise of definition, and this is sharply the case when considering the place of non-human animal life in biopolitical contexts (Lemke 2011; Wolfe 2013; Blue & Rock 2010). By taking as its focus the behaviour of the UK pet-owning public and the functioning of norms shaping the behaviour of members of this population relevant to antibiotic use, this thesis makes a specific value judgement that in this context non-human animals are part of *political* life as well as biological life. This research focus lends itself to a biopolitical perspective rooted in the work of Foucault (2003 p253) considering how the "play of technologies of discipline on the one hand and technologies of regulation on the other" cover the "surface that lies […] between body and population" in a normalizing society. In the context of antibiotic resistance for example this normalization is spatialized through disciplinary power that limits access to antibiotics to certain places, certain contexts, and through certain individuals, whilst behaviour is attempted to be regularized by consistent messaging about when and how responsible citizens should attempt access, when and how

to consume antibiotic medication, and the kinds of care that should contextualise good antibiotic stewardship.

This distinction between an individualising and massifying power is the movement from an anatomo-politics directed at 'man-as-body' to a biopolitics of 'man-as-species', also extending biopolitics' concern with the biological and political problem of the population to "the problem of the environment to the extent that it is not a natural environment [but] it has been created by the population and therefore has effects on that population" (Foucault 2003 p245). To echo Philo (2012), this is a 'profoundly geographic' way to analytically approach the topic of this thesis. There are explicit attempts by public health authorities to encourage certain spatially-contingent behaviours and attitudes around antibiotic use in the population, though attempts to normalize behaviour in this way compete with existing social norms stemming from the history of antibiotics as 'wonder drugs' (Bud 2007) and more deeply entrenched public perceptions of microbial life as generally dangerous (Lorimer *et al* 2019b; Beck 2019; Wakefield-Rann *et al* 2018a; 2018b). As Brown (2019 pp127-128) puts it: antibiotic resistance "has become a medium for the expression of prevailing cultural ambivalence about hygiene, dirt, nature, infections, bugs and the nonself or immunitary 'other'". Additionally, at the species-level biopolitics functions to categorize therapeutic access to certain antibiotic medications as contingent on membership of certain species (with particular privilege for *Homo sapiens*) through what might be considered 'prevailing cultural ambivalence' about the hierarchisation of species (Pomba *et al* 2018; Hobson-West & Davies 2019). By examining the development of perceived norms around the place of species within peoples' own narratives of self-regulation alongside relationships to institutions, society, and the environment this thesis will contribute to an understanding of the ways in which biopolitics functions in people's concrete everyday practices.

Section 2.2.4 – Summary

This section of the chapter situates the topic of this thesis within the sub-disciplines of health and animal geographies, and presents a departure point for the consideration of the politics of life surrounding antibiotic resistance as they relate to the behaviours and attitudes of pet-owners.

In the area of health geography, this section emphasises the work of geographers as dealing with the complexity of social, cultural, political, and geographic contexts underlying the giving rise to disease and disease-causing behaviours. This includes the geographies that are produced and lived in the name of mitigating disasters seen to be incubating in the present. The acquisition of information is one such spatialized context, with patients (and veterinary clients) negotiating patient-hood in the information age by seeking information in cyberspace that mediates the power relations and communication flows between healthcare professionals and patients or clients. Health, it has been argued following the work of Philo (2007) and Canguilhem (1991), is inseparable from the social or

cultural milieu in which it is experienced. This has implications that are explored through this thesis' research for how acquired information is acquired and made sense of, the functioning of relationships between pet-owners and health professionals, and how antibiotic consumption is rationalised by pet-owners.

The inclusion of companion animals as a key point of concern in this thesis' research entails both the acknowledgement of an ontological challenge for animal geographers as researchers, and a biopolitical value judgement about what 'life' is both political *and* biological in the context of antibiotic resistance. The challenge is that this thesis is attempting to ascertain the influence of companion animals who one cannot speak with clearly to, for, or with. The anthropomorphisation of this influence is somewhat inevitable as it is being constructed from the experiences and perceptions of pet-owners, however it is so elicited with the awareness that 'interspecies' is not a one-way street of zoonotic association.

Considering the politics of life around antibiotic resistance through the conceptual lens of biopolitics adds a further geographically contingent dimension to this thesis' research. Contemporary biopolitics has been briefly argued to operate at a variety of scales including linking the behaviour of individuals with moral claims about the effect of this behaviour on other lives, with non-human animal life additionally defined and spatialised in different ways in geographic engagements with this conceptual approach. The construction of antibiotic resistance will be the subject of the next section of this chapter, engaging with how individual behaviour and moral claims about this behaviour are discursively developed and propagated in different contexts that variously include, prescribers, consumers, and non-human animals. Thinking with biopolitics here serves to highlight the indeterminacy of both the regularization of behaviour and the stability of antibiotic resistance as an object of concern.

Section 2.3 – Antibiotic Resistance

Section 2.3.1 – Antibiotic Resistance as a 'One Health' Problem

Antimicrobial resistance connects human and animal health through an environmental microbiome, including in particular the so-called 'resistome' of genetic material that gives rise to antibiotic resistance (Wright 2007). Environmental reservoirs have been highlighted as a "potentially important source for the mobilisation and transfer of resistance genes" between humans, animals, and food (HM Government 2019a p8; Stenske *et al* 2009). This kind of human-animal-environmental nexus around health issues has given rise to the concept of 'One Health' – or, institutionally, 'One World One Health' – that emphasises the interconnection of human, animal, and environmental health(s).

Recent social scientific engagements with the One Health concept have highlighted that one-worldist (Law 2015; Hinchliffe 2015 p28) metaphysics can be problematic despite an apparent "common

sense" to the central interconnection that One Health underscores. There are additional complexities to the histories and spaces of such connections beyond the "institutional politics of One Health" that aim to bring together institutions that have traditionally competed for resources and attention (Galaz *et al* 2015 p20) – complexities and differences that are reduced into the service of human health within the discourses created and enacted by One Health policies (Kamenshchikova 2019). Despite this one-worldism and active attempts to ontologise health as 'One', it has been argued that "the vision of One Health is hindered both by dysfunction in the governance of global health and shortcomings in articulating a One Health agenda" (Gibbs 2014 p89). Antimicrobial resistance, it will briefly be argued here, is an issue that chimes with these areas of critique – the problematic nature of one-worldism to which 'One Health' is sometimes yoked, and the consequent complexity and difference present in the achievement of 'health' that is often anthropocentrically concentrated – in a manner relevant to the work of this thesis.

The one-world metaphysics of 'One World One Health' reduces the differences between people with varied beliefs and practices in the context of health. Hinchliffe (2015 p34; Hinchliffe *et al* 2017) has argued that this constructs a singular 'health' around which institutions must rally, with a "virtuous" world of biosecure health and a "pathological" world of risk at the expense of an acknowledgement that all life – entangled as it is with environments, technologies, practices, bodies, and microbes – is pathological. These interconnections are certainly present for pet-owners who may reside within a variety of household configurations including a variety of species of companion animal and a number of other humans at various stages of life. Rock (2017 p317, p316) for example highlights from her anthropological research that pets "exemplify life with diabetes for many people", drawing on Krieger (2012) to note that the "relational beings germane to public health are not all human in nature" and include companion animals. In this example diabetes is experienced by pet-owners through their pets, which is a markedly different experience to living with diabetes as a human. The considerations and practice that are navigated in the management of a dog's diabetes for a pet-owner – for example the cost and stress of veterinary visits and the task of medicating a pet – are differently challenging than those of people managing their own diabetes despite similar antecedent conditions and treatments for the condition in each sphere of medical care. From an example such as this it is clear that the One Health concept in the pet-owning context should be considered critically rather than reflexively, as discussed in the previous section regarding the complexity of health as a socially performative state of being. While there are shared aspects of such pathologies between people and their pets, the experiences, practices, and perceptions of common conditions are not necessarily reducible to 'One', and consequently experiences relating to antibiotics may also share this lack of easy reducibility.

People and their pets consume the same antibiotic medicines to treat bacterial infections, and consequently both people and their pets are at risk from the prospect of these medicines ceasing to be effective. While 'One Health' implies a "shared biological destiny", there are a wide range of

"diverging practice, institutions, norms, and bodies that contribute to microbial globalisation processes and their governance" (Wolf 2015 p6). How the institutions that govern health define 'One Health' is often dependent on the missions of the respective organisations (Gibbs 2014), but there is a tendency in international health policy to focus on the improvement or security of human health against animal or environmental sources of threat (Kamenshchikova *et al* 2019). In the context of antimicrobial resistance, Kamenshchikova *et al* (2019 p7 emphasis added) note that

> "…humans are usually portrayed as those who experience the burden of [antimicrobial resistance], while animals and environments are often defined as sources of this threat. In line with this, initiatives and actions proposed by the [One Health] approach unintentionally reflect the asymmetrical and hierarchical relations between human, animal, and environmental health. AMR can be caused by different factors, including the use of antimicrobials by humans, clinical waste and the use of antimicrobials in the animal and environmental sectors, that involve farming, veterinary, agriculture and manufacturing. **However, [One Health] documents unintentionally frame the risks to human health as a driving force underlining the need for greater control and prevention of AMR in the human, animal, and environmental sectors**."

The performative effect of such policy documents' messaging about the definition and distribution of risk in the context of antimicrobial resistance is a significant emphasis in communication of the health of humans, and the gravity of the risk to human health. The *Review on Antimicrobial Resistance* itself for example focused on the magnitude of human mortality and economic loss as its flagship statistical headlines. This highlights the role of biopolitical value judgements in the politics of life around antibiotic resistance – for whom is behaviour changed, and what categories are life are the intended recipients of mitigation?

Around 40% of the UK population are pet-owners (Pet Food Manufacturers' Association 2019), and despite this significant percentage the use of antibiotics for companion animals and their owners have received minimal attention from social science. Where pets are acknowledged they are often contextualised within risk-reduction for human health, for example in Kahn's (2017 p257) suggestion that microbial ecologists should conduct assessments of the homes of people with chronic medical conditions to assess the risks posed by companion animals "as members of the family". Across a diverse set of institutions there is a significantly anthropocentric focus that has a performative effect on discourse around antimicrobial resistance and the risks that it poses. A rebalancing of this messaging to incorporate the risks *to* companion animals as well as *from* companion animals could perhaps be productive in promoting positive community antimicrobial stewardship behaviours in both

human- and pet-orientated consumption as companion animals are themselves germane to public health alongside humans.

Section 2.3.2 – The Construction of Antibiotic Resistance

The use of antibiotics is enmeshed within a variety of contextual, cultural, economic, and historical influences. The specificities and idiosyncrasies of healthcare-associated professions influence prescriber behaviour and adherence to guidelines (Broom 2017a, 2017b, Cartelet *et al* 2018), and medical idiosyncrasies vary further across national borders (Pearson & Chandler 2019; Lambert *et al* 2019). Given the significant heterogeneity in use of antibiotics and other antimicrobials across such contexts, it is important to clarify the relevant social and discursive constructions of antibiotics and antibiotic resistance. As with One Health, prevalent discursive formations have performative impacts on public perception, research funding, and policy priorities in the broad context of antimicrobial resistance. This section briefly examines the way antibiotic use is constructed in the context of contemporary healthcare, and some of the significant ways in which antimicrobial resistance has been presented simultaneously as a threat of interconnection and of individualisation.

Antibiotic Resistance as a Threat

The articulation of antibiotic and antimicrobial resistance as a threat towards modernity through consequences for current infrastructures and modes of caring for bodies functions as a particular framing of antibiotic resistance. In the absence of easily quantifiable actuarial accounts of antimicrobial resistance – which are met with definitional, technical, and resource challenges – and the subsequent use of language of securitisation and militarisation ('waging war' on superbugs (Nerlich & James 2009), for example) the issue becomes a "classic biopolitical phenomenon in a neoliberal framework", argues Chandler (2020 p5). This is evidenced by the communities of practice emerging around the policy-science-industry nexus relating to antimicrobial resistance, multilateral commitments, and apocalyptic imperatives that drive action to mitigate the challenge that antimicrobial resistance poses (Chandler 2020; Nerlich & James 2009; Bud 2006). Antibiotic resistance has become a herald for a 'post-antibiotic' apocalypse, and consequently it becomes an object of political action and an object around which new social norms are being coalesced in public health interventions.

Undertaking policy or personal action towards antibiotic resistance is often predicated on the impending healthcare apocalypse associated with the loss of antimicrobial medicines such as antibiotics. 'Apocalypse' narratives have been useful in moving antimicrobial resistance up the research and policy agenda, however Nerlich critically argues that this approach has limitations as an apocalypse is often seen as an inevitability that may "induce fears which could stifle behavioural change" (Nerlich & James 2009 p584). Despite current high levels of engagement with antibiotic resistance as a topic, and Fleming's (1945) early caution against casual use of antibiotics in his Nobel

speech, antimicrobial resistance did not become a significant object of public concern or debate in the UK until the 1960s, despite previous deadly episodes of infection. Indeed, the role of antibiotics as part of the changing agricultural landscape of industrialisation was so ubiquitous that some farms sent cows to market in the 1960s with "little bags of antibiotic swinging from their necks" (Bud 2007 p168). The sensitization of the media and political system in the UK to antibiotic resistance has been traced by Bud (2006; 2007) to the implication in the 1960s of agricultural antibiotic use in the emergence of resistant strains of bacteria causing infections in humans. Bud (2006) argues that the Swann Report – whose recommendations about limiting the use of antibiotics for growth promotion in livestock became law – was a result of the widening of the issue of resistance from one of medical practice that journalists and politicians could not engage with to an agricultural issue that was otherwise fair game for participation. This spatialised attribution of antibiotic resistance in a hospital outbreak to agricultural practices further evolved to incorporate the "contaminated spaces" of hospitals themselves as Michael Howard invoked methicillin-resistant *Staphylococcus aureus* (MRSA) as a 'British disease' analogous politically with declining hygiene standards in hospitals, unionized industrial conflict, and a lack of consumer choice (Brown & Nettleton 2017 p499). Antibiotic resistance was therefore not only made visible as an issue to the general public but was enrolled in the regulation of non-human animal lives and as a threatening trope regarding the (bio)political geography of healthcare in the UK. Decades after Fleming's (1945) injunction to care for antibiotics and avoid use that may exacerbate the development of resistance, the healthcare implications of resistance have been formulated and reformulated variously as a cross-species problem, a consumer issue, and a spatial contaminant. As a threat, antibiotic resistance becomes threatening not as a singular stable object but rather as a contingent and multiple threat made coherent through a range of tactics, practices, and ontologies (Mol 1999; 2003).

Perceptions of the threatening nature of 'germs' are now deeply embedded across society, with antibiotic consumer products pervasively entrenched in household routines (Lorimer *et al* 2019b; Beck 2019; Wakefield-Rann *et al* 2018a; Wakefield-Rann *et al* 2018b) along with the consequent presence of dysbiotic effects on human microbial ecologies (Lorimer 2017a). Following the ascendance of germ theory (Latour 1993) and the consequent ontological shift from 'bad air' to 'bad microbes', cleanliness became synonymous with healthiness, and immunity with cleanliness versus dirtiness (Stallins & Strosberg 2019). Additionally, 'probiotic' approaches touted as beneficial to bodily health have been gaining traction, though such metaphors have been found to be limited in the context of domestic hygiene leading to calls for "new metaphors" to replace dominant tropes of "bad germs" (Hodgetts *et al* 2018 p7). The contrasts between the formulations of antimicrobial resistance as a connective 'One Health' issue and the individualisation of solutions to antimicrobial resistance are drawn out by Chandler (2020 p2), who reflects critically that antibiotic resistance is constructed as a paradoxical "problem of connectedness to be solved by individualised action", often at the expense of

more systemic solutions for fractured health systems, productivity challenges, hygiene, and inequality (Willis & Chandler 2019). The construction of an apocalyptic threat posed by antimicrobial resistance is itself a part of this nexus in that it shapes *who* or *what* is threatening politically or medically, and *how* the threat itself manifests for antibiotics as an infrastructure of care.

Constructing Antibiotics as a Threatened Infrastructure of Care

Antibiotics do care work beyond simply assisting immune systems with the clearing of infections. Chandler (2020 p9) for example argues that antimicrobials are "material, affective and political infrastructures", and the inversion of these infrastructures that are ordinarily invisible (Bowker and Star 2000) through the development of resistance renders them newly visible. These infrastructural functions occur at a variety of scales, from international structural inequalities within which antibiotics provide a 'quick fix' for inequality in lieu of improved hygiene or effective health systems (Willis & Chandler 2019) to practice-level routine and etiquette. An example of one such invisible aspect of antimicrobial infrastructure is the everydayness of "dynamics of ritual, performance, and drama" that form the logics of practice involved in driving antimicrobial use in hospital settings (Broom *et al* 2017a, p1996). Part of this ritual is the "caring, benevolent act of offering antibiotics themselves" to patients, with antibiotics situated as "objects that 'care'" particularly for sick or vulnerable patients (Broom *et al* 2017a p1996; Willis & Chandler 2018 p105). The differentiation and problematization of 'care' is a topic engaged by geographers seeking to bring to the fore the "relations involved in caring practice" (Parr 2003 p217), with veterinary medicine highlighted for example as a context of care involving multiple spaces of jurisdiction and scales of care (Donald 2018). The extent to which antibiotics are understood as invisibly infrastructural or newly visible in the contexts of medical and veterinary care may be an important area through which pet-owners' antibiotic consumption can be understood. Understanding antibiotic consumption here also entails an understanding of constructions of good health and good care connected to this shared infrastructure by consumers.

The invisibility of antibiotics and other antimicrobials in these infrastructures of care has implications for the public perception of these medicines given the historic "sense of power" attributable to the somewhat overnight intervention of antibiotics in healthcare that led, among other things, to a relaxation in discipline around infection prevention (Bud 2006 p196). Lambert *et al* (2019) for example question simplistic interpretations of antibiotic use for non-bacterial conditions as arising from a lack of education or awareness, suggesting instead that knowledge translation should be critically scrutinised. Healthcare practices themselves are "emergent" in broader contexts than the simple exercise of reason, and in the context of antibiotic misuse these practices can be "understood in terms of social relations of fear, survival, and a desire for autonomy" tied not only to risks for patients

but risks for professionals working in varied contexts (Willis & Chandler 2018 p105; Broom *et al* 2017a p1994; Cartelet *et al* 2018; Hopman *et al* 2018). These issues are all at work in relation to the (in)effective dissemination of contextually appropriate antibiotic stewardship information and perceptions of the care-work that antibiotics may be considered to perform by and for different publics, and these issues stem in part from the infrastructural sense of security that antibiotics provide to healthcare professionals.

From this literature, the systemic 'misuse' of antibiotics by healthcare professionals may be understood as not itself systematically attributable to a lack of knowledge or awareness about antibiotic resistance. Patterns of apparent misuse emerge through contextually coherent rationalisations, rituals, and risk-aversion that are borne of a previously effective cure no longer holding guaranteed efficacy. This analysis of healthcare professionals' behaviour reinforces Lee & Motzkau's (2012 p450) assertion that it is "difficult to identify stable sites of causal and moral responsibility" around which to stage interventions relating to antibiotic resistance. Antibiotic resistance has many social aspects, and the complexities of professionals' behaviours demonstrate the importance of understanding how contact with healthcare professionals influences the ways in which lay members of the public understand the issue and the care-work of antibiotics. This itself entails a brief engagement with the discursive formations that have come to prominence around antibiotic resistance as a problem of individuals.

Antibiotic Resistance as a Problem of Individuals

Prescribers' and patients' behaviour with antibiotics do not occur in isolation from each other or their contexts, and a sole focus on the link between knowledge and/or awareness about antibiotic use and resistance risks oversimplifying or exaggerating the benefits of educational interventions for either group. This is not to argue that improvements cannot be made in public awareness about antibiotics, their use, and the problems arising from their misuse. Instead it is simply to argue that care should be taken to acknowledge the "complex social relations of practice and the structural forces which situate and inflect the micro-dynamics of care", and that patient/client demand and consumption is influenced by experiential knowledge derived from the actions of healthcare professionals working within such social relations (Broom *et al* 2017a p2003; Lambert *et al* 2019). In researching public perceptions of antibiotic use and the rationalisations that are provided for these perceptions, this experiential knowledge is important context alongside scientific knowledge or awareness.

In the UK prescribing behaviour involves a variety of contextual and communicative factors. Prescribers work within contexts that involve clinical uncertainty, safety concerns, and external institutional pressures (Cabral *et al* 2015; Cabral *et al* 2019; Krockow *et al* 2019; Thomson *et al* 2019). A recent systematic review of qualitative evidence for example found that in hospitals the societal risks posed by antimicrobial resistance are serious but abstract, with the salience of individual

patient risks presenting a key barrier to conservative prescribing (Krockow *et al* 2019). This salience is echoed in other studies, for example by Cabral *et al* (2015 p2) who found that high rates of consulting and antibiotic prescribing for children with respiratory tract infections are driven "by fears for and priority afforded to children's safety" reflecting "social norms where children are constructed as vulnerable [and] the role of adults is to protect them from risk of harm." In this context, "normative beliefs lead parents to feel that in order to be deemed an adequate 'risk manager' they must act to reduce a perceived threat" which in the context of illness can mean deference to relevant authoritative medical professionals (Cabral *et al* 2015 p162). The role of individualised risk takes multiple forms within antimicrobial resistance, as constructed vulnerabilities and health risks for patients are also professional dangers for prescribers that can override the societal risks of antimicrobial resistance.

These constructed vulnerabilities relating to the fear of untreated infections are also present in small animal veterinary medicine (King *et al* 2018) but are supplemented by further contextual pressures. Veterinary clients for example need to pay for diagnostic testing, which can be prohibitive for clients and also be perceived as prohibitive by veterinarians in situations when it is not (Hopman *et al* 2018; King *et al* 2018). The business aspects of veterinary practice particularly impact decisions to prescribe or administer antimicrobials in practices located in areas with low socioeconomic status, and for large heavy dogs and long-term therapies (Mateus *et al* 2014). It is perhaps unsurprising then, that the attraction and retention of clients through the violation of prescription regulations has been found to be an occasional influence on prescription behaviour for some veterinarians, such as prescribing fluoroquinolones without first using susceptibility tests (Hopman *et al* 2018). The vulnerabilities constructed around human patients take on a different character in the context of veterinary medicine, where vulnerability and the prescribing decisions attached to it can be economic – for client and practice – as well as medical.

Communication between medical or veterinary professionals and their patients/clients is a key area in literature on the frictions present in prescribing practice. Parents and clinicians for example differ on both their mode of assessment of illness and their judgement of illness severity (van der Werf 2019; Cabral *et al* 2014; Cabral *et al* 2015), and clinicians' addressing of patients' informational expectations in the absence of a prescription is a key area of empowerment for patients (Cabral *et al* 2014; van der Zande *et al* 2019). Patient judgement of clinician credibility for example has been linked qualitatively to the presence of a physical examination (even where this is diagnostically irrelevant) and communication delivery (their perception of whether the clinician was listening and caring about their concerns) (Cabral *et al* 2014). Patients desiring more information – for example in the case of a viral diagnosis with a no-treatment recommendation – may be perceived by time-pressured clinicians as pressuring them to prescribe, whilst patients are simply concerned that the viral diagnosis could be "trivialising" their concerns depending on the communication style of the clinician (Cabral *et al* 2014 p252). These patient-clinician communication frictions are heterogeneous between

GP practices, with GPs in high-prescribing practices reporting difficulties stemming from variation in prescribing within their practice and the consequent reinforcement of patient expectations – an issue also reported in veterinary practices (Hopman *et al* 2018) – and GPs in low-prescribing practices noting the importance of sufficient support and resources to manage tension with patients' expectations (van der Zande *et al* 2019). Variation between practices has been attributed to a variety of factors, including higher proportions of severely ill patients, larger practice size, proportion of elderly or very young patients, ruralness, deprivation, and smoking prevalence (Stuart *et al* 2020; Curtis *et al* 2019; Hope *et al* 2018). Significant variability in antibiotic prescribing amongst different veterinary practices and corporate groups has also been shown, however the underlying reasons for this have not been explained (Singleton *et al* 2017; Tompson 2019).

In the veterinary setting, a lack of trust due to poor communication from veterinarians to clients has been described as a 'pervasive' problem (Adams *et al* 2007). The time constraints of veterinary consultations undermine efforts to provide education to pet-owners on antimicrobial stewardship (Currie *et al* 2018; Lund *et al* 2009), leading Currie *et al* (2018 p6) to argue that "effective communication would be helped by high-quality public education and awareness interventions about antimicrobial stewardship and resistance in pets, as well as humans". Whilst there are obvious differences between medical and veterinary contexts in terms of patient/clinician relationship and the role of financial pressures, there are some clear similarities in terms of the time-pressure within consultations leading to clinicians' misperceptions of patient/client expectations, the role of support structures and peer pressure within practices, and the high variability between individual practices in terms of their prescribing. When considering the role of members of the public as antibiotic consumers, it is important to contextualise the acquisition of antibiotics with an awareness of the professional environments within which antibiotics are prescribed. Furthermore, understanding that a variety of non-scientific factors lead to the prescription of antibiotics adds importance to research into how the use of these medicines is rationalised in and between contexts by members of the public who are engaged with both medical and veterinary healthcare and are the foci of these pressures.

By engaging with members of the public who navigate both human medical care and veterinary care contexts, this thesis straddles the contrast drawn out by Chandler (2020) of the One Health connectedness of antimicrobial resistance and the frequent focus of solutions on individual behaviour. These care contexts share attributes, including the use of antibiotics and a variety of professional environmental pressures, though the relationships between healthcare professional, client, and patient are additionally mediated by animal welfare and owners' financial means in ways that do not apply to point-of-care access in the UK National Health Service's medical care provision (Cartelet *et al* 2019). Framing individual members of the public as poor antibiotic stewards may draw focus to "centres of tractability", however this "underestimates the complexity of antibiotic resistance" as a biosocial problem (Lee & Motzkau 2012 p459), and this is especially the case when considering pet-owners.

‘Antibiotic stewardship’ originated as a term in the mid-1990s (Dyar *et al* 2017) with a focus on programmes of antibiotic use management within hospitals, incorporating over the course of the 1990s and 2000s other strategic programmes in community- and animal-related settings and increasing the use of the term ‘antibiotic stewardship’. The term ‘stewardship’ is clinically unique to antimicrobials as a class of medicines, as they are a non-renewable resource and the only class of drugs with clinical impacts on both individuals *and* their communities (Dyar *et al* 2017). Dyar *et al’s* (2017 p796) review of the evolution and definitions of antibiotic stewardship contends that a definition of the term could be “a coherent set of actions which promote using antimicrobials in ways that ensure sustainable access to effective therapy for all who need them”, avoiding a sole focus on prescribers and problematic value terms like ‘rational’ or ‘optimal’. Dyar *et al* (2017) conclude that ‘responsible’ antibiotic use is context- and time-specific and therefore the definition of antibiotic stewardship is something of a continuous process rather than permanent fixture. The term antibiotic stewardship therefore has relevance to pet-owners in multiple ways as they utilise antibiotics across multiple contexts for their own care and the care of their companion animals. This relevance however requires critical scrutiny to examine the actions, attitudes, and understandings of pet-owners in these parallel settings and the extent to which there is variance in whether they are ‘ensuring sustainable access to effective antibiotic therapy for all who need them’.

Antibiotic stewardship in medical and small-animal veterinary settings in the UK may share some similar characteristics for the public in terms of completing prescribed courses and adhering to professionals’ instructions, but these behaviours are subject to different individual and contextual challenges on the part of pet-owners. Taking a reactive dog to the veterinary clinic for example presents physical and emotional challenges for pet-owners attempting to access care which, as discussed earlier in this section, may in fact simply be a desire for the attention of an antibiotic rather than the attention of a veterinarian. This represents an extra dimension to Donald’s (2019 p477) discussion of the “emotional and affective geographies of the [veterinary] profession that are written out through a measured language of scientific objectivity and rationalism”. The Royal College of Veterinary Surgeons (2020) *Code of Professional Conduct for Veterinary Surgeons* (CPC) for example becomes a framing discourse in Donald’s (2018 p473) argument, as the “fleshy, affective realities” of the work of veterinarians is necessarily negotiated in practice rather that strictly scientifically rationalised. This raises further critical questions for antimicrobial resistance as a ‘One Health’ problem – the rationalisation of antibiotic use in different healthcare contexts is itself multiple. Variations in clinician experience, patient/client perception of severity, communication styles, socio-economic and geographic factors, and professional pressures provide a topography to navigate for professionals and the public.

Research and public health interventions engaging with public antibiotic stewardship behaviours should consequently avoid imagining that “taking antibiotic medicines is a decision that is taken as

unthinkingly as eating confectionary" (Chandler 2020 p7) by people who simply lack understanding, and instead try to understand the individual and contextual factors that shape antibiotic use. These factors may be the discourse to which members of the public have been exposed (Brown & Crawford 2009; Nerlich & James 2009; Bud 2006), the apparently "nonevidence-based and […] irreverent" practices and knowledge transfers arising from such appearances (Broom *et al* 2017a p2003; Lambert *et al* 2019), contextual healthcare challenges (Broom *et al* 2017b; Cartelet *et al* 2018; 2019) or indeed psychological responses to stewardship programs promoting "positive antibiotic behaviours" (Stallins & Strosberg 2019 p8). Antibiotics may be infrastructural medicines, but they are one infrastructure linked with many human and non-human actants that shape the construction of antibiotic resistance and enaction of strategies to mitigate it.

Section 2.4 – Specific Areas of Research

Section 2.4.1 – Why Pet-owners?

There are multiple overlapping literatures that provide a rationale for focusing on pet-owners as a social group in the context of antimicrobial resistance. Pet-owners are a distinct group in terms of the effect of pets on physical and mental health, and the role of pets in shaping familial microbial ecologies. Recent qualitative research also suggests that pets also have a role in shaping pet-owners' relationships with antibiotic therapies. Advancements in the health citizenship of pets also render the behaviours and attitudes of pet-owners in the context of antibiotic use as important, and the complexities of the demographics of the ownership of different pets highlight areas of interest for the design of the quantitative aspects of the thesis research.

Pet-Ownership as a Healthy Characteristic

There is substantial evidence that the presence of companion animals can provide physical and mental health benefits to pet-owners. Whilst many studies of the myriad health benefits of companion animals to humans are cross-sectional and therefore have difficulty in establishing causal relationships, Headey & Grabka (2007) have demonstrated through a longitudinal study in Germany and Australia that there is strong evidence for a causal health link between pet-ownership and human health. Specifically, Headey & Grabka (2007) found that continuous pet-owners were the healthiest group compared to those who cease to have a pet or have never had a pet. This finding raises the value of other studies that have struggled with causation, with pet-ownership being shown cross-sectionally to be associated with fewer complaints about minor health issues, higher myocardial infarction and coronary artery disease survival rates, decreased medication use, and fewer visits to physicians (Sterneberg-van der Maaten 2016; O'Haire 2010; Seigl 1990; Headey & Grabka 2007). These health advantages emerge through a nexus of physical, psychological, and social benefits relating to pet-ownership. For example, Müllersdorf *et al*'s (2010) Sweden-based study found that pet-owners took enough exercise to positively influence their health more often than non-pet-owners, whilst Wood *et*

al (2005) note that if all Australian dog owners walked their dog for half an hour per day there would be estimated health-care savings of AU$175 million. Whilst dog ownership has been associated with motivating physical activity in the form of dog-walking (Westgarth *et al* 2017), there are differences among dog owners in their propensity of walk their dogs. In the UK, Westgarth *et al* (2015) found that ownership of multiple dogs or a small dog and the presence of more people in a household predicted lower likelihood of walking a dog on a daily basis. There is some further heterogeneity to the health benefits of pet-ownership however, as shown for example in a study of older adults' health which found that older cat owners tended to have greater body mass and were less physically active than older dog owners (Heuberger 2017). Nonetheless the importance of the causal link uncovered through longitudinal study is that it is not simply the case that healthier people acquire companion animals, but that there is evidence that these health effects stem in some way from the presence of companion animals and consequently demarcate pet-owners as a demographic group of interest in health research.

Companion Animals, Antibiotic Resistance, and Microbial Ecologies

Interspecies Transmission of Resistance

There is a growing body of evidence showing that resistant bacteria are shared between humans and companion animals. Pet-ownership is a risk factor for infections in humans caused by resistant bacteria (Damborg *et al* 2016), with multiple studies suggesting that companion animals provide reservoirs of pathogens – including pathogens resistant to antimicrobial therapies – for humans and vice versa (Marques *et al* 2019a; Marques *et al* 2019b; Drougka *et al* 2016; Montgomery *et al* 2018; Weese *et al* 2006; Ishihara *et al* 2010; Strommenger *et al* 2006; Stenske *et al* 2009; Loeffler & Lloyd 2010; van Duijkeren *et al* 2019; Pomba *et al* 2017). The overall burden of antimicrobial resistance in companion animals and the risk of transmission from companion animals to humans and vice versa is difficult to quantify (Pomba *et al* 2017; Bengtsson & Greko 2014), demonstrating a specific case of Chandler's (2020) assertion regarding the absence of easily quantifiable actuarial accounts of antimicrobial resistance.

Examples of significant antimicrobial-resistant bacterial infections have been traced to companion animals, with one example traced to pet store puppies leading to 118 identified human cases of multidrug-resistant *Campylobacter* infections in the United States (Montgomery *et al* 2018). The use of similar antimicrobial medications in both human and veterinary medicine that both select for and are vulnerable to the development of common resistance poses risks for both human and veterinary medical treatment. Whilst the issue of antimicrobial resistance has been previously discursively centred on the hospital space, the implication of veterinary hospitals and clinics as sites of resistance epidemics is a more recent development.

Consequences of Companion Animal Resistance

Pets are subject to more advanced and costly healthcare than ever before, having acquired a "right to health" and with small-animal veterinarians incorporating the latest diagnostic and treatment equipment into companion animal care (Haraway 2008 p49; Bengtsson & Greko 2014). These increasing similarities between spaces of human and veterinary care mean that the "problems of resistance development and of infection control in companion animal hospitals are mimicking those in human hospitals" according to Pomba *et al* (2017 p962). Veterinary personnel, along with pet-owners, are consequently at relatively higher risk to the general population for transmission of zoonotic pathogens including methicillin-resistant *Staphylococcus aureus* (Weese *et al* 2006; Ishihara 2010; Drougka *et al* 2016). Unlike in human healthcare however, the suffering of an individual companion animal and the overall cost of companion animal health care may be limited in the case of treatment failure attributable to resistance by the alternative of euthanasia for sick or elderly animals (Bengtsson & Greko 2014). This poses the risk of severe negative emotional and social effects on owners and families akin to the loss of a family member, as well as other social consequences in the case of service animals assisting with the management of disabilities (Bengtsson & Greko 2014; Morris 2012). This illustrates an area in which the problem of antimicrobial resistance may be shared between human and non-humans, but the biopolitical negotiation of the consequences in human and veterinary medical spheres demonstrate a plurality of healths rather than 'One' health. These healths demand demonstrably different decision-making from pet-owners having to navigate these spheres of healthcare in the context of antimicrobial resistance.

Microbial Ecologies and Geographic Engagement

An area important to the interspecies transmission of resistance that has recently received growing attention from geographers is the microbiome. Lorimer *et al* (2019b) highlight that public understandings of microbial life have been largely shaped by media coverage of named species and domestic hygiene advertising promoting an absence of microbial life as a domestic hygiene objective. Indeed, Beck (2019 p7, 16) underscores the representation of microbes with "monstrous aesthetics" in hygiene advertisements as a significant contributor to the generation of a negative connotation for the word 'germ', "cementing" a dichotomisation of 'good' non-microbial life and 'evil' microbial life – or perhaps as Hinchliffe (2015 p34) puts it, "worlds divided along the lines of the virtuous and the pathological". Hinchliffe *et al* (2017 p32) also highlight that following the will to divide the world into 'pasteurised' and 'unpasteurised', microbes were "diagrammed as outsiders to healthy lives", with germ theory rekindling a "sovereign and legalistic notion of disease" in which microbes are not only visible, but also nameable and notifiable as "matters to be excluded". In Lorimer *et al*'s (2019b) research with members of the general public in Oxford however, this understanding of microbial life as individualised by identifiable nameable species was challenging to translate to an ecological

ontology of the microbiome that embraced microbial qualities of diversity, abundance and the functional roles of microbial ecologies.

The overzealous anti-biotic approach to domestic hygiene that the negative perception of domestic microbial life has produced – along with social changes such as declining family size and improvements in household amenities – has been linked through the so-called 'hygiene hypothesis' (Strachan 1989) – more recently cast as the "biome depletion paradigm" (Parker 2014 p1) – to an undermining of the human immune system in industrialised societies (Parker 2014; Levy *et al* 2017). A recent systematic review of the effect of antibiotics on the composition of the human intestinal microbiota demonstrated that antibiotics have "profound effects on the intestinal microbiota by diminishing the abundance of beneficial commensals and increasing the abundance of detrimental pathogens or commensals" (Zimmerman & Curtis 2019 p486). As well as the adverse health effects (including diarrhoea and increased risk of asthma, obesity, and autoimmune diseases) arising from potential dysbiosis following antibiotic therapy, increased levels of resistance to both the specific antibiotic used for treatment as well as induced resistance to other classes of antibiotics can still be evident up to four years after treatment (Zimmerman & Curtis 2019). The microbial ecologies that make up one's microbiome are shaped by environmental, dietary, and medical pressures that leave a footprint in this metagenome.

In the context of households, studies have shown that exposure to pets, farm animals, and siblings influence the development of the human microbiota. Song *et al* (2013) provide evidence that the more-than-human family unit has a strong effect on human microbial community composition across all body sites, with such microbial communities being more similar within than between families. Pets, they suggest, "harbour a diverse microbial community but also shed a diverse set of microbiota" that influences human family members' own microbial composition" (Song *et al* 2013 p13). Azad *et al* (2013 p4) further report that two "traditionally protective 'hygiene hypothesis' factors" – exposure to pets, and exposure to siblings – exert "distinct effects on microbiota diversity, and select for different assemblages of gut microbes." In another example, Fall *et al* (2015 p1) found evidence to support the "hypothesis that exposure to dogs and farm animals during the first year of life reduces the risk of asthma in children at age 6 years", speculating that part of this effect stems from modulation of the immune system. Azad *et al* (2013) rationalise the role of pets – and the distinction between exposure to pets and to siblings – as due to the harbouring and transmission of different organisms sourced from outdoor environments, schools or daycares, as well as organisms from the 'normal' animal or human microbiota. The evidence for multiple protective exposures selecting for different combinations of microbes indicates to Azad *et al* (2013 p7) that "multiple 'healthy' microbiota profiles are possible, perhaps due to functional redundancy among different organisms". The possibility of multiple configurations of healthy microbiota evoke further critical reflection on the 'Oneness' of health discussed previously, recalling health not only as "an achievement" patched

together as opposed to a "distinction" from illness (Hinchliffe 2015 p34) but inviting the idea that genomically one could map "the microbiome draw[ing] the external environment into bodies and then defin[ing] bodies according to these environments" (Stallins *et al* 2018 p162). Considering Stallins *et al*'s (2018 p155) invitiation to geographers to consider the microbiome as the "spatial relationships between context and DNA", the microbiomic and related 'health' profiles of pet-owners shaped by their household ecological context could be argued as being somewhat distinct from those of people whose microbiome is shaped in the absence of pets.

Behaviour of Pet-owners

As well as co-creating familial microbial ecologies, companion animals also have a role in the decision-making of their owners around antibiotics, which has begun to be explored in recent qualitative literature in Glasgow (UK) (Smith *et al* 2018; Dickson *et al* 2019) and Philadelphia (USA) Redding & Cole 2019a). Dickson *et al* (2019) for example found that some of their participants reported refusing antibiotics personally, but actively seeking their use for their companion animals predicated by a fear of the consequences of delay or complacency. The affective dimensions of emotional and unconditional relationships between owner and animal additionally serve as antecedents to behaviours that present interspecies transmission routes for AMR such as skin-to-skin contact or sharing saliva, behaviours that to the owners are ordinary expressions of closeness and affection (Dickson *et al* 2019). A finding shared between Dickson *et al* (2019) and Redding and Cole (2019) was the reporting of pet-owners pushing for antimicrobial treatments because of a fear that the veterinarian had underestimated the pet's suffering. This suffering was something the pet-owners, with their intimate knowledge of their animals, felt better able to identify and communicate give the inability of companion animals to communicate linguistically themselves. This act of translation recalls Donald's (2018) contention regarding the more-than-human empathetic aspects of veterinary care, in which affective communication between animal and human raises the animal beyond simply being an 'object of care' to a more active participant in the process of care. Dickson *et al* (2019) and Redding and Cole (2019) both also report low levels of knowledge in their qualitative samples regarding antibiotic resistance and the potential for interspecies transmission of resistance. This is an important area of disconnection, as companion animals shape both the familial microbiome and owner behaviours that may negatively impact this microbiome and promote the development of antibiotic resistance.

Summary

Given that antibiotic therapy has significant effects on microbial ecologies, and familial microbiomes are not only shared between non-microbe species (as well as moving with families to new houses (Lax *et al* 2014)), a deeper understanding of pet-owner decision-making and behaviour is needed in order to shape the communication of antimicrobial resistance as an ecological issue in which pets and owners participate and have a clear and mutual stake, rather than a neoliberalised or biosecuritised

issue of individual humans (or non-humans) and their 'health', separable from microbes that are 'to be excluded'.

Demographics

Around 40% of UK households have a pet (Pet Food Manufacturers' Association 2019), and as has been discussed this portion of the population shows some health-related difference based on positive physical and mental health boosts as well as in terms of their microbial ecologies. It is important to understand how pet-owners and non-owners differ demographically to further understand the nature of the potential risk posed for resistance development if the behaviour or attitudes of pet-owners exhibit significant difference to their petless counterparts. This is also important for shaping the study design of this thesis, in particular for the survey-related parts of the research where controlling for potentially confounding characteristics is important for the isolation of specifically pet-related associations.

The popularity of pet-ownership appears to be increasing, with "increasing evidence of socioeconomic differences between pet-owners versus non-owners" (Sterneberg-van der Maaten 2016; Westgarth *et al* 2010 p3706). Much of the literature on pet-ownership focuses on dogs and cats, occasionally linking ownership of these species to further ownership of other species. This approach is problematic, as Westgarth *et al* (2010) point out that there are demographic differences, even between dog and cat owners, that are suggestive of different human-animal relationships among difference species as opposed to a singular 'pet-owner' effect. Westgarth *et al*'s (2010) longitudinal study of the demographics of pet-ownership using ALSPAC data produced support for several aspects of pet-ownership shown through other cross-sectional studies. For example, households with older children have been found to be more likely to own pets in the UK (Murray *et al* 2010; Westgarth *et al* 2007) and Ireland (Downes *et al* 2009), and Westgarth *et al*'s (2010) study demonstrated that dog ownership is indeed associated with older children as opposed to the first few years of childhood. Other findings from this analysis include house type having an effect on dog and rabbit ownership, women being more likely to own cats, generational influences on familial pet-ownership, and education and occupation having independent effects on dog ownership (Westgarth *et al* 2010). The size of a household has also been found to affect the likelihood of dog ownership, with both Murray *et al* (2010) and Westgarth *et al* (2007) finding that larger households were more likely to own a dog. This has significant implications for the emergence and transference of antibiotic resistance given that, for example, children may be in different schools, and dogs will be walked on routes likely frequented by other dogs and their families. This presents numerous avenues for resistance transference if the behaviour-related conditions for its development are prevalent among pet-owning households.

There is no singular set of demographic characteristics for 'pet-ownership', as this category covers a range of different human-animal relationships that require differing commitments and provide different forms of companionship. The findings of these studies of the demographics underlying various pet-ownership configurations are of importance for this thesis' research design, and, in the quantitative elements of the thesis, the controlling of variables through sample and questionnaire design and within regression models in order to better isolate pet-related differences. The implications of these studies are that the demographics of the ownership of different pets are, for a start, different, but also individually complex with a range of potential influences that will undoubtedly interact with (for example) existing socioeconomic health effects and health-related behaviours.

Summary

Pets have been linked to human health in a number of ways, providing benefits to physical health by affecting changes in pet-owners' behaviour, as well as psychosocial benefits. Despite these benefits, pets have been shown to co-create familial microbial ecologies and affect behaviour around antibiotics that may be problematic in terms of the stewardship of these medicines and mitigation of resistance development. Pets are increasingly important as the subjects of medical attention and cost, and their role as social actants in the broader construction of antimicrobial resistance warrants specific attention.

Section 2.4.2 – Online Health Information

The relationship between health professionals and their patients is increasingly being mediated by the Internet as a source of health information. As discussed in earlier sections, the provision of information by health professionals is part of medical care as much as the provision of access to medicines themselves. This form of care, however, is becoming more equalised between health professionals and their patients/clients. This has been noticed in both human and companion animal healthcare, with both positive and negative effects on health outcomes. Decision-making in healthcare has trended towards an equalisation between authoritative health professionals and their patients or clients, with health-related information becoming a site of "negotiated and contingent achievements […] open to contestation, challenge and reinterpretation" (Greenhough 2010 p154) as the public draw upon their experiences with the negotiated practices of healthcare providers, the infinite and varied resource of the Internet, and the experiences of their families and friends. This changing landscape of decision-making power in medical and veterinary practice reflects the 'logic of patient choice' in which medical authorities are cast as overly-paternalistic and dismissive of patient experience (Mol 2008).

Whilst there are advantages to the breadth and accessibility of health information available on the Internet, concerns have been raised over the dissemination of poor quality information, consumers' abilities to distinguish good quality information from poor, and the impact of this information on

behaviours relating to both human and animal health (Cotton *et al* 2004; Volk *et al* 2011; Kogan *et al* 2009; Oxley *et al* 2017). Studies across a variety of health topics have demonstrated considerable variance in the quality of health-related information available on the Internet (López-Jornet & Camacho-Alonso 2009; Lawrentschuk *et al* 2009; Scullard *et al* 2010; Ream *et al* 2009; Patel *et al* 2015; Perzel *et al* 2017). Variable behaviour has also been reported with regard to consumers' discernment of good and poor information, such as unfamiliarity with quality codes (Baup & Verdoux 2017), inefficient search habits (Puspitasari *et al* 2015), high trust coupled with minimal verification behaviour (Seçkin *et al* 2016), and high trust coupled with an increased likelihood to change behaviour based on the accessed information (Beck *et al* 2014). The ease with which health information can be accessed online and the variation in quality of both information and information consumers' discerning behaviours present a significant concern with regard to the finite and valuable resource of antibiotic medicines that require informed stewardship by both healthcare practitioners and medicine consumers.

The use of the Internet for health-related information is significant and growing in the UK, with potential for uncritical use as well as patient/client empowerment. In the UK the Office for National Statistics (2018) reports that 54% of adults used the Internet for health-related information in a three-month period in 2018, an increase of 30% since 2008. Information on the Internet is often not "screened, edited, or rated for accuracy" and there are no consistently reliable predictors for any website's accuracy, and with patients rarely reporting using screening behaviours for websites from which they acquire health information, concerns have been raised over the implications for patient health, adherence to treatment, and relationships with physicians and veterinarians (Lo & Parham 2010 p20; Ayantunde *et al* 2007; Kogan *et al* 2009; Lee 2008). The increased expectation of participation by the public in medical decision-making has been facilitated by the increasing amount of readily accessible health information on the Internet, impacting upon the "traditional imbalance of power between health professionals and the general public [that] derives partly from a medical-knowledge gap between the former and the latter" (Lee 2008 p450). Furthermore, in the veterinary context, the contemporary fast-paced and highly technical medical world "no longer lends itself to the traditional hierarchical approach to veterinary practice, in which a content expert, the veterinarian, unilaterally dispensed information and treatment to a passive animal owner" (Kogan *et al* 2016 p2). Whilst these developing trends contain the potential for negative effects for healthcare consumers, they also present the potential for positive empowerment. The present literature suggests that whilst veterinarians are sometimes "seeing pets three days sicker" due to clients delaying necessary consultations because of first consulting the Internet (Volk *et al* 2011 p1278), the Internet is generally being perceived and utilised by consumers as an adjunct to medical professionals, with patients and veterinary clients attending appointments "armed" with their own research as well as other sources such as wearable technologies (Kogan *et al* 2016 p21).

A different problematic aspect of the Internet for antibiotic stewardship is the use of the Internet for the acquisition of antibiotics from poorly regulated vendors for the purpose of self-medication (Grigoryan *et al* 2007b; 2008). The Care Quality Commission (CQC) (2017a p2) notes that "the use of technology to deliver regulated activities remotely is increasing significantly," including the digital health sector "which aims to improve people's access to healthcare advice, diagnosis and treatment," with some organisations "providing regulated activities without registering as they are required to." There is "professional and public concern that some of these services may not be clinically safe and may put patients at risk" (CQC 2017a p2), as has been found in reports showing medicines being dispensed outside appropriate clinical best practice and without safety advice, without knowledge of patients' previous prescriptions or medical history, with no follow up on patient outcomes, and with clinicians working outside their scope of practice prescribing medicines for chronic and specialist conditions (CQC 2017b; 2017c).

Changes in Patients' and Clients' Attitudes to Human and Veterinary Healthcare Professionals

The consumption of online health information evidently has the potential to affect health outcomes for better and for worse, but the question remains as to whether this knowledge acquisition actually has an impact upon offline behaviour.

In a variety of contexts, the offline behaviour of consumers of online health information has been found to change as a result of accessing online health information. Examples of affected behaviour include deciding whether or not to visit a healthcare professional (Moreland *et al* 2015), adoption of modifications of behaviour regarding chronic conditions (Siliquini *et al* 2011), medical decision-making relating to screening or surgery (Couper *et al* 2010), and increased rates of noncompliance with treatment and advice of health professionals (Seçkin *et al* 2016). These alterations in behaviour arising from the consumption of online health information highlight the need to understand whether Internet use for health information may affect knowledge and behaviour in specific scenarios such as the consumption of antibiotics. In the context of antibiotic use, there have been online educational campaigns such as the e-Bug website (Public Health England 2020) and the Antibiotic Guardian campaign (Public Health England 2014). A recent qualitative evaluation of the Antibiotic Guardian campaign suggested that the campaign had a positive impact upon participants, though this was predominantly through the reinforcement of existing behaviours rather than engagement with people without pre-existing knowledge about antimicrobial resistance. There is a growing body of evidence that social media, and specifically Twitter, have been used to disseminate messaging regarding antibiotic stewardship, though the evidence on the effectiveness of social media in the area is not yet clear (Kendra *et al* 2015; Dyar *et al* 2014; Combraos-Sánchez 2019).

Despite the growth of online health information as a resource, evidence suggests that it is being used as an equaliser rather than replacement of medical authority, and users of online health information are not necessarily aiming solely to make independent decisions. Whilst there is a high prevalence of Internet use for health information across a range of health scenarios (Siliquini *et al* 2011; Baup & Verdoux 2017; Sethuram & Weerakkody 2010; Beck *et al* 2014; Andreassen *et al* 2007; Kummervold *et al* 2008) with a trend towards perceiving the Internet as an increasingly important source of health information (Kummervold *et al* 2008), healthcare professionals currently remain the most influential source of information with regards to medical decisions (Couper *et al* 2010; Mendes *et al* 2017; Ramsay *et al* 2017). The use of the Internet has had several effects on patients' behaviours towards physician contact, for example with Lee (2008 p461) reporting evidence that the use of the Internet as a source of health information "increases the frequency of health professional contact" as individuals that obtain health information from the Internet contact health professionals "to make sense of and make use of the information." Most patients that bring such information to a physician report bringing doing so in order to obtain an opinion from their physician rather than to challenge them, with consumers still valuing communication with their doctors highly relative to the use of the Internet (Lo & Parham 2010; Dumitri *et al* 2007). Despite this, Ayantunde *et al* (2007 p461) found that 95% of participants that had accessed health information on the Internet "rated such information as being average to excellent." This perception may be problematic given the aforementioned potential for information to be present in online searches, combined with a lack of effective screening measures reported by consumers of such information. There are also some demographic associations with the use of this information, for example with younger patients tending to prefer to be involved in medical decision making, and use the Internet more often for health related information than older patients (Say *et al* 2006; Dumitri *et al* 2007). Whilst the Internet generally appears to be used as an adjunct for health professionals, the extent of this use is demographically patterned between younger and older patients, and is changing the frequency of contact and the relationship between patients and health professionals.

Changes in clients' behaviour have also been seen in veterinary medicine with the growth of the Internet as a medium through which health information can be dispensed and consumed. As with physicians in human medicine, it has been found that veterinarians remain ranked by clients as the most trustworthy source of information on pet health (Kogan *et al* 2009; 2014; Hockenhull & Creighton 2013; Hofmeister *et al* 2008). Furthermore, it has been found that persons using the Internet to search for veterinary health information online often used their veterinarian to check the accuracy of online pet health information (Kogan *et al* 2012), though it has also been observed in one study that around 15% of pet-owners rely less on their veterinarian because of the use of the Internet with 39% of surveyed pet-owners consulting the Internet before their veterinarian (Volk *et al* 2011). Younger persons, mirroring the trend in human medicine, have been more likely to report using the Internet for

pet health information (Kogan *et al* 2012), however with veterinary medicine there is the additional layer of different pet species' idiosyncrasies. Cat owners for example have been reported as being less likely to take their cat to the veterinarian because of the "difficulties and unpleasantness" of taking a cat to the veterinarian – a point reinforced in Volk *et al*'s (2011 p1279) study with 83% of cat owners reporting having a primary veterinary clinic compared with 91% of dog owners. Whilst there have been fewer studies on veterinary clients' online behaviours, they appear to show similar patterns to human medicine in terms of the age groups that access and act upon online health information, with some suggestion that whilst veterinarians are still the main source of information for pet-owners there are newly developing patterns of behaviour in this area.

Understanding the ways in which people acquire information about their health and medicine use is an increasingly important avenue through which to shed light on how and why certain beliefs and behaviours around antibiotic use are developed and reinforced or changed. With the increased democratisation of knowledge production and access through the Internet, and the additional growth of poorly-regulated healthcare providers through the Internet, this is a potentially key area in which progress could be made to increase appropriate use of antibiotics by developing quality information sources readily accessible by the public.

Section 2.5 – Chapter Summary and a Methodological Note

This Chapter situates the work of this thesis within health and animal geographies, arguing that a more-than-human health geography of antibiotic consumption by pet-owners is both relevant and timely. Key theoretical perspectives in these sub-disciplinary tranches have been pushed forwards into current social scientific debates around antibiotic resistance as an issue exemplifying both an interconnected 'One' health of shared biological destiny and a problem of and for individuals within a broader infrastructure of care facilitated by antibiotic medicines. The specific areas of research within the context of antibiotic consumption that this thesis engages with have also been discussed in terms of their relevance as influences on antibiotic consumption behaviour and relations to antibiotic resistance.

This Chapter also provides a basis for the rationale of the thesis' mixed-methods approach. As discussed in this Chapter, health and behaviour can be influenced by a variety of individual and contextual factors and not all of these factors are best captured using the same research tools. For example, the characteristics that have been associated with pet-ownership in this Chapter can be incorporated into quantitative analyses as controls to better isolate any relationship between pet-ownership and antibiotic-related behaviours, whilst the qualitative research elaborates on a variety of ways in which such a relationship may be enacted with different characters of pets, previous experiences with veterinarians or doctors, or general perceptions of what health *is*. By mixing social research methods and being critically reflective regarding their strengths, weaknesses, and

complementariness this thesis addresses its research questions and speaks to the contextual material presented in this Chapter in a robust way.

The specific methodological details of each stage of the research will be presented in the respective chapters in which the research is presented. The use of mixed-methods facilitates some generalisable and relational inferences to be made about the role of a variety of factors measurable through survey questionnaires alongside and in discussion with less predeterminate qualitative approaches that allow participants more agency to discuss topics and provide generative insights not necessarily derivable from previous research or the strategies of quantitative data collection. Incorporating methodologically critical approaches, such as cognitive interviews, and protocol variables such as levels of survey respondent cooperation or previous panel participation facilitates ongoing critical reflection about the nature of the methods used and their influence on the data, findings, and conclusions drawn from this research.

Part 2: Methodological Research

Chapter 3 – Secondary Survey Analysis: Socio-economic, Attitudinal, and Online-Information Usage Trends Associated with the UK Public's Knowledge and Behaviour Regarding Antibiotics

Sections of this Chapter draw upon material that has been published in the following articles:

Sections 3.1.2, 3.2, and 3.3:

Anderson, A. (2018) Online health information and public knowledge, attitudes, and behaviours regarding antibiotics in the UK: Multiple regression analysis of Wellcome Monitor and Eurobarometer Data. *PLoS ONE*, 13(10), e0204878.

Sections 3.1.2, 3.2, and 3.4:

Anderson, A. (2019) Analysing incompliant attitudes towards antibiotic prescription completion in the UK. *Journal of Antimicrobial Chemotherapy*, 75(3), 756-763.

Section 3.1 – Introduction

Section 3.1.1 – Chapter Aim

This Chapter aims to characterise key outcome variables relating to knowledge and behaviour around antibiotics using existing random probability surveys of the UK public. The analyses in this Chapter take two forms. Firstly, two similar random probability sample survey datasets collected in 2015 and 2016 are analysed using similarly specified regression models to robustly identify consistently significant predictor variables. Secondly, two waves of one of these datasets are combined and analysed using model averaging to expand the analyses presented here, and in the literature, to examine new geographical, political, and attitudinal predictors.

The primary quantitative research of this thesis (Chapter 5) aims to newly identify associations between pet-ownership and antibiotic-related attitudes and behaviours, and the secondary data analysis of this Chapter provides evidence for variables to firstly be included in the primary research to better isolate any independent association between pet-ownership and antibiotic-related outcomes and secondly to be included in the weighting procedure for the nonprobability sample used in the primary survey research. Together these secondary data analyses provide a platform and comparison for the primary survey research of this thesis by contextualising socio-economic variables already discussed in the literature and presenting new factors unconsidered in the survey literature on antibiotic stewardship behaviour.

Identifying key variables associated with good antibiotic-related knowledge or stewardship practices in existing datasets is important when studying new factors such as pet-ownership, or comparing stewardship in different contexts such as human health and in the parallel context of companion animal health. Uncontrolled factors may lead to incorrect inferences, for example the attribution of an association to pet-ownership that is actually due to an underlying uncontrolled socio-economic or attitudinal factor prevalent among pet-owners and associated with the outcome of interest. The identification of these variables is also crucial for effective propensity score weighting, as the distribution of these variables (if they are associated with outcomes of interest in a random probability sample) in a nonprobability sample could lead to bias in statistical analysis and the conclusions that are drawn from such analyses as they may be distributed differently than in a random probability sample.

The remainder of this Chapter's introduction (3.1.2) presents the background literature covering knowledge and behaviour around antibiotics, in particular focusing on research that has used survey methodology to examine antibiotic stewardship and relevant related areas such as Internet use for health information and political orientation as a marker for underlying health-related beliefs. The

general conclusions of the Chapter are then presented (3.1.3), to give an indication of the value of the analysis of this Chapter substantively and for the thesis as a whole.

The data sources for this chapter are then presented (3.2).

Following this, a comparative analysis of the 2015 wave of the Wellcome Monitor and the 2016 Eurobarometer is presented and discussed (3.3). This analysis focuses on socio-economic factors and the use of online health information and how these are associated with antibiotic-related outcome variables reflecting knowledge and behaviour. Near-identical variables are extracted from each dataset to perform parallels sets of analyses in order to increase the confidence of conclusions drawn from these analyses.

The second piece of analysis is based on the 2016 and 2018 waves of the Eurobarometer survey (3.4). This section extends previous analyses to encompass geographic variables, social attitudes such as political orientation, and protocol variables such as survey interviewee cooperation. This section raises both substantive points about the general previous approach of survey researches on antibiotic stewardship and the variables that have been considered in this research, and methodological points for the design, implementation, and analysis of the primary survey research aspect of this thesis' research project.

Finally, the conclusions (3.5) of the Chapter are discussed and the findings are situated within the broader thesis.

Section 3.1.2 – Chapter Background

This Chapter draws upon, and adds to, several areas introduced in the previous chapter. These areas will be briefly recapped here.

Compliance with instructions for medication-taking is associated with several identified factors, including age, patient-physician relationship, beliefs about medications, misconceptions about disease conditions, experience and management of side-effects, and individual personality traits (Foot *et al* 2016; Aslani & Schneider 2014; Axelsson 2013). The National Health Service (NHS) website (National Health Service 2019 np) informs the public that "taking antibiotics when you don't need them puts you and your family at risk of a longer and more severe illness", and highlights that it is "essential to take antibiotics as prescribed by your healthcare professional". Meta-analyses of adherence to medication for example have shown that individuals believing that the medication is necessary for their health are more likely to follow medication-taking instructions, while individuals that have strong concerns about the medication such as beliefs about side-effects are less likely to follow instructions (Foot *et al* 2016; Aslani & Schneider 2014; Axelsson 2013; Horne *et al* 2013). In the Wellcome Monitor survey, 60% of respondents that reported not taking their antibiotics as

prescribed said it was because they felt better with 25% saying that it was because they experienced side-effects (Ipsos MORI 2016a). These examples highlight specific facets of the issues raised in Chapter 2 around the overlapping roles of individuals' perceptions, behaviours, and perceptions of behaviours, for example in the context of patient/physician miscommunication.

