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Too Far to Care? Examine the Effects of Distance Cues on Antibiotic Abuse Prevention

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Too Far to Care? Examine the Effects of Distance Cues on Antibiotic Abuse Prevention

ZHOU Yuchen

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Philosophy

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August 2024

DECLARATION

I hereby declare that this thesis represents my own work which has been done after registration for the degree of MPhil at Hong Kong Baptist University, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualification.

I have read the Universitry's current research ethic guidelines and accept responsibility for the conduct of the procedures in accordance with the Uninversity's Research Ethics Committee (REC). I have attempted to identify all the risks related to this research that may raise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

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Date: August 2024

Abstract

Antibiotic abuse has long been a public concern, yet there remains a widespread lack of awareness about the associated risks. Considering the crucial role of risk perception in health communication and the growing salience of antibiotic risks, this study employs construal level theory (CLT) to explore how distance cues in health messages affect individuals' antibiotic risk perception and preventive behaviors.

Our first study examined the effectiveness of each distance dimension in the context of antibiotic risk. Through a randomized experiment (n = 305), we found that distance cues significantly affected participants' antibiotic risk perception and preventive behavior intentions. However, the direction and magnitude of these effects varied across dimensions.

The second study delved into the interactions between distance dimensions. In a multi-factor experiment (n = 371), we observed that among the multiple distance dimensions, only hypothetical distance significantly affected perceptions of antibiotic risk. Additionally, there was a marginally significant interactive effect between spatial and temporal distance. When spatial distance was close, closer temporal distance was more effective at promoting risk perception. Conversely, when spatial distance was far, far temporal distance was more effective.

This thesis demonstrates that CLT and the concept of psychological distances are vital theoretical frameworks for understanding antibiotic risk awareness and behavior. However, the impact of distances, whether single-

dimensional or multi-dimensional, varied from the findings of previous studies, underscoring the unique context of antibiotic abuse. Collectively, these findings emphasize the importance of distance-based health messages in promoting the public's risk awareness and promote responsible antibiotic use.

keywords: antibiotic abuse, construal level theory, psychological distance, risk perception

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Chapter 1

Introduction

Antibiotics are seen by many as a powerful panacea capable of saving the lives of millions. However, abuse of antibiotics, which endangers rather than enhances public health, has increasingly become a global issue (Lin et al., 2015). Specifically, increased and indiscriminate use has weakened the healing power of antibiotics mainly because bacterial pathogens tend to develop resistant strains over time (Mobarki et al., 2019). In recent years, the severity of the problem has caught the attention of both medical practitioners and researchers who feel an urgent need to explore effective communication strategies to raise public awareness of antibiotic risks. In this study, we decompose distance cues embedded in publicity messages into several dimensions and observe their distinctive contributions to the promotion of public awareness and preventive behaviors.

Our study is driven by three pivotal factors. Firstly, it seeks to explore the issue of antibiotic abuse through the lens of persuasive health communication. While abusive behaviors have been extensively addressed, prescription drug abuse in the previous literature is often defined as the intentional use of medication with intoxicating effects that are not prescribed by healthcare providers (Compton & Volkow, 2006). This definition largely focuses on addictive drugs like stimulants and painkillers, omitting non-addictive ones, particularly antibiotics.

Health communication scholars have long ignored the abuse of non-addictive prescription drugs, among which antibiotics are a prime example. Since

the discovery of penicillin, various antibiotics have saved the lives of millions. However, the unrestrained abuse of antibiotics has led to the emergence of bacterial strains with multidrug-resistant (MDR) phenotypes, thus diminishing the effectiveness of antibiotics (Mobarki et al., 2019). Treatment of these pathogens has been challenging since the advent of antibiotics (Woodford et al., 2011). For instance, the widespread use of penicillin led to common bacteria like Staphylococcus aureus developing a penicillin-resistant enzyme known as penicillinase (Novick, 1963). Methicillin, as a newly developed semi-synthetic penicillinase-resistant penicillin at that time, initially managed infections caused by Staphylococcus aureus effectively (Castle, 2007). However, shortly after its clinical use, strains of methicillin-resistant Staphylococcus aureus (MRSA) emerged (A. S. Lee et al., 2018). Thus, the evolution of antibiotics has essentially become a battle against drug resistance.