Higher individual knowledge levels about antibiotics and antibiotic resistance have been found to correlate inconsistently with behavioural outcomes. Knowledge about antibiotics and antibiotic resistance has been associated with good stewardship attitudes and behaviours (Kim *et al* 2011; Jamhour *et al* 2017; Horvat *et al* 2017; Vallin *et al* 2016; Chan *et al* 2012; McNulty *et al* 2007a) as well as with negative behaviours such as self-medication or retaining leftovers (McNulty *et al* 2007a; Pan *et al* 2012). The relationships between knowledge, attitudes, and behaviour around antibiotics are key areas of interest for interventions aiming to improve antibiotic stewardship in the community (MacParland *et al* 2018; Price *et al* 2018), and this interest is addressed in this study by examining associations between specific areas of prior knowledge and attitudes towards prescription compliance.

A key mechanism of action in AMR public health interventions is the raising of public awareness through education (MacParland *et al* 2018). This occurs through the provision of information about consequences of inappropriate antibiotic use alongside information about how to take antibiotics appropriately and, commonly, the use of credible professional sources for intervention implementation. Interventions have had mixed results when targeting the general public, and it has been argued that in addition to improving public understanding of appropriate antimicrobial use, interventions should promote the role of the public in addressing AMR and its risks for individuals, their loved ones, and the wider population (Price *et al* 2018).

One aspect of the association between knowledge, attitudes, and behaviours is the information sources used by the public for health-related information. The Internet provides a variety of sources with a high and growing prevalence of use across a range of health scenarios, with studies in varied health contexts finding that the offline behaviour of consumers of online health information has been changed as a result of accessing online health information (Moreland *et al* 2015; Siliquini *et al* 2011; Couper *et al* 2010; Seçkin *et al* 2016). One example of the Internet being used to disseminate information about antibiotics is through social media, with previous studies finding that Twitter has experienced spikes in activity relating to antibiotics after national interventions and news announcements (Kendra *et al* 2015; Dyar *et al* 2014). This suggests that the Internet has potential as a communication tool in this health context. A recent study in an Italian region found that the Internet is being used by the public to address a lack of knowledge regarding antibiotic use, however these Internet users were suggested as being more likely to self-medicate with antibiotics (Zucco *et al* 2018). The authors of the Italian study argue that the key problem is not a lack of online information, but the quality of the information being consumed. This is a concern shared across health topics

(López-Jornet & Camacho-Alonso 2009; Lawrentschuk *et al* 2009; Scullard *et al* 2010; Ream *et al* 2009; Patel & Cobourne 2015; Perzel *et al* 2017).

Political orientation has been suggested as a marker for underlying attitudes, values, and beliefs relating to health in prior survey studies (Subramanian *et al* 2009). Recent research has correlated individual-level political orientation with health (Subramanian *et al* 2009; Huijts *et al* 2010) and health-related attitudes and behaviours (Boeuf 2019; Filippidis *et al* 2017; Chan 2019; Başlevent & Maran 2015), and research in political psychology has argued that politically left- and right-orientated individuals have substantively different thought styles with liberal/leftist and conservative/rightist political ideologies tending to be associated with differing psychological needs (Talhelm *et al* 2015; Jost *et al* 2018). Conservative ideology for example has been positively associated in meta-analyses with uncertainty avoidance and intolerance for ambiguity (Jost *et al* 2018), traits that have also been associated with higher national levels of antibiotic consumption using Hofstede's Uncertainty Avoidance national-level cultural dimension (Deschepper *et al* 2008). Individuals with different political orientations may think about health issues differently with possibly different attitudinal or behavioural outcomes such as compliance with antibiotic prescription instructions, and these differences may impact upon the effectiveness of public health interventions' framings. Consequently, this area was examined in this study as both a substantive and methodological interest.

Surveys are widely used to examine attitudes and behaviours with regards to antibiotic consumption. Faster and lower-cost nonprobability sampling methods that are reliant on self-selection and lack specifiable probabilities of selection for each included observation are becoming increasingly popular (Baker *et al* 2013; Stern *et al* 2014) and have been used in the study of antibiotic use (Jamhour *et al* 2017; Chan *et al* 2012; Stallwood *et al* 2019). While respondents in a nonprobability sample may be demographically identically distributed to a probability sample, they are not necessarily attitudinally or behaviourally identical (Gittelman *et al* 2015). An important consideration for survey research is the behaviour of respondents, for example their motivation and willingness to provide good-quality data and the level of correlation between participation itself and attitudinal or behavioural outcomes of interest. Section 3.4 examines whether survey respondent cooperation is an issue for the measurement of attitudes towards prescription compliance through the analysis of a random probability survey sample (in which nonresponse can be specifically adjusted for) with a survey-interviewer recorded variable for respondent cooperation.

Section 3.1.3 – Chapter Findings

The key chapter findings are divided into five areas.

Firstly, there are some consistent demographic associations in these analyses. Older respondents and female respondents were more likely to exhibit better stewardship behaviours, and levels of education

were consistently associated positively with knowledge levels but not with behaviour-related outcomes.

Secondly, members of the public who use and trust online sources of health information are more likely to be knowledgeable about and responsible with antibiotics. This could be due to the dissemination of information through online health-related sources having a positive effect on public knowledge and behaviour, however it could also be the case that respondents who use and trust online sources of health information happen to be more knowledgeable about and better stewards of antibiotics. These suggestions are not mutually exclusive.

Thirdly, regional and local geography matters for the analysis of public antibiotic stewardship in the UK.

Fourthly, political orientation may represent a marker for underlying attitudes and beliefs that relate to stewardship attitudes.

Finally, the characteristics of the data collection mode and respondents' interactions with said mode correlate with stewardship attitudes represented in the data.

These findings are discussed in the context of the thesis' overall research project, and in particular the design of the primary survey research, in each the 'Section Conclusions' of each analysis section in this Chapter (Sections 3.3.4 and 3.4.5), and these conclusions are drawn together in the concluding section of the Chapter (Section 3.5.2).

Section 3.2 – Data Sources

The data for this chapter were drawn from the Wellcome Trust Monitor Wave 3 (herein the 'Monitor') conducted by Ipsos MORI (2016b) in 2015, and Eurobarometers 85.1 (European Commission and European Parliament 2016) and 90.1 (European Commission and European Parliament 2018) conducted by TNS Opinion for the European Commission in 2016 and 2018. These random probability sample surveys collected data on multiple areas relevant to AMR, including knowledge, attitude, and behaviour regarding antibiotics, as well as data on use of or trust in the Internet as a source of health-related information. The analyses in this Chapter are the first time that these datasets have been used in a study like this, characterising antibiotic-related attitudes and behaviours and exploring new variables of interest through random-probability survey samples.

The Monitor tracks changes over time in public views on science and biomedical research. The Monitor used a stratified sample in a random probability methodology to generate a representative sample of UK adults living in private residential accommodation, who were then surveyed using face-to-face interviews between 2nd June and 1st November 2015 (Ipsos MORI 2016c). The completed Monitor sample includes 1,524 cases.

The Eurobarometer series of surveys was established in 1974 to monitor the evolution of public opinion in EU Member States. The Eurobarometer uses a stratified sample in a random probability methodology to sample approximately 1000 resident individuals aged 15 or over in each EU Member State, who are surveyed using face-to-face interviews. Fieldwork for Eurobarometer 85.1 was conducted between 9th April 2016 and 18th April 2016 and for Eurobarometer 2018 between 8th September 2018 and 26th September 2018. The completed UK segment of the Eurobarometer sample includes 1330 respondents for 85.1 and 1000 for 90.1.

The datasets differed on the weighting procedures used. The Monitor data was weighted to adjust for selection probabilities, non-response, and calibration with UK population totals by age, sex, and region (Ipsos MORI 2016c). The Eurobarometer supplied non-response weights based on age, sex, and regional characteristics (European Commission and European Parliament 2016). Design weights were not made available for the Eurobarometer data.

Section 3.3 – Socio-Economics, Online Health Information, and the Public's Knowledge, Attitudes, and Behaviours Regarding Antibiotics: Comparative Analysis of Two Cross-Sectional Random Probability Samples

The aim of this section is to provide a baseline set of analyses using commonly analysed socio-economic and demographic variables, and variables concerning the use of online health information, describing and analyses the patterning of knowledge and behavioural outcomes in two different random probability survey samples.

Section 3.3.1 – Analysis Approach

Cross-sectional multiple regression analyses were performed using binary logistic and ordinal logistic regression to investigate which independent variables influenced Internet use and trust, knowledge about antibiotics, knowledge about antibiotic resistance, and behaviour/attitudes regarding antibiotic use. The independent variable specifications were designed to resemble one another across datasets as closely as possible. To this end all models included the socio-demographic characteristics of age, sex, education, and employment type. Whether or not the respondent had been prescribed antibiotics in the past year was included in all models except the Monitor behaviour model.

In the models using Monitor data, the information source variables were whether the respondent reported using a hospital or doctor as a source of medical research information, and whether the respondent reported using at least one online source to seek medical research information including among the options NHS-run websites, search engines, and social media. In models using

Eurobarometer data, the information source variables were whether the respondent reported trusting at least one type of healthcare professional as a source of information about antibiotics, and whether the respondent reported trusting at least one online source of information about antibiotics including official health websites, other health-related websites, health-related blogs, or social media. The specification of the Internet-related variables is therefore of a set of potential sources with the common characteristic of requiring use of the Internet. Binary logistic regression was used to characterise the Internet-related variables in terms of age, sex, education, and employment variables in order to inform later conclusions drawn from models assessing antibiotic-related dependent variables.

Knowledge about Antibiotics

The variables accounting for respondents' knowledge about antibiotics were constructed differently in each dataset.

For the Wellcome Monitor sample, the antibiotic-related knowledge variable was derived from a question that asked respondents which of a series of options could be treated effectively by antibiotics. The options were viral infections, fungal infections, bacterial infections, colds, flu, and allergic reactions. The variable was constructed by subtracting for each respondent the mentions of any options other than bacterial, and adding any mention of bacteria. Any respondent that correctly answered that antibiotics only effectively treat bacterial infections had a score of 1, and respondents that responded with other options had scores <1 depending on how many incorrect responses they provided. The lowest score was -5.

For the Eurobarometer sample, the antibiotic knowledge variable is derived from a set of four true/false statement questions. The statements were "Antibiotics kill viruses", "Antibiotics are effective against colds and flu", "Unnecessary use of antibiotics makes them become ineffective", and "Taking antibiotics often has side-effects such as diarrhoea". Respondents' scores on this variable were constructed by summing correct responses, with a range from 0 (no correct responses) to 4.

These variables were used as dependent variables in ordinal regression models predicting characteristics of better knowledge levels regarding antibiotics, and as independent variables in logistic regression models predicting appropriate behaviour or attitudes regarding antibiotic use.

Knowledge about Antibiotic Resistance

This variable was only constructed for the Monitor, as there was no equivalent question in the Eurobarometer. The variable was derived from an open question in the Monitor, which asked respondents to define the term 'antibiotic resistance'. The ad verbatim responses for this question were coded into 27 items by Monitor researchers. Respondents' scores on this variable were

constructed by summing correct responses and subtracting incorrect responses. This created a range of scores from -3 to 3. Due to low numbers of respondents on the two lowest scores, the categories were condensed from seven categories to four by combining -3 and -2, -1 and 0, and 1 and 2.

This variable was used as a dependent variable for an ordinal regression model predicting knowledge about antibiotic resistance, and as an independent variable in a logistic regression model predicting appropriate behaviour with antibiotics.

Behaviour and Attitudes Regarding Antibiotics

The variables accounting for behaviour and attitudes to antibiotics were constructed differently in the two datasets due to different questions being asked in the surveys.

The Monitor asked respondents questions about how they had behaved the last time they had taken antibiotics. The variable in this study was derived from a question that asked respondents what they did with their most recent antibiotic prescription. The variable was coded as a binary variable where 1 represented respondents that had been prescribed the antibiotics and had also taken the whole course (n=1259). Respondents that were currently taking antibiotics (n=9) or had stopped taking them due to an adverse reaction (n=7) were excluded from the variable. Due to the low number of cases reporting not completing their course of antibiotics (n=93), the behaviour score was constructed such that the base represented respondents that had taken prescribed antibiotics inappropriately, had self-medicated, or had never taken antibiotics (n=249).

The Eurobarometer only asked respondents who had taken antibiotics in the past year how they had acquired the antibiotics. This reduced the available sample to the 472 cases that had consumed antibiotics in the past year. Out of these cases, 138 had been administered by a medical practitioner, and 314 were from a medical prescription. A response variable based on these data would therefore present a large reduction in sample size compared to the other models' response variables in this analysis. The Eurobarometer also asked respondents when they thought it was appropriate to cease taking a course of antibiotics. The behaviour outcome variable was derived from this attitude question, with respondents answering that one should cease taking a course of antibiotics once it has been completed (n=1179/1330) being represented by 1.

These variables were used as dependent variables in models predicting appropriate behaviour or attitude.

Section 3.3.2 – Results

Key Sample Characteristics

The key characteristics of the two samples for this study are presented in Table 2. The education variables used were not directly comparable, as the Monitor collected data on highest educational qualifications, whilst the Eurobarometer collected data on the age at which respondents left education. A weighted t-test comparison of age in each sample ($t=-6.08$, $p<0.001$) suggested a significant difference between the datasets at a 95% level of confidence. The weighted quartiles for age in each sample were similar (Monitor: 25%=32, 50%=47, 75%=63, Eurobarometer: 25%=31, 50%=45, 75%=62), and the average of the quartile cut-offs (25%=32, 50%=46, 75%=63) was used to create identical categories for age in each dataset. A weighted chi-square comparison of quartile membership ($\chi^2=5.62$, dF=3, $p=0.132$) did not reject the null hypothesis that there was no difference between the two datasets in this regard. A weighted chi-square comparison of sex ($\chi^2= 0.04$, dF=1, $p=0.83$) showed no significant difference between the two datasets. Furthermore, no significant difference was found between the numbers of respondents that reported having been prescribed antibiotics for in the past 12 months ($\chi^2=0.04$, dF=1, $p=0.849$). A significant difference was demonstrated between the datasets on the employment variable ($\chi^2=384.73$, dF=2, $p<0.001$).

In the Monitor sample, 13% of respondents reported using a hospital or doctor to actively seek medical research information, with 35% reporting using the Internet for this purpose. In the Eurobarometer 92% of respondents reported trust in healthcare professionals as a source of information about antibiotics, with 17% trusting the Internet for information about antibiotics.

Table 2. Characteristics of the data.

	Wellcome Monitor			**Eurobarometer**		
	Variable	**n**	**%**	**Variable**	**n**	**%**
Age	**18-31**	301	19.75	**15-31**	234	17.59
	32-45	332	21.78	**32-45**	281	21.13
	46-62	411	26.97	**46-62**	324	24.36
	63+	465	30.51	**63+**	491	36.92
Sex	**Male**	695	45.60	**Male**	632	47.52
	Female	829	54.40	**Female**	698	52.48
Education	**No Qualifications**	292	19.16	**Left Education 15-16**	636	47.82
	Level 1	98	6.43	**Left Education 17-18**	249	18.72

	GCSE	279	18.31	**Left Education 19-21**	161	12.11
	A-Level	234	15.35	**Left Education 22+**	196	14.74
	Other Higher	225	14.76	**Still Studying**	75	5.64
	First Degree	233	15.29			
	Postgraduate	150	9.84			
Employment Status	**Not Working**	106	6.96	**Not Working**	739	55.56
	Self-Employed	188	12.34	**Self-Employed**	89	6.69
	Employed	1216	79.79	**Employed**	502	37.74
Recent Antibiotic Consumption	**Prescribed Antibiotic in Past Year**	326	21.39	**Prescribed Antibiotics in Past Year**	314	23.61
Information Sources	**Use Hospital or Doctor for Seeking Medical Research Information**	194	12.73	**Trust Health Care Professionals for Information About Antibiotics**	1223	91.95
	Use Internet for Seeking Medical Research Information	531	34.84	**Trust the Internet for Information About Antibiotics**	230	17.29

Characteristics of Internet Variables

To initially contextualise the Internet variables used in this study, they were each regressed against the key socio-demographic variables used in the antibiotic-focussed models—specifically, age, gender, education, and employment. The results are presented in Table 3.

Table 3. Logistic regression analysis of Internet variables. Statistical significance denoted with asterisk. R^2 is Nagelkerke's Pseudo-R^2.

	Use of Internet (n=1486, R^2=0.182)				**Trust in Internet (n=1317, R^2=0.134)**		
	OR	**2.5% CI**	**97.5% CI**		**OR**	**2.5% CI**	**97.5% CI**
Ref: 18-31 (Male)				Ref: 15-31 (Male)			
32-45 (Male)	1.14	0.42	3.11	**32-45 (Male)**	1.29	0.38	4.36
46-62 (Male)	1.15	0.43	3.06	**46-62 (Male)**	3.98*	1.18	13.62

63+ (Male)	2.14	0.76	5.99	**63+ (Male)**	1.29	0.26	5.95
Female (18-31)	1.29	0.83	2.02	**Female (15-31)**	1.26	0.74	2.16
Ref: No qualifications				Ref: Left Education 15-16			
Level 1	1.95*	1.08	3.50	**Left Education 17-18**	1.51	0.98	2.31
GSCE	2.12*	1.34	3.40	**Left Education 19-21**	2.21*	1.41	3.46
A-Level	3.67*	2.33	5.87	**Left Education 22+**	3.25*	2.15	4.93
Other Higher	4.52*	2.87	7.26	**Still Studying**	3.36*	1.76	6.45
First Degree	5.74*	3.67	9.18				
Postgraduate	9.08*	5.58	15.10				
Ref: Unemployed				Ref: Unemployed			
Self-Employed	1.22	0.71	2.12	**Self-Employed**	0.78	0.42	1.40
Employed	0.99	0.62	1.59	**Employed**	0.95	0.65	1.39
32-45 (Female)	1.01	0.54	1.89	**32-45 (Female)**	1.26	0.61	2.64
46-62 (Female)	0.82	0.44	1.52	**46-62 (Female)**	0.61	0.29	1.29
63+ (Female)	0.48*	0.25	0.92	**63+ (Female)**	0.64	0.25	1.66

Both the use of the Internet for medical research information and trust in the Internet as a source of information about antibiotics were positively and confidently associated with education levels. From the Monitor data, education effect sizes increased with each extra level of education from Level 1 through to Postgraduate (OR=1.95, 95% CI=1.08-3.50; OR=2.12, 95% CI=1.34-3.40; OR=3.67, 95% CI=2.33-5.87; OR=4.52, 95% CI=2.87-7.26; OR=5.74, 95% CI=3.67-9.18, OR=9.08, 95% CI=5.58-15.10). Based on the Eurobarometer data, respondents still in education presented the largest positive education association (OR=3.36, 95% CI=1.76-6.45). The respondents that left education between the ages of 19 and 21 (OR=2.21, 95% CI=1.41-3.46), and 22 years or older (OR=3.25, 95% CI=2.15-4.93), presented positive associations with trust in the Internet as a source of information about antibiotics with the older increment presenting a stronger association.

There was one age association presented in each model. From the Monitor data, 63+ year old females (OR=0.48, 95% CI=0.25-0.92) were suggested as being less likely to use the Internet to seek medical research information than the reference group of 18-31 year old females. In the Eurobarometer data, 46-62 year old males (OR=3.98, 95% CI=1.18-13.62) were suggested as being more likely to trust the Internet as a source of information.

In summary, the clearest trend from this pair of models is that respondents with more educational capital are more likely to use and trust online information in the context of health, whether that context be medical research or antibiotics.

Wellcome Monitor Models

The Monitor data was used to predict both knowledge about the efficacy of antibiotics and the concept of antibiotic resistance using ordinal response variables. The Monitor data was also used to predict responsible behaviour with a binary response. The results of the knowledge models are presented in Table 4.

Table 4. Ordinal regression analysis of Monitor knowledge variables. Statistical significance denoted with asterisks. R^2 is Nagelkerke's Pseudo-R^2.

	Antibiotic Efficacy Knowledge (n=1332, R^2=0.473)			**Antibiotic Resistance Knowledge (n=1225, R^2=0.217)**		
	OR	**2.5% CI**	**97.5% CI**	**OR**	**2.5% CI**	**97.5% CI**
Ref: 18-31 (Male)						
32-45 (Male)	1.57	0.66	3.76	0.33*	0.12	0.92
46-62 (Male)	3.70*	1.50	9.15	0.91	0.33	2.54
63+ (Male)	2.04	0.77	5.43	0.65	0.20	2.03
Female (18-31)	1.76*	1.21	2.57	1.19	0.77	1.84
Ref: No Qualifications						
Level 1	1.13	0.70	1.81	1.45	0.82	2.54
GSCE	2.31*	1.62	3.31	1.51	0.98	2.35
A-Level	1.85*	1.28	2.67	0.91	0.57	1.45
Other Higher	2.75*	1.89	4.00	1.45	0.93	2.27
First Degree	3.09*	2.11	4.52	1.72*	1.10	2.69
Postgraduate	2.95*	1.93	4.52	2.00*	1.23	3.27
Ref: Unemployed						
Self-Employed	1.00	0.61	1.65	1.38	0.76	2.55
Employed	0.96	0.62	1.46	1.22	0.73	2.09
Prescribed Antibiotic in Past Year	0.90	0.70	1.14	0.85	0.64	1.12
Use Hospital or Doctor for Medical Research Information	0.96	0.70	1.33	0.92	0.64	1.33

Use Internet for Medical Research Information	1.37*	1.08	1.74	1.32*	1.01	1.73
32-45 (Female)	0.97	0.56	1.66	1.59	0.84	2.98
46-62 (Female)	0.70	0.40	1.22	1.07	0.57	2.03
63+ (Female)	1.05	0.58	1.92	1.18	0.59	2.39

The model predicting knowledge about antibiotics' efficacy presented multiple significant independent sociodemographic associations, as well as an independent association for use of the Internet. Age and sex were interacted in the model, and there was a strong positive association presented between 46-62 year old males (OR=3.70, 95% CI=1.50-9.15) and knowledge regarding the efficacy of antibiotics, and a weaker positive association presented for 18-31 year old females (OR=1.76, 95% CI=1.21-2.57) compared to the equivalent age group of males. Every level of education from GCSE upwards was positively associated with better knowledge about antibiotics' efficacy, though the effect size did not increase directly with each increment of education. The effect size for A-levels (OR=1.85, 95% CI=1.28-2.67) was lower than GCSE (OR=2.31, 95% CI=1.62-3.31), Other Higher (OR=2.75, 95% CI=1.89-4.00), and First Degree (OR=3.09, 95% CI=2.11-4.52). The effect size for postgraduate qualification (OR=2.95, 95% CI=1.93-4.52) was also smaller than First Degree, with wider confidence intervals. Use of the Internet to actively seek medical research information (OR=1.37, 95% CI=1.08-1.74) was positively associated with better knowledge regarding antibiotics' efficacy, with a smaller effect size than the significant levels of education. Having been prescribed antibiotics in the previous year (OR=0.90, 95% CI=0.70-1.14) was not significantly associated with better knowledge about antibiotics' efficacy.

The model predicting correct definitions of antibiotic resistance presented fewer significant associations. The 32-45 year old male group (OR=0.33, 95% CI=0.12-0.92) was associated with worse knowledge about antibiotic resistance. First Degree (OR=1.72, 95% CI=1.10-2.69) and Postgraduate qualification (OR=2.00, 95% CI=1.23-3.27) were both positively associated with knowledge about antibiotic resistance. An independent positive association was presented between the use of the Internet for medical research information (OR=1.32, 95% CI=1.01-1.73) and knowledge about antibiotic resistance. The low confidence bound was close to an OR of 1, suggesting that this association may not be as pronounced as the association between Internet use for medical research information and knowledge about antibiotics' efficacy. The effect size was also smaller than any of the significant independent educational predictors. Having been prescribed antibiotics in the previous year (OR=0.85, 95% CI=0.64-1.12) was not significantly associated with better knowledge about antibiotic resistance.

The only clear commonalities between respondents' knowledge about antibiotics and antibiotic resistance are that respondents with higher educational capital and users of the Internet for health information were more likely to respond correctly than respondents with lower educational capital or who did not use or trust the Internet in this context. That these associations were both present independently in these models is noteworthy given the previously mentioned association between education levels and use of the Internet for health information.

The model predicting responsible behaviour, with results presented in Table 5, demonstrated socio-demographic and knowledge associations. Age and sex were not interacted in this model in order to maintain comparability with the equivalent Eurobarometer model, in which these variables were not interacted due to a relatively low number of cases presenting a poor stewardship attitude. In the Wellcome behaviour model, the 46-62 (OR=2.76, 95% CI=1.73-4.46) and over 62 (OR=1.65, 95% CI=1.04-2.63) year old age groups both presented independent positive associations with responsible behaviour, with the higher of the two age groups demonstrating a smaller effect size. Positive independent associations were also presented for female sex (OR=1.86, 95% CI=1.35-2.58) and being employed (OR=1.88, 95% CI=1.08-3.16). Better knowledge about the efficacy of antibiotics (OR=1.24, 95% CI=1.10-1.39) presented a positive association with more responsible antibiotic consumption, with precise confidence intervals relative to other predictors in the model. There was insufficient evidence to suggest that knowledge about antibiotic resistance (OR=1.13, 95% CI=0.97-1.32) was an independent predictor of behaviour with antibiotics. A positive association was presented between use of the Internet as a source of medical research information (OR=1.49, 95% CI=1.03-2.18) and appropriate behaviour with antibiotics however, there was no significant independent association presented in the model between responsible behaviour and the use of health professionals (OR=1.42, 95% CI=0.80-2.67) as a source for medical research information.

Table 5. Logistic regression analysis of Monitor behaviour variable. Statistical significance denoted with asterisks. R^2 is Nagelkerke's Pseudo-R^2.

	Antibiotic Behaviour (n=1335, R^2=0.319)		
	OR	**2.5% CI**	**97.5% CI**
Ref: 18-31			
32-45	1.43	0.93	2.23
46-62	2.76*	1.73	4.46
63+	1.65*	1.04	2.63
Female	1.86*	1.35	2.58
Ref: No qualifications			
Level 1	1.34	0.66	2.82

GSCE	0.78	0.46	1.32
A-Level	1.22	0.69	2.14
Other Higher	1.55	0.84	2.92
First Degree	1.68	0.92	3.09
Postgraduate	1.51	0.78	2.99
Ref: Unemployed			
Self-Employed	1.43	0.74	2.77
Employed	1.88*	1.08	3.16
Knowledge about Antibiotics	1.24*	1.10	1.39
Knowledge about Antibiotic Resistance	1.13	0.97	1.32
Use Hospital or Doctor for Medical Research Information	1.42	0.80	2.67
Use Internet for Medical Research Information	1.49*	1.03	2.18

Use of the Internet to look up medical research information was a positive commonality between the knowledge and behaviour models. A distinction between them is the lack of independent educational association in the behaviour model.

Eurobarometer Models

The Eurobarometer data was used to predict knowledge about antibiotics with an ordinal response, and appropriate attitude towards antibiotic consumption with a binary response.

The model predicting knowledge about antibiotics, with results shown in Table 6, presented positive associations with knowledge for both self-employment (OR=1.73, 95% CI=1.12-2.70) and employment (OR=1.37, 95% CI=1.05-1.79). Having been prescribed antibiotics in the previous year (OR=1.21, 95% CI=0.95-1.54) was not significantly associated with better knowledge. The only significant age and gender association was positive for the 63+ male group (OR=2.60, 95% CI=1.03-6.60) with wide confidence intervals. Respondents that left education between the ages of 17 and 18 (OR=1.39, 95% CI=1.05-1.86), and above the age of 22 (OR=1.87, 95% CI=1.35-2.60), were positively associated with knowledge about antibiotics. Trust in the Internet as a source of knowledge about antibiotics (OR=1.66, 95% CI=1.26-2.19) was positively associated with correct knowledge about antibiotics, whilst trust in health care professionals as a source of knowledge about antibiotics (OR=0.61, 95% CI=0.41-0.90) was negatively associated with correct knowledge about antibiotics.

Table 6. Ordinal regression analysis of Eurobarometer knowledge variable. Statistical significance denoted with asterisks. R^2 is Nagelkerke's Pseudo-R^2.

	Antibiotic Knowledge (n=1317, R^2=0.172)		
	OR	**2.5% CI**	**97.5% CI**
Ref: 15-31 (Male)			
32-45 (Male)	1.11	0.45	2.74
46-62 (Male)	1.80	0.73	4.42
63+ (Male)	2.60*	1.03	6.60
Female (15-31)	1.26	0.86	1.85
Ref: Left Education 15-16			
Left Education 17-18	1.39*	1.05	1.86
Left Education 19-21	1.28	0.93	1.78
Left Education 22+	1.87*	1.35	2.60
Still Studying	1.46	0.92	2.32
Ref: Unemployed			
Self-Employed	1.73*	1.12	2.70
Employed	1.37*	1.05	1.79
Prescribed Antibiotics in Past Year	1.21	0.95	1.54
Trust Health Care Professional	0.61*	0.41	0.90
Trust the Internet	1.66*	1.26	2.19
32-45 (Female)	1.65	0.94	2.90
46-62 (Female)	1.66	0.95	2.90
63+ (Female)	1.28	0.74	2.24

The model predicting better attitude towards antibiotic consumption, results shown in Table 7, presented socio-demographic and knowledge associations. Due to the low number of cases presenting poor attitudes (n=151/1330), age and sex were not interacted in this model. Each age group presented a positive association with attitude (OR=1.81, 95% CI=1.10-2.99; OR=2.17, 95% CI=1.28-3.72; OR=5.43, 95% CI=2.87-10.47), with higher age groups showing larger effect sizes. Being employed (OR=1.88, 95% CI=1.16-3.03) and having been prescribed antibiotics in the past year (OR=1.75, 95% CI=1.11-2.84) were both independently positively associated with attitude, as was levels of antibiotic-related knowledge (OR=2.17, 95% CI=1.85-2.57). There were no significant associations between education and attitude towards finishing a course of antibiotics (OR=1.60, 95% CI=0.93-2.80; OR=1.10, 95% CI=0.63-1.97; OR=0.63, 95% CI=0.37-1.07; OR=1.98, 95% CI=0.98-4.04). Trust in the Internet as a source of information about antibiotics (OR=3.59, 95% CI=1.98-6.95) presented a

strong positive association with attitude with a wide confidence interval. This suggests that trust in the Internet has a stronger association than either levels of education or trust in healthcare professionals with good attitudes towards antibiotic use.

Table 7. Logistic regression analysis of Eurobarometer attitude variable. Statistical significance denoted by asterisks. R^2 is Nagelkerke's Pseudo-R^2.

	Attitude Towards Finishing Course (n=1317, R^2=0.284)		
	OR	**2.5% CI**	**97.5% CI**
Ref: 15-31			
32-45	1.81*	1.10	2.99
46-62	2.17*	1.28	3.72
63+	5.43*	2.87	10.47
Female	1.35	0.95	1.94
Ref: Left Education 15-16			
Left Education 17-18	1.60	0.93	2.80
Left Education 19-21	1.10	0.63	1.97
Left Education 22+	0.63	0.37	1.07
Still Studying	1.98	0.98	4.04
Ref: Unemployed			
Self-Employed	0.58	0.30	1.12
Employed	1.88*	1.16	3.03
Prescribed Antibiotics in Past Year	1.75*	1.11	2.84
Knowledge about Antibiotics	2.17*	1.85	2.57
Trust Health Care Professional	1.97	0.99	3.76
Trust Internet	3.59*	1.98	6.95

There are commonalities between these Eurobarometer models and the Monitor models, for example with the Internet-related predictor presenting positive associations with knowledge and behaviour whilst significant educational associations were only present in the knowledge model.

Section 3.3.3 – Discussion

This section analysed two random-probability sample surveys in order to assess the association between respondents' socio-economic characteristics, use of the Internet as a source of health-related information, and the public's knowledge relating to antibiotics and antibiotic resistance, and behaviour and attitudes regarding antibiotic consumption. This is an important first piece of analysis

for this thesis, as it presents a benchmark for key respondent characteristics that have been associated in the literature with one or both of antibiotic-related variables and pet-ownership.

Knowledge about antibiotics was positively and independently associated with both behaviour and attitude. This supports previous findings that higher levels of knowledge about antibiotics are associated with more responsible consumption of antibiotics (Kim *et al* 2011; Horvat *et al* 2017; Vallin *et al* 2016; Chan *et al* 2012) and more appropriate attitudes towards consumption (Chan *et al* 2012; McNulty *et al* 2007a), whilst diverging from studies that suggest that better knowledge about antibiotics is associated with less responsible behaviour (McNulty *et al* 2007a; Shehadeh *et al* 2012; Pan *et al* 2012)

In both the Monitor and Eurobarometer analyses the Internet variables presented positive independent associations with knowledge about antibiotics. The consistency between datasets of these positive independent associations with knowledge about antibiotics suggests that the Internet may be a productive space through which such knowledge is being disseminated in the UK. Both Internet variables also presented positive independent associations with respective behaviour and attitude variables. These findings are particularly significant considering the lack of positive independent associations presented by healthcare professional information variables. Furthermore, the consistency of evidence for associations between behaviour/attitude and Internet variables in the absence of evidence for an independent education association suggests that preferred sources of information may be more important than level of education for the formation of attitudes and behaviours regarding antibiotic use. Despite this consistency, these data are not able to provide clear rationales for these associations. For example, are these Internet users substituting or supplementing healthcare professionals with this information? Frequency of use was also not measured, so it is not possible to distinguish for example between those respondents that may supplement information obtained after an appointment with a healthcare professional, and those who habitually make use of the Internet as a first resort.

This analysis suggests that, independent of key characteristics such as education level and age, members of the UK public that use online sources of health-related information are more likely to be better informed about antibiotics and use them more appropriately than those that do not make use of online sources of health-related information. This diverges from a recent Italian study (Zucco *et al* 2018) of Internet use for antibiotic-related information seeking that reported users of the Internet for health-related information as less informed, suggesting geographic differences in the association between Internet use and antibiotic-related knowledge and behaviour. Whilst the publics in these countries may be using the Internet to supplement information from healthcare professionals (Zucco *et al* 2018; Bianco *et al* 2013), differences in online information provision by key stakeholders such as national health services may produce different outcomes in different geographic settings with regards

to knowledge and behaviour regarding antibiotics. This point is supported by previous evidence that exposure to health information websites can improve knowledge about antibiotic use and AMR (Madle *et al* 2004) and that offline health behaviours are liable to change because of online information (Moreland *et al* 2015; Siliquini *et al* 2011; Couper *et al* 2010; Seçkin *et al* 2016). The findings of this study, which suggest that the Internet is a viable media for the dissemination of quality information to improve behaviour with antibiotics, reinforce recommendations that health professionals should be trained to use online services such as social media to improve the dissemination of information to patients that may exhibit confusion or share misinformation through online channels (Scanfeld *et al* 2010), and that publicity campaigns should harness the public's willingness to discuss AMR, again for example on online social media platforms, in order to produce sustained and informative dialogue (Kendra *et al* 2015; Dyar *et al* 2014).

As it is an increasingly prevalent source of health information, use of the Internet for health-related information will be considered both as a control variable in further quantitative aspects of this thesis, and will be explored as a substantive area of interest. An intervention that could arise from this deeper examination of the public's use of and trust in the Internet in the context of antimicrobial stewardship is increased and targeted use of information prescriptions in both human and veterinary medical settings (Kogan *et al* 2014) given the evidence of public willingness to use online sources of health-related information.

Finally, this section also presents consistent positive associations between education levels and better knowledge about antibiotics and issues around antibiotic use, converging with literature that suggests a positive association between education levels and correct knowledge (McNulty *et al* 2007b; Pavydė *et al* 2015; Kim *et al* 2011; Horvat *et al* 2017; Vallin *et al* 2016; Hoffman *et al* 2013; Napolitano *et al* 2013; You *et al* 2013). Whilst increasing levels of education did not always demonstrate larger effects than preceding levels, university levels of education did have larger effect sizes than non-university levels of education. Associations between age and sex, and knowledge about antibiotics, were less conclusive in this analysis and the analysis of the datasets in this study does not clearly support trends in either area. Conversely, in both behaviour/attitude models there were positive associations presented between some age groups and the response variables but none for education. Older respondents were more likely to report more responsible behaviours and attitudes, contradicting previous literature that suggests that older age is associated with less responsible consumption or attitudes (Kim *et al* 2011; Pan *et al* 2012), supporting the suggestion that older age is associated particularly with better attitude towards consumption (Napolitano *et al* 2013; Kardas *et al* 2007; Pechère *et al* 2007). In summary, this analysis has suggested that higher levels of education tended to be associated with better knowledge whilst older age tended to be associated with better stewardship.

Limitations and Strengths

Interpretation of these findings should consider some limitations of this analysis. Firstly, the datasets used were both cross-sectional in design which limits the discussion of causal links between response and predictors in the models used. Secondly, as with any survey there is the possibility of the reporting of socially desirable behaviours by participants unwilling to report their own socially undesirable behaviours. The anonymization of the individual data in both datasets is a mitigating factor for such bias.

A strength of this analysis is the use of two comparable but not identical datasets, with differing constructions of knowledge about antibiotics producing similar findings regarding the association between education levels and knowledge about antibiotics. A second strength is the use of different angles on the role of the Internet for health information, suggesting that the use of and trust in the Internet for health-related information is positively associated in the UK with knowledge about antibiotics and antibiotic resistance.

Section 3.3.4 – Section Conclusions

The positive independent associations found in both datasets between Internet variables and both knowledge and behaviour/attitude suggest that people in the UK who use the Internet for health-related information are more likely to be better informed about and be more responsible with antibiotic medication than people that do not. This may have implications for the use of an online panel survey sample for the primary quantitative aspect of this thesis. For example, people more comfortable using the Internet may be biased towards better stewardship and knowledge regarding antibiotics, rather than there being a specifically positive causal link between information on the Internet and these knowledge and behaviours. To expand upon this in the primary survey, multiple types of Internet-related questions will be employed, and the relationship between levels of panel participation and survey outcomes will be examined prior to the main data analysis.

Finally, this section presents some general trends against which to compare the nonprobability sample used in Chapter 5. In particular, older age tended to be associated with better stewardship whilst higher levels of education were associated with better knowledge. Additionally, respondents who reported use of or trust in the Internet tended also to have greater educational capital, and knowledge about antibiotics also tended to be associated with better stewardship.

Section 3.4 – Demographic, Social, and Geographic Predictors of Incompliant Attitudes Towards Prescription Completion: Relative Importance and Patterning in a Multi-Year Random Probability Sample

The aim of this section is to expand the previous analyses to include geographic and attitudinal variables not considered in the literature and examine their relative importance in explaining respondents' attitudes towards compliance with prescription instructions, with the aim of informing the design and analysis of this research's primary survey.

Section 3.4.1 – Analysis Approach

This section uses the two waves of the Eurobarometer mentioned in 4.2. The combined 2016 and 2018 UK Eurobarometer samples contain 2330 observations. As model comparison was the specific aim of this analysis, rows with missing values on candidate variables were excluded so that each candidate model would be analysing identical samples. The final subset contained 2016 cases. Supplied nonresponse weights incorporating sex, age, NUTS2 regions, and size of locality, were used in the analysis (European Commission and European Parliament 2016; European Commission and European Parliament 2018).

As with the Eurobarometer behavioural attitude model in the previous analysis, the dependent variable for logistic regression in this section was based on the question "When do you think you should stop taking antibiotics once you have begun a course of treatment?". The response was binary coded with the base as "When you have taken all of the antibiotics as directed by your doctor", and the contrast as "When you feel better", "Other", and "Don't Know". The independent variable representing political orientation in this analysis was measured in the survey by self-placement on a 10-point scale from Left to Right and condensed for this study to five categories (1-2 = Left, 3-4 = Centre-Left, 5-6 = Centre, 7-8 = Centre-Right, 9-10 = Right).

Model and variable selection was undertaken using the package *glmulti* (Calcagno 2019) in RStudio by building a set of unique models from a list of explanatory variables. 20 candidate predictor variables were chosen from the Eurobarometer dataset based on the literature and analyses of the previous section and fitted in combinations using the function 'glmulti'. For computational reasons owing to the large number of potential candidate models produced by 20 candidate variables, these variables were fitted using a genetic rather than exhaustive algorithm and with no interaction terms. Candidate models were therefore constrained to any unique combination of the 20 candidate predictors as non-interacting terms. The best 100 models based on lowness of Akaike Information Criterion (AIC) were stored and used to determine the best-fitting model (model with lowest AIC

(Burnham & Anderson 2004), AIC_{min}) and relative importance of each candidate variable. These represent the best 100 explanations of the dependent variable based on the selected candidate variables, chosen Information Criterion, and the constraints described above.

By using an automated model selection process, this part of the analysis explores new candidate variables that are not established in the literature, and weigh their importance as cross-sectional explanatory variables relative to those that are established in the literature. The evidence from this section provides a basis for the selection of relevant control variables in the primary survey research of the thesis.

Section 3.4.2 – Comparing Variables' Relative Importance

The relative importance of the 20 candidate variables is presented in Figure 1 in terms of the summed Akaike weights of models in which the variable appears. Each model's Akaike weight is calculated as the relative likelihood of each model in the candidate set (for model i: $exp\ (-\frac{AIC_i - AIC_{min}}{2})$) divided by the summed relative likelihoods of all 100 candidate models, representing the probability that model i is the best model for the data in the set of specified models.

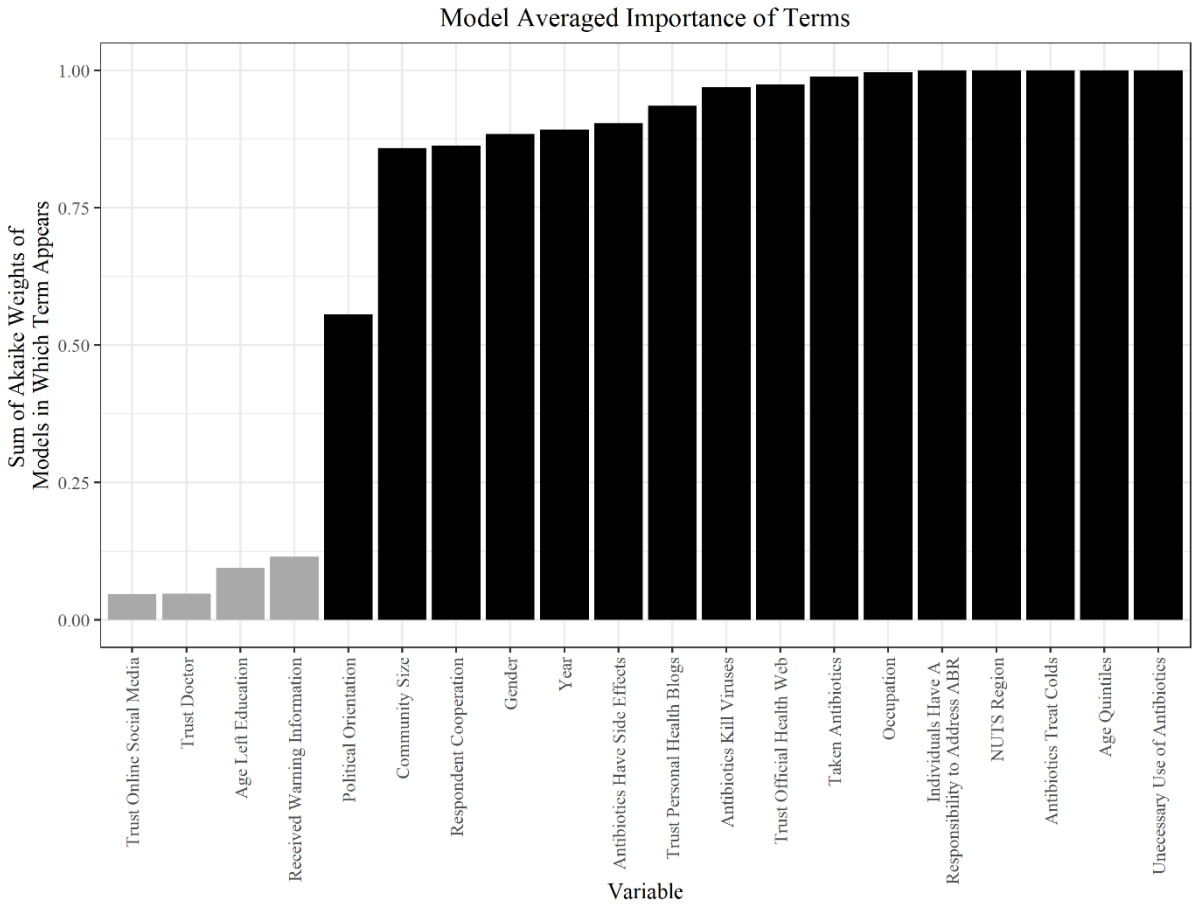

Figure 1. Model averaged importance of candidate variables, with those included in the best-fitting (AIC_{min}) regression model shaded black.

Regional and community geographies were consistently important in these 100 models for examining variation in attitudes towards prescription compliance, along with certain demographic characteristics, and respondents' cooperation with their survey interviewer. Antibiotic-related variables of importance were specific areas of knowledge about antibiotics and antibiotic resistance, respondents' perception of whether individuals have a role in addressing antibiotic resistance (ABR), and reporting trust in official health websites and personal blogs as source of information about antibiotics. Time spent in education, trust in either doctors or social media for information about antibiotics, the presence of children in the household, and recent reception of warning information about not taking antibiotics unnecessarily were rarely present in the best 100 models and consequently may be considered less important for explaining variation in compliance attitudes. The model with AIC_{min} was considered the best-fitting model and included 16 variables, which are shaded black in Figure 1.

Table 8. Results of best-fitting (AIC_{min}) multivariable regression model. Statistical significance denoted by asterisks. R^2 is Nagelkerke's Pseudo-R^2.

Attitude towards finishing antibiotic prescriptions (n=2016, R^2=0.289)	**OR**	**2.5% CL**	**97.5% CL**
Reference: Age 15-28			
Age 29-40	0.642*	0.413	0.995
Age 41-52	0.493*	0.303	0.794
Age 53-66	0.257*	0.144	0.444
Age 67+	0.221*	0.121	0.391
Reference: Large Urban			
Community Size = Small Urban	0.626*	0.417	0.945
Community Size = Rural	0.739	0.380	1.386
Reference: Not Working			
Self-Employed	2.034*	1.160	3.519
Employed	0.755	0.518	1.100
Reference: Excellent Cooperation			
Fair Cooperation	1.326	0.838	2.059
Average/Bad Cooperation	2.001*	1.108	3.526
Reference: East Midlands			
London	2.358*	1.100	5.398
East of England	0.643	0.193	1.918
North East England	0.151*	0.010	0.818
North West England	2.130	0.947	5.033
Northern Ireland	1.018	0.450	2.415
Scotland	2.418*	1.083	5.693
South East England	1.357	0.604	3.196
South West England	1.099	0.402	2.941
Wales	1.452	0.447	4.327
West Midlands	1.024	0.430	2.509
Yorkshire & The Humber	1.779	0.767	4.301
Reference: Centre			
Left	1.797*	1.010	3.115
Centre-Left	0.646*	0.409	0.998

Centre-Right	0.900	0.529	1.485
Right	0.712	0.271	1.642
Don't Know or Refuse	0.577	0.257	1.209
Reference: Female			
Male	1.479*	1.064	2.067
Reference: Antibiotics Not Taken in Past 12 Months on Prescription			
Antibiotics Taken in Past 12 Months on Prescription	0.692	0.470	1.004
Reference: 2016			
2018	0.863	0.723	1.028
Reference: Trust in Source Not Mentioned			
Trust Official Health Web for Information Mentioned	0.571*	0.332	0.941
Trust Personal Health Blog for Information Mentioned	0.160	0.003	1.203
Reference: Incorrect Response to Each Question			
Antibiotics Kill Viruses	0.644*	0.450	0.919
Antibiotics Can Treat Colds	0.412*	0.287	0.591
Unecessary Use of Antibiotics Can Make Them Ineffective	0.353*	0.230	0.544
Antibiotics Commonly Cause Side Effects	1.419*	1.014	1.999
Reference: Level at which ABR Should be Addressed is Other than Individual			
ABR Should be Addressed at the Individual or Family Level	1.839*	1.294	2.599

Section 3.4.3 – Results

220/2016 respondents – 11% of the sample – reported an attitude response other than taking antibiotics as directed by their doctor. The results of the multivariable AIC_{min} logistic regression model are presented in Table 8 with estimated odds ratios (ORs), and 95% confidence limits (CLs). Statistical significance was determined using CLs, with ORs where CLs did not include one considered significant at a 95% level of confidence.

Demographics

Incompliant attitudes towards doctors' instructions regarding antibiotics were associated with multiple demographic characteristics. Older members of the public were less likely to report an incompliant attitude towards doctors' instructions (Youngest to Oldest: OR = 0.642, CL=0.413-0.995; OR=0.493, CL=0.303-0.794; OR=0.257, CL=0.144-0.444; OR=0.221, CL=0.121-0.391). These results suggest that levels of compliance with antibiotic prescription instructions are higher among older members of the public, and that this association is clearer in the oldest quintiles compared to younger quintiles. Male (OR=1.479, CL=1.064-2.067) respondents were more likely to report an incompliant attitude than female respondents, whilst self-employed respondents (OR=2.036, CL=1.160-3.519) were more than twice as likely to report an incompliant attitude than respondents that were not in work. Respondents that had been prescribed antibiotics in the past 12 months (OR=0.692, CL=0.470-1.004) were not substantially different from respondents that had not. Alongside this, recent reception of warning information was a relatively unimportant variable in the model selection process which suggests that recency of contact with either a healthcare professional or intervention are substantially less important for explaining variation in compliance than other candidate variables included in this analysis.

Respondent Survey Cooperation

Respondents that were categorised as having average or bad cooperation during the survey interview (OR=2.001, CL=1.108-3.526) were twice as likely to report an incompliant attitude towards antibiotic prescription instructions than excellent cooperators. This suggests that members of the public that are less motivated to take part in surveys and provide good quality data are more likely to be individuals who exhibit poorer attitudes towards antibiotic stewardship, independent of other factors such as knowledge or age.

Geography

There is regional variation in the predicted probability of respondents reporting incompliant attitudes, shown in Figure 2. The smallest region size available in these data is NUTS1 level, with populations between three and seven million people.36 Respondents in North East England had the lowest and most precise probability of reporting an incompliant attitude and the probabilities associated with East

of England and South West England were also both relatively low and precise. Compared to the differences between most regions' means, which were relatively small, Londoners were substantially more likely to report an incompliant attitude despite wide CLs.

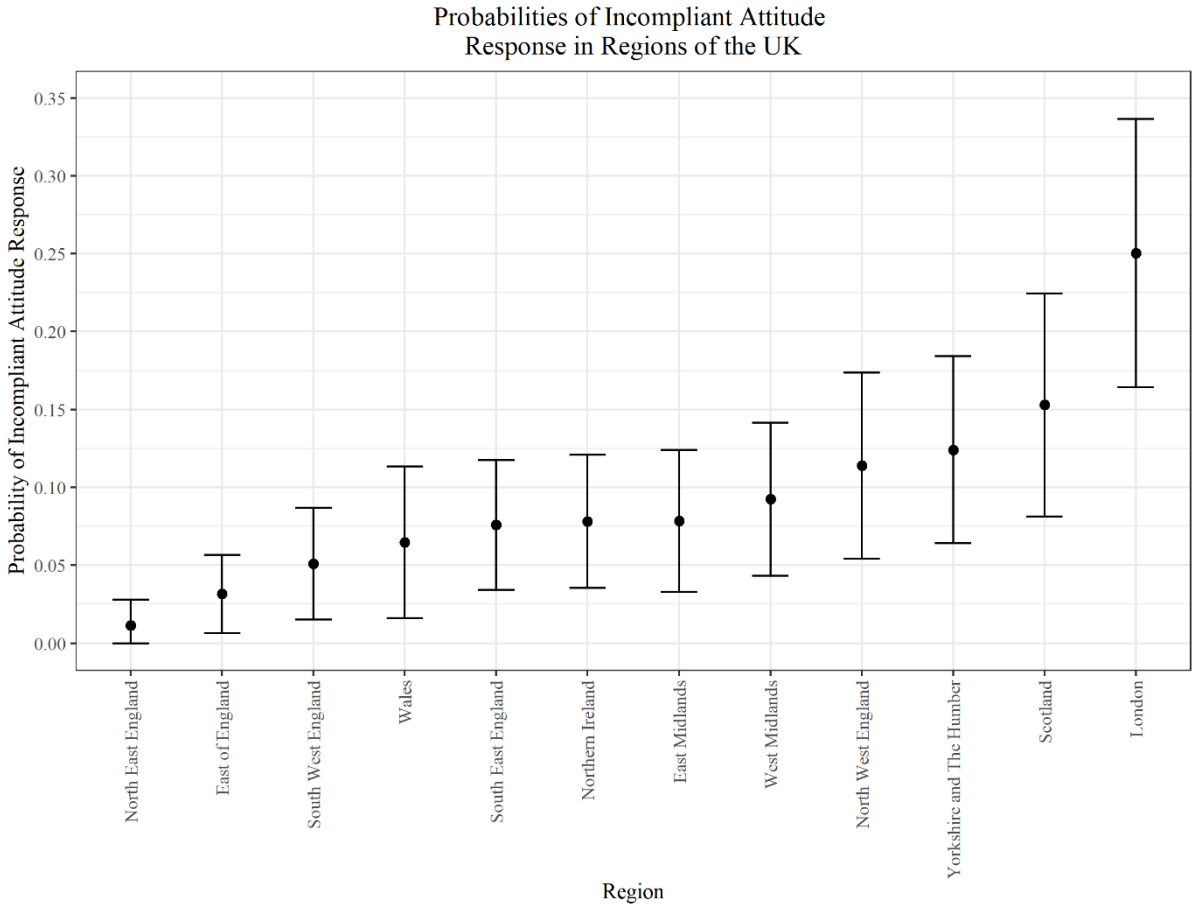

Figure 2. Mean predicted probabilities of incompliant attitude responses in each region of the UK. CLs calculated using Goldstein & Healy's (1995) procedure for graphical comparison of multiple groups with an average type one error rate of 5%.

When contrasted with the East Midlands (one of the median regions in terms of proportion of incompliant responses) there were three significantly different areas in the regression. Respondents in London (OR=2.358, CL=1.100-5.398) and Scotland (OR=2.418, CL=1.083-5.693) presented higher likelihoods of incompliant responses. Conversely, respondents in North East England (OR=0.151, CL=0.010-0.818) were less likely to report an incompliant response. These results suggest that a regional geography at the NUTS1 level – visualised using predicted probabilities in Figure 3 – persists after controlling for other factors including local geography.

The regression suggests that the local geography of incompliant attitudes is predominantly urban. Respondents that lived in small urban areas (OR=0.626, CL=0.417-0.945) were less likely than respondents in large urban areas to respond that they would not adhere to a doctor's instructions when

taking antibiotics, and there was no significant association for rural (OR=0.746, CL=0.384-1.397) respondents contrasted with respondents from large urban areas.

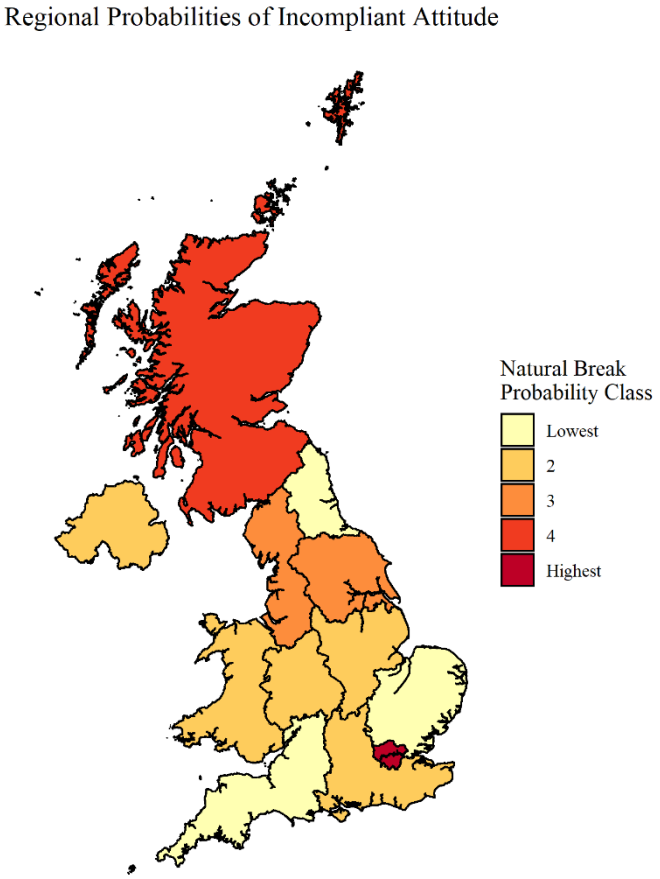

Figure 3. Map of grouped regional mean predicted probabilities of incompliant attitude responses, grouped by natural breaks.

Knowledge About Antibiotics

Four knowledge questions were included in the model. Correct responses to three of these questions were associated with lower likelihoods for respondents reporting incompliant attitudes. The strongest of these associations was for whether unnecessary use of antibiotics could make them ineffective in future (OR=0.353, CL=0.230-0.544), followed by whether antibiotics are useful to treat colds (OR=0.412, CL=0.287-0.591) and whether antibiotics kill viruses (OR=0.644, CL=0.450-0.919). These results suggest that the piece of knowledge most strongly associated with a higher likelihood of prescription compliance is knowledge about the relationship between antibiotic overuse and antibiotic resistance. Conversely, respondents that correctly answered that antibiotics commonly cause side-effects (OR=1.419, CL=1.014-1.999) were more likely to report incompliant attitudes.

Attitudes: Trusted Information, Political Orientation, and Individual-Level Roles

Of the two trusted information sources included in the model, only trust in official health websites for information about antibiotics (OR=0.571, CL=0.332-0.941) was significantly associated with

compliant attitudes. This could mean that the official health websites in the UK are successfully communicating that antibiotic prescriptions should be finished. However, it could also mean that respondents that are more inclined to trust government-sourced online health-information are also respondents that are more likely to be compliant with their doctor's instructions anyway. In either case, this result suggests that there are substantially different groups of Internet users in the context of behaviours regarding antibiotic prescriptions. Very few (n=18) respondents reported trusting personal health blogs, which likely explains the wide CLs.

Left-orientation had a stronger association with prescription compliance than right-orientation. Respondents that placed themselves on the Left of the scale (OR=1.797, CL=1.010-3.115) compared to in the Centre were more likely to respond that they would not adhere to a doctor's instructions when taking antibiotics. In contrast, Centre-Left placed respondents (OR=0.646, CL=0.409-0.998) were less likely to report an incompliant attitude. The results suggest a greater association between left-placement than right-placement and attitudes towards prescription compliance, however the pattern of this relationship is not a clear image of left-leaning individuals in general having specific predilections towards or against compliance.

The regression suggests that perceptions of personal responsibility matter for prescription compliance. Independently from political orientation, respondents that believed that it is 'most effective to tackle the resistance to antibiotics' at the individual level (OR=1.839, CL=1.294-2.599) as opposed to regional, national, EU, or global levels were more likely to report an incompliant attitude. These results suggest perceptions of personal responsibility in addressing ABR are associated with prescription compliance independent of political orientation, which itself is could be a marker for compliance-related attitudes among groups of left-leaning individuals.

Section 3.4.4 – Discussion

Incompliance with prescription instructions leading to patients underdosing and potentially later self-medicating with antibiotics is a socially-patterned driver of AMR. A set of variables in the Eurobarometer surveys were used in this section to examine variation in attitudes to antibiotic prescription compliance in the UK.

This section presents substantive and methodological findings that have implications for the design of the primary survey in this research. These include the importance of regional and local geography, the relevance of political orientation, and protocol effects.

Implications of geographic findings

The findings of this section suggest that there is geographic variation in attitudes towards compliance with prescription instructions for antibiotics in the UK that persists independently from several

individual-level factors. This section suggests that there is a difference in attitudes between people in large and small urban areas, with respondents living in small urban areas being less likely to report an incompliant attitude. There is also evidence of a regional geography persisting once several individual-level factors are accounted for. In terms of the regions analysed in this section, the evidence from regression suggests that this geographical variation manifests at the extremes, with most regions not significantly different from the median. Respondents in London and Scotland for example are more likely to report incompliant attitudes than median region respondents, while respondents in North East England are less likely to do so. A limitation of this analysis is the resolution of the regions available for analysis.

This suggests that the primary survey design for this research project should examine the geography of attitudes at a higher resolution to enable a clearer comparison with geographies of prescribing such as those presented by Curtis *et al* (2019). If high prescribing areas are positively correlated with areas exhibiting higher levels of poor attitudes to prescription compliance, this could suggest prioritisation of specific areas requiring attention from public health interventions to improve prescription practice and compliance by patients. These geographies may however have different characteristics, as Curtis *et al* (2019) found that ruralness was associated with higher levels of prescribing whilst this section suggests that rural areas are not significantly different from large urban areas in terms of attitude. Instead, attitudinal differences in prescription compliance manifest between large and small urban areas in this analysis.

Implications of knowledge-related findings

This section provides further evidence for an association between specific areas of respondents' knowledge about antibiotics' appropriate use and ABR, and attitudes towards antibiotic prescription compliance. Whilst the data is cross-sectional and limiting to causal inference, this analysis suggests that members of the public that are aware that antibiotics are not effective against colds and other viral infections, and that unnecessary use of antibiotics can lead to them becoming ineffective in future, are less likely to be incompliant with prescriptions. This may reflect the commonness suggested by McParland *et al* (2018) of information about the consequences of inappropriate use alongside information on how to take antibiotics appropriately in AMR public health interventions. Conversely, and in line with findings from meta-analyses on necessity/concerns beliefs relating to medication (Foot *et al* 2016; Horne *et al* 2013), respondents that correctly responded that antibiotics cause side-effects were more likely to report an incompliant attitude towards finishing their prescription. The most desirable message for public health interventions suggested by this section is that unnecessary use of antibiotics can render them ineffective in future.

Respondents that reported trust in official health websites for information about antibiotics were less likely to hold an incompliant attitude towards antibiotic prescriptions. Neither trust in doctors nor

social media were important predictors of compliance attitudes. This is a more specific finding than that reported in the previous section's analysis. These findings may suggest that information dissemination through the official websites such as the NHS' has had a positive impact on antibiotic stewardship, however it may also mean that members of the public that are already likely to comply with a doctor's instructions are also more trusting of 'credible' professional online sources of information through which interventions are implemented. This also mediates the previous section's suggestion that the positive cross-sectional association between use of or trust in any kind of online source may also mean that 'professional' panel respondents may be more biased towards good stewardship and correct knowledge. The results of this section move away from such a broad statement, as the association is between credible sources of health information rather than general online sources such as social media. Specifically, if panel respondents use 'official' online health information sources at a greater rate than people who are not panel members, then there may be bias in stewardship outcomes measured by the survey.

Political orientation in context of other research

Political orientation has been suggested as a marker for underlying health-related beliefs and attitudes (Subramanian *et al* 2009). Whilst movement towards right-orientation has been associated with more medicalised attitudes and other health-related behaviours in previous studies, (Boeuf 2019; Filippidis *et al* 2017; Chan *et al* 2019; Başlevent *et al* 2015) there was no evidence of substantial difference found in this section between respondents who placed themselves on the political right in contrast to the centre in terms of compliant attitudes. There were however differing associations between left-leaning placements and the Centre in terms of antibiotic prescription compliance, as incompliance was more likely for Left-placed respondents and less likely for Centre-Left-placed respondents. Independently, respondents that believed the individual level was the most effective level at which to address ABR were more likely to be incompliant than those that believed the most effective level was above the individual.

Social politics has been proposed as a better predictor of thought than economic politics (Talhelm *et al* 2015), but without the data to examine social and economic politics separately the inferences that can be made from the associations in this section are limited. For example, the lack of evidence for association between right-leaning orientations and prescription compliance could be because there is no association between right-placement and prescription compliance, but it could also be due to bias from differences between libertarians and social conservatives within this wing of the scale (Talhelm *et al* 2015). Similarly, Left- and Centre-Left-placed respondents were differently associated with compliance, suggesting that in terms of this health-related attitude, there is some substantive difference between groups that cannot be illuminated further with these data. This difference could for example relate to contextually bound obedience to authority (Frimer *et al* 2014) (Centre-Left

respondents may perceive doctors as being on their social or political 'team', for example), differences in underlying psychological needs, or styles of thought or morality (Talhelm *et al* 2015) (for example, Left-placed respondents may be averse to institutional authority in the context of health).

The primary survey will consequently examine the relationship between differently politically orientated antibiotic consumers and their levels of compliance, with attention to cognitive styles and social/economic politics, as this may be suggestive of specific and effective framings for future public health interventions addressed to the different thought styles of these groups.

Implications of survey interview-related findings

The positive association presented in the model for respondents that were reported by interviewers as having had average or bad levels of cooperation has implications for future survey research in this area. The deployment of nonprobability sampling approaches, which have been used in the area of antibiotic use (Jamhour *et al* 2017; Chan *et al* 2012; Stallwood *et al* 2019), relies on the self-selection of respondents into surveys which can lead to biases on attitudinal and behavioural measures even where samples are demographically representative. These biases are introduced because individuals that self-select for specific studies are different on both measured and unmeasured characteristics, such as agreeableness and interest in the topic, than individuals that do not take part. Random probability samples such as those used in this section do not exhibit these biases because unmeasured characteristics in the wider population are randomly sampled along with the measured variables. The findings of this section suggest that members of the public that are less motivated to take part in surveys and provide good quality data are also individuals who are more likely to exhibit poorer attitudes towards antibiotic stewardship. This means that nonprobability-based inferences are likely to be biased towards respondents with better stewardship attitudes.

Section 3.4.5 – Section Conclusions

Attitudes towards antibiotic prescription compliance in the UK are associated with a variety of factors including local and regional geography, prior knowledge about antibiotics and ABR, and demographics characteristics. There may be an association between political orientation as a marker for underlying attitudes and antibiotic prescription compliance, and more specific research is needed to examine this area. Finally, survey respondents who are less motivated to take part in surveys are also more likely to report incompliant attitudes towards antibiotic prescriptions.

These are all areas that will be examined in the primary survey research of this research project alongside pet-owner-related factors. This section – and more broadly this Chapter – has established these variables as associated in the UK public with attitudes towards complying with doctors' instructions when taking antibiotics. It follows that these factors should be considered when

examining differences between pet-owners and non-owners, as well as when considering behaviour in the spheres of human health and pet health.

Section 3.5 – Conclusions

Section 3.5.1 – Recap of the Chapter's Aims

The aim of this Chapter was to characterise key outcome variables relating to knowledge and behaviour around antibiotics using existing random probability surveys of the UK public. The analyses of this Chapter provide a platform and point of comparison for the primary survey research of this thesis by highlighting socio-economic variables already discussed in the literature and presenting new factors unconsidered in the literature on antibiotic stewardship behaviour.

As the primary survey research of this thesis is directly concerned with a new factor – pet-ownership – and whether this is associated with antibiotic stewardship in social research, the identification of variables in this Chapter that are associated with outcomes such as levels of knowledge about antibiotics or good stewardship behaviour are important. Firstly, they are variables that should be controlled in analyses when investigating new areas that may themselves be correlated with them. Secondly, they present candidates for use in propensity score weighting of the nonprobability sample used in the primary survey research of this thesis.

Section 3.5.2 – Chapter Conclusions

There are several conclusions that can be drawn from the two sections of analysis in this Chapter that build on existing foundations in the literature and move the analysis of the public's antibiotic stewardship into new areas.

Firstly, there were some consistent demographic findings between sections. Older respondents, aggregated differently between sections, were more likely to report better stewardship attitudes or behaviours. The model averaging analysis in Section 3.4 adds to this conclusion by highlighting that the age quintile variable was an important variable for model fit when predicting respondents' compliance with doctors' instructions. Gender was also highlighted as an important variable by the model averaging analysis, and males exhibited worse stewardship in analysis of both the Wellcome Monitor in Section 3.3 and the best-fitting two-wave Eurobarometer model in Section 3.4. Levels of education were consistently associated with levels of knowledge about antibiotics though were not independently associated with behaviour-related outcomes in Section 3.3, and were not included in the best-fitting model in Section 3.4. Finally, employment status was only significant for knowledge or behaviour in the Eurobarometer datasets. This may stem from differences in dependent variable makeup, or the differences in sampling approaches with regards to accommodation status. As the Eurobarometer is being used as the basis for propensity score weighting for the primary survey

research however, the significance of employment status in this dataset is to be taken seriously. These respondent characteristics will need to be measured in the primary survey in order to create useful propensity score weights, control statistical analyses, and compare trends with these higher-quality samples.

Secondly, both analyses suggest that members of the public who use and trust online sources of health information are more likely to be knowledgeable about and responsible with antibiotics. In particular, trust in official health websites specifically is not only associated with better stewardship attitudes but is an important contributor to model fit based on the model averaging analysis. Taken together, these findings could suggest multiple conclusions due to the lack of causal connection facilitated by the cross-sectional nature of the survey datasets. It could be the case that the dissemination of information through online health-related sources has a positive effect on public levels of knowledge and behaviour for members of the public that make use of such sources. This suggestion is supported by qualitative research discussed in Section 3.1.2 regarding the use of 'credible' sources to disseminate antibiotic-related public health interventions, and the specific findings of Section 3.4 where a binary distinction between respondents that trust official health websites both made a positive contribution to model fit and presented a positive association between this trust and responsible behaviour. However, it could also (or alternatively) be the case that respondents who use and trust online sources of health information also happen to be more knowledgeable about and better stewards of antibiotics. If this is the case, then the online panel sample used in this thesis' primary research may exhibit bias towards better knowledge and behaviour if habitual users of the Internet – such as panel members – are also more knowledgeable and better behaved than members of the public who are not part of the panel.

Thirdly, geography matters for the analysis of public antibiotic stewardship in the UK. In the second area of analysis (Section 3.4), both local and regional geographic variables were relatively valuable for the study of variation in incompliant attitudes towards prescription completion. The regions available in the survey data were broad, containing within them a variety of populations and communities. London, for example, is not a homogeneous region in terms of income, equality, or ethnicity. The evidence for significant variation at this regional level, and a distinction between small and large urban areas, suggests that further exploration is warranted at a higher spatial resolution. The primary survey research design for this thesis' research will consequently be stratified using NUTS2 regions to examine geographic variation.

Fourthly, political orientation may represent a marker for underlying attitudes and beliefs that relate to stewardship attitudes. Political orientation has been proposed as a marker for such beliefs in other health-related context such as nutrition, smoking cessation, and medicalisation. To examine this area thoroughly, the primary survey research will incorporate questions on both social and economic politics as opposed to the Eurobarometer's single political orientation scale question.

Finally, characteristics of survey research itself may affect the collection of data relating to stewardship attitudes. In the Eurobarometer data, uncooperative respondents were also more likely to exhibit poor stewardship attitudes. The primary survey research of this thesis will therefore need to account for poor survey-related respondent behaviour, such as lack of attention. Whilst there will be no interviewer present to collect the survey data, the use of attention-check questions and available metadata such as respondents' levels of panel participation may help to diagnose and adjust for some survey mode-related biases.

Chapter 4 – Cognitive Interview Testing of the Primary Survey Questionnaire Instrument

A version of this Chapter has been published as an open-access preprint titled "We tried to, but life gets in the way": The Value of Cognitive Interviewing for Testing a Questionnaire on Antibiotic Consumption Behaviours *on the preprint server SocArXiv. DOI: 10.31235/osf.io/zyq2t.*

Section 4.1 – Introduction

The manner in which community consumption of antibiotics takes place has been the subject of both quantitative and qualitative research scrutiny, as discussed in the previous two Chapters. Social surveys have been used for quantitative research into knowledge and behaviour around antibiotics in a variety of settings, for example in addition to the datasets used in Chapter 3 Napolitano *et al* (2013) and Vallin *et al* (2016) conducted surveys in general community settings, Stallwood *et al* (2019) have surveyed cat owners, and Fredericks *et al* (2015) specifically regarding upper respiratory tract infections. To date there has been little qualitative empirical engagement with respondents' experiences answering survey questions about antibiotic use. Ensuring that questions are clear and understandable to respondents, that respondents are answering the questions intended by researchers, and understanding the variety of experience that is reduced by questionnaire categories are all areas of interest for survey research into public antibiotic stewardship. This Chapter presents the qualitative testing of a survey questionnaire instrument which examines pet-owners' knowledge and behaviour around antibiotic use personally and in administration to their pets, and in doing so addresses these areas of methodological interest in this context.

There are some apparent issues for survey questions about antibiotic use, evidenced by the removal of questions on drug-resistant infections following the testing conducted for the 2018 global wave of the Wellcome Monitor. The Monitor's 'Questionnaire Development Report' noted that in multi-country cognitive testing both the notion of drug-resistant infections and the term 'antibiotic' were subject to confusion and differences in interpretation dependent on respondents' education levels or socio-economic status, leading to the decision to remove the questions (Gallup 2018). This highlights that the findings of questionnaire-testing relating antibiotics are not necessarily generalisable across geographic contexts, or between regions with markedly differing levels of development. Questionnaire instruments should therefore be tested where possible in different settings, and the findings of the testing disseminated clearly and systematically.

One qualitative approach to evaluating the performance of survey questions is cognitive interviewing. Cognitive interviews are predominantly concerned with the process of data generation, and aim to

provide information about how respondents arrive at their answers and uncover difficulties or ambiguities that are faced by survey respondents on the way to their responses through verbal think-aloud techniques as well as interview probes (Campanelli 2008). Cognitive interviews examine whether the questions fulfil their intended purposes and test the assumption that the meaning of the question intended by the survey author is consistent with respondents' interpretation of the question (Willis & Artino Jr 2013; Dietrich & Ehrlenspiel 2010). These techniques provide several benefits over quantitative pilot tests, for example through evidencing whether the intent of a closed question is being correctly understood by participants[1] (Campanelli 2008; Buers *et al* 2014) or capturing the variability of conceptualisations of terms such as 'health' that may be present in survey questions (Boeije & Willis 2013). Whilst cognitive interviewing may not permit researchers to make assumptions about the true number of problems in a questionnaire, nor the problems that may arise with untested specific groups in the general population, they can produce data even at small sample sizes that can greatly improve confidence in a survey instrument's quality of data collection and provide further insight to support any inferences being made.

The survey questionnaire instrument for the primary survey research of this thesis (Appendix A) mobilised some original questions, but also adapted questions from previous studies where testing information was not available in detail. To evaluate respondents' engagement with the questions the questionnaire instrument was tested with two rounds of cognitive interviews, the findings of which are presented in this Chapter. Some early qualitative findings regarding pet-owners' antibiotic-related knowledge and behaviour are also discussed.

Section 4.1.1 – Previous Cognitive Interviewing Studies Covering Antibiotic-Related Questions

Some previous cognitive interviewing studies have included antibiotic-related survey questions. These have however generally been limited to questions that mention antibiotics as context or example rather than as main study focus; for example as a term to be defined (Lapka *et al* 2008), as part of a study on misinterpretations of drug label instructions (Wolf *et al* 2007), as part of blood donor screening questionnaires (Beatty 2002; Willson *et al* 2013), or the epidemiology of drug-resistant infections (Macario *et al* 2010).

A common finding relating to comprehension is that some respondents will exhibit confusion over what an antibiotic is and what they should be used for (Beatty 2002; Wolf *et al* 2007; Lapka *et al* 2008; Macario *et al* 2010; Willson *et al* 2013). A potential consequence of this is that respondents do not report having taken an antibiotic when they have done so because they are not aware that a certain medication was an antibiotic. The reverse is also possible, with respondents possibly reporting having

[1] In this Chapter, participants and respondents are distinguished such that 'participants' refers to interviewees whilst 'respondents' refers to potential survey respondents.

taken an antibiotic when in fact they have actually taken cold medicine or other over-the-counter remedy. The extent of this finding is dependent on the sample and the specific question being posed, with some studies also finding participants very able to articulate specifics relating to antibiotics, such as their purpose or specific instances in which they had been taken (Beatty 2002).

A second common set of findings relate to information retrieval. Issues relating to participants' recollection include specifics of prescriptions (Macario *et al* 2010), and again, whether what had been taken in a specific instance was actually an antibiotic (Beatty 2002; Macario *et al* 2010; Willson *et al* 2013). These findings demonstrate the variance in the memorability of antibiotic consumption, with implications for the quality of data collection regarding the reason for consumption and the method of consumption (for example, when measuring prescription adherence). These varied findings may be expected given the range of situations in which antibiotics can be consumed, from mild or preventative cases through to severe infections.

Section 4.1.2 – Aims and Justification of the Study

There were two aims in this cognitive interviewing study. The main aim was to identify problems in individual items that would increase measurement error or respondent burden if left uncorrected. The second aim of the project was to test the questionnaire instrument as a whole and attend to contextual effects such as leading questions. Knowing the extent of any leading effects was important due to the use of duplicated questions in the first and third sections of the questionnaire covering human and pet health respectively. The correction of issues uncovered by this qualitative pretesting was the central objective of this stage of the overall research project.

The questionnaire instrument drew in part upon two previous studies' questionnaires that used differing modes of data collection. The Wellcome Trust Monitor Wave 3 (Ipsos MORI 2016c) used a face-to-face mode of administration, and the European Food Safety Authority's (EFSA) 'Perceptions on the human health impact of antimicrobial resistance (AMR) and antibiotic use in animals across the EU' study (ICF 2017) which used an online mode of administration for its survey element. Understanding how effective these questions – and adapted versions of these questions – were in this new questionnaire context, and whether they translated effectively across modes and questionnaires, was important for ensuring reliability and validity of questionnaire items and reducing measurement error in the survey study.

This Chapter contributes to the field of cognitive interviewing as a social research method, with reference to the area of antibiotic use, by presenting and discussing qualitative research into the construction of a questionnaire on antibiotic use and knowledge, with implications for future social measurements in this area. The contributions of cognitive interviews beyond questionnaire testing are highlighted, including the expansion of interpretations of dimension-reduced survey data and the early generation of exploratory themes for qualitative investigation. The study also presents some findings

regarding pet-owners' antibiotic-related knowledge and behaviour, which is an area that has only recently begun to receive substantive attention in either qualitative (Smith *et al* 2018; Dickson *et al* 2019; Redding & Cole 2019a) or quantitative (Stallwood *et al* 2019) literature.

Section 4.2 – Research Design

Section 4.2.1 – Data Collection Approach

13 interviews were conducted face-to-face, with all participants receiving an information sheet upon indication of interest in participation and both written and verbal briefings at the point of interview. Written consent was obtained prior to interview commencement.

The interviews for this study were conducted in two waves, with variation in sampling approach between waves. All but one of the interviews were recorded and transcribed with participants' permission, and the questionnaire and interview protocol were adjusted between waves. By using two waves of interviews the researcher (acting as both interviewer and analyst) was able to iteratively test and improve the questionnaire instrument. The iterative testing was not open-ended in this study due to both time and budget constraints. This also meant that saturation was not a goal of the study, but rather the aim was to identify and resolve the most serious issues with the questionnaire before its deployment.

The interviews employed a think-aloud protocol followed by retrospective probing. During the think-aloud exercise, interview participants read each question aloud and actively verbalised their thoughts on their route to an answer that fitted the options provided. Think-aloud was used because the approach provides participant-initiated data at the point of answering the question (D'Ardenne 2015), and as the survey was eventually to be self-administered with no interviewer present these data was considered more valuable than that which might be obtained through more disruptive concurrent probing. Retrospective probes were employed after the participant had completed the questionnaire. These probes contrast to concurrent probing, which entails the interrupting of the participant's flow through the questionnaire in order for the researcher to ask probes. Additionally, concurrent probing was avoided in order to facilitate the assessment of continuity in the questionnaire between the duplicated health sections.

The retrospective probes were developed to be employed where the think-aloud exercise did not cover an area of interest (for example, concepts that went undefined by participants). Specific probes included category-selection probes, for example clarifying the interpretation of response categories that were unspecific quantities of time (for example, 'once per week' compared to 'several times per week' or 'multiple times per month'). The same kind of probe was used for Likert-type items, differentiating between agreeing or disagreeing and 'strongly' agreeing or disagreeing. Specific concepts such as 'trustworthiness' or Internet-based 'information sources' were probed to examine

consistency of definitions where verbal reports had not explicitly tied the concepts to definitions that manifested in response judgements.

Section 4.2.2 – Participant Selection

In the first wave, six postgraduate student pet-owners were recruited through convenience and snowball sampling. The use of participants with higher levels of education in this round follows Ackerman & Blair's (2006) finding that it is more productive when problem identification is the aim to over-recruit respondents with above average education as they tend to find more 'low frequency' difficult-to-find problems. In Ackerman and Blair's (2006) study, respondents with higher education levels yielded higher numbers of problems per interview because they spent more time either thinking about or discussing each question, recognising potential problems as well as encountering actual problems. In this first sample, highest education levels were distributed evenly between undergraduate degrees (n=3) and postgraduate degrees (n=3). The second round of interviews recruited seven pet-owners in the local area through a social-media based convenience sample. Highest education levels in this sample included GCSE level (n=1), A-level (n=2), NVQ Level 4 (n=1), undergraduate degree (n=2) and postgraduate degree (n=1). The first sample was intended to identify a higher frequency of issues, the second sample was intended to test the questionnaire with a more general community of pet-owners that would be more reflective of the survey's eventual respondents. Interviews were conducted at locations chosen by the participants, including participants' homes, cafés/public houses, and the interviewer's home.

The first sample had a lower median age (23 years) than the second (31 years), with both samples slightly skewed towards younger age (first sample mean age = 26, second sample = 33). Cat-only pet-owners were most common in the total sample (6), followed by participants owning a mix of pets (4), dog-only owners (2) and small animal-only (1). These demographic data demonstrate that multiple configurations of pet-ownership were represented in the cognitive interviewing study, including sole smaller pets such as rodents and mixed pet-ownership (for example, dogs and chickens, or cats and guinea pigs), which was important versatility for testing the pet-health focus of the survey questionnaire.

Section 4.2.3 – Data Analysis

Transcripts were coded initially by the individual issues that arose, with 21 individual issues relating to antibiotic use or Internet questions identified across the two rounds of interviews. This enabled an appreciation of the range and recurrence of issues. The individual codes, combined with specific comments from participants, were the eventual basis for decisions over how a question/response might be altered. These individual issues and their codes were divided into three overarching categories. Firstly, those issues that were both recognised and verbalised by participants and hindered participants' responding in some way, for example through confusion over a question's wording or an inability to make a clear judgement within the categories provided. Secondly, those issues that were

not recognised but were verbalised by participants. These were issues that mainly provided a post-survey analytic problem such as participants missing a question's request for the most recent instance and verbalising their most memorable instance of antibiotic use, or telephone consultations with doctors being selected as 'Other' when the aim of the question was to deduce whether there had been a consultation of any type. Finally, there were potential issues that were identified and verbalised but that did not directly affect the participants' response where participants spontaneously suggested scenarios in which a concept or phrase might be a challenge for a hypothetical respondent.

These overarching categories gave an overview of the mechanics of the questionnaire for survey respondents – for example where interview participants were actively struggling to respond to the questions or were passively misinterpreting the aims of the questions. These categories, combined with the initial coding, provided a basis for deciding whether a question/response should be altered. For example, recurrent misinterpretations of a concept being recognised and verbalised by respondents would certainly need resolving, whereas a hypothetical syntax problem that was only verbalised by the participant that 'spotted' it would be less likely to require alteration.

The total number of issues decreased between rounds, from 27 separate issues across all question types identified in the first round to 18 in the second. This could be attributable to the improvement of the questionnaire instrument, though it could also be reflective of Ackerman and Blair's (2006) suggestion that a sample of higher-educated participants yield higher numbers of issues. The most common issue was with recollection (first round = 11 occurrences, second round = five occurrences), as participants most often consciously struggled to recall the details of the last time they or their pets had consumed an antibiotic because of the time elapsed between the event and responding to the question. The second most common issue was the potential for a participant to select multiple answer options where only one was requested – an urgent issue to be addressed before dissemination of the survey. Leading effects between questions were not a significant problem for the questionnaire instrument, with only one instance of an answer being deduced from a previous question. The volume of issues identified suggests that the exercise was a useful one in the process of the questionnaire's development.

Section 4.3 – Findings

The findings of the cognitive interviews are presented by questionnaire section (Internet-related questions, followed by antibiotic-related questions). Issues are organised thematically based on the areas in which they arose. The questionnaire itself was structured with the human-related section coming first, followed by a demographic information section, and finished with the pet-related section which was a mirror of the wordings of the human-related section.

Section 4.3.1 – Internet-Related Questions

Framing 'Information Sources'

In a question referring to the trustworthiness of Internet-based information sources relative to doctors, there was some inconsistency in the framing of 'information sources that you use on the Internet'. In the first round, four participants referred to the Internet as a general resource, whilst two referred specifically to the National Health Service's (NHS) website relative to their GP. The words 'in general' were added to the start of the questions, which resolved this issue in the second round of interviews and increased consistency across respondents in terms of how they referred to the Internet as a resource. Respondents compared a variety of information sources to their veterinarians and lacked consensus on an 'official' online information source for companion animals. This would suggest that it is important to not underestimate the prevalence of use of 'official' online information sources such as the NHS website when examining the general use of online sources of health information in this format.

Consideration of 'Trustworthiness'

The relative trustworthiness of websites, doctors, and veterinarians was considered in some depth by most participants. Some participants discussed the different diagnostic approaches between Internet-based self-diagnosis and the practices of healthcare professionals. Healthcare professionals were often perceived as having a more holistic view of symptoms and potential diagnoses, with GPs for example "*know[ing] a little of a lot of things*" (CI #6), or whilst websites provide "*reasonably true*" information (CI #1) a GP has the ability to point out the rarity of suggested diagnoses and "*do those eliminations for you"* due to their "*experience of making those judgements"*. Animal health was more directly problematic for participants, as there was general consensus that the lack of an equivalent to the NHS website in the context of animal health made the assessment of source quality more difficult. For some, making direct comparison with the NHS, this meant the lack of a "*sounding board*" for their pet's health (CI #9), whilst others highlighted a lack of "*developed trust*" in specific Internet presences (CI #6). There were also substantive differences between participants in their comparison of doctors and veterinarians to respective online information sources. For one participant, whilst there was a lack of developed trust in a specific animal health website vets also had "*less authority with me than doctors would. With the client relationship, they have less authority*" (CI #6). Conversely, for another participant this perception was reversed: "*I can feel my own pain and I can't feel the animals' pain, so I have to take [the veterinarian's] word for it. Whereas with me, it's like, I'll do what I want*" (CI #8). 'Trust' in the context of this questionnaire was constructed with regards to healthcare professionals knowledge and experience, professionals' potential financial motivations, developed trust in the NHS, and embodied feelings relating to health. As such reflections are often reduced in survey questionnaires to closed response categories, such as Likert-type items, supplementing the survey data with a set of qualitative interpretations of key concepts in the questionnaire can provide valuable insight into the diversity of intentions and experiences behind the more dimensionally-

reduced survey question responses. Furthermore, in a mixed-methods project such as the one from which these findings are drawn, these data can prompt further exploration through less structured qualitative interviews or focus groups alongside the improvement of the survey questionnaire instrument.

Frequency of Internet Use

Another area that led to inconsistencies in judgement rationales was the frequency of Internet use. For the question 'How often do you use the Internet to search for health information relating to humans' (or, in its mirrored version, '…for animals'), one participant in the first round verbalised different times at which they had used the Internet more frequently with regards to their pet without explicitly averaging their frequency of use for their answer, commenting that they used the Internet for pet health "*when my cat was sick, every day when she was sick*" (CI #6). Additionally, one participant in each round referred to their main working activity as involving health either in the context of research or direct provision of care. In both cases, this boosted the frequency with which they reported using the Internet to search for health information relating to humans as it was unclear as to whether the question was "*about work, or about me, or people that I know*" (CI #5). 'On average' was inserted at the start of the question and was picked up on by second round participants, with some participants verbalising clustered behaviour as with the first round but explicitly translating this into a perceived average frequency of behaviour. Generally the Internet was only being used when there was a specific cause for concern or where pre-existing conditions were involved, and in reporting their judgement of an average level of use respondents were conveying how habitually they would turn to the Internet as a source of information on health topics. This example emphasises the value of qualitative testing of survey questions through cognitive interviews, as the reliability of this question in its untested form was negatively impacted by specific circumstances that were skewing some participants' comprehension of the question.

Section 4.3.2 – Antibiotic-Related Questions

Memorability and Recollection

In the human-focused questions, participants that had difficulty recalling the relevant information generally did so because the last time antibiotics had been taken was either a long time ago, for something that was not memorable, or both. Three participants in each round presented some difficulty with recollection for the initial question 'Please think back to the last time *you* took antibiotics. Where did you get those antibiotics from?'. One participant in the second round who had presented a recall issue with this question also presented a recall issue with the next question, 'How did you take these antibiotics?'. This recall issue did not prevent an answer from being rationalised by the participant, however. In this instance, the participant verbalised "*I probably took them until I felt better. I'm not a fan of taking medication*" (CI #8) and chose the option 'Taken until you felt better' on the questionnaire. This suggests that some respondents will extrapolate from their underlying

beliefs about medication when recall presents a barrier to response, even when these beliefs may be socially undesirable. Both the human- and pet-focused strands of the subsequent question 'What did you do with any leftover antibiotics?' presented recall issues for participants, once on the human side after probing and three times for the pet side during think-alouds. A consequence of one recall issue was one participant checking two responses after the following verbalisation: "*Since I'm not sure – if there were leftovers and they didn't get used, we would have kept them, otherwise there were none left over*" (CI #4). A 'don't know' option was not provided in this question so as to maximise the provision of substantive responses, and the lack of such an option generally prompted all other participants to select a substantive response category to the best of their knowledge. However, following this last example, 'Please check one option' was appended to the question between rounds to emphasise the selection of a single response, with no double-selections considered by second round participants.

Conversely, some participants reported high levels of clarity in their recollections of taking antibiotics themselves or administering them to their pets. Two participants in the first round and four in the second reported that it was easy to remember the last time that they had taken antibiotics themselves either because it was recent, memorable, or both. Memorable reasons were not always attributable to the antibiotics themselves – whilst one participant did recall severe side-effects during a long course of antibiotics, another recounted a serious leg break that later became infected and, almost tangentially in their verbalisation, required antibiotics. Recall issues were less prevalent in the pet-focused iteration of 'Where did you get those antibiotics from?' (four pet-related recall issues, with six human-related recall issues) but were more prevalent for 'What did you do with any leftover antibiotics?' than for the human-focused versions (three pet-related recall issues, with one human-related recall issue). Multiple participants, particularly in the second round, noted that it was easy to remember the most recent instances of antibiotic use for their pets as they were particularly stressful or upsetting. All participants noted that it was easy to pick a response to the pet-focused acquisition question either because they would only ever get pet medication via a prescription from a vet, because the pet's condition was a "*vivid memory*" (CI #13), or because the mode of acquisition (for example, from friends or family) meant that they avoided a stressful trip to the vets with a reactive pet.

In general, there were more recall-related issues presented by participants with regards to their own antibiotic consumption than with regards to their pets. This is likely down to the higher number of factors involved in managing a pet's health with medication, including transport of the pet, veterinary bills, and actually administering the antibiotics. Beyond questionnaire improvement, these findings may be suggestive of substantively different dynamics in antibiotic consumption behaviours by pet-owners in terms of their own personal consumption and their administration of antibiotics to their pets. This is an area that is part of the broader research agenda within which this questionnaire and its testing reside.

Translating Response Categories Between Survey Modes

The section-opening question 'Please think back to the last time you took antibiotics. Where did you get those antibiotics from?', which was adapted from the Wellcome Monitor Wave 3 questionnaire (Ipsos MORI 2016d), precipitated multiple category-overlap issues. These included one participant who had obtained antibiotics abroad seeing overlaps for the category 'from abroad' with other response categories such as 'prescribe after face-to-face with a healthcare professional', two participants translating telephone consultations into the 'Other' response category, and one participant selecting both 'Prescribed after face-to-face with a veterinarian' and 'Online service with a prescription' having received the prescription from the veterinarian and subsequently bought the antibiotics online. In each of these cases the participants' scenarios had categories in which the researcher intended them to fit, but the participants interpreted multiple response categories as potentially appropriate.

In response to these issues, changes were made between rounds and following the second round. Between rounds the phrase 'health professional' in the human-focused question was changed to 'general practitioner or nurse', and 'from abroad' was changed to 'Other' to act as a catch-all for the various possible configurations of antibiotic consumption abroad that were not included in current categories. Following the second round, the question wording itself was changed with 'last' becoming 'most recent' with underscoring, and the response category 'prescribed after face-to-face with a general practitioner' again being altered to 'In person following prescription from oral consultation with a general practitioner or nurse'. Whilst this is a more verbose formation, it was considered acceptable because it was necessary to delimit the category sufficiently from 'online service with a prescription' as well as provide an option for phone consultations. Whether a respondent's consultation was in person or over the phone was not analytically important for the survey, but the general avenue of antibiotic acquisition was. With regards to the pet-focused acquisition question, the question and responses were altered to mirror the human question which addressed the category overlap issue presented for this question. The key issue in these examples was the translation of response categories from a survey administered through face-to-face interviews into a self-administered mode of data collection. The cognitive interviews here served to bridge the gap left by the lack of an interpreting interviewer by highlighting specific required changes and consequently improving the validity of the question as a measurement tool.

Social Desirability when 'Life Gets in the Way'

When responding to the questions about how antibiotics had been consumed/administered, two participants verbalised one response and consciously selected a different response. Specifically, these participants selected 'Taken as prescribed and at the correct times' when they verbalised that they had not done so. For example, one participant responding to the human question verbalised that the antibiotics were taken as "*probably a mixture of the second and third options […] but generally I*

would say taken as prescribed at the correct times" (CI #3). This issue recurred in the mirrored pet question, both with the same participant who reflected "*again, probably a mixture of correct times and not correct times*" and another participant who recalled "*usually at the correct times, but not always*" (CI #1). When prompted to settle on one category or the other, this second participant answered that they would select "[…] *given as prescribed at the correct times. We tried to, but life gets in the way*." These responses suggest that some respondents to the questionnaire may simply report that they had taken (or given) antibiotics at the correct times when there were instances where they had not done so. This challenges the reliability of the question as a measurement tool, because the implication is that the level of antibiotic consumption with incorrect timings will be underestimated while correct timings are overestimated. As the main aim of the item(s) in question was to assess the difference between respondents that stop taking antibiotic courses when they feel better as opposed to those that finish their prescribed course as instructed, distinguishing between following a prescribed course at the correct or incorrect timings was deemed not to be a useful distinction to require given this evidence. Qualitative research by Hawkings *et al* (2008) suggests that individuals that *intend* to take the full course of antibiotics take their medicines at 'mostly' the correct times and regret missing specific doses, which is reflected in this behaviour with the questionnaire. Consequently, these two response options were reduced to a single 'taken as prescribed' option in order to reduce respondent burden. This example demonstrates that such specific response categories should be interpreted with caution when behaviour is examined through dimension-reducing tools such as survey questionnaires. Qualitative approaches, such as interviews, may be more reliable for engaging with antibiotic consumption behaviour where this level of detail is desired.

Leading Effects

There was some evidence of a leading effect between knowledge questions. All participants responded that it was true that unnecessary use of antibiotics in humans could lead to antibiotics becoming ineffective to treat humans. However, in answering a similarly worded item relating to use in animals affecting antibiotic efficacy for humans (which followed directly from the human use question) one participant moved from a 'Don't Know' – which is a substantive response for this question – response to 'True' based directly on deduction from the previous (human use) question. This question and the previous item were switched in position between rounds, with no leading effect observed in the second round.

Diversity of Experience

A second-round respondent that had made two selections on the question about where they had acquired their antibiotics due to obtaining them via a telephone consultation also misread the question and recalled multiple events rather than only the most recent. This contributed to their rationale for selecting multiple response categories, as they were reporting multiple events rather than one. The same participant that missed the recency aspect of this question about acquisition also missed it in

their calculation of an answer on the human branch of the question 'What did you do with any leftover antibiotics?', verbalising about both "*a time I was prescribed antibiotics, a long course where I was allowed to stop them when I wanted to'* and *'a regular occasion*" (CI #12). Being in the second round, they did however make an explicit note of the instruction to check one box and selected their response as if for a "*regular*" occasion. This participant reported having a long-term health condition and having to take courses of antibiotics multiple times per year, so the high frequency may have had the same effect as distant recall in making a specific recent instance difficult to bring into focus. This highlights the importance of qualitatively testing a questionnaire as this can ensure that the survey questions are both accessible and reliable measurements across different respondent backgrounds, and in this case medical backgrounds.

The Role of Examples

One participant suggested, after probing, that more examples would assist with the answering of 'In humans, what conditions do you think can be effectively treated by antibiotics? (Tick all that you think apply)', because the participant was "*not medical at all*" (CI #13) but could recall the different infections that they had had treated with antibiotics previously. Conversely, the examples provided in the responses successfully triggered another participant into ticking 'bacterial infections' as opposed to just 'viral infections'. Whilst an exhaustive list could be provided (or indeed, none at all), the question was concerned with respondents' generalisations of types of infections related to antibiotic use as opposed to specific infections and the use of a small number of examples was intended to make the question more accessible with some common infection examples without increasing respondent burden rather than provide an explicit structure to a participant's recollection. This example illustrates the value of qualitative testing in examining the role of provided examples in respondents' experiences of the survey and clarifying the extent to which the examples are help or hindrance.

Section 4.4 – Discussion

The use of a qualitative approach – cognitive interviewing – to test the survey questionnaire within this mixed-methods research project added considerable value to the research in several ways. Firstly, specific challenges to the reliability and validity of questions as measurement tools were able to be identified and corrected with targeted adjustments. Secondly, the narratives that participants provided whilst answering the questions add value to the later interpretation of quantitative analyses that, whilst providing a level of generalisability and the benefits of statistical modelling, involve substantial dimension reduction that may limit consideration of the nature and diversity of research participants' experiences with the phenomena of interest. Finally, the qualitative data generated by this method is valuable for the development of other areas of the research project such as further qualitative investigations and theory development.

In this questionnaire, the first group of issues arising from questions on the use of the Internet referred to the implications for analysis of how participants were interpreting the specificity of the Internet use they were being asked about. More generically, there were issues relating to time frames that in some cases impeded response judgement or presented caveats for the later analysis of survey data. These examples demonstrate the value of qualitative testing of this questionnaire instrument, as challenges to both reliability and validity of the questions as measurement tools were raised and specific alterations could be effected by the researcher to address them.

A substantial amount of qualitative data beyond solely the testing of the questions was collected as participants discussed their understandings of concepts such as 'trustworthiness' and how they related to health information across human and animal healthcare. These data highlighted substantive differences in the consideration of human and veterinary health professionals and the consideration of online health information sources by participants, and provide qualifications with regards to the rationalisation of different responses to identical questions between each domain of health. The consistency of the NHS as a source of information about human health was contrasted with a lack of consensus over online sources that had the same kind of developed trustworthiness for pet health, and there were further differences raised between medical and veterinary professionals in terms of professional motivation and participants' perceptions of their own or their pets' embodied feelings.

Furthermore, the presence of differences in issues related to recollection between personal antibiotic consumption and the administration of antibiotics to pets highlights another aspect of the different ways participants related to the domains of human and veterinary medicine. For example, episodes in which pets required antibiotics were more often described in terms of the stress or upset caused to the participant than episodes in which antibiotics were required by the participant themselves. Whilst the quality of this difference is a substantive area of interest for the wider mixed-methods project, the effect of this difference on the survey questionnaire's capability as a measurement tool is an important finding from the cognitive interviews for the analysis of the survey itself in terms of the potential difference in measurement error between respondents' answers for their personal behaviour and their behaviour in administering medication to their pets.

The demonstration of recollection issues by participants with regards to their consumption of antibiotics were generally commensurate with previous examples of cognitive interviews that covered antibiotic consumption. Reasons for difficulty of recall often mirrored those for ease of recollection – for some participants the last time that they had taken antibiotics was a long time ago and/or not for anything memorable, whilst for others it was recent and/or vivid. With regards to the pet-related side of the questionnaire, those respondents that had given their pets antibiotics tended to remember more clearly what they had been given for compared to their personal consumption, especially in some cases where the pet-related event was a particularly stressful or upsetting occurrence. As antibiotics

may be taken in a range of scenarios, from mild or preventative cases through to severe infections, the variation in recall issues among participants may be expected though this would not necessarily be clearly reflected in the survey data alone in a quantitative pilot test.

In another example, whilst recall of specific instances of antibiotic use in pets was less of a problem than in personal use, recall issues were more pronounced for action taken regarding pet-related leftover antibiotics, with multiple participants verbalising such issues spontaneously during their think-aloud compared to a single participant bringing it up with regards to personal use only after being probed. This suggests that recall issues for the same instance of antibiotic consumption manifest differently in questionnaire responses for different aspects of the procedure of acquiring, taking, and keeping/disposing of antibiotics. This too would not be an issue that could be clearly uncovered through a simple pilot test of the questionnaire nor would it be apparent in survey data, and with the previous examples is further suggestive that the survey measurement of antibiotic-related behaviour in personal and pet-related contexts have differing amounts of measurement error even with identical questions.

As behaviour questions increased in specificity, there was evidence that for some questions their validity was reduced due to socially desirable responding. There were cases where participants' verbally recalled actions were different to those they reported in their mock questionnaire with regards to the timing of antibiotic consumption. The challenge to the validity of the split between taking or giving antibiotics with correct or incorrect timings was significant enough to require that the response categories be combined into a single category simply measuring whether antibiotics were taken as prescribed or not. If the distinction between the correct and incorrect timing of consumption for respondents is an area of interest, less dimensionally-reduced forms of data may better serve researchers. Previous examples of qualitative research have, for example, elaborated on this area in detail (Hawkings *et al*., 2008).

Section 4.4.1 – Strengths and Limitations

A strength of this study is that despite the small sample – itself not unusual or inhibitory for cognitive interviewing studies (Collins & Gray, 2015; Beatty & Willis, 2007; Boeije & Willis, 2013) – the study included participants at multiple stages of life, with multiple levels of education, and specifically for this study's overall purpose, multiple configurations of pet-ownership. A second strength is that this study examined multiple specific facets of antibiotic use and knowledge in the questionnaire – including acquisition, behaviour, knowledge of antibiotics' function, and knowledge of antibiotic resistance – in the context of both personal use and pet-orientated use.

With a larger sample and further rounds of refinement, more issues with the questionnaire would certainly have been uncovered. Blair & Conrad (2011) have demonstrated that significant issues can still be found even after 70 cognitive interviews – though with diminishing returns as the sample size

grows. Due to limitations of budget and time however, saturation was not the aim of this study. Further studies could supplement the findings of this study by testing antibiotic-focussed questionnaires in a variety of other healthcare settings and scenarios.

Section 4.5 – Chapter Conclusion

This section of the thesis' research used a qualitative method to test a questionnaire instrument for a survey covering pet-owners' knowledge of antibiotics, antibiotic use behaviour, and use of the Internet for health information. The main objective was to uncover problems with questions that would affect respondents' abilities to respond or would increase measurement error in the survey. Qualitative testing of questionnaires can provide complementary value to survey analysis by elaborating on the experiences of a subset of participants in direct relation to the questions and their response categories. This is important because while survey research has significant strengths in terms of generalisability and the quantification and controlling of associations between variables in analyses, these strengths come at the cost of dimensionally reduced data. Such reduced data can mask sources of measurement error in questionnaires if not tested thoroughly, exemplified by the dissonance between verbalisations and actual questionnaire responses regarding the timing of antibiotic consumption discussed in this Chapter. Moreover, the cognitive interviews can serve as a bridge between methods in mixed methods projects, connecting the more rigid form of data collection in the survey questionnaire to the more fluid and often spontaneous data collection of interviews and focus groups. An example of this is the discussion of trustworthiness by cognitive interview participants in the specific context of the questionnaire questions, an area that has since been examined in greater depth during semi-structured qualitative interviews in another part of the research project.

In general, the most prevalent issue for questions about previous antibiotic use in this study was recall. This was an issue identified in prior cognitive interviewing literature involving questions about participants' previous behaviour with antibiotics. This prevalence did not mean that all respondents struggled to respond to questions regarding antibiotic consumption however. Participants in this study could generally recall at least some detail of an instance in which they had taken antibiotics, and where they could not do so explicitly they extrapolated from underlying habits and beliefs regardless of their social desirability. For studies aiming to measure or model such beliefs there do not appear to be serious measurement error problems with questions regarding antibiotic acquisition and consumption, based on the verbal reports of these participants. More specific behaviours are less reliably reported however, as demonstrated by the participants that verbalised that they had not managed to take antibiotics at the correct times for their prescription, but still selected the 'correct times' response category anyway.

Beyond questionnaire problem-finding, a key finding of the cognitive interviews was the substantive difference between participants' experiences with and rationalisations of responses to identical questions about their personal use of antibiotics and their administration of antibiotics to their pets. Firstly, this suggests that there may be different levels of measurement error in surveys that examine antibiotic-related behaviour in these two settings, which may also apply to other surveys focused on parallel pet/personal behaviours (e.g. for exercise or nutrition). Secondly, this reinforces the suggestion that this is an area of substantive research interest.

Understanding trends in attitudes and behaviours in the context of community antibiotic consumption is an important part of the mitigation of antibiotic resistance. Cognitive interviewing can add significant value to research into the social patterning and individual rationalisations of behaviour with medicines both by improving the measurement potential of survey research, and by generating complementary qualitative data that can inform research conclusions and designs.

Part 3: Empirical Research

Chapter 5 – Primary Survey Analysis: Pet-owners, Geography, and Contextual Attitudes.

Section 5.1 – Introduction

This chapter presents the research project's primary survey data collection and analysis. This survey research aims to elucidate associations between pet-ownership and behaviours and attitudes around antibiotic use in medical and veterinary contexts. The chapter opens with the description of the questionnaire design (Section 5.2.1) and the sampling approach (Section 5.2.2), followed by a discussion of the propensity score weighting approach used for this survey data (Section 5.2.3). Following these methodological areas, the results of the survey analyses are presented and discussed (Section 5.3). Firstly, the descriptive statistics of the sample are presented with some discussion of the impact of the sampling approach on key outcome variables. Secondly, the results of multilevel regression models examining contextual knowledge and attitudes around antibiotic use and antibiotic resistance are discussed, followed by models examining behavioural attitudes. The results section is followed by a concluding discussion of the survey project's findings (Section 5.4).

Section 5.2 – Methods

Section 5.2.1 – Questionnaire Design

The first area covered in this Chapter is the design and testing of a questionnaire that responds to the quantitative hypotheses outlined in Chapter 1, with emphases on the hypotheses not covered by the existing data analysed in Chapter 3. Additionally, given the use of a nonprobability sample and a propensity score weighting approach employing data utilised in Chapter 3, the questionnaire needed to be compatible with aspects of the 2018 Eurobarometer used as a reference sample covering some demographic and attitudinal questions identically. Furthermore, the questionnaire was designed to respond to new areas arising from the analyses of Chapter 3 both for the purposes of improving the propensity scoring approach as well as providing more detailed analysis of contextual attitudes such as political orientation.

The questionnaire, provided in Appendix A, comprises three sections. The first section covers the attitudes and decisions relating to the respondents' personal antibiotic use. The section begins with relatively benign questions about the use of the Internet for health information, as a way of providing

some simple and uncontroversial questions to build momentum for the respondent. An attempt was made in the questionnaire to generate specific data on websites used for health information through open-text responses (questions 6 and 55) to replicate and extend the classifications used in Section 3.4. Unfortunately the data that these questions generated were unusable, and so the analyses of this Chapter focus on the frequency with which the Internet is used as a source of health information and the relative trust that respondents place in the sources they use on the Internet relative to health professionals. The second section covers demographic information, with questions providing literature-evidenced controls to assist with analysis to unpack whether any relationships found are related to pet-ownership or to socio-economic differences between pet-owners and non-owners. They will also allow the data to be meaningfully compared to relationships and trends already present in the literature. This section is not placed at the top of the questionnaire as opening with personal demographic questions has been shown to be offputting to some respondents (Oppenheim 1992). The final section covers the respondents' attitudes and decisions concerning the use of antibiotics on their companion animals. The questions are mirrors of some earlier questions from the first section, with some qualifying questions about their companion animals. The behaviour-orientated questions, present in the first (human-focused) and third (pet-focused) sections of the questionnaire, were derived from questions used in the Wellcome Monitor Wave 3 and Eurobarometer surveys examined in Chapter 3. These questions were tested and refined for those surveys, and were further tested and refined for this survey (as discussed in Chapter 4). Together, the questions used in this survey to measure participants' behaviours cover three functionally parallel areas in which antibiotic consumers make decisions in their own antibiotic consumption and administration to their companion animals: the acquisition of antibiotics, adherence to a course of antibiotics, and the disposal of leftovers. These questions are therefore based on literature precedent and adapted to the comparative requirements of this project.

An initial paper-based questionnaire was evaluated using cognitive interviewing (detailed in Chapter 4) and piloted in veterinary practices in mid-late 2018. Following this pilot, and the analysis of the 2018 wave of Eurobarometer data that was released in late February 2019 detailed in the second half of Chapter 3, the questionnaire was further adjusted and briefly piloted on the online panel Prolific Academic.

Section 5.2.2 – Survey Sampling Approach

The panel sample was clustered by NUTS2 region and by regional proportion of pet-ownership. In order to generate a sufficient sample size in each NUTS2 cluster to facilitate two-level mixed effects regression, a cluster size of 30 cases was targeted in each of the 33 NUTS2 regions following Kreft's (1996) simulation-based rule-of-thumb suggesting 30 cases within 30 clusters to avoid the underestimation of variance at either level. This resolution was used for two reasons. Firstly, it improves upon the geographic resolution used in Chapter 3 based on the NUTS1 regions available in

the Eurobarometer. Secondly, understanding regional variation in attitudes and behaviours in the context of antibiotic resistance may be important for the efficient dissemination of public health interventions, particularly if poor stewardship correlates with geographies of prescribing.

The online panel Prolific Academic (Prolific.ac) was used to recruit participants for this survey sample. Prolific.ac is an online panel originally designed by psychology researchers at the University of Oxford, which became a spin-out business for the purpose of recruiting samples predominantly for academic research. Prospective participants who join Prolific.ac pre-register their filter characteristics (such as being a pet-owner or not), and the panel then provides participants with studies that are recruiting for these characteristics. This is advantageous for research when compared to other online platforms such as MTurk or social media listings, as participants are not able to know in advance what characteristics may make them eligible for specific studies. Studies are created on the Prolific.ac panel by researchers, who provide information for participants on what the study is about, specify screening characteristics, an estimated time for completion, and payment per hour. The panel then advertises the study to relevant participants, who may choose to participate or not. The panel operates an ethical payment policy by which participants are paid a minimum of £5 per hour which is automatically monitored for the duration of each study. The Prolific.ac panel allowed for screening at either the NUTS1 region level or by postcode district due to the risks of de-anonymisation. The NUTS2 clusters were achieved in this sample by screening for postcode districts that were exclusively within the borders one NUTS2 region.

As pet-ownership was not a variable available for the propensity weighting model, each NUTS2 region was sampled to reflect regional pet-ownership totals. These regional totals were based on the People's Dispensary for Sick Animals (PDSA) Animal Wellbeing Report 2018 (PAW Report). Regional reports are provided by the PAW Report, which include the percentage of adults in each region that own a pet, and a breakdown of this ownership by dog, cat, and rabbit. London has relatively low pet-ownership at 38% compared to the UK average of 49% in the PAW Report. For this reason, London was oversampled with the target of 40 cases per NUTS2 region to ensure that there would be enough London-based pet-owners in the sample whilst maintaining the ratio of pet-owners and non-owners for the region.

Each NUTS2 cluster was associated with four mutually exclusive studies on the Prolific.ac panel. For each region, a study linked to the non-owner questionnaire was launched alongside a study screening for dog ownership linked to the pet-owner questionnaire. Once the dog ownership study was complete, a cat ownership screening study was launched that also screened out previous respondents to the questionnaire. Once the cat ownership study was complete, the rabbit owner screening study would be launched also screening out previous participants. The PAW Report does not report mixed pet-ownership totals (for example, the percentage of dog owners that also own a cat or a rabbit), so it

was not possible to judge the accuracy of the sample in this regard. At minimum, for a region in which all studies were completed with their target number of respondents, there would be at least the number of dog, cat, rabbit, and petless respondents presented by the PAW Report. These totals are inevitably inflated in the sample by pet-owners that own multiple screened pets, for example by owners of both dogs and cats who responded to the questionnaire in either the dog-screened or cat-screened sub-studies.

The totals achieved in the sample, with comparison to the regional percentages from the PAW Report, are shown in Table 9. There was some variation in the success of the sampling approach in adhering to the PAW Report region totals. This was generally due to low populations in the panel for the combination of screeners used, for example in East Riding and North Lincolnshire there were few non-owners in the panel, and in two Yorkshire and The Humber and three London regions there were no responses from rabbit owners in the panel. The median difference in percentage of pet-owners between the sample and PAW Report totals was 2% with a standard deviation of 5.3%, and a standard deviation of 2.2% with outliers North Yorkshire and East Riding & North Lincolnshire removed, which represents a reasonable success with most of the 33 sampled NUTS2 regions being proximate to the PAW Report's regional totals for pet-ownership.

Table 9. Survey sample regional pet-owner totals.

NUTS1	NUTS2	Region Sample Total	Pet-owner	Dog Owner	Cat Owner	Rabbit Owner	Non Owner	Sample Pet-owner Percent	PAW Owner Percent	Sample - PAW Difference
North East England	**Tees Valley and Durham**	31	15	9	8	1	16	48	48	0
	Northumberland and Tyne and Wear	31	15	9	8	1	16	48	48	0
North West England	**Cumbria**	32	16	9	7	1	16	50	48	2
	Cheshire	31	15	5	7	2	16	48	48	0
	Greater Manchester	31	16	10	9	2	15	52	48	4
	Lancashire	31	15	8	9	1	16	48	48	0
	Merseyside	31	15	8	7	0	16	48	48	0
Yorkshire and The Humber	**East Riding and North Lincolnshire**	24	15	8	7	3	9	63	48	15
	North Yorkshire	20	15	12	7	2	5	75	48	27
	South Yorkshire	28	16	11	8	0	12	57	48	9
	West Yorkshire	33	15	7	9	0	18	45	48	-3
East Midlands	**Derbyshire and Nottinghamshire**	30	16	9	9	2	14	53	53	0
	Leicestershire, Rutland, and Northamptonshire	29	16	9	9	2	13	55	53	2
	Lincolnshire	30	16	11	11	3	14	53	53	0

West Midlands	**Herefordshire, Worcestershire and Warwickshire**	31	17	7	10	1	14	55	53	2
	Shropshire and Staffordshire	29	15	10	8	2	14	52	53	-1
	West Midlands	30	16	9	12	1	14	53	53	0
East of England	**East Anglia**	31	17	9	13	2	14	55	53	2
	Bedfordshire and Hertfordshire	31	17	12	12	3	14	55	53	2
	Essex	31	17	9	11	1	14	55	53	2
London	**Inner London - West**	28	9	2	4	0	19	32	38	-6
	Inner London - East	40	15	7	11	0	25	38	38	-0
	Outer London - East and North East	40	15	5	10	0	25	38	38	0
	Outer London - South	40	15	8	8	1	25	38	38	0
	Outer London - West and North West	41	15	9	11	1	26	37	38	-1
South East England	**Berkshire, Buckinghamshire, and Oxfordshire**	31	17	6	9	1	14	55	52	3
	Surrey, East and West Sussex	31	17	8	7	1	14	55	52	3
	Hampshire and Isle of Wight	31	17	10	12	3	14	55	52	3
	Kent	31	17	8	9	1	14	55	52	3
South West England	**Gloucestershire, Wiltshire, and Bristol/Bath area**	33	19	10	12	1	14	59	52	7
	Dorset and Somerset	32	18	13	10	3	14	56	52	4
	Cornwall and Isles of Scilly	31	17	10	10	1	14	55	52	3
	Devon	31	17	8	11	2	14	55	52	3
		1035	523	285	305	45	512	51	49	

Section 5.2.3 – Propensity Score Weighting

Propensity score weights aim to up-weight participants that, based on a reference sample and specified regression model, are less likely to have participated in the nonprobability sample and down-weight those that are more likely to have participated in the sample. For example, in this study using an online panel sample this might mean up-weighting older or rural respondents and down-weighting younger or more urban respondents.

Following the work of Valliant & Dever (2011), Steinmetz *et al* (2014), and Ridgeway *et al* (2015), multiple approaches to utilising propensity score weighting were examined. These approaches were initially based on three logistic regression models predicting membership of the panel survey sample using demographic variables only, attitude/knowledge variables only, and a combination of demographic and attitude/knowledge variables. Four approaches to using the propensity scores to create weights were then examined, including the direct use of the inverse propensity score scaled by sample size, the use of subclass means of the scaled inverse propensity score, matching panel and reference observations based on propensity score with the panel observation inheriting the reference weight, and finally the product of the inherited weight and the inverse propensity score. These are laid out in greater detail below.

The combined dataset for the regression models contained the volunteer panel sample, and a reference sample comprised of the England subset of the 2016 and 2018 Eurobarometer waves. 285 observations with missing data were removed from the reference sample – this included 282 respondents that had not provided a substantive response to the political orientation scale question. Final sample sizes were 1035 in the panel sample, and 1451 in the reference sample. Reference sample weights were used in the regression models (panel sample weights were left as '1').

Internet panel samples may be demographically matched to random probability samples and remain attitudinally and behaviourally distinct. For this reason, propensity score weighting approaches were evaluated that included only demographics, only attitude and knowledge variables, and a combination of the two.

Following from the Chapter 3's discussion of political orientation and perceptions of individual responsibility, these two variables were included in the propensity score attitude/knowledge section. Given the study's focus on companion animals and veterinarians, the Eurobarometer Likert-type question on whether sick farm animals should be treated with antibiotics was also included. Finally, the true/false question of whether or not antibiotics cause side effects was included as it was the only knowledge measure used that was identical in both the panel survey and Eurobarometer.

As discussed in Chapters 2 and 3, age, sex, and employment are all characteristics that have been associated in the literature with pet-ownership and antibiotic resistance-related behaviours, whilst

geographic variables have been associated with pet-ownership and, in Chapter 3, antibiotic resistance-related behaviours. The size of a household, and in particular the number and age of children in the household, have also been associated with pet-ownership.

The three logistic regression models utilised variables measured in both the panel sample and the reference sample. The first model contained demographic characteristics, the second contained attitude and knowledge variables, and the final model contained all variables from the first two models. The variables included are listed in Table 10.

Table 10. Variables included in propensity score logistic regression models.

Demographic Model	**Attitude/Knowledge Model**
Age	Political orientation
Sex	Antibiotic resistance is best addressed at the individual level
Employment status	Sick farm animals should be treated with antibiotics
Number of children <10 years	Antibiotics cause side effects (e.g. diarrhoea)
Number of children 10-14 years	
Community size	
NUTS1 region	

The general logistic regression model was specified in the form of Equation 1, with the combined demographic and attitudinal model containing all 11 predictor variables. The demographic and attitudinal models take the same form, but only utilise the variables in the relevant column of Table 10. Y_i was a binary variable with two categories: Eurobarometer respondent (0) and panel sample respondent (1).

Equation 1 Regression Equation

$$p_i = \beta_0 + \beta_1 X_{1i} + \cdots \beta_{11} X_{11i} + \varepsilon_i$$

The predicted probability (p_i) derived for each respondent from each fitted model was used as the propensity score in the four approaches outlined above, explained in greater detail below.

The four uses of propensity scores as weights were as follows:

1) The inverse of the propensity score scaled by sample size used directly as a weight: **$(1/p_i)$ x (1035/2486)**.
2) The combined set of propensity scores partitioned into 5 subclasses, and the average propensity for each subclass calculated and the inverse used as a weight – again scaled by

sample size: **$1/p_{class}$ x (1035/2486)**. The aim of this approach is to reduce the variability of weights produced in approach 1.

3) Panel respondents are matched on propensity scores to the Eurobarometer respondents, and **inherit the weight of the matched Eurobarometer respondent**.
4) The product of inherited weight (approach 3) and approach (1) used as weight: **$((1/p_i)$ x (1035/2486)) x inherited weight**.

The characteristics of these weights are provided in Table 11. The fourth set of weights (product of inherited and scaled inverse propensity score) had the highest ratio of maximum to minimum weight, along with a consistently high coefficient of variation. This suggests that these weights would be the most problematic as they would give too great importance to a small number of observations compared to the other weighting approaches. As expected, the unclassed weights had higher ratios and coefficients of variation than the classed weights, demonstrating that the classed weights had correctly served their purpose of reducing the wide variability of the inverse propensity score weights.

Table 11. Description of weights.

Weights	Coef of Variation	Min	Max	Ratio
Approach 1: Social	63.79	0.46	6.43	13.85
Approach 1: Attitudinal	35.05	0.58	3.53	6.12
Approach 1: Combined	80.48	0.44	10.25	23.55
Approach 2: Social	58.58	0.61	3.30	5.40
Approach 2: Attitudinal	31.37	0.70	1.68	2.42
Approach 2: Combined	71.62	0.58	3.79	6.56
Approach 3: Social	56.00	0.33	3.00	9.09
Approach 3: Attitudinal	60.47	0.33	3.00	9.09
Approach 3: Combined	55.83	0.33	3.00	9.09
Approach 4: Social	70.15	0.18	6.99	39.42
Approach 4: Attitudinal	72.52	0.19	6.51	34.20
Approach 4: Combined	81.87	0.17	8.92	51.95

A selection of the effects of the weights on the panel sample's bias are shown in Table 12 (the full table of effects is presented in Appendix B Table 1). In general the propensity score weights (approaches 1 and 2) performed better than the inherited weights (approaches 3 and 4) in addressing bias. The demographic-only model propensity score weights provided reasonable reductions in bias on demographic variables, with reduced – though still present – efficacy on attitudinal variables. There was a similar story for the attitude-only model, as the weights from this model provided reasonable reductions in bias on attitudinal variables but much smaller or reversed effects on estimates of demographic variables.

The combined models' weights provided comparable performance on all of the variables that the demographic-only and attitude-only weights had reasonable effects on. This suggests that the most effective weighting method to simulate the representativeness of the Eurobarometer sample across both demographic and attitudinal characteristics is to control both demographic and attitudinal differences between the reference and panel samples in the weights themselves. The weights calculated using approach 1 show slight improvements over the weights calculated using approach 2. However, given that approach 1 will likely inflate standard errors in regression analyses due to the higher range of weights produced, the weights calculated using approach 2 from the combined model will be used for analyses.