The escalating abuse of antibiotics has accelerated the development of resistance (Austin et al., 1999). Antibiotic resistance is more likely to occur in regions with high antibiotic consumption (Goossens et al., 2005). In some developing countries, the prevalence of antibiotic resistance may exceed 70%, making conventional treatments ineffective against certain diseases (Zaidi et al., 2005).

Although public health scholars have noticed this urgent issue, due to the prescription drug nature of antibiotics, antibiotic abuse has mostly been attributed to the misprescription of healthcare providers (Currie et al., 2014; Wattal et al.,

2017; Zaidi et al., 2005). While the problem is exacerbated by misprescriptions in economically underdeveloped areas, the general population also exhibits high rates of self-medication (Rather et al., 2017). For instance, in some parts of India, more than 70% of people self-prescribe antibiotics for minor health concerns as well as chronic and relapsing diseases (Phalke et al., 2006). This trend is not limited to less educated populations; even well-educated groups, like Chinese college students, frequently opt for self-medication due to a poor understanding of antibiotics (Pan et al., 2012; Zhu et al., 2016). The prevalent self-medication highlights the lack of antibiotic risk awareness among the general public (Bennadi, 2014), underscoring the need to improve awareness of personal risks and preventative measures to combat antibiotic resistance.

Media and effective health communication play essential roles in cultivating public awareness of risks. The public typically gathers information and forms judgments about risks through media consumption (Niu et al., 2022). In the impact of media on individual risk perception, beyond the communication process of media messages, how to design these messages is also a key determinant in shaping individual decision-making and risk assessments (Harrington, 2015). Therefore, our study aims to identify the key elements embedded in the content of health messages that effectively raise public awareness of antibiotic risk and preventive behaviors.

Second, theoretically speaking, this study aims to examine the effectiveness of construal level and psychological distance in the special context

of antibiotic risk. Construal level theory (CLT) and psychological distance are important theoretical frameworks for understanding the public's responses to health risks. Risk is considered a concrete (i.e., low construal level) concept; individuals at a lower construal level tend to perceive risk as being stronger (Liberman et al., 2007). Since distance is the key determinant for construal level, distance cues embedded in health messages can often raise attention and health risk awareness (White et al., 2014), thus commonly used in health messages. However, psychological distance is considered a multidimensional concept (Trope et al., 2007), and the effect of each distance dimension may vary across different contexts. The distance dimensions adopted by previous studies often relate directly to the specific risks under study. For instance, spatial distance is studied in infectious disease risks (Liu et al., 2020; Lu et al., 2022; van Lent et al., 2017), temporal distance in tobacco (Kim & Kim, 2018), alcohol (Gerend & Cullen, 2008), and drug abuse (Qin et al., 2022), and hypothetical distance in chronic diseases (Watve et al., 2020). Each of these health risks presents unique properties and characteristics that could influence the effectiveness of each distance dimension on risk awareness and behavior. Therefore, it is likely that not all distance dimensions can have the same effect on health risk awareness and behavior, and certain distance dimensions may not promote health risk awareness or even produce backfire effects. Overlooking the differential effect across distance dimensions and the contextual difference behind it may render health messages ineffective and potentially harm public health.

Antibiotic abuse represents a unique form of health risk. While it can be classified as a form of drug abuse, its public health hazard is essentially infectious diseases caused by drug-resistant bacteria. Since the effect of CLT and psychological distance have yet to be examined in the context of antibiotic abuse, our study aims to explore which dimension of distance cue is effective in promoting antibiotic risk perception and preventive behavior intention.