Table 12. Sample of effects of weights on sample biases (Full table in Appendix B Table 1).

Variable	Reference	Unweighted Panel	Approach 1: Demographic	Approach 1: Attitudinal	Approach 1: Combined	Approach 2: Demographic	Approach 2: Attitudinal	Approach 2: Combined
Age (Mean)	47.53	37.02	42.13	37.80	42.50	41.80	37.73	42.06
Bias		*-10.50*	*-5.39*	*-9.73*	*-5.03*	*-5.72*	*-9.80*	*-5.46*
Bias Change			*5.11*	*0.78*	*5.48*	*4.78*	*0.71*	*5.04*
Female (%)	50.27	62.61	51.87	63.24	51.91	53.35	63.38	52.65
Bias (%)		*12.34*	*1.60*	*12.96*	*1.63*	*3.08*	*13.11*	*2.38*
Bias Change (%)			*-10.74*	*0.63*	*-10.70*	*-9.25*	*0.77*	*-9.96*
Not Working (%)	46.48	9.86	38.99	28.13	40.10	38.16	27.95	38.96
Bias (%)		*-36.63*	*-7.49*	*-18.35*	*-6.39*	*-8.32*	*-18.54*	*-7.53*
Bias Change (%)			*29.14*	*18.28*	*30.24*	*28.31*	*18.09*	*29.10*
Large Town (%)	32.27	42.80	37.80	40.77	37.10	38.10	40.88	37.79
Bias (%)		*10.53*	*5.53*	*8.49*	*4.83*	*5.83*	*8.61*	*5.52*
Bias Change (%)			*-5.00*	*-2.04*	*-5.70*	*-4.70*	*-1.92*	*-5.01*
Left-Right Placement (Mean of 1-10 scale)	5.12	4.48	4.61	4.91	4.95	4.60	4.84	4.89
Bias		*-0.64*	*-0.51*	*-0.21*	*-0.17*	*-0.52*	*-0.27*	*-0.23*
Bias Change			*0.14*	*0.43*	*0.47*	*0.13*	*0.37*	*0.41*
Agree Sick Farm Animals Should be Treated with Antibiotics (%)	75.73	80.00	80.74	80.86	81.35	80.85	80.72	81.39
Bias (%)		*4.27*	*5.01*	*5.13*	*5.63*	*5.12*	*5.00*	*5.66*
Bias Change (%)			*0.74*	*0.86*	*1.35*	*0.85*	*0.72*	*1.39*

Variable	Reference	Approach 3: Demographic	Approach 3: Attitudinal	Approach 3: Combined	Approach 4: Demographic	Approach 4: Attitudinal	Approach 4: Combined
Age (Mean)	47.53	35.57	36.79	35.91	39.68	37.52	40.47
Bias		*-11.96*	*-10.74*	*-11.62*	*-7.85*	*-10.01*	*-7.06*
Bias Change		*-1.45*	*-0.24*	*-1.11*	*2.66*	*0.50*	*3.45*
Female (%)	50.27	65.45	60.60	64.86	56.06	61.39	55.32
Bias (%)		*15.17*	*10.33*	*14.59*	*5.79*	*11.12*	*5.04*
Bias Change (%)		*2.84*	*-2.01*	*2.25*	*-6.55*	*-1.22*	*-7.29*
Not Working (%)	46.48	24.62	26.29	25.57	33.88	26.49	35.40
Bias (%)		*-21.86*	*-20.20*	*-20.92*	*-12.61*	*-19.99*	*-11.08*
Bias Change (%)		*14.77*	*16.43*	*15.71*	*24.02*	*16.64*	*25.55*
Large Town (%)	32.27	41.19	41.80	42.01	37.06	39.91	37.18
Bias (%)		*8.92*	*9.52*	*9.74*	*4.79*	*7.64*	*4.90*
Bias Change (%)		*-1.61*	*-1.01*	*-0.79*	*-5.74*	*-2.89*	*-5.63*
Left-Right Placement (Mean of 1-10 scale)	5.12	4.44	4.53	4.40	4.53	4.94	4.82
Bias		*-0.68*	*-0.59*	*-0.72*	*-0.59*	*-0.18*	*-0.30*
Bias Change		*-0.04*	*0.06*	*-0.07*	*0.05*	*0.46*	*0.35*
Agree Sick Farm Animals Should be Treated with Antibiotics (%)	75.73	80.17	79.13	79.25	81.15	80.16	80.37
Bias (%)		*4.45*	*3.41*	*3.53*	*5.43*	*4.43*	*4.64*
Bias Change (%)		*0.17*	*-0.87*	*-0.75*	*1.15*	*0.16*	*0.37*

Section 5.3 – Results

Section 5.3.1 – Descriptive Statistics

The first aim of the survey was to investigate the patterning of behaviours and attitudes relevant to antibiotic resistance, and the first results to be examined descriptively here are the outcome variables that represent this first area of interest. The second aim was to examine contextual knowledge and attitudes, and the description of these results follows later.

Figure 4 visualises the weighted percentage distributions of different behaviours within the survey sample, grouped by human- (complete sample) and pet-orientated (pet-owning sample) sets of behaviours reported in the survey. These questions are grouped together in this way as 'behaviour' to reflect different components of the antibiotic-consumption process in which consumers make decisions: the acquisition of antibiotics, adherence to prescriptions, and disposal of leftovers. These areas are functionally parallel between personal consumption and pet-focused administration, and this grouping enables a comparative analysis between these aspects of antibiotic-consumption behaviour across both human- and pet-orientated consumption in which pet-owners have to make decisions.

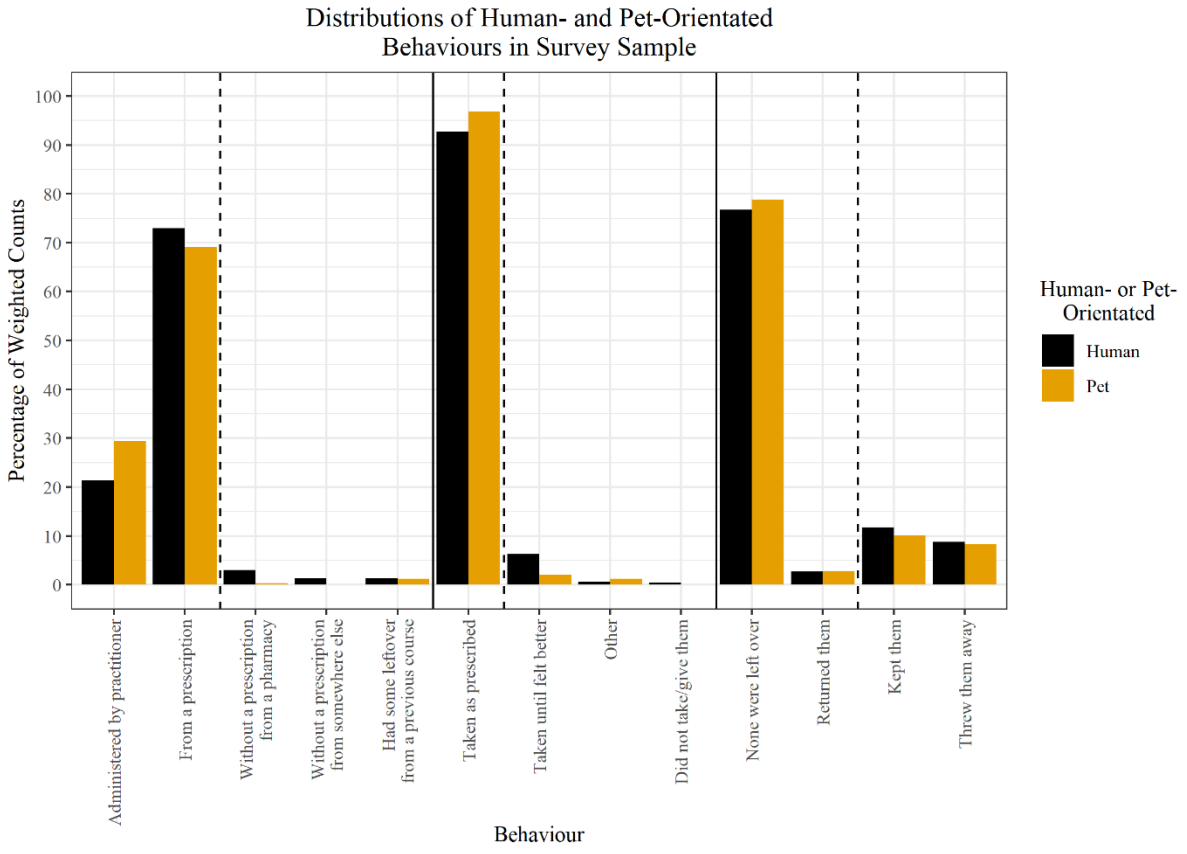

Figure 4. Distribution of human- and pet-orientated behaviours. Behaviours on the left of each dashed line represent positive stewardship for the relevant behaviour group.

The majority of respondents in both human- and pet-orientated antibiotic acquisition, consumption, and disposal behaviours exhibited good stewardship behaviours, with a lower percentage of pet-owners exhibiting poor pet-related antibiotic stewardship responses relative to the complete sample's human-orientated responses.

Pet-owners' aggregated poor (right of the dashed vertical lines in each are) and good (left of the dashed lines) stewardship responses were compared for each area (acquisition, consumption, and leftovers) with weighted χ^2 tests. Sufficient evidence for the rejection of null hypotheses was taken to be a p-value below 0.050 for these tests. There was evidence to reject the hypothesis that parallel acquisition behaviours were independent of one another (χ^2=11.4, df=1, p<0.001). Of the 263 (weighted) pet-owning respondents who had themselves consumed antibiotics and had also administered them to their pets, 250 reported a good human-orientated acquisition behaviour. Of these 250, two (0.8%) reported a poor pet-orientated acquisition behaviour. Of the remaining 13 who reported a poor human-oriented acquisition behaviour two (15%) respondents also reported a poor pet-orientated acquisition behaviour.

Respondents' behaviour with regards to leftovers were also found not to be independently distributed from one another (χ^2=56.0, df=1, p<0.001). Of the 218 pet-owners who reported a good human-orientated stewardship behaviour in this context, 22 (10%) reported a poor pet-orientated stewardship behaviour. Of the 44 pet-owners who reported a poor human-orientated stewardship behaviour, 25 (57%) also reported a poor pet-orientated stewardship behaviour.

In contrast, there was insufficient evidence (χ^2=1.88, df=1, p=0.170) to reject the hypothesis that poor stewardship responses in the context of how the antibiotics were consumed/administered were independent from one another across human- and pet-related administration. In this area, of the 244 pet-owners reporting a good personal consumption behaviour seven (3%) reported a poor pet-orientated administration behaviour. Of the 19 pet-owners who reported a poor personal consumption behaviour, two (11%) also reported a poor pet-orientated administration behaviour.

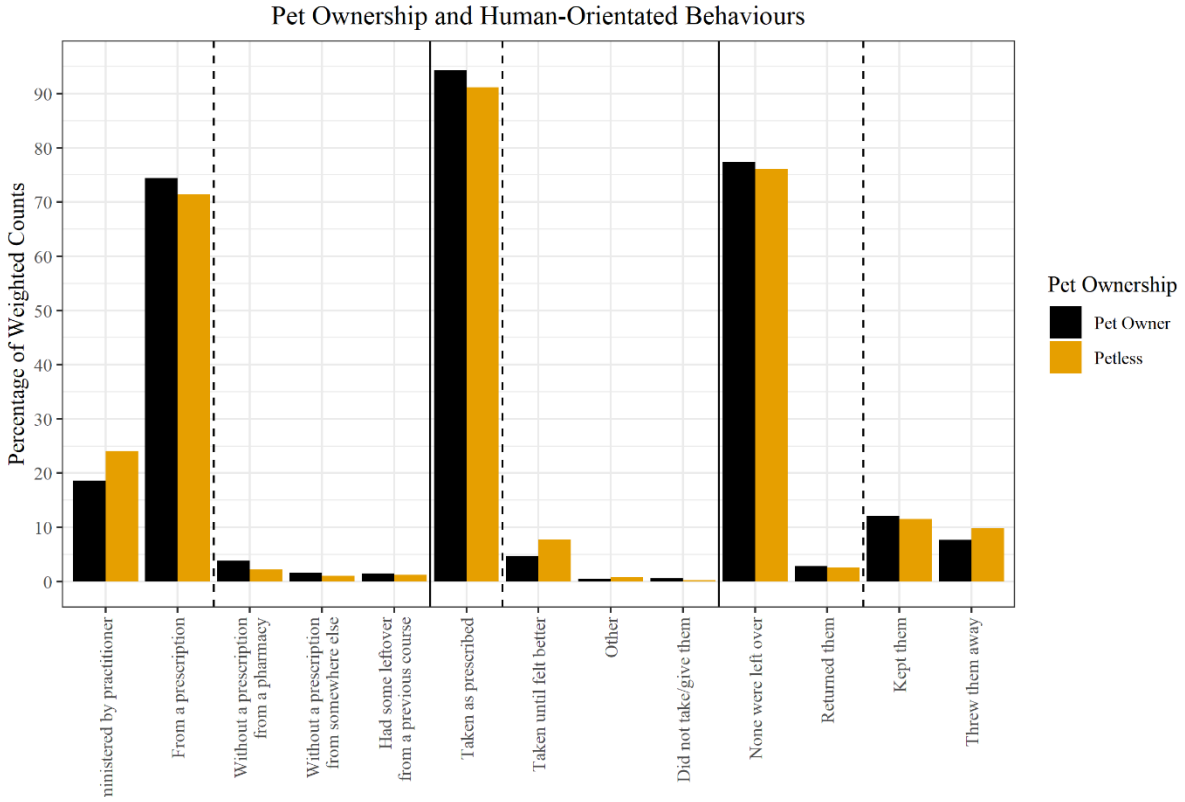

Figure 5. Pet-ownership and human-orientated behaviours.

Figure 5 visualises human-orientated behaviours comparing the percentages of responses in each group of behaviours between pet-owners and petless respondents. There was insufficient evidence to suggest that the any of the aggregate number of poor acquisition (χ^2=2.79, df=1, p=0.095), consumption (χ^2=3.47, df=1, p=0.063), or leftover disposal (χ^2=0.35, df=1, p=0.55) responses were associated with pet-ownership.

Of the 996 respondents who reported having taken antibiotics, 939 provided a good stewardship response in the context of acquisition. Of these, 456 (49%) were pet-owners. Of the 57 respondents who provided a poor stewardship response here, 34 (60%) were pet-owners. In the context of antibiotic consumption, 462 (50%) of the 923 respondents providing a good stewardship response and 28 (38%) of the 73 respondents providing a poor stewardship response were pet-owners. In the context of leftover antibiotics, 393 (50%) of the 791 respondents reporting a good stewardship

behaviour and 97 (47%) of the 205 respondents reporting a poor stewardship behaviour were pet-owners.

Stewardship levels in the context of antibiotic acquisition and disposal, on this evidence, are generally not distinct between human- and pet-orientated contexts and are also not distributed differently between pet-owners and petless respondents. The only difference arising from these hypothesis tests using these data are in the context of pet-owners' human-orientated consumption and pet-orientated administration behaviours, which have statistically significantly different aggregate distributions.

For further analyses of levels of stewardship, these behaviour variables were further aggregated initially to the number of poor stewardship responses per respondent, and later for regression analyses to binary comparisons of respondents with any poor responses and respondents with none. Table 13 presents the weighted distributions in the complete, petless, and pet-owning samples of the initial aggregation of responses to these antibiotic stewardship questions and to Likert-type questions on respondents' attitudes towards doctors and veterinarians in the context of adhering to instructions when administering antibiotics. Table 14 presents distributions of contextual knowledge and attitudinal outcomes.

Both human- and pet-orientated behaviour were distributed with a clear majority of respondents reporting no poor stewardship responses. Due to the rarity of less desirable behaviours and attitudes in the sample the behaviour variables were binarized for analyses to respondents with no poor responses contrasted with all other respondents, and the attitude variables (agreement with following instructions) reduced to three groups with respondents that strongly agreed with the statements (point seven on the Likert-type scales), respondents that expressed some agreement (points five and six on the Likert-type scales), and respondents that did not express any agreement (points one through four).

There was insufficient evidence that overall levels of human-orientated behaviour and pet-ownership were related to each other (χ^2=5.01, df=3, p=0.17), however there was evidence that for the pet-owning sample human- and pet-orientated behaviour were not independent from one another (χ^2=75.64, df=9, p<0.01). For the attitudinal outcomes, there was no evidence that either agreement that doctors or veterinarians instructions should always be followed were related to pet-ownership (χ^2=11.08, df=6, p=0.09; χ^2=6.87, df=6, p=0.33), and in both the complete and pet-owning samples responses to these questions were associated with each other (χ^2=461.30, df=4, p<0.01; χ^2=287.08, df=4, p<0.01) based on evidence from weighted chi-square tests. Together these results provide an initial suggestion that these attitudes and behaviours within this sample are not distributed significantly differently between pet-owners and people without pets, and, in terms of overall stewardship levels, respondents' parallel behaviours and attitudes between medical and veterinary spheres generally closely resemble one other.

There was no evidence that levels of knowledge about what antibiotics are useful to treat in either humans (χ^2=2.79, df=4, p=0.59) or animals (χ^2=3.67, df=4, p=0.45) were associated with pet-ownership, though they were associated with each other (χ^2=636.66, df=12, p<0.01) on the evidence of the weighted chi-square tests. There was no evidence that either levels of knowledge about the cross-species aspects of antimicrobial resistance (χ^2=2.32, df=3, p=0.51) nor levels of trust in online health sources relative to GPs (χ^2=6.94, df=4, p=0.14) were dependent on pet-ownership. Levels of trust in online health sources relative to GPs and relative to veterinarians were however associated with each other in the pet-owning sample (χ^2=321.77, df=16, p<0.01). Together these results provide an initial suggestion that these contextual knowledge and attitude variables are not associated with pet-ownership, and again that the parallel medical/veterinary variables were closely related to one another.

Table 13. Weighted distributions of behaviour-related outcomes.

	Complete Sample		Petless Only		Pet-owners Only	
Variable	**Weighted N**	**Weighted %**	**Weighted N**	**Weighted %**	**Weighted N**	**Weighted %**
Human-Oriented Behaviour (Number of poor stewardship responses)						
0	774	*77.7*	396	*78.3*	378	*77.0*
1	139	*14.0*	61	*12.0*	78	*16.0*
2	62	*6.2*	36	*7.2*	25	*5.2*
3	22	*2.2*	13	*2.6*	9	*1.8*
Pet-Orientated Behaviour (Number of poor stewardship responses)						
0	-	-	-	-	220	*80.7*
1	-	-	-	-	46	*16.9*
2	-	-	-	-	5	*1.7*
3	-	-	-	-	2	*0.7*
Doctors' instructions should be followed when taking antibiotics						
7 - Strongly Agree	685	*64.6*	296	*59.2*	326	*65.2*
6	224	*21.1*	116	*23.2*	101	*20.1*
5	77	*7.3*	42	*8.5*	34	*6.7*
4 - Neither Agree nor Disagree	33	*3.1*	15	*3.0*	14	*2.7*
3	13	*1.2*	3	*0.6*	12	*2.5*
2	15	*1.4*	6	*1.3*	9	*1.9*
1 - Strongly Disagree	14	*1.3*	5	*0.9*	5	*0.9*
Veterinarians' instructions should be followed when administering antibiotics						
7 - Strongly Agree	761	*71.7*	345	*69.0*	363	*72.6*
6	166	*15.7*	77	*15.5*	86	*17.2*
5	50	*4.7*	21	*4.2*	18	*3.7*
4 - Neither Agree nor Disagree	53	*5.0*	28	*5.7*	19	*3.9*
3	9	*0.8*	3	*0.5*	5	*0.9*
2	3	*0.3*	0	*0.0*	3	*0.5*
1 - Strongly Disagree	19	*1.8*	9	*1.8*	6	*1.3*

Table 14. Weighted distributions of knowledge and attitude outcomes.

	Complete Sample		Petless Only		Pet-owners Only	
Variable	**Weighted N**	**Weighted %**	**Weighted N**	**Weighted %**	**Weighted N**	**Weighted %**
Multispecies Knowledge Score						
0	189	*17.8*	103	*18.8*	85	*16.7*
1	297	*28.0*	158	*28.8*	139	*27.2*
2	312	*29.4*	151	*27.5*	161	*31.5*
3	262	*24.7*	136	*24.9*	126	*24.6*
Human Treat Score						
-3	2	*0.2*	2	*0.4*	0	*0.0*
-2	41	*3.9*	19	*3.4*	22	*4.4*
-1	125	*11.8*	67	*12.3*	58	*11.3*
0	284	*26.7*	146	*26.6*	137	*26.8*
1	608	*57.4*	314	*57.3*	294	*57.5*
Animal Treat Score						
-3	3	*0.3*	2	*0.4*	1	*0.1*
-2	51	*4.8*	30	*5.5*	20	*4.0*
-1	142	*13.4*	78	*14.1*	64	*12.5*
0	297	*28.0*	144	*26.3*	152	*29.7*
1	569	*53.6*	295	*53.6*	274	*53.6*
Trust Internet vs. Doctor						
Internet Much Less	213	*20.2*	101	*18.5*	113	*22.1*
Internet Slightly Less	344	*32.6*	171	*31.5*	172	*33.7*
About the Same	398	*37.7*	220	*40.4*	178	*34.9*
Internet Slightly More	71	*6.7*	41	*7.5*	30	*5.9*
Internet Much More	29	*2.8*	11	*2.1*	18	*3.5*
Trust Internet vs. Vet						
Internet Much Less	-	-	-	-	116	*22.8*
Internet Slightly Less	-	-	-	-	177	*34.6*
About the Same	-	-	-	-	172	*33.6*
Internet Slightly More	-	-	-	-	29	*5.6*
Internet Much More	-	-	-	-	18	*3.5*

Section 5.3.2 – Respondent Participation and Attention Levels Associated with Survey Outcomes

Online survey panels can suffer from so-called 'professional respondents' and deficits of attention. Testing the outcome variables for independence from respondents' levels of participation in the online panel and the number of attention check questions they failed is necessary for understanding the effect of the sampling approach on the outcomes of interest. Tables 15, 16, and 17 present the results of linear regressions testing the relationships between outcome variables and the number of studies previously done by respondents, adjusted for the type of questionnaire, and the results of weighted χ^2 tests for independence between the outcome variables and attention check question failures. For the regressions in Table 15, the dependent variable was the number of studies a participant had previously participated in and the independent variables were outcome variables to be used in the main analysis. Each regression controlled for the questionnaire type the participant responded to.

Table 15. Respondents' panel participation and key outcome variables.

Linear regressions of the number of studies a participant has previously participated in (n=1035 except for Pet Orientated Behaviour and Trust in Internet Compared to Vet where n=523)			
Independent Variable (Controlling for Questionnaire Type)	**Estimate**	**p**	**R^2**
Pet-owner	-10.38	0.450	0.001
Human Orientated Behaviour (Binary)	-25.12	0.014*	0.004
Pet Orientated Behaviour (Binary)	-30.33	0.232	0.001
Following Doctors' Instructions (Reference: Total Agreement)			
Some Agreement	5.29	0.732	0.004
No Agreement	-66.09	0.016*	0.004
Following Vet' Instructions (Reference: Total Agreement)			
Some Agreement	12.96	0.453	0.002
No Agreement	-26.51	0.302	0.002
Multispecies Knowledge Score	10.03	0.128	0.001
Human Treat Knowledge	2.45	0.761	0.001
Animal Treat Knowledge	1.84	0.811	0.001
Trust in Internet Compared to GP (Reference = 'About the same')			
Trust Internet much less	-37.75	0.047*	0.008
Trust Internet slightly less	21.26	0.196	0.008
Trust Internet slightly more	44.62	0.121	0.008
Trust Internet much more	40.06	0.350	0.008
Trust in Internet Compared to Vet (Reference = 'About the same' (Pet-owners only))			
Trust Internet much less	-28.56	0.276	0.001
Trust Internet slightly less	-31.12	0.184	0.001
Trust Internet slightly more	-22.83	0.605	0.001
Trust Internet much more	-100.24	0.0652	0.001
Number of Attention Check Fails	-20.89	0.160	0.001
Attention Check 1 Fail	-26.62	0.186	<0.001
Attention Check 2 Fail	-10.03	0.467	0.001
Attention Check 3 Fail	-36.31	0.357	0.001

There was insufficient evidence for a significant relationship between attention check failures and levels of previous participation in the panel. There was however evidence for three outcome variables having associations with respondent panel participation. All three associations were negative, with each additional poor human-related stewardship response associated with having taken part in 25 fewer studies (p=0.014), respondents reporting much less trust in the Internet compared to their GP being associated with taking part in 38 fewer studies (p=0.047) than respondents that rate online health information and their GP 'about the same', and respondents that reported no agreement with following doctors instructions being associated with 66 fewer studies (p=0.016) than respondents reporting total agreement. The first and third examples may be examples of satisficing with respondents that have taken part in many studies providing socially desirable responses to these questions, and with this satisficing only occurring in regard to human-orientated attitudes and behaviours. However there is no specific evidence for this explanation of the results, and this would also not explain why respondents who reported much less trust in online health information compared to their GP are associated with fewer studies. This finding could perhaps be explained by panel members that make less use of the Internet, or rely on the Internet less for income, having less trust in the Internet as a source of health information about human health. This may be an area of interest for future social research, specifically examining the relationship between participation in panels like Prolific.ac and responses to Internet-related survey questions.

Owing to the fact that pet-owners and non-owners answered slighted different questionnaires, attention check questions were examined in relation to the outcome variables based on the complete sample, the pet-owning sample, and the petless sample. The number of attention check failures was tested, followed by each individual attention check question. In the complete sample and the pet-owning sample, the number of attention check questions failed was not independent from the simplified doctors' instructions Likert-type item (χ^2=25.01, df=6, p<0.001; χ^2=19.74, df=6, p=0.003). There was insufficient evidence to reject the hypothesis that petless respondents' responses were independent from the number of attention checks failed (χ^2=9.77, df=6, p=0.135), or to reject the hypotheses that any sample's responses to the equivalent veterinary question were independent of the number of attention checks failed (Complete: χ^2=10.33, df=6, p=0.111; Pet-Owning: χ^2=11.54, df=6, p=0.073; Petless: χ^2=4.61, df=6, p<0.001=0.595).

Table 16. Attention-check questions and behaviour-related outcomes.

Attention Check Fails: Weighted Chi Square Tests	**Complete Sample**			**Pet-owners**			**Petless**		
Variable	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**
Pet-owner	3.71	3	0.294	-	-	-	-	-	-
Human Orientated Behaviour (Binary)	5.31	3	0.151	4.30	3	0.230	4.20	3	0.241
Pet Orientated Behaviour (PO) (Binary)	-	-	-	6.83	3	0.078	-	-	-
Following Doctors' Instructions (Simplified)	25.01	6	0.000*	19.74	6	0.003*	9.77	6	0.135
Following Vet' Instructions (Simplified)	10.33	6	0.111	11.54	6	0.073	4.61	6	0.595
Attention Check 1 Failed: Weighted Chi Square Tests									
Variable	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**
Pet-owner	0.04	1	0.833	-	-	-	-	-	-
Human Orientated Behaviour (Binary)	1.89	1	0.169	4.04	1	0.044*	0.00	1	0.997
Pet Orientated Behaviour (PO) (Binary)	-	-	-	1.12	1	0.290	-	-	-
Following Doctors' Instructions (Simplified)	11.23	2	0.004*	8.89	2	0.012*	3.06	2	0.216
Following Vet' Instructions (Simplified)	4.51	2	0.105	3.80	2	0.150	1.89	2	0.388
Attention Check 2 Failed: Weighted Chi Square Tests									
Variable	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**
Pet-owner	3.47	1	0.063	-	-	-	-	-	-
Human Orientated Behaviour (Binary)	1.48	1	0.224	0.88	1	0.347	0.61	1	0.436
Pet Orientated Behaviour (Pet-owners) (Binary)	-	-	-	5.46	1	0.019*	-	-	-
Following Doctors' Instructions (Simplified)	13.53	2	0.001*	13.92	2	0.001*	0.22	2	0.894
Following Vet' Instructions (Simplified)	11.57	2	0.003*	9.35	2	0.009*	3.66	2	0.160
Attention Check 3 Failed: Weighted Chi Square Tests									
Variable	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**	**χ^2**	**df**	**p**
Pet-owner	0.08	1	0.777	-	-	-	-	-	-
Human Orientated Behaviour (Bin)	2.92	1	0.087	1.10	1	0.293	1.84		0.175
Pet Orientated Behaviour (Pet-owners) (Bin)	-	-	-	1.83	1	0.176	-	-	-
Following Doctors' Instructions (Simplified)	5.60	2	0.061	2.41	2	0.299	5.81		0.055
Following Vet' Instructions (Simplified)	1.44	2	0.487	4.07	2.00	0.131	1.21		0.545

Table 17. Attention-check questions and knowledge/attitude outcomes.

Attention Check Fails: Weighted Chi Square Tests	**Complete Sample**			**Pet-owners**			**Petless**		
Variable	χ^2	**df**	**p**	χ^2	**df**	**p**	χ^2	**df**	**p**
Multispecies Knowledge Score	9.17	9	0.422	14.28	9	0.113	5.09	9	0.826
Human Treat Knowledge	21.57	12	0.043*	16.89	9	0.051	19.43	12	0.079
Animal Treat Knowledge	45.71	12	0.000*	46.06	12	0.000*	22.94	12	0.028*
Trust in Internet Compared to GP	27.72	12	0.006*	19.95	12	0.068	22.91	12	0.028*
Trust in Internet Compared to Vet (Pet-owners)	-	-	-	40.41	12	0.000*	-	-	-
Attention Check 1 Failed: Weighted Chi Square Tests									
Variable	χ^2	**df**	**p**	χ^2	**df**	**p**	χ^2	**df**	**p**
Multispecies Knowledge Score	8.35	3	0.039*	9.39	3	0.025*	2.50	3	0.475
Human Treat Knowledge	14.44	4	0.006*	8.30	3	0.040*	11.35	4	0.023*
Animal Treat Knowledge	17.31	4	0.002*	12.84	3	0.012*	11.94	4	0.018*
Trust in Internet Compared to GP	12.37	4	0.015*	4.96	4	0.292	9.23	4	0.056
Trust in Internet Compared to Vet (Pet-owners)	-	-	-	11.13	4	0.025*	-	-	-
Attention Check 2 Failed: Weighted Chi Square Tests									
Variable	χ^2	**df**	**p**	χ^2	**df**	**p**	χ^2	**df**	**p**
Multispecies Knowledge Score	2.08	3	0.557	0.93	3	0.817	2.67	3	0.446
Human Treat Knowledge	21.35	4	0.000*	22.44	3	0.000*	1.59	4	0.810
Animal Treat Knowledge	35.87	4	0.000*	70.44	4	0.000*	5.69	4	0.223
Trust in Internet Compared to GP	12.15	4	0.016*	12.73	4	0.013*	3.38	4	0.496
Trust in Internet Compared to Vet (Pet-owners)	-	-	-	15.97	4	0.003*	-	-	-
Attention Check 3 Failed: Weighted Chi Square Tests									
Variable	χ^2	**df**	**p**	χ^2	**df**	**p**	χ^2	**df**	**p**
Multispecies Knowledge Score	2.37	3	0.500	9.42	3	0.024*	7.19	3	0.066
Human Treat Knowledge	5.15	4	0.272	1.20	3	0.752	8.11	4	0.088
Animal Treat Knowledge	24.21	4	0.000*	14.49	4	0.006*	11.86	4	0.018*
Trust in Internet Compared to GP	8.70	4	0.069	4.52	4	0.341	9.65	4	0.047*
Trust in Internet Compared to Vet (Pet-owners)	-	-	-	22.15	4.00	0.000*	-	-	-

The results of the first two individual attention check questions ("ACQ1" and "ACQ2") were not independent of responses to the 'following doctors' instructions' question in either the complete sample (ACQ1: χ^2=11.23, df=2, p=0.004; ACQ2: χ^2=13.53, df=2, p=0.001) or the pet-owning sample (ACQ1: χ^2=8.89, df=2, p=0.012; ACQ2: χ^2=13.92, df=2, p=0.001). Furthermore in the pet-owning sample the distribution of the binarized human-orientated behaviour variable was not independent of ACQ1 failures (χ^2=4.04, df=1, p=0.044), whilst the binarized pet-orientated behaviour variable was not independent of ACQ2 failures (χ^2=5.46, df=1, p=0.019). Finally, in both the complete and pet-owning samples there was dependence between ACQ2 and responses to the Likert-type item about following veterinary instructions (Complete: χ^2=11.57, df=2, p=0.003; Pet-Owning: χ^2=9.35, df=2, p=0.009).

The contextual knowledge and attitude outcome variables were collectively more associated with attention check failures. In the complete sample, responses to all three of levels of knowledge about the efficacy of antibiotics in humans (χ^2=21.57, df=12, p=0.043), knowledge about the efficacy of antibiotics in animals (χ^2=45.71, df=12, p<0.001), and levels of trust in online health information relative to a GP (χ^2=27.72, df=12, p=0.006) were contingent on the number of attention checks failed. When examined in the pet-owing and petless samples, pet-owning respondents' responses to questions about what antibiotics are useful to treat in animals (χ^2=1.57, df=12, p<0.001) and trust in online animal health sources compared to veterinarians (χ^2=40.41, df=12, p<0.001), and petless respondents' responses to questions about what antibiotics are useful to treat in animals (χ^2=22.94, df=12, p=0.028) and trust in online health sources compared to GPs (χ^2=22.91, df=12, p=0.028) were not independent from respondents' number of failed attention check questions.

Each of the attention check questions was individually associated with multiple variables. Weighted χ^2 tests provided evidence that ACQ1 was associated in the complete sample with all four of levels of knowledge about the multispecies nature of antimicrobial resistance (χ^2=8.35, df=3, p=0.039), levels of knowledge about what antibiotics are useful to treat in humans (χ^2=14.44, df=4, p=0.006) and animals (χ^2=17.31, df=4, p=0.002), and trust in online health information relative to a GP (χ^2=12.37, df=4, p=0.015). In the pet-owning samples, these associations were repeated for multispecies knowledge (χ^2=9.39, df=3, p=0.025), and human- (χ^2=8.30, df=3, p=0.040) and animal-related (χ^2=12.84, df=3, p=0.012) efficacy responses. Additionally, responses regarding trust in online animal health information relative to veterinarians (χ^2=11.13, df=4, p=0.025) were also not independent from responses to ACQ1 in the pet-owning sample. In the petless sample, only responses to questions about antibiotics' efficacy in humans (χ^2=11.35, df=4, p=0.023) and animals (χ^2=11.94, df=4, p=0.018) were associated with attention check question 1.

ACQ2 was associated with contextual outcome variables in the complete and pet-owning samples, but not the petless sample. In both the complete and pet-owning samples, the failure of the second attention check question was not independent from responses to questions about human- (Complete: χ^2=21.35, df=4, p<0.001; Pet-Owning: χ^2=22.44, df=3, p<0.001) and animal-related (Complete: χ^2=35.87, df=4, p<0.001; Pet-Owning: χ^2=70.44, df=4, p<0.001) antibiotic efficacy or trust in online health information compared to a GP (Complete: χ^2=12.15, df=4, p=0.016; Pet-Owning: χ^2=12.73, df=4, p=0.013). Additionally, ACQ2 was associated with responses in the pet-owning sample to the question on trust in online animal health information compared to veterinarians (χ^2=15.97, df=4, p=0.003).

ACQ3 was associated in the complete sample only with responses regarding the efficacy of antibiotics in animals (χ^2=24.21, df=4, p<0.001). In the pet-owning sample, ACQ3 was associated with responses regarding the multispecies nature of antimicrobial resistance (χ^2=9.42, df=3, p=0.024), animal-related antibiotic efficacy (χ^2=14.49, df=4, p=0.006), and trust in online health information compared to a veterinarian (χ^2=15.97, df=4, p=0.003). In the petless sample, animal-related antibiotic efficacy responses (χ^2=11.86, df=4, p=0.018) were also associated with ACQ3, along with responses regarding trust in online health information relative to a GP (χ^2=9.65, df=4, p=0.047).

The results of the attention check analyses suggest that for behaviour-related outcomes levels of attention throughout the questionnaire had effects upon different sections – though only clearly among pet-owners answering the longer questionnaire and with no apparent effect towards the end of the questionnaire. For the contextual outcome variables, levels of attention throughout the questionnaire appear to have had an effect on responses to knowledge and attitude questions.

ACQ1 and ACQ2 were in identical places for both questionnaires, suggesting that the differences between the pet-owning and petless samples in their responses is due to the prospect of responding to different lengths of survey, or a kind of 'anticipatory fatigue', rather than directly due to fatigue from having responded to questions. These differences were more prominent in the behaviour-related outcomes than the contextual outcomes. ACQ1 directly preceded questions about personal behaviour with antibiotics, whilst ACQ2 was directly preceding the demographic section. These results suggest that the responses of the pet-owning sample, who answered a longer questionnaire, may be more susceptible to the attention-related satisficing or other survey-related effects, particularly given differences expressed for all of the behaviour-related outcomes, and for the contextual outcomes in relation to ACQ2.

In order to compensate for the potential satisficing issues raised by the associations presented between respondents' panel participation and attention levels and their responses to key outcome variables, the regression analyses will include as controls the number of previous studies a respondent has

participated in and whether or not they failed any attention check questions in the fixed part of the models.

Section 5.3.3 – Contextual Attitudes

Bayesian mixed-effects regression models were fitted using the *brms* package in R (Bürkner 2019), with either 1035 respondents (complete sample) or 523 respondents (pet-owning sample) nested in 33 NUTS2 regions. The dependent variables of the models examining contextual attitudes were all ordinal, with the three knowledge models' variables moving from low-knowledge to high-knowledge. The multispecies knowledge response variable was the sum of correct responses to three questions (19, 21, and 22 on both questionnaires), whilst the two efficacy knowledge variables were constructed as the subtraction of each incorrect response (e.g. Antibiotics are useful to treat viral infections) and the addition of the one correct response (Antibiotics are useful to treat bacterial infections) creating a score from -3 (three incorrect and no correct responses) to 1 (no incorrect responses and one correct response) for each respondent. Positive associations for the independent variables therefore indicate a positive association with knowledge levels. The trust variables move from 1 as the Internet being much less trustworthy compared to either a GP or veterinarian through to 5 as the Internet being much more trustworthy compared to either a GP or veterinarian. Positive associations for these variables therefore indicate a negative association with trust in GPs or veterinarians compared to online health information.

Highlighted results are presented in Table 18 with odds ratios and 95% credibility intervals. If the interval did not include 1, the association between the independent and dependent variable was considered statistically significant. All models successfully converged with R-hat values of 1.00 for all estimates. Full regression model results are presented in the appendix due to the size of the tables. By showing only results that had statistical significance within comparable models, this presentation better highlights the differences between the models in terms of their patterns of significance.

Table 18. Highlighted regression results for contextual knowledge/attitude outcomes (full regression results are presented in Appendix B Table 2). Where the CIs do not include 1, significance is denoted with an asterisk. R^2 is Bayesian McKelvey-Zavoina Pseudo-R^2 (estimate with 95% confidence intervals).

Model 1				**Model 2**			
Trust in Internet Relative to Doctor (n=1030, R^2=0.143, 0.104-0.184)	**OR**	**2.5% CI**	**97.5% CI**	**Trust in Internet Relative to Vet (n=523, R^2=0.203, 0.144-0.263)**	**OR**	**2.5% CI**	**97.5% CI**
Age	1.445*	1.249	1.667	Age	1.246*	1.009	1.539
Male	0.961	0.762	1.213	Male	1.573*	1.084	2.280
Ref: Employed				*Ref: Employed*			
Not Working	1.415*	1.089	1.827	Not Working	1.548*	1.026	2.341
Self-Employed	1.913*	1.258	2.906	Self-Employed	1.898*	1.007	3.610
Dog	0.964	0.646	1.431	Dog	0.947	0.625	1.438
Cat	1.046	0.690	1.600	Cat	1.628*	1.025	2.572
Multiple Pet Types	0.848	0.507	1.391	Multiple Pet Types	0.258*	0.108	0.613
Had Pet as Child	0.805	0.593	1.102	Had Pet as Child	1.338	0.662	2.698
Ref: 'Never' or 'Less than once per month'				*Ref: 'Never' or 'Less than once per month'*			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	1.663*	1.261	2.209	Internet Use Frequency - 'Once per month' or 'more than once per month' (Pet Health)	2.560*	1.662	3.968
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	3.360*	2.413	4.677	Internet Use Frequency - 'Once per week' to 'Daily' (Pet Health)	3.179*	1.206	8.103
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.18	0.02	0.37	NUTS2 (Sd)	0.17	0.01	0.43
Variance Partition Coefficient	0.01	0.00	0.04	Variance Partition Coefficient	0.01	0.00	0.05

Model 3			
Interspecies Knowledge (n=1030, R^2=0.201, 0.158-0.245)	**OR**	**2.5% CI**	**97.5 % CI**
Age	1.124	0.976	1.289
Male	1.762*	1.382	2.226
Ref: Undergraduate Degree			
None of the Above	0.355*	0.156	0.809
GCSE	0.585*	0.414	0.828
A-Level	0.892	0.653	1.223
Postgraduate	1.233	0.880	1.709
Ref: Employed			
Not Working	1.828*	1.416	2.401
Self-Employed	1.920*	1.234	2.991
Ref: 'Never' or 'Less than once per month'			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	0.772	0.579	1.027
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	0.683*	0.487	0.945
Social Political Orientation	0.800*	0.697	0.914
Economic Political Orientation	1.212*	1.052	1.398
Human Antibiotic Efficacy Score	1.167	0.943	1.448
Animal Antibiotic Efficacy Score	1.398*	1.135	1.719
Ref: Strongly agree sick pets should be treated with antibiotics			
Disagree Sick Pets	2.158*	1.189	4.168
DK Sick Pets	0.359*	0.220	0.576
Tend to agree Sick Pets	1.016	0.788	1.309
Studies Done	1.065	0.947	1.193
Any ACQ Fail	1.505*	1.059	2.138
Random Effects	**Estimate**	**2.5% CI**	**97.5 % CI**
NUTS2 (Sd)	0.19	0.01	0.38
Variance Partition Coefficient	0.01	0.00	0.04

Model 4				Model 5			
Human Treatment Knowledge (n=1030, R^2=0.222, 0.176-0.271)	**OR**	**2.5% CI**	**97.5% CI**	**Animal Treatment Knowledge (n=1030, R^2=0.212, 0.166-0.260)**	**OR**	**2.5% CI**	**97.5 % CI**
Age	1.445*	1.231	1.688	Age	1.432*	1.230	1.679
Male	0.611*	0.470	0.796	Male	0.690*	0.534	0.891
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*			
None of the Above	1.825	0.674	5.552	None of the Above	1.074	0.448	2.673
GCSE	0.531*	0.361	0.781	GCSE	0.609*	0.420	0.878
A-Level	0.734	0.520	1.027	A-Level	0.859	0.614	1.200
Postgraduate	1.343	0.917	1.960	Postgraduate	1.451*	1.015	2.088
Pre-Existing Health Condition	1.489*	1.140	1.932	Pre-Existing Health Condition	1.403*	1.094	1.797
Medical Professional	1.484	0.995	2.248	Medical Professional	1.505*	1.018	2.267
Dog	1.365	0.842	2.164	Dog	1.098	0.719	1.696
Cat	1.390	0.861	2.215	Cat	1.051	0.674	1.680
Multiple Pet Types	0.641	0.371	1.155	Multiple Pet Types	0.848	0.486	1.442
Pet as Child	1.691*	1.199	2.340	Pet as Child	1.841*	1.330	2.530
Interspecies Knowledge	1.496*	1.321	1.698	Interspecies Knowledge	1.518*	1.341	1.726
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5 % CI**
NUTS2 (Sd)	0.18	0.01	0.41	NUTS2 (Sd)	0.24	0.02	0.47
Variance Partition Coefficient	0.01	0.00	0.05	Variance Partition Coefficient	0.02	0.00	0.06

To examine contextual attitudes, models were specified to examine associations between demographic, knowledge, attitude, and Internet-use variables and the knowledge- and attitude-related outcome variables. Independent variables again covering demographic areas including pet-ownership and local geography, attitude and knowledge variables covering both human- and pet-related areas, and Internet-use variables were specified with relevance to the sample. In models using the complete sample, Internet variables covered frequency of use for human health information and trust in online sources of health information compared to a GP. In models using only the pet-owning sample, Internet variables covered frequency of use for animal health information and trust in online sources of health information compared to a veterinarian. Five models were fitted:

1. Trust in Online Health Information relative to a GP
2. Trust in Online Health Information relative to a Veterinarian (Pet-owners Only)
3. Level of Knowledge About the Multispecies Nature of Antimicrobial Resistance
4. Level of Knowledge About the Efficacy of Antibiotics in Humans
5. Level of Knowledge About the Efficacy of Antibiotics in Animals

The collected models generally show similarities between the patterning of parallel variables (e.g. between doctors and vets, or human- and animal-related knowledge), with some variation in the evidence for significant associations with independent variables.

Trust in online health information about humans and animals relative to GPs and veterinarians respectively are patterned in generally similar ways based on this evidence. This is somewhat unsurprising, given the earlier reported descriptive finding that responses to these questions were not distributed independently from each other. Demographically, older respondents, self-employed, and unemployed respondents were all more likely to trust online sources of health information compared to either a GP or a veterinarian. Additionally in both cases, respondents who used the Internet more frequently to look up health information trusted these sources more than a medical professional. Some subtle distinctions were present, however. Male respondents, for example, were only more likely to trust an online health source than a veterinarian. Pet-ownership associations were only suggested in relation to levels of trust between online health sources and veterinarians, with cat owners suggested as more trusting of online sources whilst pet-owners with multiple species of pet were more trusting of veterinarians than online sources.

A similar situation arises from this evidence in terms of the patterning of respondents' knowledge about what antibiotics are useful to treat in humans and animals. Older respondents were more knowledgeable in both areas, as were respondents living with health conditions, whilst GSCE-level educated respondents were less knowledgeable in both areas compared to undergraduate degree holders. The only pet-related evidence present was that respondents who had pets when they were children were more knowledgeable about the uses of antibiotics again for treating both humans and

animals. Medical professionals in the sample were evidenced as being more knowledgeable than other respondents about what antibiotics could be used to treat in animals, but there was no evidence that they were more or less knowledgeable than other respondents in the context of the human health question. Postgraduate-educated respondents were also more knowledgeable in the animal-use context compared to undergraduate-educated respondents, but again there was no evidence in the human-health context. These differences in patterns suggest that there is a sub-population who are more engaged and aware of the challenge of antimicrobial resistance, and that this level of engagement manifests in differences between the social patterning of knowledge around the use of antibiotics in the contexts of human and animal health. Whether the differences between these areas of knowledge has any relation to behavioural attitudes will be examined in the next section of this chapter.

The final knowledge/attitude area that was examined was respondents' levels of knowledge about the interspecies aspects of antimicrobial resistance. This is an important area to consider in the context of antibiotic-related companion animal care given the close relationships between pet-owners and their companion animals and the effects of these on individual and household microbiomes. While there were some similarities between the patterning of this area of knowledge and the antibiotic-use areas, for example in terms of education, this area was predominantly patterned differently. More frequent users of the Internet for human health information tended to have poorer knowledge in this area, which was not the case for either area of antibiotic-use knowledge. Furthermore, this area was the only one in which there was evidence of respondents with differing social and economic political orientations having different levels of knowledge. In this case, movement on the seven point scale from social liberalism to social conservativism was associated with fewer correct responses whilst movement from economic liberalism to economic conservativism was associated with the reverse scenario.

There was low geographical variation evident for these outcome variables, low standard deviations estimated at the NUTS2 level and no evidence of significant associations between local geography (i.e. rural or small urban areas contrasted with large urban areas) and the outcome variables.

Table 19. Highlighted regression results for behaviour-related outcomes (full regression results are presented in Appendix B Table 3). Where the CIs do not include 1, significance is denoted with an asterisk. R^2 is Bayesian McKelvey-Zavoina Pseudo-R^2 (estimate with 95% confidence intervals).

Model 6				Model 7			
Human-Orientated Behaviour (n=1030, R^2=0.363, 0.288-0.466)	**OR**	**2.5% CI**	**97.5% CI**	**Pet-Orientated Behaviour (n=523, R^2=0.982, 0.781-1)**	**OR**	**2.5% CI**	**97.5% CI**
Fixed Effects				**Fixed Effects**			
Age	0.559*	0.440	0.702	Age	0.637	0.373	1.074
Male	1.647*	1.141	2.376	Male	1.927	0.831	4.409
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*			
None of the Above	0.048*	0.000	0.798	None of the Above	0.000*	0.000	0.000
GCSE	0.940	0.548	1.572	GCSE	2.794	0.824	9.755
A-Level	1.118	0.713	1.727	A-Level	1.797	0.659	4.967
Postgraduate	1.040	0.633	1.708	Postgraduate	1.401	0.417	4.556
Ref: Large Urban				*Ref: Large Urban*			
Rural	1.760*	1.047	2.903	Rural	2.691	0.880	8.409
Small Urban	1.385	0.928	2.086	Small Urban	1.434	0.540	3.814
Ref: No Children				*Ref: No Children*			
Child 0-3 years	1.173	0.589	2.303	Child 0-3 years	6.032*	1.624	21.112
Child 4-12 years	0.791	0.466	1.362	Child 4-12 years	1.181	0.382	3.560
Child 12-18	1.877	1.048	3.430	Child 12-18	1.360	0.371	4.836
Child 18+	0.919	0.469	1.827	Child 18+	0.076*	0.004	0.800
Dog	1.009	0.547	1.869	Dog	0.194*	0.066	0.521
Cat	0.730	0.399	1.338	Cat	0.491	0.168	1.364
Multiple Pet Types	1.292	0.614	2.696	Multiple Pet Types	5.429	0.799	46.165
Pet as Child	0.810	0.511	1.254	Pet as Child	2.282	0.444	14.479
Ref: 'Never' or 'Less than once per month'				*Ref: 'Never' or 'Less than once per month'*			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	1.039	0.669	1.626	Internet Use Frequency - 'Once per month' or 'more than once per month' (Pet Health)	3.894*	1.540	9.873

Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	1.268	0.773	2.096	Internet Use Frequency - 'Once per week' to 'Daily' (Pet Health)	0.659	0.054	5.273
Agreement/Disagreement with Following Doctors' Prescription Instructions	1.325*	1.135	1.546	Agreement/Disagreement with Following Doctors' Prescription Instructions	1.287	0.853	1.910
Agreement/Disagreement with Following Veterinarians' Prescription Instructions	1.093	0.925	1.279	Agreement/Disagreement with Following Veterinarians' Prescription Instructions	1.011	0.665	1.509
Human Antibiotic Efficacy Score	0.818	0.616	1.077	Human Antibiotic Efficacy Score	1.246	0.627	2.508
Animal Antibiotic Efficacy Score	0.716*	0.541	0.952	Animal Antibiotic Efficacy Score	0.709	0.366	1.408
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.22	0.01	0.51	NUTS2 (Sd)	1.02	0.36	1.80
Variance Partition Coefficient	0.01	0.00	0.07	Variance Partition Coefficient	0.24	0.04	0.50

Model 8				Model 9				Model 10			
Doctor Instruction Attitude (n=1030, R^2=0.248, 0.189-0.305)	**OR**	**2.5% CI**	**97.5% CI**	**Vet Instruction Attitude (n=1030, R^2=0.214, 0.161-0.271)**	**OR**	**2.5% CI**	**97.5% CI**	**Vet Instruction Attitude (Owners) (n=523, R^2=0.390, 0.298-0.482)**	**OR**	**2.5% CI**	**97.5% CI**
Fixed Effects				**Fixed Effects**				**Fixed Effects**			
Age	0.837*	0.706	0.995	Age	0.775*	0.647	0.931	Age	0.917	0.688	1.228
Male	1.984*	1.482	2.616	Male	2.472*	1.832	3.360	Male	2.315*	1.423	3.772
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*				*Ref: Undergraduate Degree*			
None of the Above	0.332	0.074	1.158	None of the Above	0.280	0.052	1.117	None of the Above	0.371	0.030	2.397
GCSE	1.046	0.691	1.609	GCSE	1.631*	1.051	2.537	GCSE	1.383	0.700	2.727
A-Level	0.692	0.471	1.011	A-Level	1.004	0.666	1.483	A-Level	0.838	0.447	1.475
Postgraduate	1.272	0.882	1.832	Postgraduate	1.223	0.816	1.809	Postgraduate	0.772	0.393	1.447
Ref: Large Urban				*Ref: Large Urban*				*Ref: Large Urban*			
Rural	1.521*	1.004	2.311	Rural	1.613*	1.050	2.448	Rural	2.372*	1.265	4.474
Small Urban	0.759	0.543	1.057	Small Urban	0.856	0.606	1.213	Small Urban	0.753	0.427	1.322
Ref: No Children				*Ref: No Children*				*Ref: No Children*			
Child 0-3 years	0.917	0.475	1.721	Child 0-3 years	1.102	0.581	2.061	Child 0-3 years	1.387	0.484	3.862

Child 4-12 years	1.682*	1.141	2.502	Child 4-12 years	1.366	0.892	2.053	Child 4-12 years	1.363	0.728	2.603
Child 12-18	0.395*	0.217	0.711	Child 12-18	0.654	0.361	1.135	Child 12-18	0.598	0.255	1.393
Child 18+	1.061	0.657	1.731	Child 18+	1.562	0.957	2.594	Child 18+	1.069	0.458	2.362
Pre-Existing Health	0.717*	0.537	0.954	Pre-Existing Health	0.940	0.700	1.269	Pre-Existing Health	0.992	0.621	1.577
Medical Professional	1.596*	1.046	2.447	Medical Professional	1.292	0.843	2.001	Medical Professional	1.294	0.659	2.444
Dog	1.139	0.693	1.888	Dog	0.718	0.425	1.197	Dog	0.808	0.455	1.443
Cat	0.765	0.461	1.259	Cat	0.558*	0.329	0.947	Cat	0.475*	0.262	0.853
Multiple Pet Types	1.172	0.616	2.189	Multiple Pet Types	1.820	0.985	3.367	Multiple Pet Types	1.039	0.405	2.817
Pet as Child	0.949	0.656	1.353	Pet as Child	0.635*	0.436	0.920	Pet as Child	0.374*	0.166	0.885
Social Politics	0.827*	0.702	0.974	Social Politics	0.969	0.816	1.147	Social Politics	0.950	0.728	1.244
Economic Politics	1.179*	1.001	1.389	Economic Politics	1.088	0.916	1.298	Economic Politics	1.155	0.863	1.530
Ref: 'About the same'				*Ref: 'About the same'*				*Ref: 'About the same'*			
Trust the Internet Much Less than a GP	0.604*	0.405	0.895	Trust the Internet Much Less than a GP	0.718	0.479	1.075	Trust the Internet Much Less than a Vet	0.666	0.363	1.220
Trust the Internet Slightly Less than a GP	0.537*	0.380	0.759	Trust the Internet Slightly Less than a GP	0.596*	0.420	0.854	Trust the Internet Slightly Less than a Vet	0.562*	0.310	0.964
Trust the Internet Slightly More than a GP	1.610	0.931	2.796	Trust the Internet Slightly More than a GP	1.363	0.751	2.459	Trust the Internet Slightly More than a Vet	1.857	0.704	4.708
Trust the Internet Much More than a GP	2.911*	1.287	6.695	Trust the Internet Much More than a GP	1.513	0.626	3.491	Trust the Internet Much More than a Vet	6.182*	1.646	22.699
Interspecies Knowledge	0.704*	0.609	0.812	Interspecies Knowledge	0.729*	0.628	0.847	Interspecies Knowledge	0.598*	0.463	0.776
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.39	0.14	0.65	NUTS2 (Sd)	0.18	0.01	0.42	NUTS2 (Sd)	0.47	0.06	0.90
VPC	0.04	0.01	0.11	VPC	0.01	0.00	0.05	VPC	0.06	0.00	0.20

Section 5.3.4 – Behaviour and Attitudes Towards Professionals

The dependent variable of the behaviour models were binarized, and the dependent variables characterising attitudes towards following instructions were the three level simplified variables, all of which are described earlier in this Chapter's Results section.

Models were specified to examine associations between demographic, knowledge, attitude, and Internet-use variables and the behaviour-related outcome variables. Independent variables covering demographic areas including pet-ownership and local geography, attitude and knowledge variables covering both human- and pet-related areas, and Internet-use variables were specified with relevance to the sample. In models using the complete sample, Internet variables covered frequency of use for human health information and trust in online sources of health information compared to a GP. In models using only the pet-owning sample, Internet variables covered frequency of use for animal health information and trust in online sources of health information compared to a veterinarian. Five models were fitted:

6. Human-Orientated Antibiotic Behaviour
7. Pet-Orientated Antibiotic Behaviour (Pet-owners Only)
8. Attitude Towards Doctors
9. Attitude Towards Veterinarians
10. Attitude Towards Veterinarians (Pet-owners Only)

The collected models, whose highlighted results are presented in Table 19, show evidence of varied patterns of association between behaviour in the context of personal and pet-orientated antibiotic use, and to a lesser extent between attitudes towards doctors and veterinarians.

Whilst the descriptive statistics presented earlier suggested that among the pet-owning sample there was no independence between the provision of poor stewardship responses in the context of human and pet antibiotic use, this regression evidence suggests that there are quite different social patterns behind these behaviours. For example, pet-related associations were present exclusively in relation to pet-orientated behaviour with no apparent difference between dog, cat, or multi-species pet-owners and petless respondents in terms of human-orientated behaviour. Individual demographic and geographic associations were more pertinent in the context of human-orientated behaviour, with the evidence provided suggesting that age, sex, and rurality were all associated with human-orientated behaviour but not with pet-orientated behaviour. There were further differences between human- and pet-orientated contexts in terms of associations relating to the presence and age of children and stewardship behaviours, suggesting, along with the pet-related associations, that differences in household configuration are associated with different stewardship outcomes in the contexts of human- and pet-related antibiotic consumption.

Respondents with better knowledge about what antibiotics could be used to treat in animals were associated with better stewardship in the context of human health, whilst the distinguishing characteristics (education and medical professional status) discussed in the previous section, and knowledge about interspecies aspects of antimicrobial resistance, were controlled in the model. This may be suggestive of a further distinction in the general population between people who are aware of the correct uses of antibiotics in animals and people who are not, irrespective of their knowledge regarding the correct use of antibiotics in humans or the connection between use in animals and resistance affecting humans. This would suggest, supported by the distinct pattern present in the pet-orientated stewardship model, that there are differing rationales and motivations behind behaviour with antibiotics in the community in the contexts of human and companion animal health, and that the role of knowledge is more prominent in association with human-orientated individual stewardship. This role, however, is not contextually bound to knowledge affecting human health in relationship to human-orientated behavioural outcomes, and may in fact relate to differences in understandings of the general dynamic of antibiotic use to treat bacterial infections regardless of human or animal context. This could be evidenced by respondents who understand that the principles of antibiotics use are identical in both medical and veterinary contexts having different behavioural outcomes to respondents who may have correct knowledge about the human-health context but do not translate this to the animal-health context.

There were some similarities between attitudinal models relating to following doctors' and veterinarians' instructions, for example with rural and male respondents being more likely to disagree with following either doctors or veterinarians instructions, and older respondents and respondents with more accurate responses regarding interspecies knowledge being less likely to disagree with following either doctors or veterinarians instructions. In both doctor- and veterinarian-related models there was insufficient evidence for an association between frequency of Internet use for health information and willingness to follow instructions, but there was evidence that respondents who trust the Internet less than healthcare professionals were much less likely to disagree with following instructions than respondents who reported trusting the Internet more than the relevant healthcare professional.

Alongside the differences between human- and pet-orientated behaviour, there were differences present between attitudes towards doctors' and veterinarians' instructions. Cat owners and respondents that had a pet as a child were less likely to disagree that veterinarians' instructions should always be followed when administering antibiotics, whilst respondents with various ages of children were more (12-18 years) and less (4-12 years) likely to disagree that doctors' instructions should always be followed. Respondents with pre-existing health conditions were less likely to disagree that a doctor's instructions should always be followed, whilst medical professionals were more likely to disagree, though neither of these had a significant association with attitudes towards veterinarians.

Again, relating to doctors but not veterinarians, there were differences between respondents with social and economic political differences in terms of their likelihood of disagreeing that instructions should be followed. Here, more socially conservative respondents tended to be less likely to disagree that instructions should always be followed, whilst economic conservatism was positively associated with disagreement.

There was greater evidence for geographic variation in these attitudes and behaviours than there were for the contextual knowledge and attitude models. The lowest variations were reported for human-orientated stewardship behaviour (SD=0.22, CL=0.01-0.51) and following veterinarians' instructions when taking antibiotics (SD=0.18, CL=0.01-0.42). Attitudes towards following doctors' instructions when taking antibiotics showed greater regional variation (SD=0.39, CL=0.14-0.65) and are visualised in terms of regional probabilities of total agreement with following doctors' instructions in Figure 6, with Figure 7 presenting regional variation in attitudes towards veterinarians' instructions on the same y-axis scale. Together these are suggestive of greater regional variation in attitudes towards doctors than veterinarians.

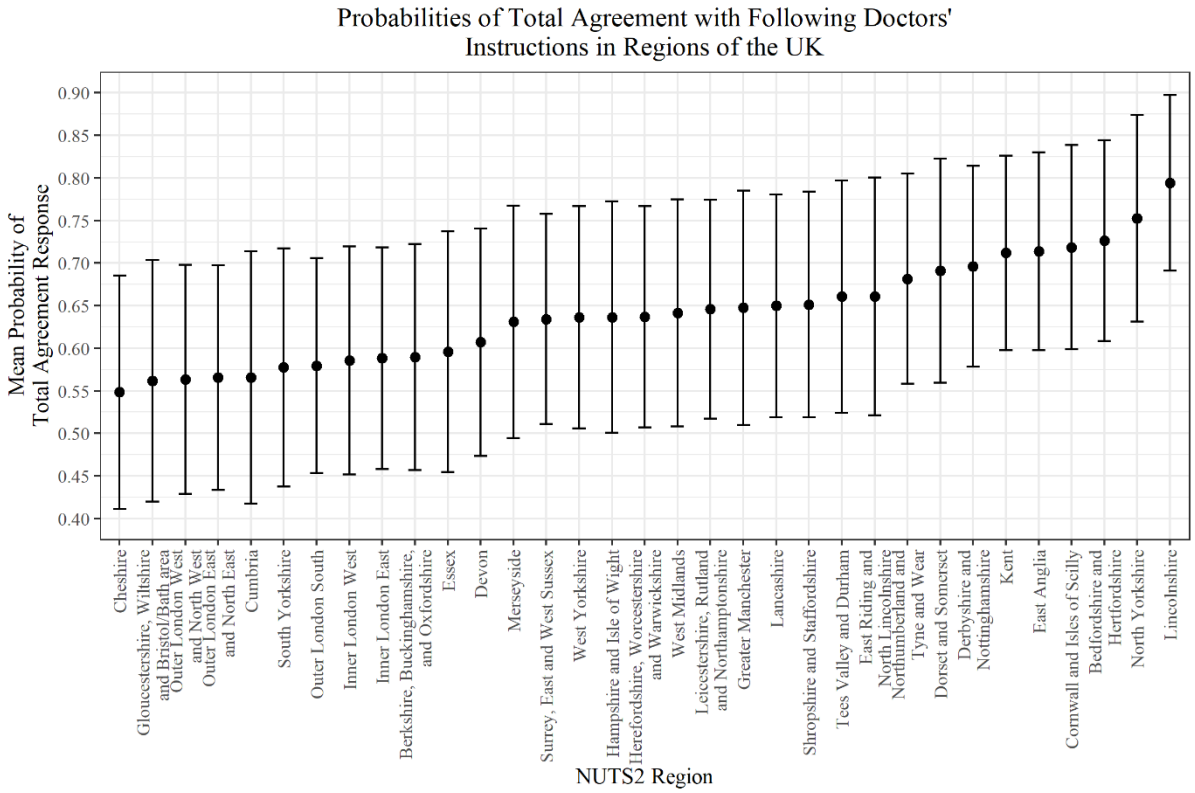

Figure 6. Caterpillar plot of regional mean probabilities of agreement with following doctors' instructions.

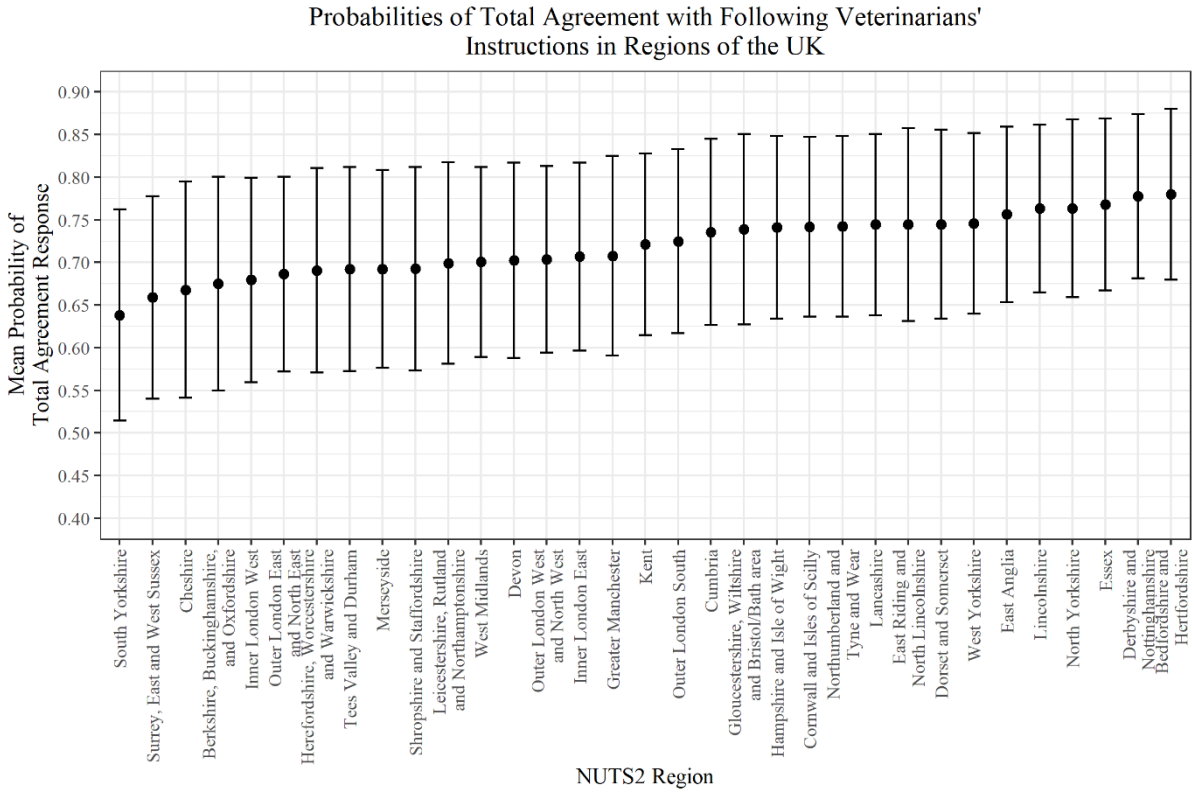

Figure 7. Caterpillar plot of regional mean probabilities of agreement with following veterinarians' instructions.

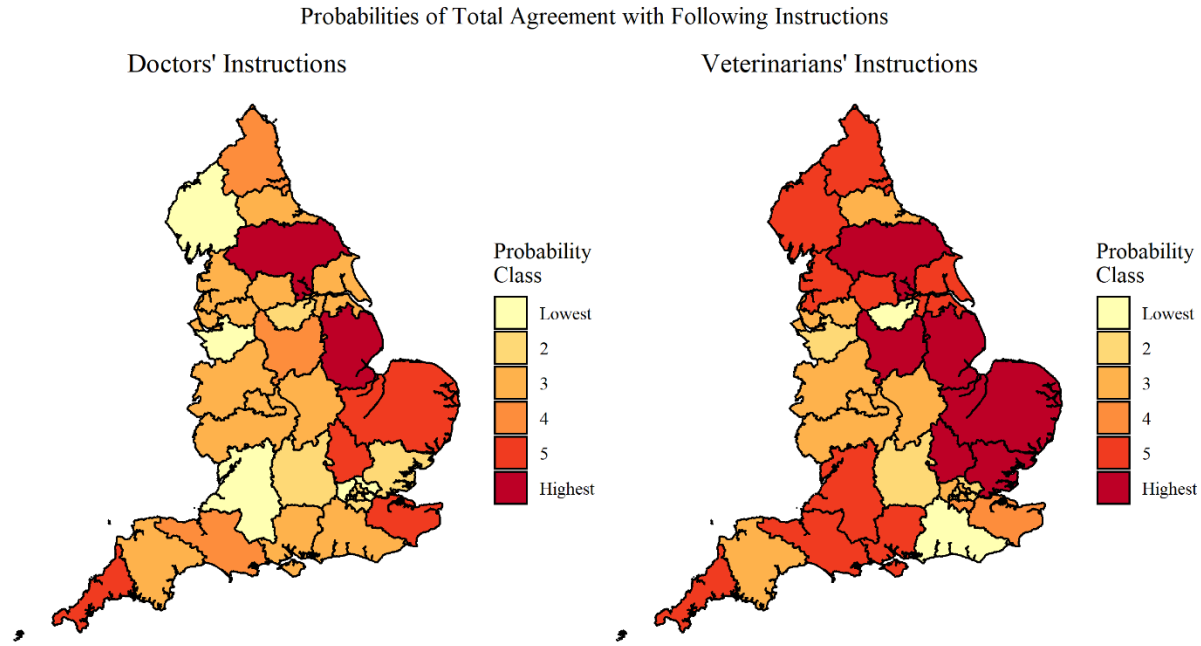

Figure 8. Maps of agreement with following healthcare professionals' instructions.

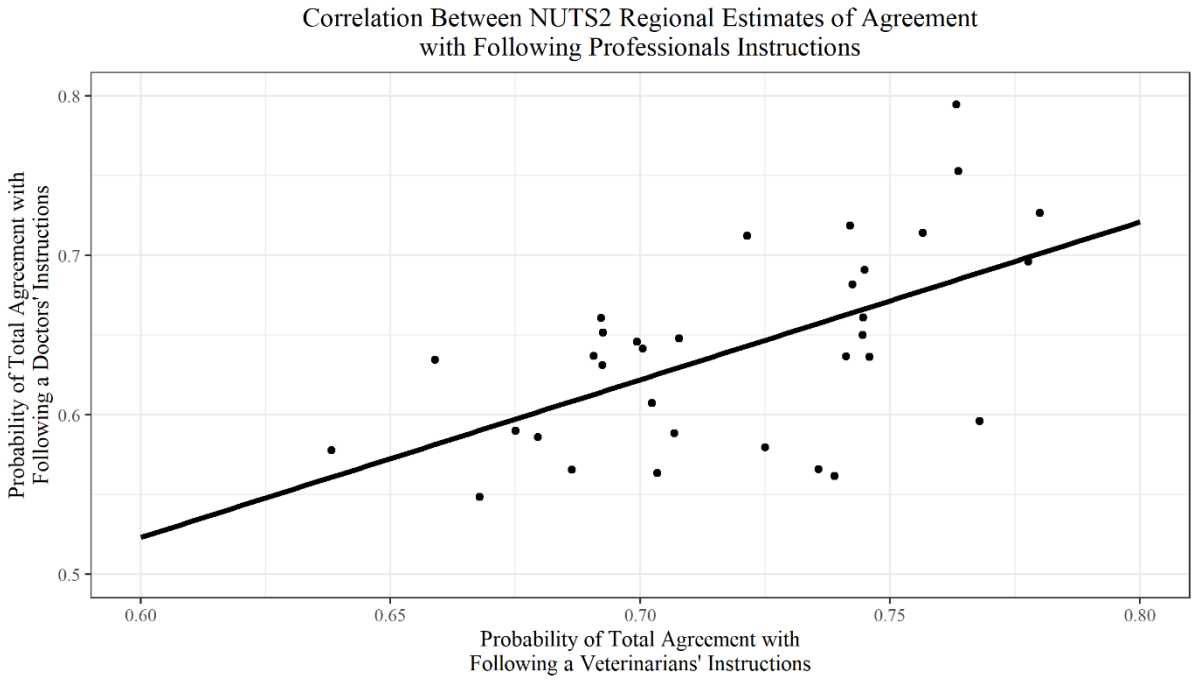

Figure 9. Illustration of the correlation between regional estimated probabilities of following doctors' and veterinarians' instructions.

This regional variation is presented in Figure 8 on maps of the NUTS2 regions in England. These probabilities are grouped by natural breaks in these maps, and a visual comparison suggests that regions in highest probability classes (those that have highest mean probabilities of total agreement) tend to group in the east of England. Regions in the north and part of the south-west also appear to have higher mean probabilities of total agreement with following veterinarians' instructions, whilst for doctors' instructions the lowest probability classes are in London and the west, with the western

regions not adjacent to one another. With the caterpillar plots in Figures 6 and 7, these maps suggest based on the clustering of natural break groupings that it is more unusual for regions to have relatively high agreement with following doctors' instructions, and more unusual for regions to have relatively low agreement with following veterinarians' instructions.

Whilst some broad patterns are visible, Moran's I tests for spatial dependence presented insufficient evidence for spatial correlation between neighbouring regions for following either doctors instructions ($I = 0.009$, $p=0.348$) or veterinarians' instructions ($I = 0.006$, $p=0.357$). There was however evidence for a noisy correlation between NUTS2 regional estimates for total agreement with following veterinarians' and doctors' instructions (linear regression estimate = 0.34, $p<0.001$, $R^2=0.34$), illustrated in Figure 9.

Together this evidence suggests that, at the NUTS2 scale, regions generally share the same predilection for following doctors' and veterinarians' instructions. At this scale there is insufficient evidence for contingency between neighbouring regions, however some visual patterns are noticeable at a national level when the regions are grouped into natural break categories.

Summary

In summary, parallel human- and pet-orientated behaviours, and doctor- and veterinarian-orientated attitudes are socially patterned in somewhat distinct ways. In the earlier descriptive statistics, it was suggested that in general the responses to these parallel sets of questions were unlikely to be independent from one another based on the evidence of weighted χ^2 tests. Following this, based on the evidence of these five behavioural and attitudinal models, while the distribution of these behaviour and attitude variables' in the contexts of human and pet health may be similar the patterns underlying them are not as analogous as the descriptive tests may imply.

There were few associations found consistently with the behavioural outcome variables, with age, gender, and rurality being the only variables with consistent evidence and direction across human-orientated behaviour and attitudes towards doctors and veterinarians. Older respondents were more likely to provide good stewardship responses and more positive attitudes towards following doctors' and veterinarians' instructions. Conversely, male respondents and rural respondents were more likely to provide poor stewardship responses and negative attitudes towards following antibiotic-consumption instructions.

Different kinds of knowledge about antibiotics and antimicrobial resistance also showed variation in their relationships across outcomes. There was no evidence for an association between respondents' knowledge about the use of antibiotics for treating humans' infections and any of the outcomes, but respondents with better knowledge about the use of antibiotics for animals were more likely to provide better stewardship responses with regards to their own health. Greater knowledge about the

interspecies nature of antimicrobial resistance was associated with more positive attitudes towards trusting healthcare professionals in both medical and veterinary contexts, but there was no evidence of an association with the behaviour outcome variables. The relationship between knowledge and stewardship-related responses is consequently not a simple one – better knowledge may be linked to more appropriate consumption of antibiotics, but what kind of knowledge matters? Awareness of the cross-species complexity of antimicrobial resistance may be independently associated with a greater propensity to trust experts when it comes to using antibiotics – but this is not necessarily reflected in what actually happens when respondents need to acquire, use, and potentially dispose of antibiotics. In this area, the only clear differences in terms of knowledge were between respondents who have differing understanding of the use of antibiotics in animals – and this was only in the context of human-orientated antibiotic use. Following from the previous summary section these knowledge associations may be highlighting sub-populations with higher levels of awareness about the interspecies breadth of the problem of antimicrobial resistance, and the evidence suggests that there are differences between those with awareness of non-human implications of antimicrobial resistance and those without in terms of their behaviour when consuming antibiotics or responding to these trust questions. However, these differences have no evidenced bearing on behaviour when administering antibiotics to pets.

Behaviour in the context of acquiring and administering antibiotics to a companion animal was patterned by household composition rather than other individual demographic, knowledge, or attitudinal factors. Dog-owning respondents (independent from cat-ownership or multiple-pet-ownership) were associated with better stewardship behaviour responses. Dog owners may find it easier to maintain good antibiotic stewardship compared to cat owners, as dogs tend to be less independent than cats and are generally easier to administer pill-based medications to (for example, when using food as an aid to this delivery approach). There were associations between the ages of respondents' eldest children and pet-related antibiotic stewardship, with respondents' whose child was below three years of age being more likely to report poor stewardship than childless respondents, and respondents with adult children being more likely to report good stewardship. This may be attributable to the attention or expense that very young children require diverting parents' resources away from companion animals' healthcare, for example when considering adding a young child to already taxing trips to veterinary practices with anxious pets, or indeed the cost of a veterinary consultation. This may contribute to the keeping and subsequent use of leftover prescriptions as a costly resource, or a lower level of persistence when administering the antibiotics. Conversely in the context of adult children who may have left the household, parents may fill in the newfound silence with the care of a companion animal may consequently be highly diligent due to an excess of attention to spend.

In addition to these pet-ownership associations, there were pet-related variables associated with attitudes towards following veterinarians' instructions. In this case, cat owners and respondents who had pets when they were children were both independently associated with more positive attitudes towards following a veterinarians' instructions when administering antibiotics. This demonstrates that, in the context of antibiotic-related behaviours and relationships with veterinarians, there is neither a single 'pet-ownership' effect nor is there a consensus of associations across human and animal healthcare contexts. Based on this evidence, household structure variables relating to pets are only clearly associated with behaviours and attitudes orientated towards companion animal care. Respondents with pets are no different to those without pets in the context of human-orientated behavioural outcome variables on this evidence.

Attitudinal variables such as political orientation and relative levels of trust in the Internet and healthcare professionals were associated with likelihood of reporting positive responses to following doctors' instructions, whilst for veterinarians' instructions the only such association was Internet-trust related. As Chapter 3 suggested, the association between political orientation and attitudes towards following doctors' instructions was confounded by differences in social and economic political outlook being condensed to a single 'political orientation' variable in the Eurobarometer dataset. Among this survey's respondents, more socially conservative respondents tended to report more positive attitudes towards following doctors' instructions. This was independent from economic orientations, for which more conservative respondents were less likely to respond that doctors' instructions should always be followed when taking antibiotics. These associations were only present in the context of following doctors' instructions, with no evidence that social or economic political orientations were associated with attitudes towards veterinarians' instructions or stewardship behaviours. This suggests that individual differences in epistemic motivation – for which there is a body of evidence that liberal and conservative political ideologies are markers, with further evidence for social political orientation as a predictor (Jost *et al* 2018; Talhelm *et al* 2015) – are associated with agreement that doctors' instructions should be followed in the context of antibiotic use. In this case, the intolerance of ambiguity and need for formal rules associated with conservative thinking may be associated with intentions to adhere to an authority's prescription. These individual differences however do not appear to relate to such decision-making with regards to antibiotic use following a veterinarian's instructions either among the complete or pet-owning samples. This suggests that attitudes towards veterinarians, or more generally the healthcare of companion animals, are independent from the ways in which people know, understand, and believe information in a general sense. To put it differently, whilst two people may make different decisions about following their doctor's instructions because of their attitudes towards ambiguity, uncertainty, and formalised rules, there is no evidence here that the decisions these same two people may make about following their

pets' veterinarian's instructions are influenced by these epistemic motivations insofar as these motivations can be inferred from this evidence.

Frequency of Internet use for either human or animal health information had no association with any of these outcome variables. However, respondents that trusted online health information sources less than doctors or veterinarians were generally more positive about following instructions when taking or administering antibiotics, whilst respondents that trusted online sources more were generally more negative about following instructions. This suggests some consistency in attitudes, with respondents more likely to trust a medical professional than an online source also being more likely to follow their instructions. This also elaborates on Chapter 3 by suggesting that it is attitudes towards online health information (similar to the Eurobarometer variables used), rather than its frequency of use (similar to the Wellcome Monitor variable used), that is related to individuals' attitudes towards antibiotic use.

There was greater regional variation in attitudes towards following doctors' instructions than veterinarians' instructions. Based on the grouping of regions by natural breaks, it could be suggested that it is rarer for these regions to have relatively high levels of agreement with following a doctor's instructions than the equivalent attitude towards veterinarians. This, with the general number of significant variables within the regression models examining parallel medical spheres, suggests that attitudes towards doctors may be more socially divided than those towards veterinarians for which there were fewer contingent characteristics measured in this survey.

Section 5.4 – Conclusions

This conclusion has three parts. Firstly, a comparison with equivalent analyses from Chapter 3. Secondly, a response to each quantitative hypothesis posed in Chapter 1. Finally, a discussion of these areas and how they related to the overall thesis and literature.

Section 5.4.1 – Comparison to Chapter 3

There are similarities between the results of analyses of the primary survey project nonprobability sample in this Chapter, and the results in Chapter 3 from two random probability samples. In the Chapter 3, older respondents were more likely to report better stewardship attitudes or behaviours. In this Chapter, older respondents in the complete sample were also more inclined towards good stewardship and agreement with following both doctors' and veterinarians' instructions. In both Chapter 3 and this Chapter, male respondents were less inclined towards good stewardship or adherence to healthcare professionals' instructions. Employment was only significantly associated with either knowledge or attitudes towards prescription compliance in the Eurobarometer data in Chapter 3. In Chapter 3 levels of education were positively associated with knowledge but not with behaviour. There is a similar pattern to the analyses of this Chapter, with knowledge outcome variables being associated with educational levels in the same direction (though with differing

contrast coding), and only one significant association with education in the five behavioural models. In this Chapter there were no associations between behavioural outcome variables and employment, though there were associations between employment and contextual attitude and knowledge variables that were not measured in the Eurobarometer. In summary, the associations between demographic variables and the outcomes of interest in both Chapters are broadly similar.

The analyses in Chapter 3 suggested that members of the public who use and trust online sources of health information are more likely to be knowledgeable about, and responsible with, antibiotics. The analyses in this Chapter examined Internet use in this context using different variables to the Chapter 3, focusing on frequency of use and levels of trust relative to medical and veterinary healthcare professionals. In general, more frequent users of online health information in this Chapter's analyses were more likely to trust online health information over a healthcare professional, and respondents that trusted the Internet less than healthcare professionals were more likely to report that they would follow healthcare professionals' instructions. Very frequent users of online health information were less likely to possess correct knowledge about the interspecies aspects of antimicrobial resistance, though this was the only such association with a knowledge outcome variable. There appear to be some differences between this and Chapter 3, though the online health information variables measured and analysed in the two Chapters are different. Whilst Chapter 3 presented a broadly positive association between online health information and antibiotic-related knowledge and stewardship, the picture painted in this Chapter is that higher levels of use and trust in online health information may in fact be associated with worse stewardship and knowledge.

Section 3.4 suggested that local geography was associated with attitudes towards prescription compliance – a suggestion supported by this Chapter. In Chapter 3, which focused on the UK as a whole, this geography appeared to manifest between large and small urban areas rather than between urban and rural areas. The analyses of this Chapter however suggest that in England, rural respondents are more likely than their large-urban-dwelling counterparts to exhibit poor stewardship. This difference could come from the nature of the survey mode (for example, rural panel members could be substantively different from rural people who are not members of the panel), the difference in national sampling frame (in this Chapter not sampling Scotland, Wales, or Northern Ireland), or elsewhere. The data from this Chapter correlate with Curtis *et al*'s (2019) findings that rural areas had higher prescribing rates. This would point to these areas as candidates for greater stewardship-improving interventions as antibiotics are both being prescribed at a higher rate and on this evidence are less likely to be consumed with good stewardship.

A comparison of the visual regional geographies of compliance/agreement with following healthcare professionals' instructions presented in Chapter 3 and this one raises several points. Firstly, there are some consistencies in terms of the areas with high probabilities for incompliance (lighter shades on

Figure 3 in Chapter 3) and low probability for total agreement (darker shades in Figure 8 in this Chapter). In both sets of maps, the East of England generally presents a higher probability of good stewardship, and the South West also presents this consistency in terms of the probability of agreeing with following veterinarians' instructions. The five London NUTS2 regions, in terms of following doctors' instructions, show consistency with the NUTS1 London region in Chapter 3. However, there are some NUTS1 regions that, when broken into constituent NUTS2 regions, show heterogeneity. Yorkshire and The Humber, the South East, and the West Midlands for example all contain a variety of probability classes in both maps in Figure 8. This suggests, within the limits of the natural breaks visualisation, that the geography of attitudes towards healthcare professionals in England is more complex than that which can be deduced from the NUTS1 regions alone.

Chapter 3 suggested that uncooperative survey respondents were more likely to report poor stewardship attitudes. The only equivalent regression model association suggested in this Chapter is that respondents that failed any attention check question were more likely to provide correct responses about the interspecies aspects of antibiotic resistance. Levels of panel participation and attention check failure were associated with some of the outcome variables in this survey. Differences between the independence tests for the first two (identically placed) attention check questions in the pet-owning and petless samples' questionnaires suggest that differences in questionnaire length may have had an impact upon respondents' attention in the survey, with the pet-owners responding to a longer questionnaire taking less time over each question. Both the random samples with face-to-face data collection used in Chapter 3 and the self-complete panel sample used in this Chapter present issues for data quality, though the lack of independent associations between panel participation, attention check failure, and most of the regression models in this Chapter suggest that these issues have not had large impacts upon these analyses.

Section 5.4.2 – Addressing Hypotheses

The quantitative hypotheses that this Chapter has aimed to address, first laid out Chapter 1, are reproduced below:

H_1: Pet-owners report greater responsibility with antibiotics than people with no companion animals.

$H_{1/a}$: Pet-owners report less responsibility with antibiotics than people with no companion animals.

$H_{1/0}$: Pet-owners report no more nor less responsibility with antibiotics than people with no companion animals.

H_2: Pet-owners are more aware of the multispecies nature of antibiotic use than people with no companion animals.

$H_{2/a}$: Pet-owners are less aware of the multispecies nature of antibiotic use than people with no companion animals.

$H_{2/0}$: Pet-owners are no more nor less aware of the multispecies nature of antibiotic use than people with no companion animals.

H_3: Pet-owners' antibiotic-related behaviour towards themselves reflects their antibiotic-related behaviour towards their companion animals.

$H_{3/0}$: Pet-owners' antibiotic-related behaviour towards themselves does not reflect their antibiotic-related behaviour towards their companion animals.

H_4: The type of companion animal has a differential association with an owner's antibiotic-related behaviour.

$H_{4/0}$: The type of companion animal has no relationship with an owner's antibiotic-related behaviour.

H_5: There is an association between levels of knowledge around antibiotics and antibiotic resistance, and attitudes and behaviours regarding antibiotic use.

$H_{5/0}$: There is no association between levels of knowledge around antibiotics and antibiotic resistance, and attitudes and behaviours regarding antibiotic use.

H_6: Use and trust in the Internet as a source of health information has an association with knowledge, attitudes, and behaviours relating to antibiotics.

$H_{6/0}$: Use and trust in the Internet as a source of health information has no association with knowledge, attitudes, and behaviours relating to antibiotics.

This section will discuss how the analyses presented by this Chapter address each hypothesis in turn.

Hypothesis 1: Pet-owners report greater responsibility with ABs than people with no companion animals.

This hypothesis was addressed by χ^2 tests in section 5.3.1 and two regression models in section 5.3.4. On the evidence of the analyses in this Chapter, pet-ownership and levels of stewardship with antibiotics in the context of human use are not related to one another. Furthermore, the owners of dogs, cats, or multiple types of pet were no more or less responsible with antibiotics in the context of their own health than people who do not live with any of these. There were no independent associations in models examining either human-orientated behaviour or attitudes towards following a doctor's instructions when taking antibiotics. In the case of hypothesis 1, there is insufficient evidence to reject the null hypothesis that "pet-owners report no more nor less responsibility with antibiotics than people with no pets".

Hypothesis 2: Pet-owners are more aware of the multispecies nature of antibiotic use than people with no companion animals.

This hypothesis was addressed by one regression model in section 5.3.3. Again, on the evidence of the analyses in this Chapter the owners of dogs, cats, or multiple types of pet were no more or less aware of the multispecies nature of antibiotic use or its interspecies aspects than people who did not live with any of these. Here, there is insufficient evidence to reject the null hypothesis presented above.

Hypothesis 3: Pet-owners' antibiotic-related behaviour towards themselves reflects their AB behaviour towards their companion animals.

This hypothesis was addressed through χ^2 tests in section 5.3.1 and regression models in 5.3.4. Initial direct comparisons of general levels of stewardship in the contexts of human and companion animal antibiotic use suggested that these parallel human- and pet-orientated behaviours were not fundamentally independent from one another with the exception of consumption and administration. Additionally, attitudes towards following doctors' and veterinarians' instructions in the context of antibiotic use were not distributed significantly independently from one another.

When examined through regression however, a more complex image of these parallel sets of outcomes was observed. Different patterns were presented between human- and pet-orientated behaviour, and between attitudes towards following doctors' instructions and following veterinarians' instructions. In a broad sense, there were more divisions presented over human-related antibiotic use and attitudes towards doctors than the pet-related equivalent variables. For example, the two models based on the complete sample and with identical fixed effects specifications examining attitudes towards doctor's instructions and veterinarian's instructions presented 13 and eight significant associations respectively. Additionally, pet-ownership was associated with pet-orientated behaviour and attitudes towards veterinarians while it was not associated with any of the human-orientated outcomes (as discussed in relation to hypothesis 1).

Whilst there are some similarities – predominantly between attitudes towards following doctors' and veterinarians' instructions as opposed to human- and pet-orientated behaviours – there are also a variety of differences in the social patterning behind what look on the surface like similarly-distributed behaviours and attitudes across medical and veterinary contexts. For this reason, it is argued here that there is insufficient reason to substantively reject the null hypothesis that "pet-owners' antibiotic-related behaviour towards themselves does not reflect their antibiotic-related behaviour towards their pets." Individuals' general levels of stewardship may be consistent across human and companion animal healthcare, but the motivations behind good and poor stewardship in these differing contexts appear to have some significant differences.

Hypothesis 4: The type of companion animal has a differential association with an owner's antibiotic-related behaviour.

This hypothesis was addressed by regression models in section 5.3.4. As discussed in relation to hypothesis 1, there was no apparent association between pet-ownership and human-orientated behaviour. However, there were associations between types of pet-ownership and pet-orientated behaviour and attitudes towards veterinary instructions. Crucially for this hypothesis, these associations were different for different pet-ownership configurations. Dog owners were more responsible in the context pet-orientated antibiotic use. Cat owners and pet-owners with multiple types of pet were no more or less responsible than people without cats or multiple pets. Conversely, cat owners were less likely to disagree that veterinarians' instructions should be followed, whilst dog owners and respondents with multiple kinds of pet were no more or less likely to agree than people without dogs or without multiple kinds of pet. In this case, there is sufficient evidence to reject the hypothesis that "the type of companion animal has no relationship with an owner's antibiotic-related behaviour" as there were independent associations presented in regression models regarding pet-orientated behaviour and attitudes towards veterinary instructions. Dog owners were less likely to report poor stewardship behaviours than other pet-owners, whilst cat owners were less likely than the rest of the sample to disagree that veterinarians' instructions should be followed.

Hypothesis 5: There is an association between levels of knowledge around antibiotics and antibiotic resistance, and attitudes and behaviours regarding antibiotic use.

This hypothesis is supported by evidence from Chapter 3, and was examined in this Chapter by regression models in section 5.3.4. In each behaviour and behaviour-related attitude model, three knowledge variables were included covering the interspecies nature of antibiotic resistance, the use of antibiotics in humans, and the use of antibiotics in animals.

More accurate knowledge about the interspecies nature of antibiotic use and antibiotic resistance was associated with both respondents' agreement that doctors' instructions should be followed and veterinarians' instructions should be followed. Correct knowledge about the kinds of infections that antibiotics could be used to treat in animals was positively associated with human-orientated stewardship. Whilst there is not one clear association presented here between a knowledge area and positive stewardship/attitudes, it is clear – in combination with the results in Chapter 3 – that knowledge is an important correlate with responses about stewardship behaviour and doctors' and veterinarians' instructions. Consequently, the hypothesis that "there is no association between levels of knowledge around antibiotics and antibiotic resistance, and attitudes and behaviours regarding antibiotic use" can be soundly rejected.

Hypothesis 6: Use and trust in the Internet as a source of health information has an association with knowledge, attitudes, and behaviours relating to antibiotics.

This hypothesis is supported by evidence from Chapter 3, and was addressed by regression models in sections 5.3.3 and 5.3.4. Chapter 3 focused on dichotomous variables asking whether or not use or trust in online sources of health-related information were associated with knowledge, attitudes, and behaviours relating to antibiotics. The conclusion of Chapter 3 was that, based on the samples used and models specified, people who used and trusted the Internet as a source of health-related information were more knowledgeable and more responsible with antibiotics than people who did not use or trust the Internet for health information. This association with independent of demographic variables such as age or education that may mediate use or digestion of such information sources. This Chapter has extended this analysis by examining the influence of frequency of Internet use (for example, are more frequent users of online health information different from infrequent users?) and explicitly examining relative trust in the Internet as a source of information relative to either doctors or veterinarians.

The first point of note, contextual to this hypothesis, is that the evidence in section 5.3.3 suggests that frequent users of the Internet as a source of health information in the context of human health are more likely to trust online health information over their doctors. The evidence suggests that this is also the case for online health information in the context of animal health and trusting such information over a veterinarian.

Based on the evidence in section 5.3.3, use or trust in the Internet as a source of information was not a significant differentiator between respondents in terms of the knowledge variables examined. Only very frequent users of online health information in the context of human health were significantly different on any of the knowledge variables, being less likely to have provided correct responses to questions about the multispecies nature of antibiotic resistance.

The evidence in section 5.3.4 suggests that there are differences between respondents with differing levels of trust in online sources of health information relative to doctors and veterinarians in terms of their attitudes towards following their respective instructions when taking antibiotics. Greater trust in healthcare professionals in both contexts generally correlated with agreement that doctor's and veterinarian's instructions should be followed. Frequency of Internet use for health information was only associated with pet-orientated behaviour, with somewhat frequent users of the Internet for pet-related health information being more likely to provide poor stewardship responses than people who rarely used the Internet for this purpose.

Overall the analyses of this Chapter and Chapter 3 present a mixed image, and there are limitations to the analysis of Internet-related factors in this Chapter. Unlike the samples used in Chapter 3, the survey sample analysed in this thesis will not have included any of the 20% of the public who do not

use the Internet (Office for National Statistics 2018). Inferences can only be made about Internet-users who do or do not use the Internet as a source of health information. This also assumes that the panel is representative of Internet users in England, which, as suggested in the first section conclusion in Chapter 3 (Section 3.3.4), may not be the case. The panel may be made up of comfortable Internet users, who may also be more likely to have responded to the Wellcome Monitor and Eurobarometer that they use the Internet for health information than lower-skilled Internet users. Additionally, the key demographic differentiator for the Internet variables used in Chapter 3 was education (Section 3.3.2), which was not included in the propensity weighting for this survey and so will not have been adjusted for.

In summary, based on the evidence of Chapter 3, the null hypothesis that "use and trust in the Internet as a source of health information has no association with knowledge, attitudes, and behaviours relating to antibiotics" can be rejected. However, the nature of this association is difficult to confidently explain with the quantitative aspects of this thesis. The evidence of this Chapter suggests that greater trust in healthcare professionals over online health information is positively associated with good stewardship attitudes. It could be reasonably argued from this that 'use of the Internet' alone is not a significantly informative differentiator as Internet users (who are effectively the panel sample's sample frame) with varied levels of trust in the Internet as a source of information will have different attitudes towards following healthcare professionals' instructions in both medical and veterinary contexts.

Section 5.4.3 – Chapter Summary and Discussion

This Chapter has presented the analysis of a survey that examined pet-owners' knowledge, attitudes, and behaviours regarding antibiotics. Previous survey researches in the context of antimicrobial resistance have not collected data on differences between pet-owners and people without pets. People who live with companion animals and make use of veterinary services for their companions' healthcare use antibiotics in two spheres of care – their own, and their pets'. Understanding the extent to which their behaviour is parallel between these two spheres is important for the generalisation of other survey research to both contexts and for understanding differences between the two sets of attitudes and behaviours. The survey also aimed to build upon the findings of Chapter 3, and in particular the second set of analyses that suggested geographic and political attitudinal variables as variables of interest that have yet to be examined in this context.

Methodologically, the survey employed an online panel sample stratified by NUTS2 regions in England. The use of this kind of sample introduced challenges for data quality and inference generalisation. Data quality issues were examined and mitigated through the use of metadata (panel participation) and attention check questions. The generalisability of inferences drawn from analysis of the sample were improved by the use of propensity score weights in the analyses.

Human-orientated behaviours tend not to differ between pet-owners and petless people

The first conclusion from the analyses of this Chapter is that there appears to be no significant differences between pet-owners and people without pets in terms of their personal levels of antibiotic stewardship. Both the descriptive statistics (and associated hypothesis tests) and regression analyses support this conclusion. This conclusion has multiple implications. Firstly, this may be problematic for the issue of antibiotic resistance at a household level. As discussed in Chapter 2, pet-owning households tend to be larger than petless households and also have distinct microbiomes. Two comparable households – one with pets and one without – will consequently pose different risks for the spread of genetic material conferring resistance to antibiotics in, on average, a differing number of environments (for example, in schools and other child-related spaces). If the levels of stewardship in the context of human antibiotic consumption are generally similar between these households, as this Chapter suggests they will tend to be, the pet-owning household will theoretically pose more issues for the spread of resistance than the petless household.

An intervention that this could suggest would be for veterinarians to actively emphasise 'One Health'-conscious behaviours to their clients, such as the importance of adhering to prescription instructions and avoiding unnecessary antibiotic consumption in the context of the client's own health as well as their companion animal's to try and improve stewardship amongst this group. This should include education that misuse of antibiotics in one sphere can affect the other – if not for the individual in question, for other more vulnerable people or animals. The lack of difference suggested by the evidence presented here suggests that this would need to be an active approach on the part of veterinarians, as currently the higher frequency of interaction with healthcare professionals that pet-owners may have does not in itself improve this behaviour. This would of course pose challenges to veterinarians who are already often pressed for time during consultations with more immediate concerns regarding patients, clients, and business. A second implication is for the field of social research. The evidence of this Chapter suggests that previous survey-based analyses of patterns of human-orientated behaviour with antibiotics is valid when discussing patterns in the context of these two groups despite one group potentially having a greater frequency and variety of healthcare-related professional interactions. In the context of this thesis, for example, the findings from the analyses in Chapter 3 in terms of this behaviour should be interpretable for both pet-owners and people without pets. This might, for example, suggest that high-probability prescription incompliance regions such as London are strong targets for a veterinary-orientated intervention such as that suggested above.

Parallel Human/Pet Behaviours are not Identically Motivated

The second conclusion is that there are differences between the patterning of parallel stewardship behaviours and attitudes in society between medical and veterinary contexts. Whilst the levels of good and poor stewardship in these contexts are not significantly independently distributed, there are differences in the groups among the public who are significantly more or less likely to exhibit poor

stewardship in each context. For example, when reporting stewardship behaviours in the context of human health and pet health, differences in household characteristics such as the presence and age of children or the presence and types of pets were only associated with pet-orientated behaviour, and differences in individual characteristics such as age or gender were only associated with human-orientated behaviour. This could be suggestive of differences in these behaviours that stem from care responsibilities – members of the public who have previously been responsible for a child who is now and adult, or who currently care for one or more dogs, are less likely to exhibit poor stewardship in the context pet-related healthcare. There is some nuance to this suggestion based on the evidence provided, with parents of very young (<3 years old) children being more likely to exhibit poor pet-orientated stewardship. This suggests that differences in household configurations are not only important in terms of the presence or absence of pets or children, but that there are substantive differences between the earlier and later stages of parenthood compared to people without children, and the presence of dogs and multiple kinds of pet in the same household compared to people with no pets.

This also raises questions over why there is a distinction among pet-owners between dog owners and other pet-owners. Companion dogs are relatively easy to medicate using pills compared, for example, to cats, which may go some way to explaining why dog owners are less likely to report poor stewardship responses. Dog owners may have more confidence that money spent on veterinary services (and prescription medication arising from the use of such services) will see a return in the health of their pet, and so may be less inclined to find other routes to the acquisition of antibiotics, and may be less discouraged when administering them.

Responses to the healthcare-practitioner focused questions – whether or not respondents agreed/disagreed that doctors' or veterinarians' instructions should be followed – were again not distributed significantly differently, but unlike the stewardship behaviour outcomes these attitudinal outcomes had multiple similarities between regression models as well as some key differences. Unlike stewardship behaviours, there were no clear general differences in terms of individual characteristics (e.g. age or gender) or having care responsibilities (e.g. childcare or pet-ownership) between models predicting attitudes towards doctors or veterinarians. Instead, there were more nuanced patterns of differences along these outcomes that suggest that there are generalisable differences in people's rationales for following antibiotic-related instructions in the context of human- and pet-related healthcare.

In both healthcare contexts there were consistent differences presented between respondents of different ages, genders, rural/large urban dwelling, levels of trust in online health information, and levels of knowledge about the interspecies aspects of antibiotic resistance. In general, one can conclude from the evidence presented in this Chapter that older people, people who trust healthcare

professionals more than online health information, and people who have better knowledge about the cross-species issues presented by antibiotic resistance are more likely to agree with following a healthcare professional's directions when taking or administering antibiotics. Conversely men and people who live in rural areas are more likely to disagree with following a healthcare professional's directions when taking or administering antibiotics.

However, there were also distinct areas of significance between these attitudes in each healthcare context, with different care relationships being associated with different healthcare contexts, and differences in individual characteristics associated with greater likelihoods of disagreement in each context. The presence of children was associated with the likelihood of agreeing with following doctors instructions – though not in a linear manner – whilst cat owners and respondents who had pets when they were children were more likely to agree with following veterinarians' instructions. This suggests that, beyond the similarities discussed above, differing configurations of household care produce differences in parallel behaviours across medical and veterinary contexts. For example, parents of pre-teen children are suggested as being less likely to agree that one should follow a doctor's instructions when taking antibiotics, but there is no evidence for such an impact upon following veterinarians' instructions. Conversely, and as with human-orientated stewardship behaviours, there was no association between any kind of pet-ownership and agreement with following doctors' instructions.

The framing of messages needs to be cognisant of the moral intuitions of politically differing individuals

A second area of difference between agreement with following doctors' and veterinarians' instructions is that political orientations were associated with agreement with following doctors' instructions but not veterinarians' instructions. In their study demonstrating social political orientation as a better predictor of moral thought and attitude, Talhelm *et al* (2015 p250) argue that "liberals and conservatives in the same country think as if they were from different cultures". Differences in political orientation and ideology have been associated with self-reported health and healthier lifestyles, with right-wing individuals reporting better health or healthier lifestyles than left-wing individuals (Subramanian *et al* 2009; Huijts *et al* 2010; Chan 2019), leading to the suggestion that these orientations and associated ideologies may be markers for underlying health-promoting beliefs (Subramanian *et al* 2009). In this Chapter however it does not appear to be strictly the case that the behaviours themselves, as measured and analysed here, are independently associated with such differing thought styles and moral foundations, but rather attitudes towards following the instructions of healthcare professionals only in certain species-relevant (*Homo sapiens*) contexts are somewhat contingent on these characteristics.

An implication from this, in conjunction with evidence from the literature, is that messaging around this aspect of antibiotic stewardship needs to be carefully constructed in order not to alienate sections of the public for whom the framing may create friction. Research in this area has shown that morally or politically framed rhetoric can be ineffective or even have negative influence on behaviours such as perceptions of the health risks of certain food products, or environmental behaviours such as recycling if it conflicts with the moral intuitions of individuals (Boeuf 2019; Kidwell *et al* 2013; Feinberg & Willer 2015; Wolsko *et al* 2016). However, it has been argued that the incorporation of moral foundations into messaging can be used to effect positive changes in attitudes and behaviours (Feinberg & Willer 2015; Wolsko *et al* 2016; Voelkel & Feinberg 2018). Appealing to fundamentally different groups through targeted messaging (for example, using adaptations from Kidwell *et al*'s (2013) studies, framing antibiotic stewardship as 'the right thing to do for the good of society' for liberals, or 'joining the fight against antibiotic resistance' for conservatives) is one option here. Wolsko *et al* (2016 p18) however argue that such narrowcasting may not benefit the sustainability of broad movements, for which the "development and implementation of moral frames that are inclusive of and engaging to a wide range of demographics, including across the political spectrum" is essential. The conclusion here, then, is that in the context and antibiotic stewardship – and specifically attitudes towards doctors' instructions – the framing of interventions' messages through language and imagery needs to be cognisant of the moral intuitions of politically different individuals interpreting this language and imagery.

Together, these areas of difference suggest that the small amount of variation between individuals' attitudes towards doctors' and veterinarians' stem, at least in part, from care-related and epistemic motivations. Where doctors are concerned, the presence of children (and their age) and people's perceptions of moral and social roles are markers for differences in likelihood of people following their antibiotic-related instructions. In the context of veterinarians however, the distinctions are instead between certain experiences or care relationships with companion animals.

Online Health Information is a Complex Picture

Unpacking inferences about the use of online health information from this Chapter is made difficult by the survey mode, which was exclusively online. This data may however be used to make some careful inferences about people who use the Internet varying amounts and who have varying levels of trust in the Internet relative to healthcare professionals.

Frequent use of online health information, which has been associated with high levels of health anxiety in previous research (Muse *et al* 2011), was associated with greater trust in this information relative to healthcare professionals in either medical or veterinary contexts, and frequent users were also more likely to have incorrect knowledge about the interspecies aspects of antibiotic resistance or have provided poor stewardship responses in the context of pet health. This negative image of the role

of online health information is supported by the associations present between relative trust in online health information and most other outcomes.

Overall, users of online health information may be differentiated from people who do not use online health information as concluded with the samples and analysis in Chapter 3. However, this Chapter supplements this simple and cross-sectional conclusion with a caution. Heavy users of online health information, and those who trust this information over relevant healthcare professionals, are argued from these data to have worse attitudes towards following prescription instructions and worse knowledge about some aspects of antibiotic resistance. This adds a new dimension to the suggestion raised in Chapter 3 regarding information prescriptions, also in light of the findings of Chapter 4 in which online health information was predominantly adjuncting for professional care. Healthcare professionals in both medical and veterinary spheres should take a more active role in providing direction for their patients' and clients' online health information consumption habits. However, where there is a lack of trust in healthcare professionals or a surplus of confidence in online health information this approach could be ineffective.

Chapter 6 – The Plural Dynamics of Human and Companion Animal Care

Section 6.1 – Introduction

Section 6.1.1 – Chapter Aims

This Chapter is the first of two Chapters analysing the qualitative interview data collected as part of this mixed-methods project. This Chapter aims to develop an understanding of the different dynamics of care, health, and healthcare that are present in the contexts of human and veterinary medicine.

This analysis focuses on three areas: the construction of 'health' for humans and companion animals, relationships between pet-owners and medical and veterinary professionals, and the use of the Internet for human and animal health information. These areas have their own substantive importance, as shall be relayed in the discussion of the background literature on the 'dynamics of companion animal care', but also connect and provide some explanation for other parts of this thesis. Previous survey-based Chapters 3 and 5 have made connections between the use of online health information, trust in professionals, and behaviours around antibiotic stewardship. This Chapter elaborates qualitatively on how pet-owners make use of online health information in different contexts, and discusses the different challenges posed when accessing routine medical or veterinary care. Chapter 7 discusses the findings from these qualitative interviews in the specific context of antibiotic stewardship and antibiotic resistance, and provides context for those findings as well as making links to other potential public health areas informing the dynamics and health-perceptions present in companion animal care.

This Chapter provides a platform of understanding for how pet-owners make sense of health and care in different contexts, informing this thesis' knowledge contribution regarding pet-owners' understanding of antibiotic stewardship and antibiotic resistance as a public health issue in Chapter 7.

The remainder of this Chapter's introduction discusses background literature and summarises the findings of the Chapter. Section 6.1.2 covers some of the key dynamics of companion animal care focusing on the challenges that distinguish companion animal care from human medical care, and some of the concerns presented by veterinarians around how care is received and mediated by pet-owners. Recent hypotheses on the role of spillover between perceptions of human and companion animal health are discussed, situating this Chapter not only within this thesis but also in relation to this nascent literature on the social science of veterinary care. Section 6.1.3 presents some high-level conclusions from the Chapter in the context of this literature and the broader literature discussed in Chapter 2.

Section 6.1.2 – Dynamics of Companion Animal Care

Companion animal veterinary care raises challenges that distinguish it from human medical care. Companion animal veterinary care takes place "within an intricate set of relationships" that are shaped by dependence, space, the contractual nature of veterinary services, and the dual status of pets as 'person' and possession (Hobson-West & Jutel 2020 p396; Donald 2018; Morris 2012; Fox 2006). These relationships affect both the pet-owning client and their companion animal, and the veterinarian providing care. The emergent critical social scientific literature on the veterinary profession and its challenges can provide context for understanding the actions and motivations or pet-owners on topics such as antibiotic stewardship. The interplay of veterinarian, client, and companion animal alongside the role of financial challenges and the stressful practicalities of veterinary clinic visits disrupt simplistic understandings of companion animal care in terms of lay-expert roles.

A commonly reported concern of veterinarians is that they are perceived to 'sell' products, which arises from a lack of time during consultations or otherwise poor communication and leads to breakdowns in trust between clients and veterinarians (Coe *et al* 2007; 2008; Belshaw *et al* 2018; Morris 2012). Balancing the financial limitations of clients with the business needs of veterinary practice is a significant challenge and source of stress for veterinarians (Armitage-Chan *et al* 2016), and clients who lack financial resources may avoid veterinary clinics altogether (Rock *et al* 2020). This avoidance is not solely a risk for the health of the companion animal (Volk *et al* 2011), but given the emotional support that companion animals provide throughout the lives of their owners (Walsh 2009; Turner 2005; Charles 2017) this can be a risk for mental wellbeing of pet-owners with limited resources (Rock *et al* 2020).

Pet-owners, and especially cat-owners, find visits to veterinary clinics stressful for both themselves and their companions which can lead to compromised health outcomes for those who forego regular veterinary care (MacMartin *et al* 2014; Volk *et al* 2011). This is ameliorated in some instances by, for example, "pet-directed talk" on the part of veterinarians in the presence of clients to manage "interactional tensions" (MacMartin *et al* 2014 p171). This example demonstrates one among a variety of ways in which veterinarians care for their clients alongside their patients, managing stressful situations and emotional decision-making (Morris 2012). The avoidance of veterinary clinics has been linked to an increase in pet-owners consulting online sources for health information, with use of such information stemming from poor veterinary communication (Belshaw *et al* 2018), occasionally resulting in negative impacts on companion animal health (Volk 2011), or more mildly being used as an 'adjunct' for professional care (Kogan *et al* 2009; 2012).

In addition to this literature, there is some evidence that pet-owners draw connections between companion animal health and their own health as humans. Rock (2017) for example has highlighted that pets "exemplify life with diabetes for many people" with parallels being drawn by her research

participants between their own care if they were living with diabetes, and their pet's healthcare needs. Further examples demonstrate that companion animals can be central to owners' health narratives, such as in Ryan & Ziebland's (2015) secondary analysis of interviews with people living with long-term conditions in which companion animals were often presented as important family members whose health was considered alongside the participant's (though the interviewers were found to downgrade the importance of the companion animals during the interviews). In the context of blood donation, Ashall & Hobson-West (2017 p908) found that pet-owners' narratives around the donation of canine blood entangled human and non-human animals, leading them to argue that "decision-making in healthcare more generally might be influenced by experiences at the veterinary clinic, and vice versa". This argument is continued in Hobson-West & Jutel's (2020 p401) recent review of the emergent sociology of veterinary medicine, in which the authors argue that researching health and health-related decisions beyond species boundaries

> "…may become more urgent given the e-scaped nature of medicine [because] with the wide availability of health information, it is likely that owners seeking information to aid with lay diagnosis of their pet […] may also source and evaluate information on human health, further destabilising the porous boundary between human and animal diagnosis."

This Chapter is predominantly situated within these outlined areas, focusing on how pet-owners perceive and prioritise aspects of their own health and the health of their companion animals, how pet-owners relate to different forms of medical and veterinary expertise, and how pet-owners navigate human and animal health information online. By examining the challenges raised in this literature, this Chapter adds to the evidence base on interspecies health understandings among the public and contextualises Chapter 7's discussion of antibiotic stewardship and perceptions of antibiotic resistance across species barriers.

Section 6.1.3 – Chapter Findings

The first main finding from this Chapter is that spillover between constructions of human and companion health do occur, but they tend to be context- or experience-specific. In general, participants perceive the practice of good health for themselves and their companion animals in different ways, emphasising different aspects of health, illness, and routine care. Whilst some participants openly connected human and animal health through physiological or therapeutic similarities, others pointed to differences in these same areas as reasons for the translation of health knowledge or practices across species boundaries to be transgressive.

In the second finding, veterinary care presented greater challenges for access and trust than medical care in participants' narratives. Whilst the difficulties of access were consistently framed across veterinary medicine, trust was often parsed between corporate chains and independent or 'family'

veterinary practices. There was some evidence of linkage between this area and the first area, with differences between the utilisation of oversubscribed medical care and contractual veterinary care reinforcing perceptions of difference between the healths of people and companion animals.

Finally, online health information was predominantly used as an adjunct for professional sources of information with the caveat that there is 'no NHS for animal health'. Participants in this study highlighted their own lack of knowledge and experience as the limitation of using online health information, and without a clear reference point for animal health they spent more time searching for sources of information online and found it harder to ascertain the legitimacy of information. This suggests that veterinarians should be more explicitly signposting reliable online sources of information for pet-owners that regularly try and make use of such information given the barriers that exist to accessing veterinary care.

Section 6.2 – Methods

Section 6.2.1 – Data Collection

Chapters 6 and 7 incorporate the 13 cognitive interviews conducted to support the design and implementation of the thesis' primary survey research element which were analysed to that end in Chapter 4, and 16 further semi-structured qualitative interviews that were conducted alongside and following the cognitive interviews and primary survey. Two qualitative interviews were re-interviews of cognitive interview participants, and so the total number of unique interview participants in the qualitative dataset was 27. All participants were pet-owners. The situation of this Chapter and Chapter 7 within the thesis' multiple methodological components is provided below in Figure 10.

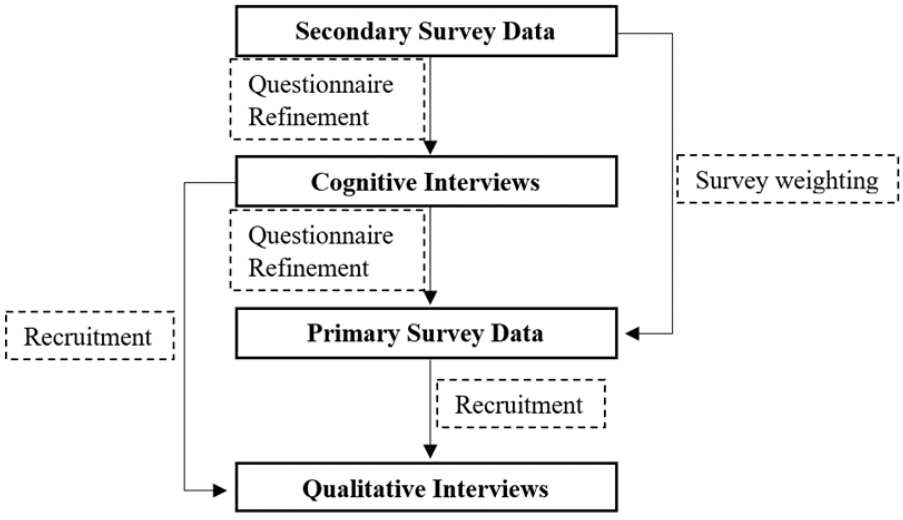

Figure 10 Diagram of methodological components in the thesis and their methodological relationships.

The number of participants recruited to the research study was influenced by external and theoretical factors (Baker & Edwards 2012). Specifically, the key external areas of consideration were funding, time, and the practicalities of recruitment. Social media and snowball sampling were most effective for the recruitment of cognitive interviews, and more explicitly offline methods such as posters in veterinary practices performed poorly in the paper-based survey pilot and were completely ineffective for cognitive interviewee recruitment. Responding to these lessons, the recruitment of qualitative participants built upon the successful strategies used elsewhere in data collection.

Qualitative interviews were recruited in multiple ways through the course of the overall research project and were drawn from the samples recruited in other areas of the research. Two participants were recruited in the second wave of cognitive interviews, but face-to-face interviews were impractical for these participants. Due to the nature of the cognitive interviewing method requiring face-to-face interaction, these participants were offered the opportunity to participate in a qualitative interview via telephone instead. Two further cognitive interview participants enquired about the possibility of additional conversation, and these participants were offered the opportunity to also participate in qualitative interviews that were conducted in person. Two further participants responded to the cognitive interviewing call after that segment of the research was complete and were subsequently offered the opportunity to participate in qualitative interviews, which were conducted in person. One participant was recruited from the paper-based pilot of the survey in a local veterinary practice and was interviewed via telephone. The remaining nine qualitative interviews were recruited from respondents to the survey reported in Chapter 5 and due to the online panel's ethics requirements around anonymity these interviews were conducted over Skype with a mix of video-calls and audio-only calls dependent on participant preference. Where interviews were conducted via Skype, participants' contact details were not retained following the interview. Of the qualitative interviews, 12 were conducted remotely and four were conducted in person. The joint sample of cognitive and qualitative interviews included seven dog owners, 13 cat owners, one small-animal owner, and six multiple-species owners.

As with the cognitive interviews reported in Chapter 4, all participants that were not recruited through the panel received an information sheet upon indication of interest followed by a verbal briefing and written consent form at the point of interview. For panel-based participants, prospective interviewees who expressed an interest in follow-up participation received a second study through the panel that acted as an information sheet. A verbal briefing was also given at the point of interview. All qualitative interviews were recorded and transcribed with the permission of participants. In-person interviewees provided informed written consent, and panel-based participants provided informed consent using an online form.

Theoretical factors influencing the cessation of qualitative data collection were defined in relation to the aims of the qualitative aspects of the research, juxtaposed methodologically to the quantitative aspects, within the broader mixed-methods endeavour. To borrow Saldaña's (2016 p10) distinction, thus far the presented research of this thesis has largely been concerned with "calculat[ing] the mean" through quantitative survey analyses, whilst the qualitative research of the thesis aims more broadly to "calculat[e] meaning". Rather than drawing on more positivist approaches such as the grounded theory-influenced concept of 'saturation' (e.g. Glaser & Strauss 1999) or centring the number of cases as a marker for quality in determining the end of qualitative data collection, a judgement was made regarding the "information power" of the collected interviews based on the aims of the study, the presence of existing literature on the topic of antibiotic stewardship, and the quality of the dialogue (Malterud *et al* 2016 p1754; Low 2019). Specifically, as the study was focusing on a specific public (pet-owners), building upon an established antibiotic stewardship literature with some pre-existing developed concepts rather than generating new theory from scratch, and was being complemented by primary data from a cognitive interviewing study (Chapter 4) and social survey (Chapter 5), it was decided in late July 2019 that the 29 cognitive and qualitative interviews provided sufficient data to achieve the aims of the qualitative study.

All qualitative interviews consisted of three segments. The first segment was a conversation about participants' pets. This segment was primarily used to get the conversation flowing and build rapport with participants, for example through comparing stories about participants' and researcher's cats or contrasting family pet histories. This segment was a substantive part of the interview, occasionally taking up over half of the duration of the interview for relatively historically healthy participants with relatively healthy pets. Building up this rapport was essential to facilitate the later discussions around health and relationships with health professionals, and the interviews were not, as Hitchings & Latham (2019 p5) put it in their recent *Progress* report, a case of "straightforwardly strolling into people's lives […] and effortlessly engaging them as useful and interested interlocutors". Charles' (2017) comparison of written responses to a Mass Observation directive on 'Animals and Humans' and a sample of qualitative interviews exemplifies the influence of interviewer presence on how people talk about companion animals and the role of rapport. Anonymous written accounts relayed "emotionally intense relationships between writers and animals […] without apology", Charles (2017 p125) found, "made possible by both the absence of an interlocutor and by the anonymity of these accounts both of which mean that there is no possibility of moral censure." Interviewees on the other hand occasionally became caught up in their own embarrassment, meaning that the interviewer had to actively close off parts of the interviewees' thinking in order to keep interviews on track. In this thesis' qualitative study, navigating such moments of embarrassment as participants discussed intimate details of their relationships with their companion animals and their health management practices was a challenge that required ongoing subtle revision of interview questions and probes to

maintain the flow of conversation and avoid disruption. The second segment of the qualitative interviews covered the participants' management of their pets' health, including relationships with veterinarians, use of online health information, and previous use of antibiotics. The final segment covered parallel information regarding the participants' own health.

General conversations around pet and personal health were often unproblematic in terms of communication, however when prompting participants to think about health across species boundaries the conversation, and interviewee's thoughts, were often "falteringly presented in ways that the researcher's own interactional strategies no doubt influence[d]" (Hitchings & Latham 2019 p7). These areas of the interview protocol were the most often revised as the interviews progressed, developing multiple angles from which to approach the topic of interspecies health in ways that participants could engage with having potentially never given the topic serious thought.

Section 6.2.2 – Data Analysis

Interviews were transcribed with participants' consent and were analysed in reverse chronological order. The intention here was to avoid retracing the steps taken in the data collection process in which the interview questions themselves were developed over the course of data collection, but rather to analyse the transcripts in the reverse direction away from the most developed interview schedule back to the least developed early schedule.