Apart from the contextual differences that could alter the effectiveness of distances, we also noticed the gap in the effect of multidimensional distances in previous literature. Despite the established efficacy of distances in health communication, existing studies have predominantly focused on the effect of single-dimensional psychological distance (Griffioen et al., 2016), often assuming that close distance cues universally enhance risk awareness and behavior. The impact of coexisting multidimensional distance cues in persuasive health messages remains an understudied area. In reality, health risks are often complex and diverse, with multiple dimensions of distance coexisting simultaneously. The simultaneous existence of multidimensional distance may affect risk awareness differently. In situations where potential risks exhibit multifaceted characteristics or complexity, individuals' risk assessments may become muddled or biased, leading to underestimating risk and hindering preventive behaviors (Dawson et al., 2017). Such biases may also manifest when multiple dimensions of distance coexist since different dimensions of distances represent different characteristics of risks, such as probability (hypothetical distance) and time (temporal distance)

of occurrence, affected social groups (social distance), and regions (spatial distance). Consequently, individuals' processing of coexisting multidimensional distances has the potential to skew individuals' risk perceptions or even yield counterproductive effects, ultimately undermining the effectiveness of health messages. As a result, the current study also aims to explore the effect of coexisting multidimensional distances on antibiotic risk perception and prevention intention.

In the following chapters, Chapter 2 reviews the previous literature on CLT and proposes the research questions of the current study. Chapter 3 outlines the research design and findings for study 1, which is a single-factor experiment aiming to examine the effectiveness of each distance dimension on antibiotic risk perception and behavior. Chapter 4 conducts a multi-factor experiment to examine the effect of coexisting multidimensional distance on antibiotic risk perception and preventive behavior, as well as potential interaction effects between distances. Finally, Chapter 5 summarizes the findings from two studies and discusses potential implications and limitations.

Chapter 2

Literature Review

2.1 Construal Level and Psychological Distance

CLT posits that the level of abstraction shapes individuals' perception of external objects. A low construal level is characterized as a concrete, unstructured, contextualized representation. At a low construal level, individuals tend to focus

more on the peripheral features of objects. In contrast, a high construal level is abstract and schematic, under which individuals pay more attention to the core features of things (Trope et al., 2007). Previous studies have indicated that individuals' estimates of recent events (i.e., close temporal distance) are more detailed and specific, while those of distant events (i.e., far temporal distance) are more abstract and simple (Liberman et al., 2002). Other studies have also found similar results by comparing self-representations at different time scales. Self-evaluations of distant times tend to be more structured, abstract and complete, while self-evaluations of the present are more specific and tend to change with the current situations (Trope et al., 2007).

Previous studies have indicated the link between construal level and risk perception. Individuals at low construal level exhibit stronger emotional reactions to risk (Lermer et al., 2016), and strong emotional reactions are closely associated with risk perception (Slovic et al., 2004). Additionally, at a high construal level, the likelihood of potential risks, a crucial component of risk perception, tends to be underestimated (Wakslak & Trope, 2009). Consequently, numerous studies have suggested that a high construal level reduces risk perception, whereas a low construal level heightens risk perception (Liberman et al., 2007).

Psychological distance serves as a precursor to individuals’ construal level (Liberman & Trope, 2008). Objects falling outside of an individual's immediate experience are deemed psychologically distant and are thus more likely to be conceptualized at a higher level of abstraction (Liberman et al., 2007). The

distance between external entities and individuals' direct experience encompasses multiple aspects. As such, psychological distance is considered a multidimensional concept, encompassing the perceived temporal, spatial, social, and hypothetical distance (Trope et al., 2007). Given the strong link between psychological distance and construal level, along with the influence of construal level on risk perception, it is generally inferred from existing research that a closer psychological distance enhances risk perception.

Persuasive health messages often incorporate distance cues to heighten the public's awareness of risks. Close temporal frames typically convey a sense of immediacy and threat (Chandran & Menon, 2004). Spatial distance intensifies emotional responses and alters perceptions of risk, such as in measles outbreaks (Yang & McAllister, 2020). Anti-smoking campaigns that depict realistic threats—representing a close hypothetical distance—are often more convincing than those using abstract scenarios (Katz et al., 2020).