Transcripts were coded in two cycles in NVivo 12. In the first cycle of coding, transcripts were coded line-by-line with an emphasis on process and in vivo codes to draw out participants' physical and conceptual actions, and use their own phrasing and language to generate the first list of codes as "tentative categories" (Charmaz 2014 p189; Saldaña 2016) – for example, "Having a Google" as a code within the category 'Engaging with online health information' foregrounds how participants tended to vocalise their use of search engines to navigate health information sources on the Internet. The second cycle of coding involved interpretively grouping similar codes together and naming the categories constructed through this grouping process. The process and in vivo codes were drawn upon here to put names to these categories that clearly signal the essence of the physical or conceptual process being presented. Some larger categories include subcategories, for example 'Constructing companion animal health' contained two distinct areas that were thoroughly discussed by participants. Within 'Constructing companion animal health' therefore, there are two sub-categories: 'Being vigilant' and 'Maintaining routine veterinary care'. 'Constructing human health' on the other hand exhibited less variety and a lower depth of engagement from participants and did not warrant further subdivision from this broad category.

Codes and categories were developed through a creative and subjective process. The analysis was not approached as if the codes and categories generated from these data were "'in' the data, waiting to be identified and retrieved by the researcher" (Braun & Clarke 2019 p594). The analytic outputs of this Chapter and Chapter 7 are active creations of the researcher and the processes of data collection and analysis described above. The interpretive understandings provided by these Chapters are consequently constructivist in character, acknowledging not only that there are "multiple social realities" (Charmaz 2003 p250), but that data and analyses are "created from shared experiences and relationships with participants" (Charmaz 2014 p239). The analyses in this thesis for example will have been informed by the author's experiences as a pet-owner alongside the specific literature readings discussed in Chapter 2, secondary analyses presented in Chapter 3, and questionnaire design and survey research discussed in Chapters 4 and 5. The findings and discussion below are therefore an interpretive story developed from these data interacting with the biography of a specific researcher, and are not necessarily an objective assessment of reality.

Section 6.3 – Findings

Section 6.3.1 – Constructing Health(s)

Constructing companion animal health

Companion animal health was discussed from multiple perspectives by participants, with key referents being an inability to communicate clearly with companion animals and the consequent need to be vigilant and maintain a healthcare routine. The inability of companion animals to use language to "*tell us when something is wrong*" (QI #13) or "*tell you what is wrong*" (QI #10) underpinned a variety of strategies to observe and maintain companion animal health and wellbeing.

Being Vigilant

The first set of strategies described by participants were conceptually linked in the process of 'being vigilant'. Vigilance was not simply a static and watchful state-of-being, but a dynamic process that involved a sensitivity to physical – or, to borrow Canguilhem's (1991) terminology, quantitatively varying – cues and routines, and an important openness to learning qualitative and affective cues throughout a companion's life course to understand when and how they feel different.

Physical cues were often described as obvious tells for when a companion animal might be suffering – for example "*if he's walking with a limp he's probably hurt himself*" (QI #7 – referring to a male cat). Other physical cues allowed for superficial monitoring of changes in companion animal wellbeing, including for example "*keep[ing] an eye on litter trays*" (QI #1, also mentioned by QI #4 and QI #16 as a specific aspect of vigilance), levels of food consumption (six participants), and noting fluctuations in aesthetic condition described for example by QI #4 regarding their cat: "*I tried various different foods, she started losing weight, and her fur started… she's got exceptionally soft fur, and it*

started to look a bit unwashed really. Separating, and losing its kind of fluffiness". These behaviours on the part of pet-owners represent the most basic level of being vigilant, requiring familiarity with what one's companion animal and their bowel movements usually looks like. These signs were more often associated with more urgent responses, such as contacting a veterinarian or searching for information about symptoms online.

The second dimension of vigilance enrolled the affective connection between a human and their companion animal. For this dimension, participants described 'getting to know' their companions' character and personality, in addition to their routines and behaviours, to connect to and work with their "significant otherness" (Haraway 2008 p97) in constructing interpretable signifiers of health and illness. Deviation from routine for example was associated with companion animals not *feeling* well, as elaborated by QI #13:

> *"You know straight away when she's under the weather because she just can't be bothered. She's a bit of a lazy cat in any way because she's part Persian, but when she can't be bothered to come over for her cuddles and things like that,* ***that's when I know that she's feeling a bit under the weather****."*

Understanding deviance from the felt norm, as opposed to simply observing deviance in physical appearances, took on an affective rather than medical character in the narratives of some participants. QI #15 for example reflected on their experience with bull terriers, summarising their thoughts as: "*They just tend to… if they're not their* ***normal bouncy selves****, you just think there's something wrong*". In another example of this affective appreciation, a participant mused that "*You just get to know their body language,* ***the look in their eyes****, and if they are not doing what they normally do it's fairly subtle… but I think once you know an animal you pick up on it quickly*" (QI #5). Knowing a companion animal's feelings was sometimes considered a partial bridge for the lack of clear linguistic communication, a position verbalised by QI #12: "*You're generally looking at their general condition, their attitude, whether they are depressed, whether they are… you know,* ***you can tell their feelings****, if you know what I mean, and how they are.*" Unless a companion animal had a specific chronic or recurrent condition these affective cues were taken as general signs that an animal might be experiencing some sort of illness and were attached to less urgent responses, predominantly heightening alertness for physical cues. For QI #12, being "*observant enough*" to pick up on an animal's feelings was a reliable guide to knowing whether something was amiss with the animal, and this was rooted in getting to know their personality over time.

The process of being vigilant as part of the construction of companion animal health emphasises that there must be more than one companion species in "co-constitutive relationships in which none of the partners pre-exist the relating, and the relating is never done once and for all" (Haraway 2003 p12). For these pet-owners, being vigilant themselves was a key component of their companion animals'

health. This vigilance is a dynamic process responding to a somewhat flexible construction of health as not only incorporating physical cues of illness or abnormality but necessitating the learning of and attuning to affective cues given by companion animals. The seriousness with which these cues were taken illustrates Donald's (2018 p6) contention that "when affective relations between human and animal bodies are valued as communication, animals are no longer just the object of care". Substandard companion animal 'health' was constructed as a detectable phenomenon for these pet-owners, but it required learning and developing an understanding of amorphous signifiers – not quantitative variations, but perceived qualitative experiences – of pathology with their companion animals as co-constitutive subjects of care.

Maintaining Routine Veterinary Care

A second aspect of the construction of companion animal health was the maintenance of routine contact with veterinary services. This was a commonly mentioned aspect of companion animal health management for these pet-owners, who included annual health checks alongside vaccinations, dental checks, and spaying and neutering as important parts of companion animal health management. Assurance from veterinary professionals during routine checks to participants that their companion animals were being cared for in the right way was also important for some participants as a source of confidence. Routine veterinary contact was valued for the quantitative management of healthy norms but for some participants it was also valued for its validation of pet-owners' experiences with their companion animal, supporting their personal navigation of vigilance around their companion animal's health status.

The importance of veterinary reinforcement here reflects an existing pattern in the literature around veterinarians' management of clients alongside their non-human patients (Morris 2012; MacMartin *et al* 2014). Additionally, it invokes the spatiality of pet-keeping and veterinary care with the jurisdiction of the veterinarian extending from the clinic to the home (Donald 2018). Veterinarians are relied on here not only to 'fix' companion animals in every sense, but to reassure that the care being provided outside the clinic by the human guardians of companion animals is appropriate and sufficient. Companion animal veterinary care encompasses biopolitical characteristics that centre on the welfare of the non-human animal (Srinivasan 2013; Lorimer et al 2019a) but extend to the welfare of the human owner as well. Considering the previously-discussed role of antibiotics as a form of non-therapeutic care, the reliance of pet-owners on veterinarians for reassurance raises questions over which species is receiving this care and the nature of the "gift" (Brown 2019 p140) being dispensed.

Constructing human health

Good health was defined narrowly by participants with regards to their own health, with the key considerations being the ability to function well enough to carry out day-to-day tasks and having what were perceived as good habits for healthy living.

This functional definition of 'being healthy' was often constrained and not elaborated as being in perfect health with no problems, but rather as being able to "*function normally without too much complaint*" (QI #14), or more specifically "*being not restricted in being able to do the things that I want to do*" (QI #16). This was further caveated by some participants with regards to age, for example in "*not having too many aches and pains*" (QI #15) rather than being completely ache-and-pain-free. When discussing what they considered to be a good state of health no participants referred to biomedical considerations, instead generally centring health as qualitatively variable rated by their ability to function at what they considered to be an acceptable or normal level.

To maintain health, participants commonly described behaviours in terms of self-responsibility, mentioning a range of behaviours including getting 'enough' sleep, maintaining a 'good' diet, and exercising. Keeping a routine with regards to these behaviours was generally considered important as deviations from regular patterns could give rise to illness, or result in the body 'giving' symptoms, for example as QI #13 put it: "*If I'm not sleeping enough then my body can kind of give me the symptom of, 'Oh, you're coming down with something', but really I just need a good night's sleep*". Health, for these participants, was essentially an embodied state of functionality in which one is not necessarily free from illness or suffering, but rather one is able to function to a desired level relative to personal context.

This functional construction of health is in line with previous participant-led definitions that emphasise both the experiential aspects of illness experience and self-responsibility for maintaining one's health (for example, O'Sullivan & Stakelum 2004; Conrad & Barker 2010). O'Sullivan & Stakelum (2004 p40) for example found that lay definitions of health were often relative to social context, including the experience of aging, with some respondents wanting to "claim good health even in the face of illness" while other respondents were "reluctant to claim health despite the absence of illness". Conrad & Barker (2010) further highlight that the social construction of illness experience can have implications for clinical policies, as physicians can misunderstand or trivialise the suffering of patients who lack visible cues to account for their suffering. These examples and the interview evidence provided above are illustrative of illness and health resting upon "what everyday people take as a normal state of bodily and mental functioning relative to the demands of their immediate circumstances" (Philo 2007 p85) rather than an objective set of pathological symptoms.

Translating between human and companion animal health

Whilst human and animal health had their own specific characteristics within participants' narratives, some participants also reflected on the ways that they had translated practices or advice between these spheres of health. In some cases, these reflections were grounded in biomedical understandings of the mammalian body or commonalities between pharmaceutical products, and conversely in other cases

perceptions of difference between human and animal bodies rendered such translation as transgressive in the context of health.

Elements of preventive healthcare such as vaccinations were repeated examples reflected upon by participants. For some, their personal attitude towards vaccination was translated directly into their practices regarding their companion animals' health:

> *"Annual vaccinations, which I know not everyone agrees with, but I just think I vaccinate myself when I go on holiday and if you're sort of doing the titre test that they do to see if the vaccinations are needed [for the companion animal], that's a lot of faffing around. I can't see that vaccinations have had a negative impact on him or any of my previous dogs in any way, so it just seems sensible to go with that" (QI #15).*

For others, there was some difference between vaccination for themselves and their companion animals, in this example from QI #16 drawing upon differences in relation to their and their companion's environmental interactions:

> *"I suppose I would probably skimp more on him than I would on my own health. For example, with vaccinations, I would always have vaccinations that I needed whereas for him,* ***because he doesn't go out and he doesn't mix with other animals, he's not up to date with his vaccinations****" (QI #16).*

These extracts highlight that even amongst pet-owners that have a positive attitude towards vaccination, there is variation with regards to their practice relating to companion animals. For QI #15 their personal health practice translates directly across to their companion animal whilst QI #16 did not make such a clear translation due to the different direct environmental exposures they perceived themselves and their companion animal receiving.

In another preventive healthcare example, QI #16 discussed the importance of dental hygiene:

> *"I think dental hygiene is really important and I learned from experience that with cats it's not just about keeping their teeth looking nice, it's actually very detrimental to their health to have dental cavities, just like it is with humans, if you have bad teeth then it can affect other organs in your body.* ***I guess just generally knowing what I know about human health, I guess I extrapolate in a way to him****" (QI #16).*

This example presents an explicit case of, in the participant's own words, extrapolating knowledge about human health to their companion animal's health. Together with the considerations of vaccination, this suggests that there are clear pathways in the communication of preventative care to

highlight that good practices for one species are applicable to others, but also that people who practice good preventative measures for themselves may not always translate these across to their companion animals.

The advice of doctors was mobilised by some participants to rationalise behaviours towards their pets. In one example, QI #1, who reported suffering from Seasonal Affective Disorder and owned a therapy lamp on the advice of a doctor, observed what they believed to be the same symptoms occurring in one of their three cats. Following this observation, they recalled:

> *"I kind of looked it up, can cats get winter depression? It turns out that they can* ***because they have the same sort of brain chemicals as us****. Which is like what the… light and darkness cycles are set in humans so it is the same in cats. So I put my light on sometimes and he'll come and sit with me and he seems to actually quite like it. It wasn't something I'd have known if it hadn't happened to me already" (QI #1).*

In another case, CI #7 discussed obtaining a course of antibiotics for their companion animal from a friend in order to avoid a stressful veterinary trip with a reactive pet and consulting a family-member doctor on what kind of course to administer to their companion animal. Here, participants were particularly focusing on similarities between quantitatively varying elements of human and animal health – vaccine schedules, brain chemicals, the removal of infections – occasionally contextualised by qualitative experiences or reflections in the process of crossing species lines in their conceptualisation of health and care. This points to the basis of participants' rationalising of the characteristics of a shared health as being confirmed through quantitative variation rather than a qualitative or affectual nature. The 'significant otherness' of companion animals in the context of health is distinctly bridgeable for these participants, as these humans and non-humans share physical and biomedical traits that participants easily translate across species boundaries through their contextual knowledge or experience.

This quantitative rationalisation was also borne out in a common connection that was mentioned by participants: commonalities between medications used for humans and animals. When considering antibiotics as shared medication for example, participants reflected on the parallels between infections experienced by humans and animals:

> *"We both get similar infections, or the causes are similar. Like the streptococcal infections and things. I'd imagine the treatment would be fairly similar for people and pets. The need for [antibiotics]" (QI #5).*

> *"In terms of what [antibiotics] do, they're the same aren't they? They treat similar things. They're used for similar purposes" (QI #15).*

> *"I know that a lot of the drugs that are given to animals are exactly the same as the ones given to humans. They just give them different names sometimes" (QI #16).*

In some cases, a specific experience led to the connection being made between human and animal pharmaceutical products, as elaborated in this anecdote from QI #11:

> *"When [my dog] is being allergic to something, it sort of upsets the yeast or fungal balance on his skin, and my other half on and off gets a thing on his skin in the summer where he gets these sort of white patches, like the pigment disappears a bit, and the doctor's basically said it's a similar thing, it's an imbalance in the naturally occurring bacteria or fungus that live on your skin, and in warm conditions they get a bit out of kilter and you lose the pigment.*
>
> *We were looking at treatments for that, and I said, 'well, the key ingredient in what [dog] has in his wash that we have to wash him in, is basically the same as an anti-dandruff shampoo, so perhaps you can try using anti-dandruff shampoo on your fungus, on your skin'" (QI #11).*

Together, these examples illustrate some of the ways that participants drew connections between human and non-human animal – or non-human animal and human – health. The similarities between the quantitatively varying states of normal or abnormal health were used to point to the connections between healths, and the similarities between the pharmaceutical products used to address such abnormalities in both humans and companion animals were used to suggest similarities in conditions affecting humans and their companion animals.

Although many participants drew these connections, for other participants the linking of advice or medication between human and animal health was considered transgressive. For example, QI #4 stated that they would not use advice they were given for humans or their companion animals because of the lack of communication between human and animal, and differences in dietary requirements. A specific example QI #4 provided in terms of medication was the toxicity of paracetamol for cats. QI #7 similarly considered human and cat physiology to be incomparable beyond "*hav[ing] the same tools*" such as hearts and lungs, whilst QI #12 described humans and animals as having "*different systems*" and "*different process[es]*". Whilst these participants drew different conclusions regarding the comparability of human and animal health to the participants described in the previous paragraphs, they did so through broadly similar references. Whilst some participants drew upon quantitatively varying similarities in physiology and infection to connect human and companion animal health with differences in degree, these participants emphasised specific quantitative differences in physiology in rationalising a separation between human and companion animal health as differences in kind.

Summary

There were some clear differences in the ways in which participants demarcated 'health' in the contexts of their own health and their companion animals' health. Participants also drew connections between their health and their companions' health in a number of ways, though some participants considered the drawing of such connections as a more transgressive act.

Discussions of companion animal health focused on the behaviours and perceptions of the participants themselves, with the quality of their vigilance and the maintenance of routine veterinary care being the key components of 'good' companion animal health. Vigilance here was a dynamic process that involved attention to quantitative physical cues such as limps and lumps, but also an openness to learning from their companions and becoming attuned to qualitative affective cues that provide a window into the experience of the companion animal – illustrated for example by 'the look in their eyes'. In contrast, discussions of personal health focused exclusively on the embodied experience of the individual. This experience was contingent on personal context and being able to function to an acceptable level within this context. For example, older participants accepted that they had some non-inhibitory aches and pains that were not signifiers of poor health. As with companion animal health, there was an element of routine to the maintenance of personal health, though the focus was on diet, sleep, and exercise rather than the enrolment of healthcare professionals. These definitions reflect differing epistemologies regarding health with companion animal's status weaving together challenges of knowing about and speaking for non-human animals (Buller 2014) and the role of affective interspecies communication in companion animal care (Donald 2018), whilst human health was defined by the contingency of individual experience (Canguilhem 1991).

When translating aspects of health across species lines, participants made connections through preventive healthcare practices, biomedical similarities, and the use of common pharmaceutical interventions. Some participants that discussed their own use of vaccines made direct connections to their companion animals' vaccination schedules, though there was variation here in whether companion animals were routinely vaccinated in the same ways as their owners or whether differences in environmental exposure led to vaccine schedules not being adhered to strictly. Qualitative aspects of health held clear importance for participants as a way of determining their own state of health and being attuned to the wellbeing of their companion animals, however the basis for commonalities between human and animal health was drawn quantitatively. The connections that were being made across health contexts were based in considerations of quantitative variations such as the presence of types of infection, allergies, or physiology. The same was true for participants who felt that making such connections was inappropriate – whether for physiological, dietary, or pharmaceutical reasons. These reflections hold implications for the biopolitical nature of interspecies health issues governed by 'One health' pragmatism as they either draw together or separate out the medical and veterinary professions depending on the perspective. Where these separations occur, it is

not simply the case that medical and veterinary institutions are separate but that the basis of some pet-owners' understanding of health and illness is irreconcilable with a borderless conception of health.

These areas of discussion were participant-led, and a number of areas were not brought up by participants such as routine preventive veterinary healthcare measures like spaying, neutering, and euthanasia. These measures are not unrelated to antibiotic resistance, for example neutering can reduce the likelihood of urinary tract infections and euthanasia may be considered an alternative to intensive antibiotic therapy. Participants' constructions of companion animal care tended to focus on the owners' actions around being attentive towards therapeutic needs and potential, rather than the kinds of routine that came up around their own health, for example the maintenance of a balanced diet and appropriate levels of exercise. The way participants structured health for companion animals was therefore quite narrow, focusing in on veterinary-related aspects such as whether a companion animal needed to visit the clinic or not rather than other potential preventive avenues. This may be because veterinary-related issues are the first things that came to mind for participants during the interview when asked about what 'good health' was for their companions, however it may also be an artefact of the interview approach itself and the role of the information sheet and consent process in priming interviewees to think about the topic in a particular way.

Section 6.3.2 – Relating to Healthcare Professionals

Visiting the Veterinarian

The cost of visiting the veterinarian was referred to by multiple participants when discussing motivating factors for taking their companion animal to the veterinarian. CI #6 for example described a greater reliance on online health information sources because "*it is easier to get to a website and far cheaper – vets are really expensive*". QI #2 and QI #16 also elaborated that the cost was a significant off-putting factor: "*For a lot of people that's the overwhelming thing about the vet, I guess you hesitate because it is just so expensive*" (QI #16). More assertively, QI #8 referred to the business side of veterinary practice with regards to the individual veterinary surgeons working within a practice, stating that: "*they're [two dogs] not down the vets very often at all, because I'm sure I know my pets just as well as a money-making vet does*". This is not in and of itself a new finding – the cost of veterinary services has previously been linked to pet-owners holding off on visiting a veterinarian when their companion animal is sick, leading to veterinarians treating pets that are "three days sicker" than they should be (Volk 2011 p1279) and is a common concern relayed by veterinarians (Morris 2012; Belshaw *et al* 2018). However, this highlights a significant material difference between accessing healthcare for companion animals and accessing human healthcare in the UK. For pet-owners, the cost of accessing veterinary care can be prohibitive and raise issues of trust and transparency alongside potentially worsening health outcomes for their companion animals.

Many participants in the sample associated veterinary visits with stress. Occasionally this was linked to financial concern:

> *"It's just the stress of going to the vet and not knowing how much everything is. And not know what's going to happen or how many tests or the results, and the length of the procedure. It's all a big up in the air thing that makes you really worried. I don't know, it's just a nasty feeling, pit of your stomach feeling really" (QI #12).*

In other cases, anxiety was drawn from the physical signs of treatment, such as for QI #6's dog with a neurological condition:

> *"We have always been a bit anxious when the results come out, or when he was doing the op[eration], a little bit obviously in the brain scan and the ultrasound – those things... because there's usually some sort of sedation; they shave him as well. So like seeing all of these things, he comes back home, and he gets home and he's just like super tired, and just sits in a corner and all shaved up, it is a bit… it's a hard image to see" (QI #6).*

Similarly, QI #13 highlighted the death of a previous companion as the source of veterinary-related anxiety:

> *"I get very stressed because I lost her sister three years ago to polycystic kidney disease, so now more than ever I hate taking her to the vet. I associated it with bad feelings" (QI #13).*

In these examples, participants associated veterinary visits with deep negative feelings: 'bad' or 'pit of your stomach' feelings, and a 'hard image'. These extracts exemplify the significance of client-focused aspects of the veterinary profession, such as dealing with emotional pet-owners in a 'spatial jurisdiction' that involves clients' homes as well as veterinary practices (Morris 2012; Donald 2018). For these participants visiting the veterinarian is a difficult experience, and care for the client is evidently required as much as care for the companion animal patient.

Levels of stress for companion animals were also cited as a stressful factor for pet-owners in the context of veterinary visits. The constituent elements of visiting the veterinarian were referred to by different participants, for example the journey to the veterinarian was considered stressful for indoor cats (QI #9; QI #13), dogs occasionally became anxious in proximity to other dogs in the veterinary practice (QI #6), and companion animals occasional reacted badly to the veterinarians themselves (QI #7; CI #7). QI #5 went as far as to suggest that "*the trauma sometimes of going to the vet is worse than letting them [the companion animal] get on with it*". Returning to a previously used example, CI

#7 cited their dog's reactive nature as a specific reason to avoid going to the veterinarian and to obtain antibiotics from a friend: "*I didn't want to go back to the vets, because she is quite vet-reactive and it really stresses her out. So when I was offered some leftovers I was like yes! I don't have to go back to the vets!*". Once a pet-owner decides to make a trip to the veterinarian with their companion animal, considerable emotional energy is often required to actually make the trip. Accessing routine veterinary care in the UK for many of these participants – though not all – is an endeavour marked by stressors. The sometimes-unknown financial costs of care are supplemented by a variety of companion animal-related sources of stress that may arise from several aspects of the visit.

Visiting the Doctor

Visits to GPs were not as strongly associated with specific sources of negative feeling. Instead, participants highlighted the difficulty of getting appointments (QI #3; QI #7; QI #11) as a significant reason for not making trips to the doctor, instead preferring to use pharmacies for mild complaints (QI #11; QI #12). Participants with chronic conditions were more resolute in accessing medical attention, for example in the case of QI #16 living with cystic fibrosis acting quickly for chest-related concerns – "*That's not something that I tend to let go because it probably won't go away by itself*". Multiple participants described persistent conditions that led to them visiting a doctor, explicitly outlining the severity of scenarios for example when QI #15 "*ripped [their] knee*" and struggled with walking for six months and QI #5 slipped a disc in their spine and visited a physiotherapist and a chiropractor before going to the doctor. In contrast to the specifically elaborated sources of anxiety related to accessing veterinary care, participants were more inclined to highlight general inconvenience as a de-motivator for visiting the doctor for all but the most serious complaints. There was a tendency to exhaust other options first such as over-the-counter remedies, making use of pharmacists' expertise, or simply living with pain before visiting the doctor.

Section 6.3.3 – Developing Trust in Veterinarians and Doctors

Deferring to qualifications and experience

When discussing trust in either doctors or veterinarians, a strong common thread was a level of deference to their qualifications and training. This deference was not simply in reference to professionals' knowledge but rather was contextualised by professional accountability and experience relative to the participant, with some participants explicitly placing limits on professionals' knowledge.

The length of training that GPs and veterinarians undergo was highlighted by multiple participants as a key differentiator between lay and professional perspectives, for example in these extracts from CI #4 and QI #14:

> *"A GP, someone who has trained for seven or eight years, or you who has looked up on the Internet without any idea what's going on?" (CI #4)*

> *"Really, if there's a vet or doctor who's telling you something, they're usually telling you it for a reason. And they're the one who spent goodness knows how many years training" (QI #14).*

A second area of differentiation between lay and professional perspectives was the experience of the professional, though this was only mentioned in relation to veterinarians. For example in the case of QI #9: "*They see hundreds of animals, thousands of animals over the course of a year or whatever. So I assume they know what they are talking about*".

The role of training and professional qualifications also served to bolster confidence in professional perspectives by providing an air of accountability, for example in comparison to other sources of information such as those found on the Internet:

> *"I mean, the vet at the end of the day has got the qualification. They are in a job that requires them to be monitored. If they had twelve cats come into them and twelve cats died there would be some… they are somewhat more accountable than people on the Internet" (CI #12).*

This accountability was brought into focus by participants who highlighted the fallibility of professionals despite having years of training and experience. CI #7 for example, referring to GPs as generalists, reflected that "*I don't think they are very accurate for everything, they can't know everything can they?*" whilst QI #7 said of veterinarians: "*they've got so much training I don't see why they would be wrong, although it is possible to miss things as mistakes are still mistakes*".

As these examples illustrate, participants viewed the training and qualifications of medical and veterinary professionals as a significant reason to place trust in their diagnoses and treatment suggestions. This aspect of trust arises not simply because of a knowledge gap between participants and professionals – the fallibility of professionals was itself mentioned by some participants – but from the experience and accountability that professionals had relative to either participants or other sources of information that a participant might be able to access.

Valuing discussion

The extent to which participants felt that doctors or veterinarians explained their decision-making and accepted queries was of considerable importance when gauging the trustworthiness of these professionals. For some participants, becoming informed about their health or their pets' health was as important as receiving treatment.

Understanding *why* a doctor or veterinarian came to decisions about treatment, especially where the decision involved no treatment, was referenced by multiple participants. QI #2 for example discussed their unease with black box decisions made by doctors in previous encounters: "*I think because I can feel it, if they take it easy and they say 'don't stress yourself' or they don't give you anything for it, you're like 'but why'?*". The value of discussion for building confidence in treatment decisions was similarly raised by QI #4: "*If a GP is willing to sit and discuss something with me, I may feel more confident about it. But if it is one of these 'here take these pills and go away', I don't see how that works*". Extracts like these were similarly provided by other participants, emphasising involvement and understanding as a basis for building trust in healthcare professionals rather than simply deferring to expertise. This link between discussion and empowerment was also made with regards to veterinary care, though in this extract from QI #14 the client relationship is highlighted as a mediator of the relationship between veterinarian and participant:

> *"If I go to the vet and they say, 'don't worry about it, it's fine because…' and then, they give you a reason and they tell you exactly what it is that they think and why they think it, then I would find that to be much more confidence inspiring in them. So, in regards to how it would affect what I do if I was taking her to a vet that didn't seem to be giving me – because ultimately it is me they're talking to –* ***if they're not giving me the information that I'm looking for, then I'd be more inclined to try and find somewhere else that would****" (QI #14).*

The role of discussion as an aspect of empowerment for participants translated quite clearly between the two contexts of medical and veterinary care, however a key difference highlighted within participants' narratives was the different balance of power facilitated by the veterinarian-client relationship juxtaposed to the doctor-patient relationship. If veterinarians did not provide a suitable level of information provision, as QI #14 highlights, the client could take their business elsewhere.

Narratives around the value of discussion in veterinary care bore similarity to those regarding medical care, but in a second area of difference often incorporated time as an intrinsic part of veterinary discussions that were sometimes juxtaposed to consultations with doctors. QI #4, who in the previous paragraph emphasised the link between discussion and confidence, again referenced this link with regards to veterinary care but this time with further emphasis on time:

> *"We had a conversation, she [cat] had these indicators and she may have kidney disease but it is very early stages, there is no harm in giving her the food with less protein that affects kidneys in a different way… oh yeah, ok, well that makes sense you know? She explained how it can sometimes be difficult to diagnose something.*

> *She had a conversation with me, she didn't treat me like… she had a conversation with me in a language I could understand. Erm…* ***and she gave me that time****. I think that is the key thing, giving somebody that time to actually… giving me that time. So that I can feel confident in what I do or don't need to be doing" (QI #4).*

These themes were picked up by other participants, such as QI #15:

> *"I found that they gave me time and if I'd got any questions, they were happy to answer them and actually have the conversation as opposed to saying 'this is what…'. I think that's maybe the slight difference between them [veterinarians] and a doctor.* ***You've got a bit more time*** *with a vet than you have with a doctor" (QI #15).*

The quality of discussion has been highlighted as a key area in which trusting relationships are built and maintained or break down in veterinary (Everitt 2013; Morris 2012; Coe *et al* 2007) and human (Skirbekk *et al* 2011; Hawley 2015) medicine. The level of discussion involved in both medical and veterinary consultations was, in these interviews, a clearly demarcated area in which confidence and trust could be built between lay individual and respective professional. A distinction is visible between doctors and veterinarians within participants' narratives here however, as veterinarians were perceived as providing more time for such discussion and participants had more power to change their veterinarian if the level of discussion was unsatisfactory.

Being a third party

The experience of 'being a third party' in veterinary consultations came up repeatedly in participants' narratives regarding the development of trust with veterinarians, sometimes specifically juxtaposed to the process of developing trust with a doctor.

Being a third party for some participants meant that they felt a greater level of trust in the processes of medical care than veterinary. QI #12 for example highlighted the communicative aspects of this third party experience: "*I think I'd trust my doctor more than a vet. Simply for the fact that we can communicate better with a doctor than a vet can communicate with a pet*", whilst for QI #13 the rationale was more protective: "*I think it's probably a bit more trust with the doctor because it's me rather than me caring for somebody else*". This difference in attitude was juxtaposed with material differences in behaviour discussed by other participants reflecting that they would be quicker to take up treatment options for their companion animals than themselves, adhere to companion animal treatment, and could be more comfortable with being sent away with no medication for themselves than for their companions:

> *"What's always going through my head with dog health is if it's me, I know how I'm feeling and I know if I can put up with it or not and I know how much it's*

bothering me. With the dog, you can't. So, I think, maybe sometimes, I go for treatment options for the dog more quickly than I do for myself just because I don't know, they can't tell you how bad it is.
I would probably be happier being sent away to wait for a bit to see what happens than I would for the dog because I know how I feel and I know how bad it is and I know if I can wait or not" (QI #15).

"I can feel my own pain and I can't feel the animals' pain, so I have to take their [veterinarians'] word for it. Whereas with me, it's like, I'll do what I want" (QI #4).

"It's even worse than a child because he [dog] doesn't talk. So when he has a problem – and I trust the vet that he has a problem – I completely go on information that has been given to me, so I can't leave anything out on my own judgement" (QI #6).

This attitude towards the embodied aspects of healthcare and illness experience across species boundaries was carried by some participants directly into reflections on how and why they would be inclined to use antibiotics differently for their companion animals compared to themselves:

"I would suggest that I would be more inclined to give my dogs antibiotics than I would myself because they can't communicate. So, I have to rely far more on a professional, as opposed to… I would rely on my feelings if you see what I mean, and how I feel. Whereas I can't do that with a dog, I can't read the dog's mind, so in that case I wouldn't think twice about listening to the vet saying they need antibiotics" (QI #8).

"It might be more compassionate, if you like, to use the antibiotics as the first line of defence in an animal, whereas it might be more viable because humans are more sentient, to say, 'would you mind trying something else first'?" (QI #11).

The distinctions drawn here by participants between their own healthcare and its embodied experiential – or qualitative – elements and the lack of a clear experiential equivalent in the context of their companion animals' health is important in the context of antibiotic stewardship. The recommendations of veterinarians hold greater importance in some participants' narratives due to the communication barriers that participants felt they faced with their companion animals. For these participants then, good antibiotic stewardship on the part of veterinarians could be considered especially important as potentially unnecessary antibiotic prescriptions would be followed with great

care and may lead to future expectations of antibiotics for similar scenarios. However, the distinction of greater reliance on veterinary opinion was not universal as the extracts from QI #12 and QI #13 illustrate. This poses a different issue around scepticism and the financial burden of veterinary care for pet-owners in which veterinarians may have to convince a pet-owner that a cost-increasing medication is necessary – an issue that has been described in previous research around preventative care (Belshaw *et al* 2018). Here, the context in which the veterinarian works adds another dimension to the client-patient-veterinarian dynamic through the character of the veterinary practice itself.

Practice character

Several participants made reference to the character of the veterinary practice itself when discussing the development of trust in veterinary professionals. A distinction was regularly drawn between 'independent' or 'family-run' veterinary practices and practices that were part of chains or became part of chains. QI #8 for example recalled a specific incident that drove them from a 'big business organisation' to a 'family vet':

> *"We weren't happy with that vet because our previous dog, as I say was 16, and they wanted to knock her out and clean her teeth and take some of her teeth out. At which point we said that at that age, there was absolutely no way she was being knocked out. We were then given the hard sell about it was a half price deal until the end of that month, at which point we weren't very happy.*
> *I live right in the middle of the countryside and I took them to the kennels there, and the woman there, I said to her, '**Can you recommend a family vet? Because I don't trust this big business organisation, they're trying to make money out of us**'" (QI #8).*

The association of large veterinary organisations and perceived excessive financial demands was echoed in the narratives of other participants such as QI #5:

> *"It depends on the vet as well, because you get some practices that are really big organisations and you do start to wonder if they are giving you treatment that the animal doesn't exactly need because it gives them a profit. I know that might sound horrible, but some practices you do wonder. **I know with ours, it is a small family run one, so I've got a bit more faith in their wanting to treat the animal rather than rake in the money**" (QI #5).*

The scepticism engendered by the perceived financial demands of larger veterinary organisations was a prompt for other participants to change veterinary practices in the past in addition to QI #5 and QI #8 (specifically QI #3, QI #11, and QI #12). However, some participants acknowledged that veterinary practices were a 'business like any other' and such scepticism could be unhealthy:

> *"I did get to a point with these guys where, I wondered, you know… is the financials more important than the health? But you can't think like that, you've got to kind of have a certain degree of trust otherwise what would I do? Do I not take her anywhere? It's a business like any other business" (QI #4).*

This dynamic is not one that was present when participants were discussing their own health or their experiences with doctors. Furthermore, in the context of antibiotic prescribing, research has shown that different corporate veterinary organisations prescribe antibiotics differently to one another (Tompson 2019). This would suggest that the relationships developed between pet-owners and veterinary practices through routine encounters or financial incentives may have material manifestations in pet-owners' behaviour and preferences regarding veterinary treatment. If pet-owners feel alienated due to the behaviour of a veterinary practice, they may be more sceptical about treatment or feel the need to avoid future costs by retaining antibiotics obtained from a prescription. Indeed, the differing prescription patterns found by Tompson (2019) may be part of this process.

Summary

As with the construction of health in participants' narratives there were some similarities between the way participants related to doctors and veterinarians, but also some distinctions drawn through the additional requirements of veterinary care.

While doctors were regularly referred to as difficult to contact, the process of visiting a veterinarian required significant physical and emotional energy and entailed a variety of stressors. Participants avoided doctors for minor complaints because of difficulty of getting an appointment, often preferring to wait until an illness could be considered persistent. Veterinarians were avoided because of the potential stress of financial costs, with some participants simply stating that veterinary services were expensive while others associated the unknown financial costs with negative emotional reactions. Individual participants with specific negative experiences involving veterinarians also mentioned emotional challenges with taking their companion animals to see veterinarians. Together the narratives provided by participants painted an image of complexity around accessing routine veterinary care that differed from the majority of accounts regarding accessing medical care. Rather than barriers within the infrastructure of care provision, the key challenges emerged from multiple sources of anxiety relating to finance, companion animal stress, and previous emotionally distressing experiences.

Participants developed trust with doctors and veterinarians in several ways, again with some similarities and extra dimensions to veterinary care. The knowledge and accountability provided by training and qualifications was a key differentiator in participants' narratives between themselves and professionals. This differentiator was however dependent on the extent to which professionals explained their decisions to participants and informed them alongside treating them. This was

important for participants in both the contexts of medical and veterinary care, and participants particularly emphasised that information was important when no treatment was being provided for their complaint. Veterinarians were perceived as being better at this than doctors, giving participants more time in order to respond to their queries than doctors – who participants generally perceived to be overworked – would or could.

Another layer to the distinction between doctor and veterinarian was rooted in the experience of being a third party in a veterinary consultation. The lack of an embodied experience regarding companion animals' illnesses led some participants to place greater trust in veterinarians than doctors, whilst for other participants this outcome was reversed for the same reasoning. Contextualising these attitudes and the individual veterinarians in participants' recollections was the corporate status of the veterinary practices that participants used. This context was unique to the veterinary sphere here, and some participants drew distinctions between the financial transparency and care ethos of practices that were part of larger chains and those that were independent practices, holding greater scepticism for the clinical decision-making of larger chain practices.

These findings raise some potential issues in the context of antibiotic stewardship. In both medical and veterinary practice, it is evident that communication between public and professional is a point at which decisions around antibiotic use can be clarified and appropriate actions be explained. However, the trust that the public has in veterinarians has additional dimensions to those in medical practice. The experience of being a third party in veterinary consultations, and prior experiences with other members or practices in the veterinary sector, informed participants' perceptions of veterinarians' trustworthiness. Financial- or anxiety-related stresses can mean that pet-owners avoid a trip to the veterinarian, increasing the potential for the administration of antibiotics without a prescription (as in the example of CI #7) or resulting in owners holding off on taking a sick companion animal to the veterinarian (Volk *et al* 2011; Rock 2020) and subsequently requiring more significant antibiotic intervention. These stressors are not only problematic for the pet-owner and their companion animal, but also the broader public for which the prescriber and their profession is responsible (Brown 2019).

Ensuring that antibiotic prescriptions are accompanied by clear communication of the rationale and consumption of antibiotic medication is one direction for improving antibiotic stewardship, however these findings suggest that broader confidence-raising measures are also needed. This is supported by the findings in Chapter 5 that levels of trust in healthcare professionals was associated with following doctors and veterinarians' instructions regarding antibiotic consumption. Clear explanations of why antibiotics may not be needed and responsive signposting to home remedies or trustworthy sources of online information could have a positive effect on antibiotic stewardship by increasing public confidence not only through being informed and empowered, but by buttressing trust in the veterinary profession servicing companion animals.

Section 6.3.4 – Engaging with Online Health Information

"Having a Google"

'Having a Google' was an important part of several participants' healthcare decision-making in both their own and their companion animals' health. Online health information was often used in an adjunct capacity, and participants were often conscious of their own limitations in interpreting online health information. This particularly manifested in participants' observation that there is 'no NHS for animal health'.

Adjuncting for professionals

Online health information was used in a number of ways preceding and following on from medical or veterinary consultations. Difficulties in getting GP appointments were cited as a reason for using online health information to self-diagnose (CI #4; QI #3), along with difficulties in getting to veterinarians (CI #6; QI #6). For other participants, a common practice was to search for information online prior to visiting a veterinarian in order to gauge whether the expensive of a visit would be necessary (QI #2; QI #5; QI #8; QI #12). More consistently, participants recalled using online health information after veterinary consultations (seven participants). Ensuring adequate follow-up care was one reason for sourcing additional information (QI #5; QI #7), while other participants simply wanted more information about the companion animal's condition or treatment (CI #12; QI #6; QI #14; QI #16). No participants suggested that they solely relied on online health information or placed greater reliance on online health information than professionals.

A division was made between the use of online health information and the information provided by professionals in their utility for understanding the experience of illness. Participants often mentioned the use of online forums for understanding the experiences of other people who had similar symptoms or had to manage similar symptoms in a companion animal. QI #11 for example recalled the following regarding a treatment for her dog's long-term illness:

> *"They [the veterinary practice] had also then just switched brands to a different brand [of medication] and again I had a look at Dr Google on that and some of the reviews. A lot of people sung its praises, other people were like, 'It killed my dog in six weeks', and stuff like that. So, I wasn't entirely comfortable, and maybe that's what gave me the idea that this immune-therapy stuff is not necessarily a good idea long term" (QI #11).*

The value of online health information was cast by some participants explicitly as being a source of information about experiences with illness:

> *"If people have commented on the site that I'm looking at, then I'd read that quite a bit. Yeah, as much information as possible from somebody who thinks they've*

got similar symptoms or has been through something like that. I would trust the public more than I would trust the website" (QI #8).

"In this day and age I think Google is a good resource, because there's always going to be someone who's had the same symptoms or experience as what your animal's got" (QI #13).

For these participants, the use of online health information was less about correcting or replacing a doctor or veterinarian and was rather a useful tool to supplement professional knowledge with the lived experiences of people who have lived with an illness that they or their companion animal had.

Despite this utility, more participants understood online health information to be limited in its translation of disease and illness due to their own lack of experience or knowledge. This understanding was expressed in a number of ways across both medical and veterinary contexts, for example in terms of diagnosis:

"It'll just be like a list, but it won't say that if you've got this then it could *be this but then it might be 3000 other things as well. But the GP would obviously do those eliminations for you, like 'yeah that can happen but it often doesn't or it doesn't usually', so they have more experience of making those judgements" (CI #1).*

"It might be that I've actually got a stomach bug, but if I describe it to the GP they are going to pick up on more symptoms, they will ask questions, and it is that questioning that you don't get with a web doctor. They can draw parallels, the Internet can't" (CI #13).

"It [the Internet] doesn't give you definitive answers because you are not a vet" (QI #1).

"I'm not trained to diagnose. And you can relate, you can relate symptoms to how you feel and that then leads you to inventing how you might really be feeling" (QI #4)

The limitation here is with the participant, rather than solely with the information source. Drawing a conclusive inference from the information is placed beyond the scope of the participant's ability as they do not have the training or experience to make eliminations and understand whether a diagnosis is likely or unlikely, and their own embodied experience is not necessarily considered reliable enough to translate the information accurately. These acknowledgements recall 'Deferring to qualifications and experience' as part of 'Developing Trust in Veterinarians and Doctors' – in both categories the

experience and expertise of professionals is the primary source of reliable information regarding either human or companion animal health owing to participants own acknowledged limitations.

"No NHS for animal health"

The phrase 'no NHS for animal health' does not just literally reference that there is not an NHS website for animal health - it conceptually denotes a broader lack of reference point that participants felt with regards to animal health. The comparison between using the NHS website and finding animal-related health information was invoked by multiple participants:

> *"Finding sources that are trustworthy for pets online is more difficult. Or I'd expect it to be more difficult, because you don't have a source like the NHS website necessarily that is easy access or is easy to find" (CI #4).*

> *"I don't use a regular… unlike me using the NHS site for myself as a kind of sounding board, I don't have one for the cat" (CI #9).*

> *"The NHS is trustworthy, but there is no equivalent for dogs. The sources online differ so much" (CI #11).*

The variability of online health information for companion animals without the 'sounding board' of an NHS-type source made the experience of finding and using online health information a significantly different proposition for participants than finding information relating to their own health. Rationales like those in the extracts above often led to participants feeling more inclined to visit a veterinarian due to uncertainties in the validity of online information they had read about companion animal health. 'Having a Google' holds different meanings for finding information about health across species boundaries – for human health in the UK there is a central resource often locatable through search engines in the NHS website, however animal health information is sourced from more diffuse and difficult to find online resources.

Judging Online Health Information

The legitimacy of online health information was judged in a variety of ways by participants. The central criteria for legitimacy was the professional status of the source, alongside the reputability of the source and its national context.

For their own health, participants regularly stated that they would make use of the NHS' online presence as a source of information:

> *"I quite often got to the NHS website. I don't plough much beyond the first top searches" (CI #6).*

"My sister, who has always worked around medicine as a nurse, as a midwife, as a social worker, erm… has always used the NHS website. She's pointed me in the direction of the NHS website. So, if someone that works with drugs feels that's a good place, a good source of information, then ok I'm happy to agree with that. But I have nothing similar for animals" (CI #9).

"I'd prefer to find a legitimate website like the NHS where they know what they are talking about, whereas a random website might make it worse than it actually is" (CI #10).

These extracts highlight three common attitudes expressed by participants. Firstly, that one needs to search around for information less because the NHS is a reliable source. Secondly, the experience of being signposted to the NHS website by a trustworthy person. Finally, that other less 'legitimate' websites might provide bad information or frighten the reader unnecessarily. Other websites that were referenced in a similar vein to the NHS were charity-run websites, and especially those dealing with specific diseases. As CI #9 highted above however, and following from 'no NHS for animal health', legitimacy was perceived as more difficult to ascertain for online companion animal health information.

For companion animal health, participants spoke of charity websites or endorsements from veterinary professionals, though there was less clarity on a specific source that had a 'developed sense of trust' like the NHS did:

"Websites all over, there's no specific one. I don't have that sense of developed trust in specific websites that you do with the NHS" (CI #6).

"With the NHS one you feel like that is something you can trust, whereas… I don't know, I wouldn't know with the vets" (CI #7).

"There are things like, animal welfare charities and things like that. I would trust their websites if they had some information about some animal sickness because I would assume that they would have the best interests of the animals in mind" (QI #9).

"For human health I tend to go to the NHS website but I don't know the equivalent for animals, but I would probably try and find something that looked reliable. I generally know, or get a feeling when things are not quite so reliable or a bit more alternative. I'm not into that kind of thing at all. […]
I guess I'd probably look for something that was endorsed by a veterinary college

and not full of advertising or obviously run by a company selling veterinary products" (QI #16).

Again, these extracts highlight some of the common attitudes among participants regarding the legitimacy of companion animal health information found online. The story told by participants regarding companion animal health information was starkly juxtaposed to their own health. Without the central 'sounding board' of the NHS, participants searched around more and used a range of sources that either felt credible or had some sort of badge of credibility such as being run by a charity or endorsed by a veterinary college. This suggests that the dissemination of information on companion animal health in the UK may not be being clearly signposted, as very few participants mentioned groups like the Royal College of Veterinary Surgeons or the British Veterinary Association as sources of guidance. The British Veterinary Association (2013), for example, provides information on antibiotic resistance on its website, but the Association was not cited as an important source of information by participants. The variability of online companion animal information sources used may also partially explain why fairly frequent users of Internet for pet health and survey respondents who trusted the Internet more than their veterinarian in Chapter 5 were more likely to report poorer antibiotic stewardship behaviours in the context of companion animal health, whilst the frequency of online health information use did not correlate with human-orientated behaviour.

The national context of online health information was raised by multiple participants, usually with reference to being American- or UK-based websites. QI #8 for example pointed to the different institutional landscape of healthcare between the countries: "*I don't trust the American sites because they're all insured up to the hilt and they'll dish out whatever they can*", a position echoed by CI #9: "*The problem with search engines is that they bring up so many American sites and I'm not really interested in American health as much because they have different laws and different ways of treating things*". These extracts show that some participants used the national context of the information they were reading to judge its credibility, emphasising differences between 'American health' and UK health based on the operating of the countries' healthcare systems. Online health information is not purely judged based on badging from perceived reputable sources, but is further mediated by perceptions of other countries' health systems. For these participants, 'American health' and UK health were sufficiently different to warrant drawing a distinction between online sources based in each country.

Summary

Online health information was used in various ways as an adjunct to professional contact, for example deciding whether or not to visit a professional or to become more informed following a consultation. Online health information occasionally filled in the gaps when it was difficult to get a GP appointment or the prospect of a veterinary visit felt too difficult or potentially not cost-effective. A

common benefit of online health information cited by participants was as a source of information about illness experiences both for human health and companion animal health.

Despite these uses, participants often felt that they were not well-placed to make full use of online health information due to a lack of contextual knowledge that professionals would have when confronted with a set of symptoms. This was particularly the case around companion animal health, where participants felt like there was a lack of clear equivalent to the NHS as an online source of health information. The Royal College of Veterinary Surgeons and the British Veterinary Association for example were not cited by participants as a source of companion animal health information, despite providing numerous resources for animal owners.

These findings have potential implications for antibiotic stewardship, especially in the context of companion animal care. When searching for health information regarding their own health participants tended towards the NHS website, which itself reinforces good antibiotic stewardship behaviours and adherence to prescriptions. Whilst some centralised sources of information regarding companion animal health exist, such as the British Veterinary Association's website, participants unanimously felt that there was no equivalent centralised source of information to the NHS in the context of companion animal care. This meant that participants rooted through several online sources looking for information, some of which may be inaccurate or conflicting, without necessarily having a clear idea of what a credible source might be. As these sources were predominantly being used alongside professional services however, this may not be a significant problem in the context of antibiotic stewardship. Online health information is more likely, based on these accounts and the findings of Chapter 3, to be reinforcing stewardship behaviours rather than changing them in a negative way.

Section 6.4 – Discussion

The qualitative interview evidence of this Chapter speaks to several concerns and challenges raised from the literature. The Chapter has presented findings relating to the construction of companion animal and human health by pet-owners, along with the challenges of companion animal care, the characteristics of trust in veterinary and medical professionals, and the use of online health information. The qualitative interview evidence presented in this Chapter contributes to the nascent social science literature on veterinary medicine by providing novel insights into how pet-owners prioritise aspects of companion animal health relative to the way they prioritise aspects of their own health, and into the parallels and differences between the development of trust by pet-owners in veterinary and medical professionals. These areas hold importance for understanding how healthcare decisions are made by the pet-owning public, with implications for the design and communication of, for example, 'One Health' public health interventions. Antibiotic stewardship improvement is one such area, and this Chapter provides context on key areas of pet-owners' understanding of health and

healthcare professionals that may underpin behaviour with antibiotics, perceptions of antibiotic resistance, and mediate beliefs such as bodies rather than bacteria being resistant to antibiotic medication. This specific area is examined in greater detail in Chapter 7, whilst the focus in this Chapter remains on the context of pet-owners general attitudes, perceptions, and behaviours.

The inferences made from the analyses presented in this Chapter are limited in some important ways. Due to the small size and qualitative nature of the sample, the analyses are not able to draw out systematic differences between different companion animal species' care (for example, between dogs and cats) and so the inferences are undifferentiated in this regard. These kinds of differences, though only sufficiently detectable through the use of larger samples, have importance for how care is practiced. Cats for example are much more independent than dogs, and consequently generate more barriers for pet-owners attempting to deliver care or observe their condition. However, all of these pet-owners share the experience of visiting a veterinarian and using the Internet to access health information with the result of these aspects being foregrounded in the analysis and the more detailed species-specific forms of ownership and practices of care being otherwise undifferentiated and subsumed into these analytic categories.

This limitation also applies to the treatment of participants' use of the Internet to access health information. The analysis does not draw out specific groupings of websites privileged by participants, instead focusing on the general topics of search engine use and the lack of a central 'sounding board' source for companion animal health. The comparison of different kinds of websites used by members of the public had been attempted in Chapter 5, however the questionnaire resulted in unusable data for this purpose. The aim of the qualitative analysis has been to examine these practices and motivations in participants' own narratives and language. The size of the sample means that the analysis is limited in terms of the specificity of inferences or classifications that can be made regarding the impact of types of website on attitudes and behaviours, however inferences can be made about general motivations such as the use of online material to adjunct for professionals, the limitations that participants perceive in their use of online material, and the challenges faced in companion animal care relative to human-focused care.

Section 6.4.1 – Spillover between constructions of human and companion animal health is complex

There is some evidence in the literature that pet-owners draw informative connections between companion animal health and healthcare and their own personal health and healthcare. Ethnographic evidence has for example shown that diabetes sufferers with diabetic companion animals draw a number of parallels regarding diagnosis and care of the condition, whilst for non-diabetic people with diabetic companion animals the companion animal exemplifies life with diabetes (Rock 2017). Ashall & Hobson-West (2017), and later Hobson-West & Jutel (2020), have also hypothesised that decision-

making in healthcare may exhibit spillovers between human and veterinary medical contexts for pet-owners. This suggestion takes on a further urgency, Hobson-West and Jutel (2020) argue, in the increasingly e-scaped context of medicine as pet-owners may utilise information on human health to perform lay diagnoses on companion animals.

This evidence presented in this Chapter suggests that pet-owners do indeed translate some aspects of health across species boundaries, but in general perceive the practice of good health for companion animals and for their own personal health in different ways. Companion animal health and healthcare revolved around routine and vigilance on the part of the pet-owner, watching for the exhibition of quantitative variations from normality such as limps or lumps, or more attuned affective variations that might suggest changes in a companion animals' experience of health. Routine professional veterinary care was also important, echoing the relationship between veterinarians and the wellbeing of client pet-owners noted in other research (Morris 2012; MacMartin 2014; Rock *et al* 2020). Personal health in participants' narratives was much more contingent on their social experience of health and illness and its effect on how they went about their day-to-day lives, with routines focused on diet, sleep, and exercise rather than the enrolment of professional care. This emphasis is closer to Canguilhem's (1991) sociology of medicine, summarised by Philo (2007 p85) as health being "relative to the demands of their immediate circumstances" and echoed in other participant-led definitions of health (O'Sullivan & Stakelum 2004' Conrad & Barker 2010). Whilst for companion animals in participants' narratives health was predominantly related to observing and maintaining norms of physical care, human health was predominantly related to personal context and functionality within this context.

The ways in which participants expressed spillovers in their reflections on human and companion animal health hand healthcare were less consistent than participants' reflections on how health is practiced for humans and companion animals. Physiological characteristics of humans and animals led some participants to contend that human and animal health shared a number of similarities for which healthcare behaviours could be translatable, whilst for other participants physiology was the source of distinction between human and animal health rendering such translation as transgression. Whilst qualitative and affective aspects of health held clear importance for participants, the basis for commonalities between human and animal health were comparisons of "quantitatively varied extension[s] of the physiological state[s]" (Canguilhem 1991 p89) such as similar infections or symptoms of allergies. Some participants even connected similarities between symptoms across species and pharmaceutical products marketed for different species. Conversely, there were also participants that resisted the idea of translating health and health-related practices across species boundaries due to perceptions of physiological or dietary difference, or knowledge about the toxicity of pharmaceuticals marketed for different species. In responding to the hypothesis that pet-owners may translate health-related decision-making across species boundaries (Ashall & Hobson-West

2017; Hobson-West & Jutel 2020), this evidence paints a complex picture of individual experience and heterogenous rationalities in this area.

Even in areas where participants made explicit connections, such as vaccination, there was variation in whether companion animals were routinely vaccinated in the same ways as their owners. This reflects some of the differences between human and companion animal care, as Belshaw *et al* (2018 p100) note that "risk aversion amongst owners and fear of being seen to make profit amongst veterinary surgeons" are barriers to uptake of preventative care in veterinary practice. Whilst risk-aversion is also present in the context of preventative care in human medicine (Hobson-West 2007), there are extra contextual barriers within veterinary care. It may be reasonably hypothesised from the evidence of this Chapter and examples in the literature that the translation of health decision-making across species boundaries is itself context-bound by specific illness conditions or practices such as diabetes (Rock *et al* 2017) or blood donation (Ashall & Hobson-West 2017), whilst in other areas pet-owners may be more hesitant to make such translations without previous knowledge or experience. The differences between utilising medical and veterinary care may also play a key role in emphasizing differences in species' healths, illustrated in this Chapter by the emphases placed by participants on how health is practiced personally and for their companion animals.

Section 6.4.2 – Veterinary care presents different challenges for access and trust

Caring for companion animals through veterinary medicine presents challenges that are distinct from routine human medical care. In the literature, veterinarians are commonly concerned about the perception of their profession as 'selling' products rather than providing medical care (Coe *et al* 2007; 2008; Belshaw *et al* 2018; Morris 2012). Pet-owners with limited financial resources were noted as sometimes avoiding veterinary clinics due to the cost of care, along with pet-owners who find visiting the veterinary clinic stressful, with negative implications for the health of both companion animal and owner (Volk *et al* 2011; Rock *et al* 2020; MacMartin *et al* 2014). Together these obstacles to veterinary care highlight the importance of the emotional support provided by veterinarians to pet-owners and the maintenance of pet-owners' trust (Morris 2012; MacMartin *et al* 2014).

The variety of examples present in the literature of barriers – whether financial or affectual – that pet-owners encounter when deciding whether to access veterinary care were also present in the qualitative interviews of this study. These difficulties differentiated accessing routine veterinary care from accessing routine medical care. Medical care was perceived as oversubscribed, whilst veterinary care entailed challenges relating to finance, physical logistics of getting companion animals to a veterinarian, stress associated with previous experiences, and uncertainty.

Participants often separated themselves from professionals based on differences in qualification and experience and the levels of accountability that were attached to professionalism. The extent to which this translated into trust was dependent on the quality of professionals' explanations of their decisions

and diagnoses. As well as connecting treatment and prognosis, diagnoses serve social functions in differentiating healthcare professionals and their tactics from their patients/clients in both human and veterinary medicine (Mol 2002; Jutel 2017; Hobson-West & Jutel 2020). However, as the evidence of this Chapter suggests, diagnoses alone do not completely instil trust in healthcare professionals. The extent to which professionals informed and educated participants was more consistently important in participants' narratives around the trust they did or did not feel towards healthcare professionals, a finding echoed in other contexts in the literature on both human and veterinary medicine (Skirbekk *et al* 2011; Hawley 2015; Everitt 2013; Morris 2012; Coe *et al* 2007). This was acute in the context of veterinary care due to its contractual nature (Morris 2012; Hobson-West & Jutel 2020), with participants quicker to scepticism but also noting that they could take their custom elsewhere if they were not satisfied. The quality of the contractual nature of veterinary care was not presented as singular however, as participants often parsed veterinary practices into corporate chain practices and independent or 'family' practices, holding greater scepticism or providing negative anecdotes about chain practices. Whilst there may be spillover between conceptions of human and companion animal health influenced by differences in medical and veterinary care contexts, there is evidence here of a further differentiating influence in veterinary care due to experiences at different *kinds* of veterinary practice. These experiences could be generalised by pet-owners to the veterinary profession as a whole, but more often in these interviews they were used to typify a corporate kind of veterinary practice juxtaposed to a more honest, gentler, or transparent kind of veterinary practice.

Improving communication on the topic of antibiotic consumption is one direction for improving antibiotic stewardship, and these findings suggest that this kind of intervention may need to be coupled with interventions to raise the confidence of the public in the veterinary profession and in particular in larger corporate veterinary practices. In Chapter 5, it was argued from survey evidence that levels of trust in healthcare professionals was associated with positive attitudes towards following doctors' and veterinarians' instructions regarding antibiotic consumption. Antibiotic stewardship therefore requires not only improvements in communication about antibiotic consumption (Currie *et al* 2018), but broader improvements in trust in the veterinary profession where it is lacking.

Section 6.4.3 – Online health information adjuncts for professionals

The avoidance of veterinary clinics by pet-owners has been linked to an increase in consultation of online health information by pet-owners, often as an adjunct to veterinary care (Kogan *et al* 2009; 2012), sometimes due to poor veterinary communication (Belshaw *et al* 2018), and leading to occasional negative impacts on companion animal health (Volk *et al* 2011). Veterinary professionals have however remained ranked as more trustworthy than online health information in literature (Kogan *et al* 2009; 2014; Hockenhull & Creighton 2013; Hofmeister *et al* 2008).

Online health information was consumed by participants as a supplement to professional services rather than a replacement. Participants valued the insight into other people's experiences with illness or treatment in both human and veterinary medicine. This consumption was heavily contextualised by the challenges described above, covering scenarios in which accessing professional care was either too difficult or where participants were unconvinced about the effort needed to access professional care.

In common with the literature evidence, professionals had greater value as a source of information than the Internet. Participants often explicitly reflected that they were not well-placed to accurately interpret online health information because they did not have the experience and qualification of healthcare professionals. This challenge was acute in the context of companion animal health, for which participants lacked a clear reference point like the NHS website for human health. Hobson-West & Jutel (2020) have speculated that the wide availability of health information may lead to pet-owners evaluating information on human health to perform lay diagnoses of their companion animals. For topics such as antibiotic stewardship, this may be of benefit to public health as the information provided by the NHS regarding following prescriptions is directly applicable to the care of companion animals.

Given the confidence placed in the NHS website by participants here relative to sources of online health information concerning animal health, Hobson-West & Jutel's (2020) speculation may be reality for pet-owners that make connections between human and animal health. The variation in perceived spillover between species' health(s) and the heterogenous rationalities provided by participants for perceiving such spillovers suggest that this may be an important area for future research. Specifically, it would be of interest to know for which conditions or treatments pet-owners are likely to make connections across species. Examples in the literature suggest such translations are made for diabetes treatment and blood donation (Rock *et al* 2017; Ashall & Hobson-West 2017), and understanding for example whether information regarding treatments for chronic conditions or preventative treatments such as vaccines are crossing species boundaries may help the development of future public health information dissemination efforts.

Section 6.5 – Conclusion

Section 6.5.1 – Recap of the Chapter's Aims

This Chapter has analysed qualitative interview data on pet-owners' navigations of human and veterinary medical care, situated within the emergent social scientific literature on veterinary care. The principal aim of the Chapter has been to develop an understanding of the different dynamics of care, health, and healthcare that are present in the contexts of human and veterinary medicine.

Within the context of this thesis, this Chapter has provided a platform of understanding for how pet-owners make sense of health and care in different contexts that informs this thesis' knowledge contribution regarding pet-owners' understanding of antibiotic stewardship and antibiotic resistance as a public health issue. The specific discussion of antibiotic stewardship is presented in Chapter 7.

Section 6.5.2 – Chapter Conclusions

The construction of health in different species contexts has been shown in this Chapter to be a varied phenomena with context-specific spillovers between individuals' perceptions of 'health' for themselves and their companion animals. This is important for the consideration of antibiotic stewardship, as well as other areas of public health such as vaccination, as the clinical questioning and therapeutics of medical activity have a "relationship with the patient and [their] value judgements" (Canguilhem 1991 p122). These judgements are part of a social and cultural milieu (Canguilhem 1991; Philo 2007) that includes companion species such as companion animals and their microbial collectives (Haraway 2008). Companion animals were often centred as co-constitutive subjects of care in this Chapter, not simply being cared *for* through the routines that pet-owners recounted but actively shaping how care took place and occasionally how pet-owners thought about health across species boundaries without being able to 'speak dog' (Donald 2018; Gorman 2019; Buller 2015). Understanding this relationship as co-constituted draws one into the ongoing and "colossal" task of developing and presenting symmetrical understandings of action involving humans and non-humans (Murdoch 1997 p751). Whilst the development of 'co-constitution' here is limited by the focus on pet-owners and their actions as opposed, for example, to an ethnography involving the companion animals themselves, this Chapter has highlighted that in terms of animal health and care the manner in which care is sought out and delivered is shaped by the frictions and affective signals of companion animals. The form that care takes is something of a network effect, produced by multiple actors including the pet-owner, their veterinarian, their use of the Internet, and of course the companion animal themselves. The concept of co-constitution is taken forward in this context by this limited understanding of the human-animal healthcare relationship being situated and shaped by a range of actors that would otherwise not be networked in this way and do not "pre-exist the relating" (Haraway 2003 p12). The interpretation of affective signs is one important part of companion animal care in which the animals are subjects for example, but the translation of these signs is itself dependent on other relationships brought into existence by – and further shaping – this human-animal relationship.

For interspecies health issues like antibiotic resistance, understanding when and how connections are made by members of the public between the healths of different species can be illustrative and informative for communicating the facets of the problem. For example, the use of specific medications was an area in which pet-owners in this Chapter seemed to connect or differentiate the health of different species which is a promising finding for the communication of antibiotic stewardship as an important behaviour relevant to both humans and companion animals. This supports

the suggestion made from more generalisable evidence in Chapter 5 (5.4.3) that veterinarians may be a constructive avenue through which to inform the public about antibiotic stewardship principles relevant to human health as well as companion animal health, given the urgency indicated by the lack of evidence for difference in quality between pet-owners and petless survey respondents in their antibiotic stewardship behaviour.

Issues around access to professional care and online information demonstrated the complexity that characterises the negotiation of patient-hood in the 21st century (Crooks 2006), with acute challenges facing veterinary care and online animal health information. As demonstrated by the various constructions of health provided by participants, and the discussions of the ways in which online health information supplemented professional care, the main site for diagnosing potential illnesses is the "world of everyday life" rather than the Jennerized world of laboratories (Prior *et al* 2011). The variation with which participants came to 'know' about their companion animals and act upon their knowledge broaches questions integral to the work of animal geographers regarding the status of animals and our knowledge of them (Buller 2014; 2015). The judgements made by pet-owners regarding their companion animals' health and healthcare were contextualised by individuals' perceptions of normality (Canguilhem 1991), which are influenced by their social and cultural milieu as well as the temporally and spatially diffused medical consciousness of the Internet (Parr 2002). The extension of veterinarians' jurisdiction beyond the clinic is not simply a case of making judgements about whether a pet-owner is capable of delivering a particular treatment or performing home-visits, but may need to evolve further into cyberspace to ensure that the world of everyday life is adequately anchored to the education space of the veterinary clinic. This suggestion is supported by inferences made in Chapter 5 around the frequency of use and trust in online health information and its association with antibiotic stewardship behaviour, though this Chapter provides a significant caveat that the provision of online health information through veterinarians will need to be combined with the maintenance of the public's trust in the veterinary profession.

Chapter 7 – Consuming Antibiotics and Situating Resistance in More-than-Human Families

Section 7.1 – Introduction

Section 7.1.1 – Chapter Aims

This Chapter is the second of two Chapters analysing the qualitative interview data collected as part of this mixed-methods project. This Chapter draws on the same sample of interviews as Chapter 6, and consequently used the same methods of data collection and analysis. This Chapter aims to develop an understanding of how pet-owners approach antibiotic use in the context of their own healthcare and their companion animals' healthcare, the extent to which these approaches share common rationalisations, and how pet-owners' conceptions of the problem of antibiotic resistance map across healthcare contexts.

This analysis is focused in two areas: obtaining, consuming, and administering antibiotics, and how pet-owners situate antibiotic resistance. These areas draw upon other parts of this thesis, predominantly Chapters 5 and 6, in order to critically reflect upon how pet-owners' narratives around antibiotics and antibiotic resistance connect to broader conceptions of health and illness in human and companion animal care, trust in healthcare professionals, and the extent to which these narratives illuminate generalisations produced from the survey data.

The remainder of this Chapter's introduction discusses background literature on public antibiotic stewardship with reference to both human and companion animal care. This short review of the literature develops questions arising around misconceptions about antibiotic resistance, the relationship between misconceptions and stewardship behaviours, individualism, and recurrent spatial tropes in lay narratives regarding antibiotic resistance.

Section 7.1.2 – Antibiotic Stewardship and Companion Animal Care

Previous qualitative researches into lay attitudes, beliefs, and behaviours around antibiotics and regarding antibiotic resistance present some consistent themes. Misunderstandings over the siting of antibiotic resistance are common (for example, exclusively within hospitals, farms, or bodies), as is the apportionment of blame to 'other' members of the public alongside variously GPs, hospital management, and the government. The findings of this Chapter are situated here relative to this

qualitative literature, drawing not only upon the growing body of qualitative research on community antibiotic consumption but also an emergent critical social science of veterinary medicine including the previous Chapter of this thesis.

Misconceptions about antibiotic resistance are commonly reported in qualitative studies, including for example the perception that antibiotic resistance is situated in one's body (Brookes-Howell *et al* 2011; Hawkings *et al* 2007; Brooks *et al* 2008; Norris *et al* 2013; Dickson *et al* 2019; Davis *et al* 2020a). This is an important area of distinction, as this understanding contributes to the perception that antibiotic resistance is not a societal problem but is rather a problem of individual personalised risk management. This "immunitary individualism" (Brown 2019 p141) forms part of what Davis *et al* (2020a p10) recently described as the "conceptual bricolage of lay publics contending with AMR". Davis *et al* (2020a p12) argue that the enduring importance of this misconception, linked to the idea of immunity as self-defence, suggests that messages about antimicrobial resistance "come into a cultural context of assumptions about the body and how it responds to infection and antibiotics, most particularly, long-standing notions of the body as possession in immunity discourse and consumer culture". In the context of Hobson-West & Jutel's (2020 p400) recent suggestion – based on available emerging evidence – that animal owners may "implicitly or explicitly draw on their own illness experiences when dealing with their animal's diagnoses or treatment", and the caveated support of the previous Chapter for this suggestion, this expression of the public's 'conceptual bricolage' regarding antibiotic resistance may entangle or separate human and animal health depending on prior conceptions of immunitary individualism. If bodies, rather than bacteria, are resistant to antibiotics, how do pet-owners translate this understanding into practice? For example, do pet-owners 'save up' the immunitary biovalue of their companion animals in the same way that they may do for themselves? How are veterinarians' prescribing practices understood, relative to doctors? Conversely if pet-owners understand that bacteria, rather than bodies, become resistant to antibiotics, does this shape their understanding of antibiotic resistance as a societal problem in the context of veterinary, as well as human, medicine?

Concerns about the effect of antibiotics on the body also affect consumption behaviour. In Hawkings *et al*'s (2008) typology of antibiotic user behaviours, one of the six types of user actively seek to limit antibiotic use because of reservations about the nature and effects of antibiotics such as antibiotics being 'unnatural' and harmful or the body becoming used to the antibiotic. This kind of behaviour is echoed in Norris *et al*'s (2013) findings that reported participants being concerned about the use of antibiotics for recurrent infections, with participants employing a range of strategies to avoid antibiotics. Such concerns and strategies have also been reported in pet-owners' behaviours with regards to administering antibiotics to their pets, with Redding & Cole (2019 p629) relaying the case of one particular owner who "reported giving less than the indicated dose and not following the entire course of treatment because her pet, like her, was 'not a pill taker'." The potential parallels here

between healthcare decision-making in individuals' everyday lives affecting either or both their own health and companion animals' health are clear, and would reflect recent research that evidences the entanglement of humans and companion animals in the health narratives of pet-owners in contexts such as long-term conditions (Ryan & Ziebland 2015) and canine blood donation (Ashall & Hobson-West 2017). However, as has been discussed in the literature (Hinchliffe 2015) and demonstrated in the previous Chapter there are some differences between the ways that some pet-owners understand their own and their pet's health(s), challenging the conceptual 'Oneness' of 'One Health' with implications for antibiotic stewardship practice and communication.

Individualism in the context of antibiotic resistance, and the enormous complexity of the issue, can leave members of the public feeling that they have no way to individually contribute to solving the problem. Low motivation to change personal behaviour has been evidenced in qualitative research, for example as Brooks *et al* (2008 p346) highlight from a focus group study: "most [participants] did not see [antibiotic resistance] as something that would affect them personally or something they could control and therefore did not perceive a reason to modify their own individual antibiotic use." Public feeling that individuals do not have a clear stake in addressing antibiotic resistance is something that has been specifically drawn out through qualitative approaches, for example again with Hawkings *et al* (2007 p1158) noting from their interview research that "few participants talked about the individual's potential contribution to controlling bacterial resistance through adherence to medication regimes or by working with clinicians to limit antibiotic to essential indications". Recent qualitative research with pet-owners also found minimal concern about resistance, interspecies transmission, or the use of the same antibiotics in both people and pets in the US and UK (Redding & Cole 2019a; Dickson *et al* 2019). Recalling the anthropocentrism present in One Health discourse as it relates to antimicrobial resistance discussed in Chapter 2, it may be the case that pet-owners in the UK are also broadly unaware of the interspecies complexity of antibiotic resistance. Understanding the extent to which this anthropocentrism impacts upon the attribution of responsibility by pet-owners regarding antibiotic resistance may help to direct future informational engagement efforts by highlighting, for example, that as pet-owners they have a commitment to interspecies health and "more-than-human solidarity" (Rock *et al* 2020 p2).

The perception of antibiotic resistance as an individual's problem can also lead to moralisations of others' behaviour away from critical reflection of one's own practice (Davis *et al* 2015; 2020a; Brown 2019). For example, Davis *et al* (2015 p147) describe the concept of "choice immunity" in the context of influenza pandemics with prevalent "do-it-yourself immunity-boosting" and moral judgement of "those who failed to adequately care for their immunity". Choice here confers on immunity "the meaning of self-managed biovalue that can be accumulated and exchanged for health in the event of infection" (Davis *et al* 2015 p148), extended to antibiotic resistance by Brown (2019 p134) as reflecting "one's own purposeful and volitional capacities" such as deliberately 'sitting out' from the

unrelenting flow of life "to create personal immunitary intervals for recuperation unaided by antibiotics." This 'sitting out' is often presented in sharp contrast to 'getting on top of things' quickly using antibiotics to maintain daily obligations such as work and parenting. Understanding antibiotic resistance as a bodily, rather than bacterial, phenomenon therefore has potential to undermine the societal nature of antibiotic stewardship efforts when responsibility is perpetually individualised and located in *other* individuals, such as other people who misuse antibiotics or 'willy-nilly' prescribers (Davis *et al* 2020a). Identifying how – or indeed, whether – this moralisation enters into pet-owners' conceptions of immunity, disease, and illness can help develop an understanding of how different dynamics of human and animal healthcare and lay/professional relationships translate into antibiotic-related praxis.

A common spatial trope found in the literature is the siting of antibiotic resistance in the hospital, specifically through methicillin-resistant *Staphylococcus aureus* (MRSA). Familiarity with 'MRSA' and 'superbugs' is reported as being common though this is underpinned by reliance on television, newspapers, and radio reports that repeatedly emphasise the place of superbugs like MRSA as within hospitals (Brooks *et al* 2008; Hawkings *et al* 2007; Davis *et al* 2020b). In Hawkings *et al*'s (2007 p1157) study for example, "no participants expressed a belief that bacterial resistance was a common community problem or that resistant infections could affect those who were not in hospital". This spatial narrative around antibiotic resistance in the UK has had the effect of increasing anxiety about hospital admission for some members of the public, leading to refusals for admittance for treatment (Hawkings *et al* 2007). Aversion to accessing primary care due to perceived difficulties in access has also been reported as a rationalisation for stopping taking an antibiotic course early to create a supply for future self-initiated use (Hawkings *et al* 2008). Resistance development in animal hospitals has been found to mimic developments in human hospitals (Pomba *et al* 2017), and in the context of veterinary care which differs from human healthcare in the UK in its contractual nature there are additional complications arising from clients' financial status (Morris 2012; Rock *et al* 2020). Many people may link antibiotic use with antibiotic resistance (Brookes-Howell *et al* 2011) though this link is often being mistranslated by members of the public as a personalised rather than societal risk, as outlined previously. This personalised risk has further spatial dimensions as a problem located within healthcare providers, with implications for antibiotic-related behaviour fuelled by broader concerns around healthcare provision and access in both human and veterinary care. There is little evidence yet on how barriers to veterinary care (financial, practical, emotional or otherwise) such as those discussed in the previous Chapter affect antibiotic-related behaviour, and addressing this gap would be a significant addition to understanding barriers to antibiotic stewardship in the community.

Communication between the public and healthcare professionals is a central area of interest for the improvement of antibiotic stewardship behaviour. This has been highlighted as a potentially problematic area in both qualitative literature on the general public's relationship with physicians and

in the emergent qualitative literature on pet-owners and veterinarians in the context of antibiotic resistance. Parents with children have for example been reported as judging the credibility of diagnoses and treatment recommendation based more on the manner of a clinician's communication delivery rather than explicitly what the clinician says (Cabral *et al* 2014), and Hawkings *et al* (2008 p151) found that clinician's instructions were an influence on adherence though "not all respondents were encouraged to adhere to antibiotics regimes simply because the clinician told them to do so". Both of these accounts may be reflective of the shift in power relations between healthcare providers and their patients or clients due to an increase in access to medical knowledge through other means, with lay publics feeling more empowered to make decisions about their health that may contravene medical praxis expounded by healthcare professionals. Across the species divide, the quality of communication between veterinarians and clients has been presented by Smith *et al* (2018) as marked by differing perceptions on each side of the conversation with pet-owners reporting deference and veterinarians often perceiving pressure to prescribe. This lack of clarity and inclination to misinterpretation has the potential to lead to "unnecessary prescription and inappropriate use of antibiotics", Smith *et al* (2018 p8) argue. It is apparent from the emergent critical social science of animal medicine that veterinary professional power contends not only with lay/expert frictions in relation to diagnosis (as with human medicine), but that there are significant and intricate complexities to the lay/expert relationship introduced by the contractual nature of veterinary services (Morris 2012; Hobson-West & Jutel 2020). Understanding the dual lay/professional relationships between pet-owners in the context of both being the *patient* of a physician and the *client* of a veterinarian could help with the communication-related interventions suggested by much of this qualitative literature (e.g. Brookes-Howell *et al* 2011; Hawkings *et al* 2007; Smith *et al* 2018) by uncovering key commonalities or differences between the two experiences which can be addressed through interventions to improve prescribing and adherence in both primary care and veterinary care.

Section 7.2 – Findings

Section 7.2.1 – Obtaining, consuming, and administering antibiotics

Explaining why doctors and veterinarians prescribe antibiotics

When considering why doctors and veterinarians might prescribe antibiotics, each area of healthcare had its own vagaries for participants with only one category shared between the two. This shared category, which was also frequent, referred to antibiotics being 'appropriate for the issue' that the doctor or veterinarian was presented with. When considering doctors' processes however, participants also reflected on change over time in prescribing behaviour and the pressure put on doctors by other members of the general public. In the context of veterinary care, participants discussed the possibility of financial influences and a perceived lack of messaging about antibiotic resistance within veterinary practices compared to GP surgeries.

Why doctors prescribe

The perception that doctors had become stricter with their prescribing of antibiotics was mentioned by multiple participants. This was attributed by participants to time-saving, and believing that antibiotics were a panacea of care:

> *"I guess perhaps there might be an element of time saving or an expectation that you expect something, like I mentioned earlier about how it used to be that people would expect antibiotics for things even where it wasn't appropriate to have antibiotics. I think sometimes probably GPs just would give something to keep the patient happy" (QI #16).*

> *"I used to get really bad sore throats, erm, in the days when we thought antibiotics were the cure-all. I'm going back about forty years. Then I would have gone to the doctor expecting to be given antibiotics. These days I wouldn't go so quickly" (QI #5).*

This perception of a history to the practice of GP prescribing was echoed by QI #8 who also linked it to time-saving and noted a recent "*backlash*" over unnecessary prescribing. This change in prescribing practice was also recounted by other participants who held misconceptions about what antibiotics could be useful for:

> *"At one stage, doctors were giving antibiotics out for everything, and now it's right down to, it's got to be the flu or whatever, which is fair enough" (QI #12).*

This sense of historicity to the antibiotic prescribing practices of GPs is important as it demonstrates an awareness in some participants of the changing landscape of medical practice attributable to antibiotic resistance. Previous practices are understood in these extracts to have created problems that precipitate contemporary conservative use of antibiotics, situating the problem and individuals' (professionals and patients) behaviours within a historical, if not social, context.

Some participants believed prescribing practices to be too liberal, with GPs bowing to pressure from patients. In one example, this was an issue associated with time pressures:

> *I think they tend to give them out easily. […] Especially the people that go to the doctors loads. Like, 'hey have some antibiotics and go away'. Because the mission is to get people in and out fast" (QI #7).*

In another, the issue of overprescribing was due to variability between doctors:

> *"So, I don't know, maybe it depends on the doctor. Maybe some are better at saying to not pushy patients than others" (QI #15).*

These extracts show that perceptions of overprescribing are attributed to systemic and individual factors, without necessarily overlapping. For example for QI #7 speed of consultation is part of the 'mission', leading to unnecessary prescriptions of antibiotics. Conversely in QI #15's extract, the focus is on the doctor themselves as some are better at dealing with 'pushy' patients than others.

Why veterinarians prescribe

The financial side of veterinary practice was mentioned in the context of antibiotic prescribing by two participants, though the angles differed. QI #16 felt that veterinarians may take into account the frequency of a client's potential visits, and avoid multiple consultations by simply prescribing antibiotics:

> *"Every time I've taken him [dog] with the skin problems, even though they don't usually look actively infected, he always gets antibiotics. I guess partly they're doing that because they think people don't want to have to go back more than necessary. Maybe that's factored into their thinking" (QI #16).*

QI #8 on the other hand had previous bad experiences with a veterinary practice, and they felt that this practice was motivated by financial gain when making prescription decisions:

> *"First one, well, probably the most expensive I would have thought, and for the longest period of time" (QI #8).*

These extracts reflect the discussion of 'Practice character' in 'Dynamics of Human and Companion Animal Care' in the previous Chapter. The variation in levels of trust that participants felt in their veterinarians' financial motivations manifests here as differing perceptions of veterinarians' motivations when prescribing antibiotics either in favour of the client by using apparently generous precautionary prescriptions or in favour of the veterinary practice by using costly prescriptions.

The absence of messaging from veterinarians about antibiotic resistance was also mentioned by participants in the context of veterinary health. This was a source of uncertainty around veterinarians' prescribing process:

> ***Interviewer:*** *"What about with vets, do you think it would be the same kind of approach?"*
> ***Participant:*** *"I guess maybe it wouldn't be quite as rigorous. Again, I don't know if vets require continuous training or whether things like antibiotic resistance is sort of on their radar as such. So maybe they wouldn't be quite as diligent about potentially overprescribing antibiotics" (QI #9).*

> *"All I know is that I don't see as much messaging around the importance of… I mean, no one's ever really said you must finish the course of antibiotics for them [companion animals] (QI #11).*

This uncertainty was relative to certainty about doctors – here veterinarians were less rigorous, or had less messaging. These participants felt certain that for their own doctor-prescribed antibiotics they should finish the course and that antibiotic resistance was potentially linked to overprescription, but these messages were not being specifically received or translated in relation to their companion animals.

Using leftovers

The use of antibiotic pills presented an opportunity for future use beyond their intended prescription for participants and their companion animals. Participants were split on this topic however, with some disavowing the practice of self-administering leftover antibiotics for future infections.

The use of leftover antibiotics often went hand-in-hand with the use of Internet sources to decide how to take the medication, for example in the case of QI #16 who lives with cystic fibrosis and routinely received antibiotics for chest infections:

> *"I had a different kind of infection, so I looked up what would be appropriate dosage for this other infection and took the antibiotics which had been given to me for my chest, which they always give me if I'm going away just because you don't have easy access to drugs" (QI #16).*

CI #6 also self-medicated with antibiotics whilst abroad, and used the Internet to decide on the course:

> *"When I've been abroad and been given medicine by someone who had some antibiotics left over and I wanted to check that they were the right ones for this particular thing that I was experiencing" (CI #6).*

In both of these extracts the participants were abroad and felt that they had limited access to healthcare, and consequently self-medicated with antibiotics that they had been given for a specified reason or with leftovers from a friend. For these participants, these instances were specific exceptions to normal behaviour. In other examples however, retaining leftovers for self-medication or the administration of antibiotics without a prescription were more routine:

> *"There are times when you know it is a bacterial infection and you have some stuff left over from a previous course that you may just be like, I'll use that for now the same way I used it previously" (CI #4).*

"We basically generally tend to follow what the vet sets, if it's a five day course we give him those five days if it's… and… and then, the spare ones if you like, in the past I've used those in a situation where his [dog] allergies are coming back again and I haven't been able to get to the vet so when I do he's already had a one day course of whatever antibiotic it is" (QI #11).

"I had an antibiotic for a cough that was really bad. I used to smoke two packs a day, so obviously I knew there might be a time again that I might need this. So you know, if it [the packet] wasn't over I wouldn't throw it away" (QI #6).

These extracts highlight a variety of ways in which self-medication can occur, but they all have in common the use of previously prescribed medication. In each of these examples the principle is to pick up where the previous antibiotics left off should a similar condition be perceived to be occurring. Only QI #11 referenced not being able to access healthcare as a prompt for this behaviour, though it was specifically regarding being able to access veterinary care quickly rather than at all and getting a head start on what they believe to be the treatment. There is also a distinction in these extracts in how participants came to know that antibiotics were needed – for CI #4 they believed that they had a bacterial infection, for QI #11 there was a recurrent allergy problem, and for QI #6 they had recurrent coughs due to heavy smoking. Each of these examples however is a case of repetition either of physical symptoms or in the perception of an underlying cause.

Following the Course

'Following the course' draws together the various rationales that participants provided for adhering to instructions for a course of antibiotics. This includes why participants finished courses as well why they did not.

Finishing the course

The key reasons participants gave for finishing a course of antibiotics were the potential for resistance to develop and the possibility of not completely clearing an infection so that it recurs. Several participants specifically linked themselves not finishing a course of antibiotics with the development of bacteria resistant to antibiotics:

"Well, it's pretty important, because not finishing courses of antibiotics promotes antibiotic resistant bacteria. So, I try and make sure that they [companion animals] receive all of the doses that they're prescribed" (QI #14).

"If you are given a course, it's based on a course of… medication is based on I guess the virulence of the bacterium that it is treating. So… if an infection is believed to be cleared up in seven days then it's seven days. If it takes fourteen days it takes fourteen days. If you… if you don't take a full course, my

understanding is that that bacterium will… is more likely to become more resistant to that antibiotic" (CI #9).

In both of these extracts is present the idea that not finishing a course of antibiotics in some way promotes or makes likely the development of resistance by bacteria to antibiotics, with this being the rationale behind finishing a course. For other participants however, the main reason to follow a course of antibiotics was more immediately to address the infection and prevent a recurrence without reference to the development of resistance:

"I always give the full course whether they [companion animals] look like they have got better or not because at the end of the day, you know, it can still be going in the system and you just don't know. So, I always make sure that the full course has been given and watch them afterwards" (QI #12).

"Apparently it can come back if you think it's gone… if you stop the course it can come back. So there is no point in starting them and not finishing" (QI #1).

"You finish the course. Otherwise it will just come back. You don't decide to stop taking the medication, even if you feel fine you finish the course" (QI #7).

Here, QI #12 calls back to vigilance as a part of good companion animal health. Once a course of antibiotics has been completed, they remain vigilant even if their companion 'looks like they have got better' in case their infection is still 'going in the system'. The idea that one cannot know for sure that an infection is gone is echoed in QI #1's extract, and the key to avoiding an infection returning is to finish the course of antibiotics. Finally, QI #7 invokes some deference to medical professionals by removing themselves from the site of decision-making about the length of their antibiotic course regardless of how they feel. In these extracts the qualitative and experiential aspects of health are set aside in the process of antibiotic consumption. Instead, the presence of an infection – felt or otherwise – is the focus for this practice, and the decision to cease taking the medication is left to the professional rather than the consumer.

Not all rationales for finishing a course of antibiotics were so biomedical. QI #4 echoed QI #1's reflection that "*there is no point taking them in the beginning if you're not going to take the full course*" (QI #4) whilst QI #16 also recounted that not finishing a course of antibiotics is a waste of both time and money in the veterinary context, linking also to personal accountability and positive veterinary relationships:

"Generally speaking I will follow their advice because I think well, if I don't, then things don't get better, I can't go back then and say I've given him [dog] this and it hasn't worked.

> *[…] I'm sort of wasting my own time and money and so yeah, I guess having faith in the vet means that I do tend to follow the advice that they give me or the course of treatment that they give to him" (QI #16).*

This 'all or nothing' approach to antibiotic course adherence arose in multiple ways, with QI #1's simple link to avoiding the recurrence of infections more complexly framed by QI #16 in the context of veterinary care. QI #4 on the other hand simply stated that the treatment is pointless if you do not follow through with it without a link to a specific scenario or care setting. Common to each of these stances is an hierarchy between consumer and professional in the process of treatment if one has already invested time or money into accessing care. From this perspective, if one accesses care then one should follow the prescribed regimen of treatment otherwise there could be negative consequences arising directly from an incomplete therapy or in subsequent treatment if the first step was not properly taken.

Some participants did not link their understanding of the importance of finishing a course of antibiotics to a particular situation – it was simply the case that "*we all know we are supposed to finish the course of antibiotics otherwise we're all saving up problems for the future*" (QI #11). QI# 11 extended their rationale to the veterinary setting, along with a similar extrapolation of behaviour by QI #5:

> *"If it was something like a course of antibiotics, then yes I would consider it quite important to give them the whole course. Knowing how it is for humans and… I'm sure it applies to animals and if you don't catch the infection quickly especially in older cats then it could become much more serious" (QI #5).*

> *"All I know is that I don't see as much messaging around the importance of... I mean no one's ever really said you must finish the course of antibiotics for them [companion animals]. I just do the same because if humans must… it must be the same" (QI #11).*

For others, 'finishing the course' was synonymised with finishing packets of pills:

> *"When to stop? I've been told – I don't know whether this is true, I haven't looked it up – but I've been told to follow the cycle. There's some sort of cycle that I must follow, which usually involves ending the packet" (QI #6).*

In these examples the importance of finishing a course of antibiotics was general knowledge – 'we all know' that a course should be finished, there is a cycle to follow that involves finishing a packet, and these principles that have been expressed in relation to human health are assumed to be transferable to companion animal care.

Taking antibiotics until you feel better

Three participants mentioned stopping a course of antibiotics when they felt better or stopping a companion animal's course when the animal seemed to feel better. All of the extracts mentioning this behaviour are from cognitive interviews, which may be suggestive of a methodological bias in the discussion of these behaviours arising from the different emphases and prompts that occur during a cognitive interview revolving around participants reading and reflecting upon a physical questionnaire and more conversational semi-structured qualitative interviews.

For two of the participants that mentioned ceasing a course of antibiotics due to a qualitative improvement in their condition, there were qualifications provided around the behaviour. For CI #7, this was not a behaviour that they would do in the context of human health:

> *"Yeah, I did give them until my pet seemed better. Which… I don't know. She didn't get worse afterwards, I wouldn't have done that for a child though" (CI #7).*

CI #13 also separated the behaviour from their general perception of what 'good' behaviour was:

> *"There is a huge problem with people taking antibiotics for three or four days and then… that's what I've done. I'm honest. And you feel better, and you don't want to take them anymore but actually it's just treated the symptoms rather than the actual root of the condition" (CI #13).*

In these extracts both participants reflect that stopping a course early without direction is not the right thing to do, as they would not do it for a child and there is a 'huge' problem with people performing this behaviour. Similar to CI #13's reflection that once they felt better they no longer wanted to take the medication, CI #8 in responding a questionnaire item about finishing a course of antibiotics stated "*I probably took them until I felt better. I'm not a fan of taking medication*". For these three participants, unlike those quoted in 'Finishing the course', the qualitative aspects of the antibiotic consumption process come to the fore and have a role in decision-making. Rather than emphasising the presence of infection the focus is upon how one feels or how one perceives a companion animal to be feeling despite this being avowedly not 'best practice'.

Administering antibiotics

Being "tricksy"

The difficulties of administering antibiotics in pill form to companion animals were a common feature of participants' narratives. Cats in particular were highlighted as being "*quite tricksy*" (QI #16) compared to dogs, often avoiding swallowing pills and spitting them out in choice spots around the

house later on (seven participants). In some cases, participants recounted physical difficulties in even getting the pill into a cat in the first instance:

> *"You had to wrap him in a towel, so he couldn't claw you (laughs) and then try and force his mouth open and get the pill in and hold his mouth shut until he swallowed it. And then, even then, sometimes he would spit it out, like ten minutes later, which was a real battle" (QI #14).*

The 'tricksy-ness' of companion animals adds a layer to the stressors related to accessing veterinary care discussed in 'Visiting the Veterinarian'. There are initial hurdles to accessing care and acquiring appropriate treatment, but once outside the practice and away from the professional setting there are specific difficulties with administering antibiotics as a form of companion animal care. Whilst participants often had strategies for getting pills into their companion animals – predominantly involving cheese, ham, or tuna – for others like QI #14 it was a 'battle'. This difficultly meant that sometimes participants did not give their companions the full course of antibiotics in order to avoid distress:

> *"If it's clearly causing real distress and they won't eat the pill without you basically like, using some sort of contraption to hold their mouth open, then I wouldn't force it down. So I give them a few misses in the sense that I don't want to upset my cat to the point that she doesn't come home one day" (QI #7).*

Though some participants struggled with their companions, others circumvented the problem by paying for veterinarian-injected antibiotics. Injected antibiotics were explicitly enrolled as a solution to the difficulties of administering pills personally:

> *"Vet injected as I can't get pills into the cat. You know, she is the most beautiful, placid, calm, lovely pussycat. We sat in the car for four hours driving to Suffolk and she hardly made a sound. But try getting a pill down her, and she turns into the most vicious, vile animal. So I don't even try now" (CI #9).*

> ***Participant**: "I've had to attempt to give her pills, yeah, so I've always actually paid the little bit extra to get the injections rather than trying to give her pills".*
> ***Interviewer**: "Why do you go for the injections rather than the pills?"*
> ***Participant**: "Because she's far too clever for her own good and she'll eat the food around the tablet and spit the tablet back out" (QI #13).*

> *"I'm not very good at giving them tablets though I have tried in the past. They tend to have the two-week antibiotic injection now at the vet. That saves me having to give tablets, but yes in the past I have tried to" (QI #5).*

This approach incurs extra financial cost for the pet-owner whilst alleviating the stress of doing battle with a companion animal. This approach also increases the potential societal cost of treatment in the context of antibiotic resistance as doses are less flexible and often longer and with broader spectrums than are necessary than orally administered antibiotic courses (Weese *et al* 2019). This is a quintessential balancing act in the use of antibiotic medication between treating the patient, ensuring compliance with the treatment, and minimising the societal risk of antibiotic use. This balancing act involves multiple sites (including the veterinary practice, the client's home, and the environments that the companion animal patient encounters) and enrols multiple actors (the veterinarian with their credentials and practices, the pet-owner with their concerns finances, and the veterinarian-client relationship itself). This approach complicates "simplistic understandings of lay-expert roles in veterinary practice" (Hobson-West & Jutel 2020 p399) and demonstrates the intricate spatiality of antibiotic stewardship in companion animal veterinary care. Here, participants were asking for a more expensive option that veterinarians may worry about offering in case they are perceived as trying to raise money for their practice (Morris 2012). More expensive options are sometimes not even offered to "bare bones clients" (Morgan 2009 in Hobson-West & Jutel 2020 p398). Antibiotic stewardship in companion animal care is demonstrably complex, as strategies to improve adherence (such as the use of injections) may involve extra financial burden for the client and societal burden in terms of selection pressure resulting from the medication used. If not requested by the client, these could also take on the appearance of unnecessary expenditure when cheaper – though more challenging to administer – alternative are available.

Summary

This section has presented the various ways in which participants navigated the obtaining, consuming, and administering of antibiotics. There were some clear overlaps in participants' narratives across human and companion animal care, such as in rationales for the use of leftover antibiotic medication and rationales for following courses of antibiotics. There were however some clear differences, particularly around the perceptions of doctor and veterinarian prescribing practices and the processes of consuming or administrating antibiotics.

There was a general sense that doctors have become stricter over time with their antibiotic prescribing practices, demonstrating that some participants were placing contemporary issues relating to antibiotic consumption within a historical frame as previous practices were understood to have led to current problems. Some participants felt that prescribing by doctors is still too liberal, and responsibility for overprescribing was attributed across multiple levels. On the one hand participants recognised systematic issues with the volume of patients being seen and the 'mission' of getting patients in and out of consultations quickly, whilst individual doctors were also felt to be differently skilled at dealing with 'pushy' patients. These issues were not raised with regards to veterinarians, with the presence of antibiotic resistance on the veterinary 'radar' being queried and variations in trust in veterinary

practices manifesting as differing perceptions of the role of financial motivation in prescribing practices. The issue of developed trust was more prominent with regards to veterinarians, with negative prior experiences acting as the basis for suspicion of financial motives while more positive trust-based relationships being the basis for believing that the veterinarian may be looking out for the client's financial interest.

The use of leftover antibiotic medication was occasionally supplemented with the engagement of online health information to determine dosages, though this confluence was accompanied by an awareness that this was sub-optimal antibiotic stewardship and was only undertaken due to an exceptional circumstance. In other cases of leftover medication being mobilised, it was used to address recurrences of symptoms for which the medication had previously been prescribed in both humans and companion animals.

Multiple rationales were provided for finishing a course of antibiotics. For some participants finishing a course of antibiotics was motivated by a desire to avoid promoting the development of antibiotic resistance, while others prioritised the more immediate end of avoiding a recurrence of the infection. Some participants mobilised elements of 'Being vigilant' and 'Deferring to qualifications and experience' as part of these rationalisations as antibiotic courses were coupled with continued vigilance over their companion's condition, and decisions over when to cease courses of antibiotics were left to professionals. Non-biomedical rationales were also presented such as not finishing a course being a waste of time and money, notably in the veterinary context which has a plethora of additional stressors as discussed in 'Visiting the veterinarian'. Other participants prioritised more qualitative aspects of health and reported stopping taking antibiotics once they felt better or their companion animal seemed to feel better. This was often coupled with an awareness that this behaviour might be bad antibiotic stewardship. These narratives demonstrate the salience of Raman & Tutton's (2010) perception of coalescence between individualising ethopolitics and collectivising biopolitics – in their example in the context of climate change. Here there are a number of individual rationales for following a course of antibiotics sometimes connected to more collective or expertise-based rationales even where the poor individual stewardship was being exercised. Companion animal care therefore presents several moments of disconnection between a collectivised biopolitics of antibiotic stewardship, and the challenging ethopolitics rooted in the "concrete everyday practices" (Bellacasa 2017 p137) of providing interspecies care.

Finally, participants often described the difficulties of administering antibiotics to companion animals. These difficulties, in these conversations, were unique to companion animal care. These challenges to the administration of antibiotics to companion animals sometimes led to companion animals not receiving a full course of antibiotics and potentially being underdosed, though some participants circumvented this by paying for injections of antibiotics which may present the opposite issue of

having a longer dose and broader spectrum than necessary. Evidently antibiotic stewardship poses a different set of challenges in the context of companion animal care than personal health care, with its distributed sites of care and the obstacles associated particularly with the administration of antibiotics by pet-owners at home. The challenges and solutions described by participants here lead to two avenues – under-dosing and excess-dosing – through which antibiotic resistance could be promoted.

Section 7.2.2 – Situating antibiotic resistance

Becoming aware

The news media were a common source of information for participants on the topic of antibiotic resistance. Television adverts and news items were referenced as the main source of awareness for several participants (CI #7; QI #5; QI #10; QI #11; QI #15), whilst others reflected that their main source of information was the Internet (QI #4; QI #13). Posters were also mentioned by a number of participants in different contexts such as in GP surgeries (CI #7; QI #11) and on bus stops (QI #9). The absence of veterinarians as a source of information about antibiotic resistance was both implicit from their lack of mention, as well as explicitly reflected upon:

> *"I've seen the adverts on the telly and read about it for people and I've obviously read stuff about farm animals being given antibiotics and, you know, the food chain. But in terms of pet health, no I don't think I have" (QI #15).*

This was also evidenced in participants' reflections on what they learned from professional sites of healthcare such as GP surgeries and veterinary practices:

> *"I've not heard as much generally either from my vet or in the press around animals being resistant to antibiotics as you do around humans. So yeah, if I go to the doctor's surgery there are posters up telling me that antibiotics won't work for flu or colds so I shouldn't ask for them and things like that. There doesn't seem to be the prevalence of similar information in the vets. There's not a single, I can tell you because I was there today, not a single sign about not overprescribing antibiotics for animals in my vet's surgery" (QI #11).*

> *"It is all over GP surgeries. […] I don't think I have ever seen it at the vet… I have certainly never discussed the overuse of antibiotics with the vet" (QI #4).*

The issue of antibiotic resistance in healthcare was received by these participants in a particularly anthropocentric way, including where it is misconceived as an issue of bodies becoming resistant, with a dominant focus on human health and GP practices as sites of communication and relevance. As

discussed previously, where antibiotic use and antibiotic resistance was considered in the context of companion animal care it was often through translating human-orientated advice or knowledge. The exception to this was the use of antibiotics in agriculture, which was a topic that participants were regularly well-versed in.

Farm animals were referenced numerous times when participants were discussing how they became aware of antibiotic resistance. This was sometimes contrasted to the context of companion animal care, where again there was a conscious lack of awareness:

> *"It's more to do with… not pets… sorry I was thinking it's more to do with farm animals. Yes. They've given them, they tend to give farm animals antibiotics and that's why they're becoming resistant" (QI #10).*

> ***Interviewer:*** *"Have you come across the term 'antibiotic resistance' in relation to your pets' health?"*
> ***Participant:*** *"No, I don't think I have. You hear about it with farm animals, and you hear about it with humans. I don't think I ever have." (QI #4).*

> *"I wouldn't say specifically in relation to my pet's health, but I know for livestock and things like that. Yeah" (QI #9).*

> *"In relation to the food chain, I guess and factory farming and routine use of antibiotics in farm animals. I hadn't really thought about it that much in relation to pets before now" (QI #16).*

Similar to studies that place the conceptual site of public awareness around antibiotic resistance within the hospital (e.g. Brown & Nettleton 2017), the awareness of animal-related issues associated with antibiotic resistance was here sited repeatedly on the farm and within the food chain (Bud 2006; 2007). Antibiotic resistance here is less of a community-level or society-level issue, but a spatially-bounded concept affected by the behaviours and practices tied to a specific process of production.

Siting resistance

Participants were split almost evenly on whether antibiotic resistance was a property of a microbe (whether bacteria or virus) or a body. Participants who believed that one's body became resistant to antibiotics tended to have more developed stories about why they held this belief, while those who believed that a microbe became resistant were more likely to make reference to specific organisms or conditions such as MRSA (QI #10; QI #14), superbugs (QI #13), or norovirus (QI #7).

A commonly verbalised concept was that one's body develops a resistance, immunity, or tolerance to antibiotic medication as it is consumed. This concept functioned identically across species boundaries, with participants verbalising bodily immunity in the context of both companion animal care and their own healthcare:

> *"Like us, I think that animals will become tolerant to them [antibiotics] over time, and if you have a big issue with something, you don't like to think later on that they've built a tolerance to it and it's not going to do them any good whatsoever" (QI #12).*

> ***Interviewer:*** *"Have you come across the term 'antibiotic resistance' in relation to your pets' health?"*
> ***Participant:*** *"Not specifically in relation to pets, but I'd imagine it is the same as it is for humans. That, if they are overused, then the animal can become resistant to them" (QI #5).*

Some participants specifically analogised their body developing resistance to antibiotics with other personal experiences, such as smoking and alcohol use in this longer extract from QI #6 discussing an episode of treatment in which their dog had a resistant infection and an increasingly intensive course of antibiotic treatment:

> *"To be honest for me I can relate to it with my own personal experiences, with either drugs or alcohol, or smoking. Like, I can understand how… like for instance with smoking, when you first pick it up, you have one cigarette in the morning and all of a sudden you're feeling like… not high, but you feel a bit in some sort of state. And the more you get into smoking, that just stops. […] The same with medication – like for the various operations I have had done; there has been morphine for instance, I was given morphine for like a month. And I knew what it was like to grow like…. To get a tolerance in that.* ***Your body is like… it doesn't react the same way with the same amount.*** *You need to increase the amount to get to where you were before." (QI #6).*

One of the ways that the perception of bodies becoming resistant was mobilised by participants was as a form of personal biological value. For example in this articulation by QI #8:

> *"I purposely avoid them [antibiotics], and I deliberately didn't give them to my daughter when she was growing up because of resistance in humans. My philosophy was always that if she got meningitis they would pump her with every*

> *antibiotic known to man. And if she had been taking antibiotics for the slightest thing, I wanted those to work. So, she never had antibiotics growing up. […] My philosophy has always been, meningitis is the worst that can happen, and that's when you want to be non-resistant to anything they pump into you" (QI #8).*

This attitude was echoed by QI #3, regarding a cat rather than a child:

> *"Neither of us have taken a lot of them [antibiotics], so neither of us are going to be immune to them" (QI #3).*

In QI #8's narrative, the concept of one's body becoming resistant to antibiotics reshapes how responsibility is enacted. Vulnerability is constructed in an explicitly individualised way, in this case with a child not being treated with antibiotics specifically to prevent their body becoming resistant to antibiotics. There are both positive and negative ramifications from this belief being turned into action (or a lack of action) in the manner described by QI #8. On the one hand, it may reduce the likelihood of antibiotics being used for misdiagnosed infections. However, it could also lead to complications if genuine infections requiring antibiotic treatment do not receive professional attention until they are serious.

The conception of antibiotic resistance as a body-centric issue not only removes focus from societal-level behaviour, but through this individualised construction of resistance vulnerability may increase risks to health for people avoiding visiting a doctor or veterinarian in order to avoid 'taking antibiotics for the slightest thing' to save up susceptibility for perceived serious infections. These extracts suggest that the "conceptual bricolage" (Davis *et al* 2020a p12) of lay publics that includes cultural assumptions about how the body responds to infections and antibiotics alongside notions of the body as a possession in immunity discourse does, in some cases, extend to include non-human companion animals as well. Some participants explicitly recounted actively saving up immunitary biovalue in themselves or their children, whilst other participants perceived this biovalue as simply a byproduct of not having had to take many antibiotics previously.

Addressing antibiotic resistance

There were three main strands of thought for participants when discussing how antibiotic resistance should be addressed and who holds responsibility for addressing antibiotic resistance. The first two strands, echoing previous discussion of the conservatism or liberalism of doctors' prescribing, were that prescribers hold most responsibility and should be stricter, and secondly that the public have significant responsibility to 'not be so reliant' on antibiotics. Finally, several participants felt that they lacked a clear understanding of the issue and that the government should be doing more to educate the public.

The power of health professionals to prescribe antibiotics was the focus of some participants' rationalisations of their attribution of responsibility. This was tied into the national context of the UK, in which one cannot obtain antibiotics without a prescription:

> *"They [prescribers] obviously have the most power, they have the most knowledge and therefore because of that they have the most responsibility in making sure antibiotic resistance doesn't become a big issue. But at the same time the people taking them do have some degree of personal responsibility. Just not as much (QI #9).*

> *"GPs I suppose, or doctors, have got the power to prescribe something or not. So, a lot of the responsibility is going to fall on them to say, 'Yes, you need this' or, 'No, you don't need it'" (QI #14).*

> *"I think there has to be more responsibility on the prescribers and the regulators because, you know, in this country we can't – unless you order dodgy stuff off the Internet – we can't get antibiotics any other way" (QI #15).*

In these extracts, prescribers are centralised as the responsible party being the gatekeepers to antibiotic medication for the general public. A hierarchy is constructed in these participants' narratives of a public with some responsibility but no significant power beholden to prescribers not only to access antibiotics but to be refused antibiotics when it is not in their interests. This reflects membership of a public that has a "reciprocal duty of accountable responsibility to the world in which one is biomedically and biopolitically located" (Brown 2019 p140). Prescriptions are "in the gift of the prescriber" (Brown 2019 p140), and in these extracts the prescriber is accountable to the *communitas* to ensure antibiotics are appropriately dispensed. For another participant, this hierarchy was present but involved less distance:

> *"So, for me, I can't say the bigger picture… So for me, it's the relationship between my doctor and myself. And I would say that the onus is on the doctors more. I think they're now taking on board, whether that's advice from the public health bodies or not I don't know, but to not prescribe as much (QI #8).*

Here, the participant consciously focuses in on their specific situation involving themselves and their doctor removed from the 'bigger picture'. They highlight the relationship between themselves and their doctor as the key component of addressing antibiotic resistance with the 'onus' being on the doctor to take responsibility for facilitating the stewardship of antibiotics.

Some participants felt that the public had a significant amount of responsibility for addressing antibiotic resistance, though this was mediated by differences between human and companion animal care. Basic articulations of this position were exemplified by QI #10 and QI #12:

> *"We've all got to try not to be so reliant on antibiotics and try to fight this disease off a bit first before you go dashing off to the doctors or the vets" (QI #10).*

> *"You know, not to go for every little whim. You get, sort of like, a niggle, and say, 'I need antibiotics'. And to take the full course when it comes because at the end of the day if you don't you might be going back for twice as much" (QI #12).*

In these extracts the public are responsible for going to the doctor or the veterinarian too quickly, and part of addressing antibiotic resistance involves the public relying more on their own bodies' capabilities to deal with illness associated with infections. QI #10 developed their position with regards to companion animal care:

> *"Well, the vets you see… I suppose the first sign if [dog] was poorly I'd take him straight to the vet and trust what they say I suppose. Because the dog, they can't tell you what's wrong with them. Whereas myself I perhaps thing 'oh well I can leave it' you know, I'll leave that for a while. With the pet, I suppose you don't really… if it's something you don't really know what it is you'll be taking them straight to the vets" (QI #10).*

This recalls the earlier discussion of 'Being a third party', with this responsibility for not visiting health professionals quickly having caveats in the context of companion animal care. The experience of being a third party with regards to their companion's healthcare gives QI #10 pause when suggesting that one should avoid going to health professionals before attempting to deal with an illness themselves. Participants focused on human healthcare when discussing how antibiotic resistance should be addressed, and this is reflected in the above extracts that largely focus on the relationship between participants and doctors in the context of prescribing. However, as QI #10 notes, the responsibility placed on the public here is based on their own ability to experience illness rather than their ability to perceive illness in their companions. A vigilant pet-owner here is more likely to visit the vet quickly if they perceive an illness in their pet, whilst they are able to enact responsibility (Brown 2019) if they experience illness themselves by 'leaving it for a while'.

Finally, participants felt that the public should be better educated about antibiotic resistance. Whilst there was some consensus among participants about this central point, there were divergent thoughts on how this education could or should materialise. QI #9 reflected on the propensity for antibiotic consumers to stop taking antibiotics when they feel better rather than completing the full course, and postulated that correct use of prescription antibiotics was a 'civic duty':

> *"I think it is definitely something that all people should sort of, maybe be a bit more educated about and I don't know what the correct word is. I guess be a bit more conscious of like, they shouldn't misuse antibiotics. There's like a personal responsibility, or like a civic duty not to misuse prescription antibiotics" (QI #9).*

Other participants located the need for education as dealing with a perceived desire for antibiotics among the public, with QI #11 for example feeling that there needs to be a 'more widespread educational programme':

> *"I think there has to be a more widespread educational programme for us as consumers, as individuals, because I don't think the message is out there. I think the fact that the GP has to have this notice on their pinboard that says, 'Stop coming here and asking for antibiotics for a cold' means that a significant quantity of the population haven't got the message yet. So, I think there needs to be some kind of widespread educational campaign. So, maybe not government cracking down on who can prescribe what, but some more concerted efforts to get the message out there" (QI #11).*

QI #11 here locates educational resources within the GP's practice, but calls for a more widespread educational programme for the public rather than 'cracking down' on prescribers themselves. QI #16 also put an emphasis on doctors rather than veterinarians and located education within the sites of human healthcare:

> *"I guess it's perhaps to do with funding and giving GPs or hospital doctors more time to be able to explain to people that antibiotics are one, possibly not going to be effective and two, about the problem with antibiotic resistance and helping people feel happy that they're not automatically being given antibiotics for things" (QI #16).*

This calls back to the feeling that doctors are significantly constrained by time, and also the value that participants placed in discussion as a part of both doctor and veterinarian consultations. Education is valued as much as treatment here, with both the efficacious treatment of the individual and the societal problem of antibiotic resistance linked by helping the public to feel comfortable not receiving antibiotics. Participants pictured themselves here as human consumers of antibiotics, with no explicit references to education regarding the use of antibiotics in companion animals. This is reflective of a recurrent node in participants' discussions of antibiotic use and antibiotic resistance in which the problem is often approached anthropocentrically. It could be reasonably hypothesised that this anthropocentrism is attributable to the sources of information about antibiotic resistance that participants recalled having contact with. If GP practices and the media have focused on antibiotic

resistance as a problem of human healthcare made worse by practices within food production, it is perhaps unsurprising that participants routinely located responsibility in the context of doctors' prescribing behaviour, their own personal consumption of antibiotics and the general public's personal consumption behaviour, and agricultural production.

Section 7.3 – Discussion

This Chapter has presented novel qualitative research examining the parallels between pet-owners' beliefs, attitudes, and behaviours regarding antibiotics in the contexts of their own personal health and their companion animals' health.

Previous research has highlighted a number of themes in public perceptions regarding antibiotics and antibiotic-related behaviours. A common perception is that one's body becomes resistant to antibiotics rather than bacteria becoming resistant, and this misperception impacts upon consumption behaviours (Brookes-Howell *et al* 2011; Hawkings *et al* 2007; 2008; Brooks *et al* 2008; Norris *et al* 2013; Dickson *et al* 2019; Davis *et al* 2020a). Messaging about antibiotic resistance and antibiotic stewardship behaviour combine with cultural understandings of immunity as personal biovalue to produce moralising discourses around the act of visiting a doctor or taking antibiotics (Brown 2019; Davis *et al* 2020a), and lay communication with doctors or veterinarians on the topic of antibiotic consumption is also subject to a number of pressures and misperceptions on both sides (Cabral *et al* 2014; Smith *et al* 2018). Furthermore, moralisations of antibiotic use regularly adopt specific spatial sites such as hospitals (Brooks *et al* 2008; Hawkings *et al* 2007; Brown & Nettleton 2017; Davis *et al* 2020b) or farms (Bud 2006; 2007), further distancing 'antibiotic resistance' from being understood as a societal or community problem.

Only recently has social scientific research begun to take seriously and question community antibiotic consumption – and other health-related behaviours and decision-making – across the species borders inherent to pet-ownership. Some aspects of antibiotic consumption unique to the pet-owner context have begun to emerge, such as pet-owners pushing for antimicrobial treatments because of a fear that the veterinarian had underestimated the pet's suffering, and low levels of knowledge about the interspecies nature of antibiotic resistance (Redding & Cole 2019a; Dickson *et al* 2019). In the broader health-related literature, it has been speculated that health-related decision-making may exhibit spillover between human- and pet-orientated healthcare contexts (Ashall & Hobson-West 2017; Hobson-West & Jutel 2020).

This research supports and develops a number of areas identified in this previous research, and supports recent calls to examine health-related attitudes and behaviours across species boundaries (Hobson-West & Jutel 2020) and specifically in the context of intervention design focusing on the pet-owning public (Dickson *et al* 2019).

Section 7.3.1 – Misconceptions about antibiotic resistance translate across species boundaries

The misconception that one's body becomes resistant or immunity to antibiotics was identified in the literature and was also present in participants' narratives in this study. In the previous Chapter it was also demonstrated that some pet-owners translate some health-related concepts across species boundaries. The research presented in this Chapter demonstrates that this conception of body-centric immunity is translated by some pet-owners across the species boundary, with pet-owners articulating body-centric antibiotic resistance conceptions in the context of both their own and their companion animals' health. This included the immunitary individualism that often accompanies such articulations, with the stored biovalue of not being immune to antibiotic medication being projected into the future as a protective characteristic for both people and their companion animals. The 'conceptual bricolage' of lay publics' understandings of antibiotic resistance thus extends to include non-human companion animals, suggesting that One Health-orientated messaging about antibiotic resistance needs to be more ubiquitous to communicate the need for appropriate stewardship arising from antibiotic resistance being a societal rather than individual problem. Not only does antibiotic resistance need to be distinguished from body-centric conceptions of immunity, such as 'choice' immunity (Davis *et al* 2015), but this effort should emphasise that public health is a more-than-human endeavour in which the 'public' is not just made up of human beings (Rock 2017; Rock & Degeling 2015; Rock *et al* 2014; Blue & Rock 2020).

Section 7.3.2 – Overprescription as a symptom of other systemic issues in healthcare

The perception of overprescribing by healthcare professionals was articulated in several participants' narratives, though there were differences between the perception of why doctors might overprescribe and why veterinarians might overprescribe. Doctors' prescribing of antibiotics was sometimes placed in historic context, with antibiotics have the historic property of being a cure-all. In the present day, participants pointed to systemic issues relating to the volume of patients and time-pressures of GP surgeries. Here antibiotics were infrastructural as a 'quick fix' for these systemic limitations to medical care, and the provision of antibiotics was perceived as objects that care, rather than necessarily providing biomedical care (Willis & Chandler 2019; Broom *et al* 2017a). In the veterinary context however participants queried whether antibiotic resistance was an issue that veterinarians were conscious of, with variation between veterinary practices and the role of financial motivations instead being prominent in participants narratives regarding veterinary prescribing – issues that have been identified in other social science research on veterinary practice (Morris 2012; Belshaw *et al* 2018; Rock *et al* 2020). Whilst participants identified different sets of issues with medical and veterinary antibiotic prescribing, in both cases the issues were embedded within perceptions of the

institutions. As described in the previous Chapter, the providers of medical and veterinary care are perceived in distinct ways along lines that are reflected here. Perceptions of antibiotic prescribing were consequently reflective of broader perceptions of the institutions providing care, with overprescription diagnosed by participants as a symptom of other systemic issues in the delivery of healthcare by GPs or veterinarians. When reflecting on how they felt antibiotic resistance should be addressed, participants often focused on the power – or, 'gift' (Brown 2019) – of healthcare providers to prescribe, zeroing in particularly on doctors rather than veterinarians. Giving doctors the funding or time to educate as well as prescribe was highlighted as a desirable solution to raise awareness among lay publics, again reflecting the importance of the in-consult discussion that was discussed in the previous Chapter.

The identification of individual 'other' members of the public as being too quick to visit the doctor or veterinarian was part of some participants' reflections, echoing similar findings in the literature (Brown 2019; Davis *et al* 2015). One participant however caveated this concern through the lens of 'Being a third party', an area identified in Chapter 6. Taking a companion animal to the veterinarian quickly was forgivable in this participants' view, due to the embodied distance from being able to experience the companion's illness. The desirable ability to react with less urgency to feelings of illness, couched by Brown (2019 p134) for example as being able to 'sit out' and create "immunitary intervals for recuperation" that do not involve antibiotic consumption, as opposed to 'getting on top of things' quickly using antibiotics consequently had some infrequent species differences. However, participants' discussions of responsibility were predominantly anthropocentric and focused on medical care with only occasional reference to veterinary care. This is somewhat unsurprising given the anthropocentric nature of much of the education and media coverage material that participants recalled being exposed to.

Section 7.3.3 – Awareness of antibiotic resistance was anthropocentric

Participants recalled becoming aware of, or learning about, antibiotic resistance from news media, the Internet, or posters. The focus of much of the awareness was on human health, with multiple participants explicitly reflecting on the lack of information that they had received about antibiotic resistance in the context of companion animal care. Where animals and antibiotic resistance were connected, the focus was on farm animals and agricultural production with consequent concerns for human health. The anthropocentric nature of participants' awareness of antibiotic resistance reinforces the need for public health communication to embrace the more-than-human members of the public that are "germane to public health" (Rock 2017 p316). It additionally suggests, following the finding presented in Chapter 5 that there were insignificant differences between the behaviours of pet-owners and petless survey respondents, that this anthropocentrism without specific companion animal-focused messaging may be a common baseline from which the public understand antibiotic use. An implication of this, previously argued for in Chapter 5, is that companion animal veterinarians should

provide companion animal-related education on antibiotic resistance and link this to human health to highlight the interconnected consequences of behaviours, and furthermore that companion animals should be normalized in existing relatively effective interventions that have underpinned this anthropocentric conceptualisation of antibiotic resistance.

More broadly, this suggests that the infrastructural inversions discussed by Chandler (2020) – in which antibiotic resistance has rendered invisible infrastructural antibiotics as newly visible – are themselves anthropomorphic in the perceptions of the general public. The development of resistance as an object of concern has rendered antibiotics visible, but this visibility is primarily in the spaces and rituals of human care and food production. Public health educational interventions could be more explicit in removing the spatial bindings that appear to limit conceptions of the problem of antibiotic resistance among the public to specific species and disassociate antibiotic resistance from being a 'hospital' problem or 'farm' problem. This effort may go some way to invigorating lay publics to feel that they have a stake in the issue as individuals with the ability to address the problem with their own behaviour in multiple care contexts, as well as refocusing the problem as a societal issue that affects humans and non-humans and can be affected by health-related behaviour for humans and companion animals.

Section 7.3.4 – The challenge of medicating a companion animal impedes antibiotic stewardship

Many participants recounted the difficulties associated with medicating their companion animals, and in some cases these difficulties led to poor antibiotic stewardship. In some cases participants missed doses from companion animals' prescriptions, in other examples antibiotics were obtained from family or friends in order to avoid a stressful veterinary visit. A group of participants however avoided doing 'battle' with their companion by paying for veterinary-injected antibiotics. Whilst missing doses can lead to underdosing, injected antibiotics commonly involve longer or broader-spectrum courses than are necessary. The 'tricksy-ness' of companion animals can therefore lead to multiple avenues of poor antibiotic stewardship in ways distinct from human antibiotic consumption. This tricksy-ness illustrates the discussion of the co-constituted relationship in Chapter 6, here in the context of antibiotic use. The effect here arises from the animals in some way transgressing their 'animal space' in the home (and its required behaviours) (Power 2012; Philo & Wilbert 2000), becoming 'vicious and vile' rather than 'beautiful and placid' as one interviewee put it when care is delivered in pill-form. This transgression reverberates through the network of relations that facilitate companion animal care, leading to less-optimal antibiotic stewardship as injectable antibiotics with greater influence on the development of resistance become required for the care of antibiotics to be delivered.

Whilst there are parallels in pet-owners' perceptions and behaviours regarding their own and their companion animals' healths, as discussed in the literature (e.g. Ashall & Hobson-West 2017) and the previous Chapter, companion animal healthcare provides its own challenges – exemplified here with antibiotic stewardship outcomes – that evidence the suggestions made in Chapter 5 regarding differences in patterns between models predicting attitudes towards following doctors or veterinarians' prescriptions. These findings support the suggestion of Dyar *et al* (2017) that antibiotic stewardship is definitionally context-specific. Whilst the principals of stewardship are broadly identical across medical and companion animal veterinary settings (for example, in terms of prescription adherence), the client/patient side of the stewardship equation poses different challenges in each setting and pet-owners have navigate these different challenges with evident differences in stewardship outcomes.

Section 7.4 – Conclusion

Section 7.4.1 – Recap of Chapter Aims

This Chapter has analysed qualitative interview data on pet-owners behaviours with antibiotics and understanding of antibiotic resistance across both human and companion animal care. The main aims of the Chapter have been to develop an understanding of how pet-owners approach antibiotic use in the context of their own healthcare and their companion animals' healthcare, the extent to which these approaches share common rationalisations, and how pet-owners' conceptions of the problem of antibiotic resistance map across healthcare contexts.

Section 7.4.2 – Chapter Conclusions

The findings of this Chapter draw together areas from the primary research of this thesis presented in Chapters 5 and 6, centring the previous focuses on generalisable measures of behaviour and trust and qualitative perceptions of health and healthcare on antibiotic stewardship. The evidence of this Chapter suggests that in the context of companion animal care, the more-than-human geographies of antibiotic stewardship enrol sites of care, institutional differences, and individuals' preconceptions about health and illness into differing topologies of behaviour and rationalisation between species' healthcare contexts.