2.2 The Effectiveness of Distances in the Context of Antibiotic Risk

Risk perception is the key to health communication, facilitating enhanced interactions among the public, experts, and policymakers. Communicating potential risks boosts risk analysis and policy development, ultimately reducing the potential hazards associated with risks (Slovic, 1987). Moreover, risk perception is a critical factor influencing health behaviors, and interventions targeting it can significantly encourage preventive behaviors against health risks (Slovic, 1987). Essentially, risk perception reflects an individual's subjective

judgment of objective risks. Unlike the risks themselves, the perception of risk is dynamic. These subjective perceptions of risks are often determined by various social, cultural, and situational factors and evolve as the external environment changes (Slovic, 1987). Individuals' perceptions of risks are also diversified, incorporating multiple aspects such as perceived severity, likelihood, and susceptibility (Darker, 2013). These psychological aspects together constitute the public's subjective judgment of risk.

Despite the previous evidence indicating the role of distances in forming health risk perception, the effects of each dimension of distance cues may differ depending on the type of risk. In the case of infectious diseases like Ebola (van Lent et al., 2017) and COVID-19 (Liu et al., 2020; Lu et al., 2022), spatial proximity is crucial in raising public risk awareness due to the higher perceived chance of infection. Conversely, for issues like alcohol abuse (Gerend & Cullen, 2008) and smoking (Kim & Kim, 2018), temporal distance holds more sway in enhancing risk perception, as individuals are more likely to modify their behavior if they recognize the short-term consequences. Each distance dimension is closely related to various aspects of risks, including probability (hypothetical), time (temporal distance), location (spatial distance), and population affected (social distance) in the risk. The public pays attention to different aspects of risks under different contexts, which may explain why only certain dimensions of distance effectively promote risk awareness in a given situation. In other words, in a given context, such as antibiotic abuse, it is likely that only one or some of the distance

dimensions can target aspects of public concern and effectively promote risk awareness. In addition, the nature of risk itself shapes the aspects of public concern (Fellenor et al., 2020). Therefore, we believe that certain dimensions of distance related to the characteristics of antibiotic abuse may be more effective in promoting antibiotic risk awareness.

Antibiotic abuse represents a distinctive form of risk, primarily leading to the development of drug-resistant bacteria (Mobarki et al., 2019). While infections caused by drug-resistant bacteria are the main concern, public perception often equates antibiotic abuse with other drug abuses despite antibiotics lacking addictive properties. This misconception might skew the public's attention away from the true risks of antibiotic misuse. For instance, a worldwide survey conducted by the World Health Organization (2015) found that a large portion of the public believes antibiotic risk only pertains to those who misuse them, not affecting non-abusers. In addition, as a form of prescription drug, unlike other abused drugs, antibiotics do not contain addictive properties. These peculiarities may bias the public's focus on antibiotic-related risks. Thus, the effectiveness of multidimensional distance cues may differ from other health risks. Taken together, we pose the following research question:

RQ 1: In the context of antibiotic risks, which dimensions of distance cues can effectively promote risk perception and preventive behavior?

2.3 The multi-dimensional Effect of Distances

Although the public is more inclined to perceive risks as more serious

when the distance is closer, this observation predominantly stems from studies that manipulate a single dimension of distance within health messages. Less consideration has been given to the effect of coexisting multidimensional distances.

Coexisting multiple dimensions of distance may cause distance to have different effects on risk perception and behavior. First, due to individuals' limited attention, it is likely that only one or a few dimensions of distance can be effective in promoting antibiotic risk perception and preventive behaviors. Multiple dimensions of distance cues often exist simultaneously in health messages. Distances can be regarded as different aspects of potential risks, such as the geographical closeness of the risk (spatial distance), the probability (hypothetical distance), and time (temporal distance) of risk occurrence, and which social individuals or groups are affected (social distance). However, individuals' perception of risk is not a comprehensive but a subjective judgment based on various aspects of the risk (Slovic et al., 2004). A comprehensive assessment of all information related to the potential risk is beyond individuals' attention. This limitation is more prominent in the social media era.

In today's social media-driven landscape, the public frequently turns to online health information to shape their views on health risks. Given the limited span of individual attention, people tend to focus on only a fraction of the extensive content available online (Cohen, 2014). Consequently, the public's risk perception is often shaped by a limited focus on one or a few risk aspects that

capture their concern rather than a comprehensive analysis of all available information. In essence, the general public is more inclined to concentrate on a few primary risk factors while neglecting less immediate ones.

Among the four dimensions of distance, some may be deemed primary for the public, relegating others to a lesser status. One of our previous studies had found a similar result. Spatial proximity represents a higher risk of infection. Therefore, the effect of social distance cues in health-related misinformation is suppressed by spatial distance, and only individuals with spatial proximity are more receptive to the content of misinformation (Zhou et al., 2023). In the context of antibiotic abuse, complexity in individuals' distance-based risk assessment is likely to be especially pronounced due to the complexity of the information involved.

Despite the widespread discussion of antibiotic resistance in academic and medical communities, public awareness of this particular risk remains significantly limited. Faced with the daunting task of understanding and making decisions about such complex and unknown issues as antibiotic risks, individuals often resort to heuristic decision-making strategies. These strategies simplify the cognitive process by relying on the most accessible or intuitive information (Mazzotta & Opaluch, 1995). Consequently, an individual's perception of antibiotic risks may be shaped by a limited number of information and arguments or, in our case, distance cues that seem most immediate or relevant in their personal risk assessment. Hence, although each distance dimension might

individually influence antibiotic risk perception, when they coexist, the impact of distances deemed secondary may be overshadowed by those deemed primary.

Furthermore, individuals' sensitivity to distance may also diminish as the number of distance dimensions increases. Prior research suggests that sensitivity to distance decreases as an object moves further from the observer. The perception of distance from a distal position to a distal position is much less sensitive than a similar change between two proximal positions (Zauberman et al., 2009). The change in distance sensitivity implies that individuals' perception of multidimensional distance might not necessarily be the same as when only a single close dimension exists. (Kim et al., 2008). Consider a scenario where four dimensions of distance coexist and are all relatively close; despite their proximity in each dimension, when combined together, they might be perceived as more distant than only one single dimension exists. As sensitivity to distance decreases with distance, we hypothesize that the perception of distance weakens when multiple dimensions are present simultaneously. In other words, individuals' assessments of potential risks, when based on multidimensional distances, may lack precision due to this diminished distance sensitivity.

To summarize, coexisting multidimensional distances introduce complexity and variability to the effect of distances on risk perception (Huang et al., 2016), especially in the context of antibiotic risk. Due to the weakened perception of distance and limited capacity to process information in such complex risk scenarios, perceptions of antibiotic risk based on distance might vary

when multiple dimensions of distance coexist. When a single-dimensional distance takes priority in risk assessment, it could overshadow the influence of other distances, thereby rendering other dimensions of distance ineffective in curbing antibiotic abuse. We thus pose the following research question:

RQ 2: How does the effect of psychological distance on antibiotic risk perception differ when multiple dimensions coexist?

Chapter 3

Study 1

3.1 Procedure

The purpose of Study 1 is to examine and compare the effects of single-dimensional cue distance on antibiotic risk perception. A post-test only experiment with 2 (hypothetical distance: low/high) + 2 (temporal distance: low/high) + 2 (social distance: low/high) + 2 (spatial distance: low/high) groups was conducted to answer our research questions. Participants were randomly assigned to different groups and were asked to read a public health advertisement about antibiotic abuse. Each participant only received the stimulus of a single-dimensional distance cue. After reading the experiment material, participants completed a questionnaire to measure antibiotic risk perception and preventive behavior intention.

3.2 Participants

Social distance represents the perceived distance in social relationships between an individual and other individuals/groups. When participants come from

different social backgrounds (e.g., social status, occupation, and age), the perceived social distance of each participant is difficult to manipulate. Therefore, in order to diminish the confounding effects of demographic differences among participants, participants with similar geographic locations, occupations, and educational backgrounds were recruited. Thus, in October 2023, we recruited 305 participants from a university in Zhuhai City, Guangdong Province in China. Before the experiment, ethical approval was obtained from the Research Ethics Committee of Hong Kong Baptist University. All participants were 17-28 years old (M = 21.32, SD = 3.24), university students (64.6% undergraduate students and 35.4% postgraduate students), and currently living in the Guangdong Province of Mainland China. Among the participants, 77% were females and 23% were males.