Chapter 6 suggested that pet-owners' understandings of interspecies health and pathology were context-specific, and this Chapter does suggest that antibiotic use and antibiotic resistance is one such context both for correct and incorrect understandings of the 'site' of resistance. Conceptions of immunity and resistance were translated across the species boundary in the narratives presented in this Chapter, reflecting existing considerations of immunitary individualism expressed in the literature (Davis *et al* 2015; Brown 2019). Awareness of antibiotic resistance was highly anthropocentric however, with participants repeatedly bringing the discussion back to the doctor's clinic or the food

chain and either explicitly or implicitly leaving out companion animals and the small animal veterinary clinic. These inclusions and exclusions of companion animals speak to ontological questions raised by animal geographers (e.g. Buller 2016; Donald 2018), and other social scientists for example in the context of conceptualising trans-biopolitics in relation to bovine and feline spongiform encephalopathy (BSE and FSE) (Blue & Rock 2010) and more recently COVID-19 (Blue & Rock 2020). Blue & Rock (2020 p3) suggest that COVID-19 has highlighted the humanist ethos of public health with the premium it places on human life, and argue that "human-animal-viral relations are also part of socio-technical and cultural systems that play a significant role in fostering and responding to illness." This Chapter, and more broadly the primary research of this thesis, highlights that this argument applies outside of the pandemic setting, echoing Blue & Rock's (2020 p2) appreciation for more-than-human approaches that "include animals and other nonhuman entities such as chemicals and technologies as active agents in the making of health and illness".

The anthropocentric focus of participants' understanding of antibiotic resistance suggests that animals have not quite been 'let back in' (Wolch & Emel 1995; Buller 2014) in the context of health, and this is partly driven by the communication (or lack thereof) from veterinarians who mediate the geographies of companion animal care (Donald 2018). In terms of its trans-biopolitical implications, this Chapter draws attention to the distinctions made not only between human and animal species, but between animal species (Blue & Rock 2010). As with BSE and FSE, there were clear distinctions between the governance of cows and cats and the stringent and often terminal biosecurity measures enacted. This distinction often plays out here in pet-owners' understanding of antibiotic resistance as a health issue placed within the spaces of human healthcare and spaces of agricultural production. Clearer and more prominent messaging about the companion animal dimensions of antibiotic resistance are required to displace antibiotic resistance from its currently perceived geographies of human healthcare and agricultural production, and highlight that it is an issue in the more-than-human family setting as well as the food chain.

This Chapter, together with Chapters 5 and 6, highlights the inconsistent application of 'One Health' principles in the context of companion animal antibiotic stewardship among the public and in their perception of veterinary practice. Companion animal care provides a number of additional challenges to members of the public when consuming and administering antibiotics – challenges that have been articulated in narratives presented in this Chapter and Chapter 6, illuminating some of the distinctions suggested from the survey data in Chapter 5. Chapter 5 suggested that human-orientated behaviours were distributed consistently between pet-owners and petless survey respondents, and the evidence of this Chapter suggests that veterinarians are not having a significant impact on pet-owners' understandings of antibiotic stewardship or antibiotic resistance. A conclusion of this Chapter – and more broadly, the thesis itself – is that companion animal care is an area through which education about the interspecies nature of antibiotic resistance should be being communicated to improve

antibiotic stewardship more broadly. Pet-owners often have well-developed conceptions of their companion animals' health, and may come into contact with veterinary services multiple times in a year. Connecting the health of a companion animal to the rest of the more-than-human family unit and society as a whole through the issue of antibiotic resistance could improve public understanding of antibiotic resistance as not only a societal problem, but an issue of more-than-human solidarity (Rock *et al* 2020), reinforcing the necessity of antibiotic stewardship behaviours across multiple healthcare contexts. Based on the evidence presented in this Chapter, this kind of interspecies intervention is not currently being effectively executed.

Since the data for this thesis were collected the BVA has produced a new poster for veterinary practices that presents a One Health perspective, stating that "the guidance for responsibly taking antibiotics is the same for both humans and animals" and advising readers that antibiotics "should always be taken as prescribed by your doctor or vet" (British Veterinary Association 2019b np) with images of people alongside animals. Recent research has however presented evidence that posters have limited utility in conveying antimicrobial stewardship messages to pet-owners (Redding & Cole 2019b). Given the regularity of the anthropocentric framing that participants in this thesis' research and their recollections of messaging present in GP surgeries, a potentially productive strategy would be to move the focus of One Health approaches like these recently-produced materials from the veterinary clinic to the human-focused GP. Not only may this improve the visibility of stewardship materials to improve responsible antibiotic use for companion animals, but it may also serve to bridge the professional divide perceived by some pet-owners between doctors and veterinarians by referring to veterinarians in the context of the more consistently trusted doctors' space. A further intervention could be to consistently 'bring the animals in' to existing community-focused antibiotic stewardship educational interventions (for example, television pieces and e-Bug resources) to normalize companion animals in public conceptions of antibiotic resistance and responsible antibiotic use.

Part 4: Concluding Section

Chapter 8 – Conclusion

Section 8.1 – Aims of the thesis

This thesis examines antibiotic stewardship in the context of companion animal care. This focus addressed an understudied area of community antibiotic stewardship since minimal social research has addressed the complexity introduced to community antibiotic stewardship by the challenges of companion animal care.

In addressing this gap, the research of this thesis has responded to one of the ten areas identified as a 'front' on which antimicrobial resistance is to be addressed by the wide-ranging and agenda-setting *Review on Antimicrobial Resistance*. Improving community antibiotic stewardship is one of a number of areas in which antibiotic resistance is to be addressed, and understanding the challenge requires an appreciation for the social contexts in which these behaviours are enacted. Whilst previous social research has examined knowledge, attitudes, and behaviours around antibiotic use in context such as in paediatrics (for example Cabral *et al* 2015) or among the general public (Hawkings *et al* 2007; 2008; McNulty *et al* 2007a), at the commencement of this research there was no existing work found by the author on the topic of companion animal antibiotic stewardship from the perspective of pet-owners. Now at the end of this research, this thesis contributes to emergent social science literatures not only on the topic of companion animal antibiotic stewardship (Smith *et al* 2018; Dickson *et al* 2019; Redding & Cole 2019a) but also a growing interest in the spillovers, translations, and transgressions made by pet-owners between medical and veterinary contexts (Ashall & Hobson-West 2017; Hobson-West & Jutel 2020).

This thesis has responded to four central questions laid out in Chapter 1:

1) How do pet-owners perceive the health(s) of themselves and their companion animals in relation to antibiotic use?
2) What impact do these perceptions have on beliefs about how antibiotics should be consumed?
3) Are there differences in reported personal antibiotic use between pet-owners and people who do not have companion animals?
4) What role does online health information have in shaping the understanding of information relating to antibiotics and their use?

These questions were addressed through quantitative and qualitative approaches with quantitative methods focusing on understanding differences between groups and outcomes, and qualitative approaches allowing research participants to have a more significant role in shaping the research process. Together these methods were intertwined to establish a robust methodological foundation

through the initial methodology-orientated explorations provide in Chapters 3 and 4, and facilitated the investigation of the above questions through contrasting tools with common aims, the results of which were discussed in Chapters 5, 6, and 7. Each Chapter has made contributions within the context of the thesis, and this conclusion will now highlight some of the broader implications of these contributions beyond this context in terms of the broader field of social research into antibiotic resistance, and research into the social experience of companion animal healthcare.

Section 8.2 – Contributions of the thesis

This thesis makes contributions in terms of the methodologies used in social research into antibiotic resistance and in the social science of companion animal healthcare, the ongoing conceptual conversations about how we think about antibiotic resistance as an issue characterised by an interconnected 'One'-ness, and empirically in terms of extending previous understandings of lay pet-owner perspectives on antibiotic use and antibiotic resistance.

Section 8.2.1 – More-than-human geographies of antibiotic consumption

Recent qualitative research engaging with antibiotic use in the context of companion animal care has borne out the supposition that the relating between companion species is never a completed experience (Haraway 2003). The work of Dickson *et al* (2019) in particular has been suggestive of an element of co-production of antibiotic stewardship between pet-owners and their companion animals. The intimacy of relations between the members of more-than-human households intensifies the flows of microbial companion species between members of these households and extends these flows to and from the local environment beyond the household. This is not to construct 'virtuous' and 'pathological' worlds of risk, as Hinchliffe (2015 p34) warns, but to acknowledge that life itself is pathological, "entangled as it is with environments, technologies, practices, bodies, and microbes." Along with these entanglements the veterinary profession itself is entangled with multiple jurisdictions including homes and clinics (Donald 2018) and, in the context of antibiotic resistance, many other spaces of pet-ownership. Pet-owners' accounts of human and companion animal health in the context of antibiotic resistance are accounts of space-making that explicitly enrol sites of care such as the veterinary clinic and the home whilst implicitly relating to the shared environmental spaces inherent to pet-ownership and daily life such as the parks through which dogs are walked, the gardens through which cats roam, and the workplaces and schools to which family members take their own microbial companion species. This geography, enrolling multiple species, microbes, spaces and places, is inherently more-than-human in character.

The evidence of this thesis suggests that whilst there are specific challenges to companion animal antibiotic stewardship, these experiences do not have the effect of differentiating pet-owners from petless members of the public in terms of their general relationship to the issue of antibiotic resistance. The conclusion of Chapter 5 pointed to similarly distributed levels of antibiotic

stewardship behaviour across medical and veterinary contexts but highlighted the likelihood that these behaviours may be motivated or rationalised differently. This suggestion was borne out in Chapters 6 and 7, with varied constructions of human and companion animal health being presented by pet-owners alongside differing perceptions of medical and veterinary professionals and the processes and practices of prescribing and administering antibiotics in these contexts. The more-than-human geography of antibiotic consumption in the context of pet-ownership and companion animal care discussed through this thesis centres not on a differentiation between pet-owners and people without companion animals, but more explicitly on the differences between the infrastructural and emotional contexts of care navigated by pet-owners.

The navigation of different contexts of care by pet-owners does to simply refer here exclusively to spatial relations or indeed practice-orientated decision-making. The experience of different sites of care of course matters in multiple ways, from the stressors discussed in Chapter 6 to the presence or absence of information discussed in Chapter 7. This navigation includes the pet-owners' own value judgements and understandings of health and illness, contemporarily contextualised by the "generalised medical consciousness" of the Internet (Canguilhem 1991; Parr 2002 p79). These judgements were exhibited in a number of ways in this thesis including in terms of trust in professionals, strategies for determining companion animals' states of health or illness, and approaches to the challenge of medicating a companion animal with antibiotics. These judgements are interconnected and need to be considered together when approaching the issue of antibiotic stewardship in companion animal care. Pet-owners may be sceptical of the costs associated with diagnostic testing or medication prescriptions, or resistive of diagnoses that differ from their understanding of their companion animals' state of health. Whilst there are evidently some parallels between human medical care and veterinary care in the context of antibiotic stewardship, the visibility of healthcare infrastructure and its costs in the context of veterinary medicine is interwoven with the responsibilities that pet-owners have for knowing and caring for their companion animal as well as the multispecies antibiotic-consuming collective. This interweaving gives rise to variability in the rationalisations and behaviours of pet-owners in their own healthcare and their companion animals' healthcare, and also challenges animal and health geographers to pursue a deeper integration of the challenges of speaking to and for animals and perceiving health and its contexts.

Section 8.2.2 – 'One Health' and companion animal antibiotic stewardship

This research of thesis provides a critique of the translation of 'One Health' as a policy conceptualisation into antibiotic stewardship behaviours. Governmental strategies to address antibiotic resistance have taken a One Health approach that overtly considers the interconnection of human, animal, and environmental healths (HM Government 2013; 2019b). This is an attractive policy framing, however based on the evidence presented in this thesis most notably the qualitative material in Chapters 6 and 7 this is not consistently the lived understanding of pet-owners themselves.

Chapter 2 highlighted some social scientific critiques of 'One Health' in multiple contexts including antimicrobial resistance discourse (Hinchliffe 2015; Wolf 2015; Kamenshchikova 2019). The combined research of this thesis extends these critiques to the context of antibiotic stewardship in the context of companion animal healthcare.

The general take-home message from this thesis in terms of the 'One Health' approach to addressing antibiotic resistance is that, for pet-owners, this approach seems to be absent. Firstly, pet-owners draw their own borders around conceptions of human and animal health and whilst some of these borders overlap through common channels such as medications or illness conditions, many do not. At a basic level, then, human and companion animal health may be 'One' in some lay perspectives but multiple in others. This holds implications for antibiotic stewardship, explored in Chapter 7, such as the translation of misconceptions as well as correct conceptions of antibiotic resistance across species boundaries with the potential reinforcement of good and poor antibiotic stewardship behaviour in multiple contexts. This challenge presents the opportunity to address misconceptions and poor stewardship behaviour in the context of companion animal care with impacts that extend to human medical care.

The invisible infrastructural work of antibiotics, now inverted and rendered visible as Chandler (2020) has indicated, seems to have remained invisible in the context of companion animal care. The repetitive refrain from participants that they had neither seen nor heard any information about antibiotic resistance in the context of their companion animals' health, yet were generally aware of the problem in the context of human health and often in the context of agricultural production, also points to a mode of biopolitical thought that emphasises the human animal in communication around antibiotic resistance. Blue & Rock (2010 p363) argue that 'trans-biopolitics' infuses contemporary politics of health, contending that biopolitically "we can no longer speak and think solely in terms of human relations when it comes to questions of health" from evidence in the contrasted contexts of public health action relative to bovine and feline spongiform encephalopathies based on which animals were being consumed by which other animals. Mirroring this context, in antibiotic resistance it would appear to be the case that the relations within which antibiotic resistance is being discussed are anthropocentric in terms of direct health effects and food consumption.

Implementing 'One Health' interventions in the context of antibiotic stewardship should address this communication gap, bringing the optics of companion animal antibiotic stewardship into line with the optics of human-focused antibiotic stewardship in sites of care as well as online. An intervention of this kind could reach a significant portion of the almost half of the UK population that lives with a companion animal, reinforcing key messages about antibiotic resistance as well as emphasising the links between human and companion animal health. This kind of intervention could be to improve veterinary communication on this topic – though this focus would be challenging for a number of

reasons associated with the intensity of the job of companion animal veterinary practice as well as the inefficacy of (for example) poster-based interventions in companion animal veterinary clinics. A broader One Health strategy to normalize companion animals within the context of antibiotic resistance and antibiotic stewardship educational materials may be more productive in challenging the anthropocentric focus of public perceptions of the topic. There are a number of proactive and innovative communication approaches that have been developed in the context of antibiotic resistance in recent years, ranging from games to musicals and theatre productions for children (Panford-Quainoo 2020) as well as more conventional approaches mentioned by interview participants such as posters in GP practices and television pieces. Normalizing the presence of companion animals and veterinarians within these resources may help to reduce the anthropocentricity of antibiotic resistance in public perceptions and improve understanding and responsible behaviour for the almost half of the UK population with companion animals in their families.

Section 8.2.3 – Online health information

The increasingly prescient role that online health information plays in modern patient-hood has been a phenomenon of interest for the medical and veterinary professions as well as social scientists. This thesis makes two contributions in this area based on survey data and qualitative interview data. Firstly the relationship between use and trust of online health information and trust or behavioural outcomes is mediated by the weight of use of online information sources. Whilst Chapter 3 suggested a positive correlation between members of the public who use and trust online health information sources and antibiotic-related outcomes, the primary research in Chapter 5 suggests that within this broad categorisation there are distinctions between heavy users who tend to trust this information over healthcare professionals and less intensive users who tend to trust healthcare professionals rather than online sources. Secondly, whilst online health information was generally perceived as an adjunct for professionals, there was a clear division between the confidence that participants had in sourcing human-orientated information and companion animal-orientated information. This calls back to the uneven implementation of ‘One Health’ as a policy orientation as well as the disconnected infrastructures that shape the more-than-human geography of antibiotic consumption for pet-owners. It has been speculated in the literature that pet-owners seeking information may attempt to translate advice across contexts in order to fill information needs (Hobson-West & Jutel 2020), and these kinds of translations were evident in Chapter 6. Whilst this translational behaviour may open possibilities in terms of communicating One Health antibiotic stewardship interventions, the findings of Chapter 5 suggest that there may be negative implications for companion animal health in households that have low levels of trust in their veterinarians and high levels of trust in online health information and the inferences drawn from it. This is a challenging area to navigate, and any policy intervention relating to online health information and especially companion animal-relevant information should account for the fact that whilst some users are supplementing professional advice, others are seeking to replace it.

Section 8.2.4 – Survey methodological contributions

The key methodological contributions that were made in the thesis relate to the use of social survey methods for studying attitudes and behaviours in the context of antibiotic resistance. These contributions were made in Chapters 3 and 4, highlighting previously unconsidered variables as potential areas for deeper investigation and discussing issues relating to survey question construction. Within the thesis, these contributions served to direct and refine the survey presented in Chapter 5. Beyond this thesis however, these contributions are relevant to the broader field of survey research into community antibiotic stewardship behaviours outside the context of companion animal care.

The implications of the findings of Chapter 3 for example, whilst incorporated into the work of Chapter 5, point to new considerations in variable selection by highlighting the potential importance of sub-national geographic variation and differences in antibiotic stewardship behaviour between differently politically-orientated individuals. The geographic issue is taken up to an extent in Chapter 5's modelling approach, but the contribution of Chapter 3 here is to highlight that there are regional variations in antibiotic prescription adherence within the UK that should be explored in greater depth to explain why adherence appears to vary across space. In the context of the thesis, local and regional geography was predominantly considered as an element of sample design rather than a specific variable of interest and as such was not elucidated in depth in this way. The finding that political orientation is a variable of interest, again taken up in Chapter 5, has multiple implications for social research into antibiotic stewardship. The extent to which this variable is a marker for underlying attitudes or behaviours in the context of antibiotic stewardship has been beyond the scope of this thesis, however evidence drawn from political psychology literature and parallels drawn in Chapter 5 with climate change and environmental behaviours suggest that a deeper exploration and explanation of the importance of this variable in antibiotic stewardship in the UK are warranted and will hold relevance for the implementation of future antibiotic stewardship interventions.

In addition to these contributions on variable selection, this thesis has made methodological contributions to survey question design and mixed-methods social research into antibiotic stewardship. The use of cognitive interviewing in this thesis was novel in that it is the application of this method to a questionnaire that was exclusively focused on understanding antibiotic stewardship attitudes and behaviours. In the context of companion animal care for example, the cognitive interviews presented in Chapter 4 highlighted clear differences in the rationalisations of responses to identical questions about personal and pet-orientated antibiotic use, and about trust in doctors and veterinarians. Whilst these differences were carried forwards in the research presented in Chapters 5, 6, and 7 regarding antibiotic stewardship, they also contribute to a broader literature on the similarities and differences between experiences of medical and veterinary care. Specifically, not only are there some apparent overlaps and distinctions between the social experience of medical and veterinary care, but survey questions that explore parallel aspects of these areas of care appear to perform differently

between these contexts and future research in this vein should take this performance into consideration.

Taken together, these contributions extend previous practice in survey research into antibiotic stewardship behaviours both in the context of companion animal care and beyond, and provide a basis for future survey work comparing medical and veterinary contexts from lay perspectives.

Section 8.3 – Future directions

There are a number of potential future directions for research following this thesis. Some of these directions may extend the methods used in the thesis to provide a deeper analysis of the issues raised in this research, whilst others could explore topics that naturally follow on from strands of work explored here. Two key areas are elaborated here.

Firstly, there are methodological routes that could be explored that for a lack for time or resources were not explored for this thesis. This thesis has relied heavily in its primary research on the participation of online publics. Developing and commissioning a face-to-face random probability sample to explore the hypotheses examined in Chapter 5 would provide a greater level of generalisability and provide information on survey mode effects that may have been undetected in this thesis. The goal of this extension would not be to reinforce or disprove the analyses carried out on the data collected for this thesis, as the survey would likely be being carried out in a post-pandemic setting that may have significantly altered attitudes towards medical professionals and the promises of infection treatments. Such a survey may be able to provide a higher level of geographical granularity however, and could be combined with a small sample of the kind used in Chapter 5 to examine survey mode effects more directly, and may be more directly comparable to the samples used in Chapter 3.

Secondly, a clear successor topic to extend this research is vaccination and vaccine hesitancy. Vaccine hesitancy is a growing issue in the UK in both medical (Godlee 2019) and veterinary (Loeb 2019) spheres, vaccination is one of the *Review on Antimicrobial Resistance's* (2016) ten fronts on which antimicrobial resistance is to be tackled, and vaccine hesitancy is currently prescient in relation to the ongoing COVID-19 pandemic and preparation for future pandemics (Royal Society for Public Health 2020; Meggett 2020). Through analysis of Wellcome Monitor Wave 4 data, I recently have argued that attitudes towards antibiotic use and vaccine uptake should examined together due to the correlation between perceptions of vaccine risk and the role of antibiotics (Anderson 2020). Researching the extent to which attitudes towards vaccination in medical and veterinary contexts are connected would also be a productive direction to explore in order to further understand the spillovers between medical and veterinary contexts in pet-owners' perceptions and behaviours that have been examined in this thesis and hypothesised elsewhere (Ashall and Hobson-West 2017; Hobson-West & Jutel 2020). By developing strands of work examining specific medical interventions and their

application and interpretation across species boundaries this thesis and future work can inform public health interventions addressing interspecies health issues such as antibiotic resistance, and inform the communication of information regarding treatments or practices common to both human and veterinary medicine.

Appendices

Appendix A: Chapter 5 Survey Questions

Reproduced below is the full list of questions that pet-owners responded to for the data collection for Chapter 5. The exact structure of each individual survey questionnaire is not reproduced below as it varied based on responses to questions with routing (for example, a respondent that had never taken antibiotics would not answer further behaviour questions about antibiotics).

Questions that do not have responses with a box next to them are open text response questions.

Questionnaire Begins:

Introduction

Dear Respondent,

I am a researcher studying the use of the Internet as a source of health information, the use of antibiotics, and the differences between pet-owners and non-owners in these areas.

This survey is composed of four parts. The first section covers your personal health decision-making. The second section covers your demographic background. The third section covers your health decision-making with regards to any pets that you care for. The fourth section asks about some contextual attitudes.

Each response to the survey is anonymous, and will not be used in a manner that allows the identification of your individual responses.

If you are happy for your anonymous data to be used for research purposes including the dissemination of findings by publication or presentation, please tick the consent agreement below. If you exit the survey at any time before completion, your responses will not be kept. If you do not wish to take part, or start the survey but decide to withdraw from the study, please **return** your submission in Prolific.

Thank you for your time and responses!

Alistair Anderson

1) Consent
   - ☐ **I agree to participate in this survey, and consent to the use of my data for research purposes**

2) Please enter your Prolific ID below.

Section 1: Human health

3) On average, how often do you use the Internet to search for human health information for yourself, family, or friends?
   - ☐ Daily
   - ☐ Several times per week
   - ☐ Once per week
   - ☐ Multiple times per month

- Once per month
- Less than once per month
- Never

4) In general, how trustworthy would you rate the information sources that you use on the Internet *compared* to your general practitioner (GP)?
   - 1 – Much less trustworthy
   - 2 – Slightly less trustworthy
   - 3 – Similar levels of trustworthiness
   - 4 – Slightly more trustworthy
   - 5 – Much more trustworthy

5) If you use the Internet to search for human health information, do you more often visit a specific website *or* a search engine?
   - Specific website
   - Search engine

6) If you selected “Specific Website” in the previous question, please make a note of the website that you most frequently use.

7) Have you brought information found on the Internet to a discussion with a human-health professional?
   - Yes
   - No

8) Have you used the Internet to search for information about antibiotics for humans?
   - Yes
   - No

9) How far do you agree with the following statement: "A patient must always take antibiotics in the way instructed by a doctor"?
   - 1 (Strongly Disagree)
   - 2
   - 3
   - 4 (Neither Agree nor Disagree)
   - 5
   - 6
   - 7 (Strongly Agree)

10) There are several different browsers and apps that are used to access information on the Internet, such as Google Chrome and Mozilla Firefox.
    It is important to be attentive to the wording of questions in this survey. When this question asks which browser you most often use, please type in "None" to show that you have read this instruction.
    Based on the above information, which Internet browser do you most often use?

11) Have you ever taken any antibiotics orally such as tablets, powder, or syrup?
   - Yes
   - No

For these questions, please think about the *most recent* occasion when you took an antibiotic.

12. When was the *most recent* time that you took an antibiotic?
    - Within the last month
    - Within the last three months
    - Within the last twelve months
    - Within the last two years
    - More than two years ago

13. How did you obtain the *most recent* course of antibiotics that you used?
    - From a medical prescription
    - You had some left over from a previous course
    - Administered by a medical practitioner
    - Without prescription from somewhere other than a pharmacy
    - Without a prescription from a pharmacy

14. How did you take these antibiotics?
    - Did not take them
    - Took them until you felt better
    - Other
    - Took them as prescribed

15. If you answered "Did not take them" or "Other", please elaborate below (stating which response you gave previously – e.g. "Did not take them: Reason XYZ")

16. What did you do with any leftover antibiotics?
    - Kept them
    - Returned them
    - Threw them away
    - None were left over

17. In humans, what conditions do you think can be effectively treated by antibiotics? (Tick all that you think apply)
    - Viral infections (e.g. flu)
    - Bacterial infections (e.g. pneumonia)
    - Fungal infections (e.g. athlete's foot, ringworm)
    - Allergic reactions (e.g. bee stings)

18. What do you understand the term 'Antibiotic Resistance' to mean?

Please answer 'True', 'False', or 'Don't Know' to the following five questions:

19. Unnecessary use of antibiotics in animals can lead to antibiotics becoming ineffective to treat humans.
    - True
    - False
    - Don't know
20. Unnecessary use of antibiotics in humans can lead to antibiotics becoming ineffective to treat humans.
    - True
    - False
    - Don't know

21. Antibiotics used on animals work the same way as those used on humans.
    - □ True
    - □ False
    - □ Don't know
22. Antibiotic resistance only affects people.
    - □ True
    - □ False
    - □ Don't know
23. Taking antibiotics often has side-effects such as diarrhea.
    - □ True
    - □ False
    - □ Don't know

24. *In the last 12 months*, do you remember getting any information about not taking antibiotics unnecessarily?
    - □ Yes
    - □ No
    - □ Don't know

25. In which of the following contexts do you remember receiving warning information about using antibiotics unnecessarily?
    - □ In the context of human health
    - □ In the context of pet animals' health
    - □ In the context of non-pet animals' health
    - □ You do not remember a specific context for the information you received
    - □ You have not received any information about using antibiotics unnecessarily

26. Please select a response below.
    Additionally, please write "Comment" into the comment box for this question.
    This is to screen for random clicking of responses that are inattentive to question instructions.
    - □ 1 – Very Rarely
    - □ 2
    - □ 3
    - □ 4
    - □ 5 – Very Frequently
    - □ [Comment box]

Section 2: Demographic information

27. What is your age (based on your last birthday)?

28. Please select your gender.
    - □ Female
    - □ Male
    - □ Other
    - □ Prefer not to say

29. What is your highest academic/vocational qualification?
    - □ GCSE/NVQ Level 2
    - □ A-Level/NVQ Level 3
    - □ Undergraduate degree/NVQ Level 4
    - □ Postgraduate degree/NVQ Level 5+
    - □ None of the above

30. Are you currently a student?
    - Yes
    - No

31. Which of these best describes your employment status?
    - Employed
    - Self-Employed
    - Not working

32. Do you, or any of your family/pets, have a pre-existing health condition (e.g. diabetes, asthma, allergies, etc.)?
    - Yes
    - No

33. Do you, or any of your family, work in a medical field (e.g. as a doctor, veterinarian, dentist, nurse)?
    - Yes
    - No

34. Would you say you live in a…?
    - Rural area or village
    - Small or middle sized town
    - Large town

35. How many children aged less than 10 years old live in your household?

36. How many children aged between 10 and 14 years live in your household?

37. What is the age of your oldest child (based on their last birthday)? *Please leave blank if this is not applicable.*

38. In total, how many of each of the following pets did you live with as part of any household whilst growing up? *Please enter 0 if none of one animal, rather than leaving blank.*
    - Dog
    - Cat
    - Rabbit
    - Reptile
    - Bird
    - Small mammal (e.g. hamster, gerbil)
    - Fish
    - Other

39. How many of each of the following pets are currently part of your household? *Please enter 0 if none of one animal, rather than leaving blank.*
    - Dog
    - Cat
    - Rabbit
    - Reptile
    - Bird
    - Small mammal (e.g. hamster, gerbil)
    - Fish
    - Other

40. Did you grow up in a household that looked after farm animals?
    - Yes
    - No

41. Do you currently live in a household that looks after farm animals?
    - Yes
    - No

42. For how much time (in years) have you lived with your current pets? Please respond to the nearest half year (e.g. 1.5 or 4.0).

43. How far do you agree with the following statement: "A pet must always be given antibiotics in the way instructed by a veterinarian"?
    - 1 (Strongly Disagree)
    - 2
    - 3
    - 4 (Neither Agree nor Disagree)
    - 5
    - 6
    - 7 (Strongly Agree)
44. There are several search engines that can be used to find information on the Internet. It is important to be attentive to the wording of questions in this survey.
    When this question asks which search engine you most often use, please type in "Attention" to show that you have read this instruction.
    Based on the above information, which Internet search engine do you most often use?

Section 3: Companion animal health

45. Have you ever given a pet any antibiotic orally such as tables, powder, or syrup?
    - Yes
    - No

For these questions, please think about the *most recent* occasion when you gave a pet an antibiotic.

46. When was the *most recent* time you gave a pet an antibiotic?
    - Within the last month
    - Within the last three months
    - Within the last twelve months
    - Within the last two years
    - More than two years ago

47. Please think back to the most recent time you gave a pet antibiotics. Where did you get those antibiotics from?
    - From a veterinary prescription
    - You had some left over from a previous course
    - Administered by a veterinary practitioner
    - Without prescription from somewhere other than a pharmacy
    - Without a prescription from a pharmacy

48. How did you give your pet these antibiotics?
    - Did not give them
    - Gave them until you felt better
    - Other
    - Given as prescribed

49. If you answered "Did not give them" or "Other", please elaborate below (stating which response you gave previously – e.g. "Did not take them: Reason XYZ")

50. What did you do with any leftover antibiotics?
    - Kept them
    - Returned them
    - Threw them away
    - None were left over

51. In animals, what conditions do you think can be effectively treated by antibiotics? (Tick all that you think apply)
    - Viral infections (e.g. flu)
    - Bacterial infections (e.g. pneumonia)
    - Fungal infections (e.g. athlete's foot, ringworm)
    - Allergic reactions (e.g. bee stings)

52. On average, how often do you use the Internet to search for animal health information for yourself, family, or friends?
    - Daily
    - Several times per week
    - Once per week
    - Multiple times per month
    - Once per month
    - Less than once per month
    - Never

53. In general, how trustworthy would you rate the information sources that you use on the Internet compared to your usual veterinarian?
    - 1 – Much less trustworthy
    - 2 – Slightly less trustworthy
    - 3 – Similar levels of trustworthiness
    - 4 – Slightly more trustworthy
    - 5 – Much more trustworthy

54) If you use the Internet to search for animal health information, do you more often visit a specific website *or* a search engine?
    - Specific website
    - Search engine

55) If you selected "Specific Website" in the previous question, please make a note of the website that you most frequently use.

56) Have you brought information found on the Internet to a discussion with an animal-health professional?
    - Yes
    - No

57) Have you used the Internet to search for information about antibiotics for animals?
- Yes
- No

58) At what level do you believe it is most effective to tackle the resistance to antibiotics?
- At the individual level or within the family
- At regional level
- At national level
- At EU level
- At global level
- Don’t know

59) To what extent do you agree or disagree that sick farm animals should be treated with antibiotics if this is the most appropriate treatment?
- Totally agree
- Tend to agree
- Tend to disagree
- Totally disagree
- Don’t know

60. To what extent do you agree or disagree that sick companion/pet animals should be treated with antibiotics if this is the most appropriate treatment?
- Totally agree
- Tend to agree
- Tend to disagree
- Totally disagree
- Don’t know

61. In political matters people talk of "the left" and "the right". How would you place your views on this scale?
- 1 (Left)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (Right)

62. How would you describe your political outlook with regard to social issues?
- 1 (Very Liberal)
- 2
- 3
- 4 (Moderate)
- 5
- 6
- 7 (Very Conservative)

63. How would you describe your political outlook with regard to economic issues?
    - 1 (Very Liberal)
    - 2
    - 3
    - 4 (Moderate)
    - 5
    - 6
    - 7 (Very Conservative)

Appendix B: Chapter 5 Tables

Appendix Table 1: Effects of weights on sample biases

Variable	Reference	Unweighted Panel	1: Demographic	1: Attitudinal	1: Combined	2: Demographic	2: Attitudinal	2: Combined	3: Demographic	3: Attitudinal	3: Combined	4: Demographic	4: Attitudinal	4: Combined
Age (Mean)	47.53	37.02	42.13	37.80	42.50	41.80	37.73	42.06	35.57	36.79	35.91	39.68	37.52	40.47
Bias		*-10.50*	*-5.39*	*-9.73*	*-5.03*	*-5.72*	*-9.80*	*-5.46*	*-11.96*	*-10.74*	*-11.62*	*-7.85*	*-10.01*	*-7.06*
Bias Change			*5.11*	*0.78*	*5.48*	*4.78*	*0.71*	*5.04*	*-1.45*	*-0.24*	*-1.11*	*2.66*	*0.50*	*3.45*
Female (%)	50.27	62.61	51.87	63.24	51.91	53.35	63.38	52.65	65.45	60.60	64.86	56.06	61.39	55.32
Bias (%)		*12.34*	*1.60*	*12.96*	*1.63*	*3.08*	*13.11*	*2.38*	*15.17*	*10.33*	*14.59*	*5.79*	*11.12*	*5.04*
Bias Change (%)			*-10.74*	*0.63*	*-10.70*	*-9.25*	*0.77*	*-9.96*	*2.84*	*-2.01*	*2.25*	*-6.55*	*-1.22*	*-7.29*
Not Working %	46.48	9.86	38.99	28.13	40.10	38.16	27.95	38.96	24.62	26.29	25.57	33.88	26.49	35.40
Bias (%)		*-36.63*	*-7.49*	*-18.35*	*-6.39*	*-8.32*	*-18.54*	*-7.53*	*-21.86*	*-20.20*	*-20.92*	*-12.61*	*-19.99*	*-11.08*
Bias Change (%)			*29.14*	*18.28*	*30.24*	*28.31*	*18.09*	*29.10*	*14.77*	*16.43*	*15.71*	*24.02*	*16.64*	*25.55*
Large Town %	32.27	42.80	37.80	40.77	37.10	38.10	40.88	37.79	41.19	41.80	42.01	37.06	39.91	37.18
Bias (%)		*10.53*	*5.53*	*8.49*	*4.83*	*5.83*	*8.61*	*5.52*	*8.92*	*9.52*	*9.74*	*4.79*	*7.64*	*4.90*
Bias Change (%)			*-5.00*	*-2.04*	*-5.70*	*-4.70*	*-1.92*	*-5.01*	*-1.61*	*-1.01*	*-0.79*	*-5.74*	*-2.89*	*-5.63*
Antibiotics Taken in Past	29.07	41.35	40.12	42.27	40.13	39.95	42.45	40.11	43.00	39.99	42.46	42.61	40.85	41.39

12 Months (%)														
Bias (%)		*12.28*	*11.05*	*13.20*	*11.06*	*10.88*	*13.38*	*11.04*	*13.93*	*10.92*	*13.39*	*13.54*	*11.78*	*12.32*
Bias Change (%)			*-1.24*	*0.92*	*-1.22*	*-1.40*	*1.10*	*-1.24*	*1.64*	*-1.36*	*1.11*	*1.26*	*-0.50*	*0.04*
Received Information %	35.59	45.22	44.86	45.22	46.11	44.91	45.28	45.04	44.36	44.48	44.57	44.08	44.59	43.50
Bias (%)		*9.63*	*9.27*	*9.63*	*10.52*	*9.32*	*9.69*	*9.45*	*8.77*	*8.89*	*8.98*	*8.49*	*9.00*	*7.91*
Bias Change (%)			*-0.36*	*0.00*	*0.90*	*-0.31*	*0.06*	*-0.18*	*-0.85*	*-0.74*	*-0.65*	*-1.14*	*-0.62*	*-1.72*
Left-Right Placement (Mean)	5.12	4.48	4.61	4.91	4.95	4.60	4.84	4.89	4.44	4.53	4.40	4.53	4.94	4.82
Bias		*-0.64*	*-0.51*	*-0.21*	*-0.17*	*-0.52*	*-0.27*	*-0.23*	*-0.68*	*-0.59*	*-0.72*	*-0.59*	*-0.18*	*-0.30*
Bias Change			*0.14*	*0.43*	*0.47*	*0.13*	*0.37*	*0.41*	*-0.04*	*0.06*	*-0.07*	*0.05*	*0.46*	*0.35*
AB_Individual Level (Yes %)	22	14	13	19	19	13	18	18	15	14	12	14	20	17
Bias (%)		*-8.51*	*-9.08*	*-2.64*	*-3.23*	*-9.11*	*-3.75*	*-4.02*	*-7.45*	*-8.10*	*-9.67*	*-7.86*	*-2.16*	*-5.12*
Bias Change (%)			*-0.56*	*5.87*	*5.28*	*-0.60*	*4.76*	*4.50*	*1.07*	*0.41*	*-1.16*	*0.65*	*6.35*	*3.39*
% Agree Sick Farm Animals	75.73	80.00	80.74	80.86	81.35	80.85	80.72	81.39	80.17	79.13	79.25	81.15	80.16	80.37

Bias (%)		*4.27*	*5.01*	*5.13*	*5.63*	*5.12*	*5.00*	*5.66*	*4.45*	*3.41*	*3.53*	*5.43*	*4.43*	*4.64*
Bias Change (%)			*0.74*	*0.86*	*1.35*	*0.85*	*0.72*	*1.39*	*0.17*	*-0.87*	*-0.75*	*1.15*	*0.16*	*0.37*
% Antibiotics Cause Side Effects	62.57	53.82	56.01	62.94	64.17	56.32	62.64	64.00	53.73	53.33	51.11	55.90	62.62	60.91
Bias (%)		*-8.75*	*-6.56*	*0.37*	*1.60*	*-6.25*	*0.07*	*1.44*	*-8.84*	*-9.24*	*-11.46*	*-6.67*	*0.06*	*-1.65*
Bias Change (%)			*2.19*	*9.12*	*10.35*	*2.50*	*8.82*	*10.19*	*-0.09*	*-0.49*	*-2.71*	*2.08*	*8.81*	*7.10*

Appendix Table 2 Full regression results for contextual knowledge/attitude outcomes. Where the CIs do not include 1, significance is denoted with an asterisk. R^2 is Bayesian McKelvey-Zavoina Pseudo-R^2 (estimate with 95% confidence intervals).

Model 1				Model 2			
Trust in Internet Relative to Doctor (n=1030, R^2=0.222, 0.176-0.271)	**OR**	**2.5% CL**	**97.5% CL**	**Trust in Internet Relative to Vet (n=1030, R^2=0.212, 0.166-0.260)**	**OR**	**2.5% CL**	**97.5% CL**
Age	1.445*	1.249	1.667	Age	1.246*	1.009	1.539
Male	0.961	0.762	1.213	Male	1.573*	1.084	2.280
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*			
None of the Above	0.920	0.397	2.175	None of the Above	0.894	0.302	2.671
GCSE	1.161	0.819	1.633	GCSE	1.300	0.758	2.244
A-Level	1.303	0.957	1.776	A-Level	1.235	0.796	1.925
Postgraduate	0.797	0.580	1.089	Postgraduate	0.990	0.610	1.616
Ref: Employed				*Ref: Employed*			
Not Working	1.415*	1.089	1.827	Not Working	1.548*	1.026	2.341
Self-Employed	1.913*	1.258	2.906	Self-Employed	1.898*	1.007	3.610
Ref: Large Urban				*Ref: Large Urban*			
Rural	0.820	0.581	1.154	Rural	0.851	0.518	1.396
Small Urban	0.896	0.683	1.165	Small Urban	0.790	0.531	1.198
Ref: No Children				*Ref: No Children*			
Child 0-3 years	1.410	0.810	2.511	Child 0-3 years	1.312	0.583	2.868
Child 4-12 years	1.199	0.843	1.705	Child 4-12 years	1.052	0.655	1.727
Child 12-18	1.116	0.728	1.722	Child 12-18	1.029	0.578	1.825
Child 18+	0.764	0.521	1.135	Child 18+	0.935	0.522	1.681
Pre-Existing Health Condition	0.909	0.719	1.147	Pre-Existing Health Condition	1.270	0.897	1.780
Medical Professional	1.097	0.769	1.540	Medical Professional	1.151	0.717	1.835
Dog	0.964	0.646	1.431	Dog	0.947	0.625	1.438
Cat	1.046	0.690	1.600	Cat	1.628*	1.025	2.572
Multiple Pet Types	0.848	0.507	1.391	Multiple Pet Types	0.258*	0.108	0.613

Pet as Child	0.805	0.593	1.102	Pet as Child	1.338	0.662	2.698
Ref: 'Never' or 'Less than once per month'				*Ref: 'Never' or 'Less than once per month'*			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	1.663*	1.261	2.209	Internet Use Frequency - 'Once per month' or 'more than once per month' (Pet Health)	2.560*	1.662	3.968
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	3.360*	2.413	4.677	Internet Use Frequency - 'Once per week' to 'Daily' (Pet Health)	3.179*	1.206	8.103
Social Political Orientation	1.033	0.900	1.185	Social Political Orientation	1.236	1.000	1.521
Economic Political Orientation	1.050	0.911	1.210	Economic Political Orientation	0.863	0.690	1.088
Antibiotic Resistance Should be Addressed at the Level of the Individual	1.114	0.812	1.533	Antibiotic Resistance Should be Addressed at the Level of the Individual	1.565	0.972	2.524
Human Antibiotic Efficacy Score	0.875	0.702	1.096	Human Antibiotic Efficacy Score	0.808	0.586	1.123
Animal Antibiotic Efficacy Score	1.134	0.908	1.410	Animal Antibiotic Efficacy Score	1.051	0.774	1.441
Interspecies Knowledge	1.043	0.926	1.173	Interspecies Knowledge	0.969	0.814	1.151
Studies Done	1.029	0.918	1.157	Studies Done	1.061	0.893	1.267
Any ACQ Fail	1.096	0.778	1.549	Any ACQ Fail	1.515	0.906	2.520
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.18	0.02	0.37	NUTS2 (Sd)	0.17	0.01	0.43
Variance Partition Coefficient	0.01	0.00	0.05	Variance Partition Coefficient	0.02	0.00	0.06

Model 3			
Interspecies Knowledge (n=1030, R^2=0.201, 0.158-0.245)	**OR**	**2.5% CL**	**97.5% CL**
Age	1.124	0.976	1.289
Male	1.762*	1.382	2.226
Ref: Undergraduate Degree			
None of the Above	0.355*	0.156	0.809
GCSE	0.585*	0.414	0.828
A-Level	0.892	0.653	1.223
Postgraduate	1.233	0.880	1.709
Ref: Employed			
Not Working	1.828*	1.416	2.401
Self-Employed	1.920*	1.234	2.991
Ref: Large Urban			
Rural	0.902	0.636	1.281
Small Urban	1.017	0.785	1.319
Ref: No Children			
Child 0-3 years	1.073	0.634	1.825
Child 4-12 years	1.069	0.745	1.540
Child 12-18	0.852	0.569	1.302
Child 18+	0.829	0.562	1.226
Pre-Existing Health Condition	0.844	0.667	1.067
Medical Professional	0.970	0.676	1.385
Dog	0.805	0.532	1.213
Cat	1.248	0.818	1.876
Multiple Pet Types	1.179	0.726	1.897
Had Pet as Child	1.130	0.835	1.531
Ref: 'Never' or 'Less than once per month'			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	0.772	0.579	1.027
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	0.683*	0.487	0.945
Social Political Orientation	0.800*	0.697	0.914
Economic Political Orientation	1.212*	1.052	1.398
Antibiotic Resistance Should be Addressed at the Level of the Individual	0.993	0.732	1.341
Ref: 'About the same'			
Trust the Internet Much Less than a GP	1.118	0.817	1.549
Trust the Internet Slightly Less than a GP	1.010	0.769	1.333
Trust the Internet Slightly More than a GP	1.397	0.852	2.304
Trust the Internet Much More than a GP	1.961	0.934	4.084
Human Antibiotic Efficacy Score	1.167	0.943	1.448
Animal Antibiotic Efficacy Score	1.398*	1.135	1.719
Ref: Strongly agree sick pets should be treated with antibiotics			
Disagree Sick Pets Should be Treated	2.158*	1.189	4.168

Don’t Know Whether Sick Pets Should be Treated	0.359*	0.220	0.576
Tend to Agree Sick Pets Should be Treated	1.016	0.788	1.309
Studies Done	1.065	0.947	1.193
Any ACQ Fail	1.505*	1.059	2.138
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.19	0.01	0.38
Variance Partition Coefficient	0.01	0.00	0.04

Model 4				Model 5			
Human Treat Knowledge (n=1030, R^2=0.222, 0.176-0.271)	**OR**	**2.5% CL**	**97.5% CL**	**Animal Treat Knowledge (n=1030, R^2=0.212, 0.166-0.260)**	**OR**	**2.5% CL**	**97.5% CL**
Age	1.445*	1.231	1.688	Age	1.432*	1.230	1.679
Male	0.611*	0.470	0.796	Male	0.690*	0.534	0.891
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*			
None of the Above	1.825	0.674	5.552	None of the Above	1.074	0.448	2.673
GCSE	0.531*	0.361	0.781	GCSE	0.609*	0.420	0.878
A-Level	0.734	0.520	1.027	A-Level	0.859	0.614	1.200
Postgraduate	1.343	0.917	1.960	Postgraduate	1.451*	1.015	2.088
Ref: Employed				*Ref: Employed*			
Not Working	1.063	0.788	1.421	Not Working	1.151	0.864	1.544
Self-Employed	1.125	0.676	1.887	Self-Employed	1.148	0.711	1.860
Ref: Large Urban				*Ref: Large Urban*			
Rural	0.899	0.615	1.323	Rural	0.906	0.623	1.319
Small Urban	1.073	0.803	1.422	Small Urban	1.070	0.811	1.406
Ref: No Children				*Ref: No Children*			
Child 0-3 years	0.860	0.484	1.576	Child 0-3 years	1.053	0.610	1.834
Child 4-12 years	0.935	0.643	1.355	Child 4-12 years	1.240	0.851	1.804
Child 12-18	0.757	0.476	1.202	Child 12-18	0.978	0.620	1.559
Child 18+	1.288	0.821	2.048	Child 18+	1.235	0.798	1.901
Pre-Existing Health Condition	1.489*	1.140	1.932	Pre-Existing Health Condition	1.403*	1.094	1.797
Medical Professional	1.484	0.995	2.248	Medical Professional	1.505*	1.018	2.267
Dog	1.365	0.842	2.164	Dog	1.098	0.719	1.696
Cat	1.390	0.861	2.215	Cat	1.051	0.674	1.680
Multiple Pet Types	0.641	0.371	1.155	Multiple Pet Types	0.848	0.486	1.442
Had Pet as Child	1.691*	1.199	2.340	Had Pet as Child	1.841*	1.330	2.530
Ref: 'Never' or 'Less than once per month'				*Ref: 'Never' or 'Less than once per month'*			

Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	1.102	0.806	1.493	Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	1.178	0.863	1.623
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	1.285	0.891	1.866	Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	1.076	0.743	1.553
Social Political Orientation	0.942	0.813	1.095	Social Political Orientation	0.930	0.798	1.083
Economic Political Orientation	1.128	0.963	1.319	Economic Political Orientation	1.122	0.957	1.315
Antibiotic Resistance Should be Addressed at the Level of the Individual	0.818	0.593	1.130	Antibiotic Resistance Should be Addressed at the Level of the Individual	0.789	0.567	1.096
Ref: 'About the same'				*Ref: 'About the same'*			
Trust the Internet Much Less than a GP	0.962	0.674	1.376	Trust the Internet Much Less than a GP	0.905	0.644	1.288
Trust the Internet Slightly Less than a GP	0.948	0.693	1.296	Trust the Internet Slightly Less than a GP	0.954	0.720	1.283
Trust the Internet Slightly More than a GP	0.992	0.562	1.747	Trust the Internet Slightly More than a GP	1.094	0.642	1.907
Trust the Internet Much More than a GP	0.941	0.408	2.191	Trust the Internet Much More than a GP	1.257	0.543	2.943
Interspecies Knowledge	1.496*	1.321	1.698	Interspecies Knowledge	1.518*	1.341	1.726
Studies Done	0.911	0.805	1.028	Studies Done	0.930	0.826	1.052
Any ACQ Fail	0.827	0.566	1.192	Any ACQ Fail	0.834	0.574	1.216
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.18	0.01	0.41	NUTS2 (Sd)	0.24	0.02	0.47
Variance Partition Coefficient	0.01	0.00	0.05	Variance Partition Coefficient	0.02	0.00	0.06

Appendix Table 3 Full regression results for behaviour-related outcomes. Where the CIs do not include 1, significance is denoted with an asterisk. R^2 is Bayesian McKelvey-Zavoina Pseudo-R^2 (estimate with 95% confidence intervals).

Model 6				Model 7			
Human Behaviour (n=1030, R^2=0.363, 0.288-0.466)	**OR**	**2.5% CI**	**97.5% CI**	**Pet-Orientated Behaviour (n=523, R^2=0.982, 0.781-1)**	**OR**	**2.5% CI**	**97.5% CI**
Fixed Effects				**Fixed Effects**			
Age	0.559*	0.440	0.702	Age	0.637	0.373	1.074
Male	1.647*	1.141	2.376	Male	1.927	0.831	4.409
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*			
None of the Above	0.048*	0.000	0.798	None of the Above	0.000*	0.000	0.000
GCSE	0.940	0.548	1.572	GCSE	2.794	0.824	9.755
A-Level	1.118	0.713	1.727	A-Level	1.797	0.659	4.967
Postgraduate	1.040	0.633	1.708	Postgraduate	1.401	0.417	4.556
Ref: Employed				*Ref: Employed*			
Not Working	0.790	0.518	1.178	Not Working	1.184	0.481	2.932
Self-Employed	0.698	0.331	1.423	Self-Employed	0.958	0.204	3.864
Ref: Large Urban				*Ref: Large Urban*			
Rural	1.760*	1.047	2.903	Rural	2.691	0.880	8.409
Small Urban	1.385	0.928	2.086	Small Urban	1.434	0.540	3.814
Ref: No Children				*Ref: No Children*			
Child 0-3 years	1.173	0.589	2.303	Child 0-3 years	6.032*	1.624	21.112
Child 4-12 years	0.791	0.466	1.362	Child 4-12 years	1.181	0.382	3.560
Child 12-18	1.877	1.048	3.430	Child 12-18	1.360	0.371	4.836
Child 18+	0.919	0.469	1.827	Child 18+	0.076*	0.004	0.800
Pre-Existing Health	1.225	0.858	1.764	Pre-Existing Health	1.363	0.636	2.965
Medical Professional	0.993	0.576	1.656	Medical Professional	0.691	0.188	2.395
Dog	1.009	0.547	1.869	Dog	0.194*	0.066	0.521
Cat	0.730	0.399	1.338	Cat	0.491	0.168	1.364
Multiple Pet Types	1.292	0.614	2.696	Multiple Pet Types	5.429	0.799	46.165

Pet as Child	0.810	0.511	1.254	Pet as Child	2.282	0.444	14.479
Ref: 'Never' or 'Less than once per month'				*Ref: 'Never' or 'Less than once per month'*			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	1.039	0.669	1.626	Internet Use Frequency - 'Once per month' or 'more than once per month' (Pet Health)	3.894*	1.540	9.873
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	1.268	0.773	2.096	Internet Use Frequency - 'Once per week' to 'Daily' (Pet Health)	0.659	0.054	5.273
Social Politics	1.217	0.993	1.502	Social Politics	0.989	0.619	1.612
Economic Politics	1.094	0.881	1.346	Economic Politics	1.089	0.658	1.805
Antibiotic Resistance Should be Addressed at the Level of the Individual	1.361	0.873	2.073	Antibiotic Resistance Should be Addressed at the Level of the Individual	1.680	0.591	4.837
Ref: 'About the same'				*Ref: 'About the same'*			
Trust the Internet Much Less than a GP	0.996	0.605	1.613	Trust the Internet Much Less than a Vet	1.593	0.572	4.512
Trust the Internet Slightly Less than a GP	0.887	0.576	1.359	Trust the Internet Slightly Less than a Vet	0.680	0.258	1.782
Trust the Internet Slightly More than a GP	0.913	0.412	1.910	Trust the Internet Slightly More than a Vet	0.526	0.070	3.055
Trust the Internet Much More than a GP	1.544	0.577	4.005	Trust the Internet Much More than a Vet	0.362	0.027	3.141
Agreement/Disagreement with Following Doctors' Prescription Instructions	1.325*	1.135	1.546	Agreement/Disagreement with Following Doctors' Prescription Instructions	1.287	0.853	1.910
Agreement/Disagreement with Following Veterinarians' Prescription Instructions	1.093	0.925	1.279	Agreement/Disagreement with Following Veterinarians' Prescription Instructions	1.011	0.665	1.509
Human Antibiotic Efficacy Score	0.818	0.616	1.077	Human Antibiotic Efficacy Score	1.246	0.627	2.508
Animal Antibiotic Efficacy Score	0.716*	0.541	0.952	Animal Antibiotic Efficacy Score	0.709	0.366	1.408
Interspecies Knowledge	0.928	0.772	1.116	Interspecies Knowledge	1.066	0.694	1.662
Studies Done	0.898	0.740	1.078	Studies Done	1.089	0.675	1.659
Any ACQ Fail	1.021	0.636	1.623	Any ACQ Fail	1.568	0.531	4.598
Random Effects	**Estimate**	**2.5% CI**	**97.5% CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5% CI**
NUTS2 (Sd)	0.22	0.01	0.51	NUTS2 (Sd)	1.02	0.36	1.80
Variance Partition Coefficient	0.01	0.00	0.07	Variance Partition Coefficient	0.24	0.04	0.50

Model 8				Model 9				Model 10			
Doctor Instruction Attitude (n=1030, R^2=0.248, 0.189-0.305)	**OR**	**2.5% CI**	**97.5 % CI**	**Vet Instruction Attitude (n=1030, R^2=0.214, 0.161-0.271)**	**OR**	**2.5% CI**	**97.5 % CI**	**Vet Instruction Attitude (Owners) (n=523, R^2=0.390, 0.298-0.482)**	**OR**	**2.5% CI**	**97.5 % CI**
Fixed Effects				**Fixed Effects**				**Fixed Effects**			
Age	0.837*	0.706	0.995	Age	0.775*	0.647	0.931	Age	0.917	0.688	1.228
Male	1.984*	1.482	2.616	Male	2.472*	1.832	3.360	Male	2.315*	1.423	3.772
Ref: Undergraduate Degree				*Ref: Undergraduate Degree*				*Ref: Undergraduate Degree*			
None of the Above	0.332	0.074	1.158	None of the Above	0.280	0.052	1.117	None of the Above	0.371	0.030	2.397
GCSE	1.046	0.691	1.609	GCSE	1.631*	1.051	2.537	GCSE	1.383	0.700	2.727
A-Level	0.692	0.471	1.011	A-Level	1.004	0.666	1.483	A-Level	0.838	0.447	1.475
Postgraduate	1.272	0.882	1.832	Postgraduate	1.223	0.816	1.809	Postgraduate	0.772	0.393	1.447
Ref: Employed				*Ref: Employed*				*Ref: Employed*			
Not Working	0.875	0.643	1.197	Not Working	0.744	0.526	1.043	Not Working	0.567	0.320	1.009
Self-Employed	0.976	0.585	1.598	Self-Employed	0.877	0.510	1.479	Self-Employed	1.170	0.508	2.579
Ref: Large Urban				*Ref: Large Urban*				*Ref: Large Urban*			
Rural	1.521*	1.004	2.311	Rural	1.613*	1.050	2.448	Rural	2.372*	1.265	4.474
Small Urban	0.759	0.543	1.057	Small Urban	0.856	0.606	1.213	Small Urban	0.753	0.427	1.322
Ref: No Children				*Ref: No Children*				*Ref: No Children*			
Child 0-3 years	0.917	0.475	1.721	Child 0-3 years	1.102	0.581	2.061	Child 0-3 years	1.387	0.484	3.862
Child 4-12 years	1.682*	1.141	2.502	Child 4-12 years	1.366	0.892	2.053	Child 4-12 years	1.363	0.728	2.603
Child 12-18	0.395*	0.217	0.711	Child 12-18	0.654	0.361	1.135	Child 12-18	0.598	0.255	1.393
Child 18+	1.061	0.657	1.731	Child 18+	1.562	0.957	2.594	Child 18+	1.069	0.458	2.362
Pre-Existing Health	0.717*	0.537	0.954	Pre-Existing Health	0.940	0.700	1.269	Pre-Existing Health	0.992	0.621	1.577
Medical Professional	1.596*	1.046	2.447	Medical Professional	1.292	0.843	2.001	Medical Professional	1.294	0.659	2.444

Dog	1.139	0.693	1.888	Dog	0.718	0.425	1.197	Dog	0.808	0.455	1.443
Cat	0.765	0.461	1.259	Cat	0.558*	0.329	0.947	Cat	0.475*	0.262	0.853
Multiple Pet Types	1.172	0.616	2.189	Multiple Pet Types	1.820	0.985	3.367	Multiple Pet Types	1.039	0.405	2.817
Pet as Child	0.949	0.656	1.353	Pet as Child	0.635*	0.436	0.920	Pet as Child	0.374*	0.166	0.885
Ref: 'Never' or 'Less than once per month'				*Ref: 'Never' or 'Less than once per month'*				*Ref: 'Never' or 'Less than once per month'*			
Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	0.991	0.700	1.407	Internet Use Frequency - 'Once per month' or 'more than once per month' (Human Health)	0.920	0.643	1.329	Internet Use Frequency - 'Once per month' or 'more than once per month' (Pet Health)	0.772	0.403	1.438
Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	1.196	0.808	1.792	Internet Use Frequency - 'Once per week' to 'Daily' (Human Health)	1.285	0.840	1.957	Internet Use Frequency - 'Once per week' to 'Daily' (Pet Health)	2.069	0.629	6.549
Social Politics	0.827*	0.702	0.974	Social Politics	0.969	0.816	1.147	Social Politics	0.950	0.728	1.244
Economic Politics	1.179*	1.001	1.389	Economic Politics	1.088	0.916	1.298	Economic Politics	1.155	0.863	1.530
Antibiotic Resistance Should be Addressed at the Level of the Individual	1.015	0.709	1.449	Antibiotic Resistance Should be Addressed at the Level of the Individual	0.906	0.615	1.337	Antibiotic Resistance Should be Addressed at the Level of the Individual	0.649	0.337	1.238
Ref: 'About the same'				*Ref: 'About the same'*				*Ref: 'About the same'*			
Trust the Internet Much Less than a GP	0.604*	0.405	0.895	Trust the Internet Much Less than a GP	0.718	0.479	1.075	Trust the Internet Much Less than a Vet	0.666	0.363	1.220
Trust the Internet Slightly Less than a GP	0.537*	0.380	0.759	Trust the Internet Slightly Less than a GP	0.596*	0.420	0.854	Trust the Internet Slightly Less than a Vet	0.562*	0.310	0.964

Trust the Internet Slightly More than a GP	1.610	0.931	2.796	Trust the Internet Slightly More than a GP	1.363	0.751	2.459	Trust the Internet Slightly More than a Vet	1.857	0.704	4.708
Trust the Internet Much More than a GP	2.911*	1.287	6.695	Trust the Internet Much More than a GP	1.513	0.626	3.491	Trust the Internet Much More than a Vet	6.182*	1.646	22.699
Human Antibiotic Efficacy Score	1.008	0.775	1.313	Human Antibiotic Efficacy Score	1.023	0.787	1.339	Human Antibiotic Efficacy Score	1.418	0.959	2.165
Animal Antibiotic Efficacy Score	0.935	0.728	1.199	Animal Antibiotic Efficacy Score	0.996	0.775	1.288	Animal Antibiotic Efficacy Score	0.814	0.544	1.198
Interspecies Knowledge	0.704*	0.609	0.812	Interspecies Knowledge	0.729*	0.628	0.847	Interspecies Knowledge	0.598*	0.463	0.776
Studies Done	0.989	0.860	1.133	Studies Done	1.034	0.894	1.192	Studies Done	1.071	0.848	1.328
Any ACQ Fail	1.410	0.921	2.109	Any ACQ Fail	1.376	0.909	2.056	Any ACQ Fail	1.410	0.714	2.786
Random Effects	**Estimate**	**2.5% CI**	**97.5 % CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5 % CI**	**Random Effects**	**Estimate**	**2.5% CI**	**97.5 % CI**
NUTS2 (Sd)	0.39	0.14	0.65	NUTS2 (Sd)	0.18	0.01	0.42	NUTS2 (Sd)	0.47	0.06	0.90
VPC	0.04	0.01	0.11	VPC	0.01	0.00	0.05	VPC	0.06	0.00	0.20

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