3.3 Stimuli

Eight experiment stimuli were designed to manipulate participants' psychological distance to antibiotic risk. We manipulated participants' psychological distance from antibiotic risks by using various distance cues in health messages, such as the likelihood of the consequences (hypothetical distance), when those consequences will occur (temporal distance), the social groups affected by antibiotic risk (social distance), and the main regions affected by it (spatial distance).

3.3.1 Hypothetical Distance

Hypothetical distance refers to individuals' judgment on the probability

of an event occurring in reality (Todorov et al., 2007). We manipulated hypothetical distance by emphasizing different side effects caused by antibiotic abuse (low or high probability side effects).

3.3.2 Temporal Distance

Temporal distance refers to an individual's subjective judgment of when an event occurs (Liberman & Trope, 1998). Temporal distance represents the time when the antibiotic risk may occur in our study. We manipulated the temporal distance of antibiotic risk by emphasizing the time point of the consequences of antibiotic abuse occurring (short-term risk/long-term risk).

3.3.3 Social Distance

Social distance is the degree of closeness in social relationships with other individuals (Stephan et al., 2011). It refers to individuals' social proximity to victims of antibiotic abuse in the study. Our participants were students from the one university. They were all in their youth (age: M = 21.32, SD = 3.25) and rated their health condition as relatively good (personal health status: M = 3.48, SD = 1.37) on a 7-point scale (1 = very good, 7 = very bad). Therefore, the youth generation should be socially closer to our participants. In addition, the youth generation was known for having a high rate of antibiotic abuse and thus were chosen for close social distance stimuli. Another social group that is well-known to be at risk from antibiotics is people with chronic illnesses. Chronic illnesses, such as cancer, often weaken individuals' immune systems, making them more susceptible to infection, especially from drug-resistant bacteria (Nanayakkara et

al., 2021). For our participants, people with severe diseases should be socially farther away and thus were chosen to act as the remote social distance stimuli. We manipulated social distance by emphasizing the different populations of people who have varying concerns for antibiotic resistance (youth/ rare disease patients).

3.3.4 Spatial Distance

Spatial distance is defined as an individual's perceived geographical distance from other things. Spatial distance refers to the geographical distance between our participants and the region severely affected by antibiotic risk in our study. We manipulated spatial distance by emphasizing the region plagued by antibiotic risk. For example, “Antibiotic resistance kills tens of thousands of people every year at home/abroad.”

3.4 Measures

3.4.1 Risk Perception

The general public's judgment on risk is often diversified. Based on the dimension division proposed by Darker (2013), this study used the following three dimensions: perceived severity, likelihood, and susceptibility as the basis for measuring antibiotic risk perception. The detailed list of items and descriptive statistics can be seen in Appendix 1.

3.4.2 Prevention Behavior Intention

We modified the items of the health behavior intention scale from Zhou et al. (2019) to measure preventive behavior intention. The final scale consisted of six items for intention to prevent antibiotic abuse (e.g., “I will not use antibiotics

as the first choice for the treatment of diseases on my own in the future”). See Appendix 1 for specific measurement contents.

3.5 Manipulation Checks

In our study, the manipulation check process was implemented through a set of four questions designed to measure participants' perceived distances regarding a health issue related to antibiotics. Each type of distance—hypothetical, temporal, social, and spatial—was assessed through specific questions on a five-point Likert scale.

Due to the limited sample size of our study, we employed a relatively lenient criterion for participant selection in the manipulation check. Participants whose manipulation was unsuccessful, who completed the questionnaire in an unusually short amount of time (under 60 seconds), and who consistently selected the same option across most questions were excluded from further data analysis. This approach ensured that our results were not skewed by responses that did not reflect genuine engagement or understanding of the survey questions.

3.5.1 Hypothetical distance

Participants were asked to rate their agreement with the statement, "The probability of encountering health problems related to antibiotics is very small," on a scale from 1 (strongly disagree) to 5 (strongly agree).

3.5.2 Temporal distance

We measured perceived temporal distance by the following question, "How far in time are the health risks associated with antibiotics?" with options

ranging from 1 (very close) to 5(very distant).

3.5.3 Social distance

Social distance was measured by the statement, "The people affected by antibiotic risks are ____ to me," where participants could choose from 1 (very similar) to 5 (very dissimilar).

3.5.4 Spatial distance

Participants evaluated their spatial proximity to the risk through the statement, "The place where I live will be affected by health risks associated with antibiotics," rated from 1 (strongly disagree) to 5 (strongly agree).

3.6 Findings

Since this study employed single-factor experiments, each independent variable had only two levels (close or far), and the dependent variables were all continuous variables, our study used independent sample t-tests to examine the effects of each distance dimension on antibiotic risk perception and preventive behavior intention.

3.6.1 Hypothetical Distance

The results of the independent samples t-test showed that hypothetical distance significantly affected the perceived severity of antibiotic risk ($t = 2.06$, $p < .05$). Compared with far hypothetical distance, participants who received close hypothetical distance stimulus perceived a stronger severity of antibiotic risk (far hypothetical distance group: $M = 4.66$, $SD = .72$; close hypothetical distance group: $M = 4.99$, $SD = .74$). However, hypothetical distance did not significantly

affect perceived susceptibility (t = 1.41, p = .161), likelihood (t = .86, p = .392), and preventive behavior intention (t = -1.07, p = .288) to antibiotic risk.

Table 2

Effect of hypothetical distance on risk perception

Construct	Close distance (n = 43)	Far distance (n = 40)	*t*	*p*
Perceived likelihood	5.76 (.86)	5.61 (.77)	.86	.392
Perceived severity	4.99 (.74)	4.66 (.72)	2.06	.043*
Perceived susceptibility	4.65 (1.15)	4.31 (1.05)	1.41	.161
Preventive behavior intention	5.24 (1.00)	5.48 (.96)	-1.07	.288

Hypothetical distance cues significantly affected the severity dimension of risk perception. Consistent with findings from previous studies (Katz et al., 2020; White et al., 2014), participants in the close hypothetical distance group rated antibiotic risks as severer than those in the far hypothetical distance group. Simply put, hypothetical distance refers to the probability of occurrence of certain things (Todorov et al., 2007). Probability is the primary factor for individuals to judge various health risks (Baillon et al., 2022), including the probability of the risk occurring, the probability of the risk affecting themselves, the probability of handling the consequences of the risk, and other aspects. These are the most essential factors in all types of health risk perception, the effects of which are not expected to vary between contexts. Therefore, our results suggest that hypothetical distance cues can still be effective in influencing the public's perceived severity of antibiotic risk in the context of antibiotic risk.

3.6.2 Temporal Distance

The results of the independent samples t-test showed that temporal

distance significantly affected the perceived likelihood of antibiotic risk (t = -2.77, p < .01). Compared with far temporal distance, participants who received close temporal distance stimulus had a lower level of perceived likelihood of antibiotic risk (far temporal distance group: M = 6.06, SD = .85, close temporal distance group: M = 5.32, SD = 1.12). However, temporal distance did not significantly affect perceived susceptibility (t = -.49, p = .625), severity (t = -1.15, p = .256), and preventive behavior intention (t = -.83, p = .413) to antibiotic risk.

Table 3

Effect of temporal distance on risk perception

Construct	Close distance (n = 31)	Far distance (n = 27)	*t*	*p*
Perceived likelihood	5.32 (1.12)	6.06 (.85)	-2.77	.008**
Perceived severity	4.80 (1.02)	5.10 (.93)	-1.15	.256
Perceived susceptibility	4.29 (1.15)	4.44 (1.23)	-.49	.625
Preventive behavior intention	4.84 (.92)	5.04 (.96)	-.83	.413

In our experiment, temporal distance cues significantly affected risk awareness. Surprisingly, rather than strengthening risk awareness and prevention, close temporal distance weakened the perceived likelihood of antibiotic risk. This result is inconsistent with previous studies related to other types of health risks. It is generally believed that closer time frames of risks are perceived as more specific and threatening (Chandran & Menon, 2004). Therefore, health messages that emphasize short-term risks tend to be more effective in promoting risk awareness and health behaviors (Gerend & Cullen, 2008; Kim & Kim, 2018).

However, the distinct finding of temporal distance cues in this study may be attributed to the specific characteristics of antibiotic risk. The threat of

antibiotic abuse is essentially induced by drug-resistant bacteria. Although the development of drug resistance in some bacteria is tortuous, antibiotic resistance is a process that accumulates over time (Livermore, 2007). In other words, antibiotic risk will inevitably increase over time, and the long-term risk will be far greater than the short-term risk. Therefore, we speculate that this unique characteristic of antibiotic risk caused participants who received far temporal distance stimulus to exhibit a stronger risk perception.

3.6.3 Social Distance

The results of the independent samples t-test showed that social distance significantly affected the perceived severity of antibiotic risk (t = -2.17, p < .05). Compared with far social distance, participants who received close social distance stimulus had a lower level of perceived severity of antibiotic risks (far social distance group: M = 5.15, SD = .83, close social distance group: M = 4.70, SD = .99). In addition, social distance also had a significant effect on antibiotic risk preventive behavior intention (t = 2.92, p < .01). Compared with far social distance, participants received close social distance stimulus had a lower level of preventive behavior intention toward antibiotic risk (far social distance group: M = 5.36, SD = 1.03, close social distance group: M = 4.75, SD = .87). However, social distance did not significantly affect perceived susceptibility (t = -.94, p = .352) and perceived likelihood (t = -1.48, p = .144) of antibiotic risk.

Table 4

Effect of social distance on risk perception

Construct	Close distance (n = 51)	Far distance (n = 33)	*t*	*p*
Perceived likelihood	5.24 (1.30)	5.64 (1.08)	-1.48	.144
Perceived severity	4.70 (.99)	5.15 (.83)	-2.17	.033*
Perceived susceptibility	3.99 (1.11)	4.23 (1.19)	-.94	.352
Preventive behavior intention	4.75 (.87)	5.36 (1.03)	-2.92	.005**

In order to attract the public's attention and promote health behaviors, it is important to make messages more relevant to the target audience by presenting such groups in the health messages (Kreuter & Haughton, 2006). However, we found that compared with health information targeting in-groups, health information targeting out-groups could enhance the perceived severity of and preventive behavior intention toward antibiotic risk. Mixed results exist in studies on the relationship between social distance and risk perception. Some studies indicated that individuals would regard socially closer health problems as high risk (Ahn, 2015; So & Nabi, 2013), which echoes the hypothesis of the pessimistic bias. Individuals with pessimistic bias tend to underestimate the probability of positive outcomes while overestimating the probability of negative outcomes (Mansour et al., 2006). In contrast, others have found that under some circumstances, individuals would regard their own health risk as lower than others (Han et al., 2014; Perloff & Fetzer, 1986; Taylor & Brown, 1988), as the hypothesis of optimistic bias predicts. Optimistic bias causes people to believe that good things are more likely to happen to them than others (Weinstein, 1982). Pertinent to health risk perception, individuals with an optimistic bias tend to underestimate their risks and believe that others are more likely to be affected by health risks than themselves.

Cross-cultural differences may be the explanation for this self-other optimistic bias observed in our result. Collectivism is one of the fundamental values among the Chinese public, with collectivists prioritizing collective and societal goals over individual goals (Triandis, Bontempo, et al., 1988). In other words, collectivists care more about the whole society and the members of it (Hui & Triandis, 1986), whereas individualists tend to be more self-centered (Triandis, Brislin, et al., 1988). Such cultural differences may also affect individuals' judgment of risk. Previous studies on social distance and risk perception have primarily focused on participants from Western countries, where individualistic culture prevails. Westerners are more inclined to focus on things socially closer to themselves (Blum & Goldfarb, 2006). Therefore, the individualistic values may result in their higher attention to socially closer health risks. On the contrary, our participants from mainland China may have prioritized the well-being of society over themselves, resulting in a stronger risk perception when the risk is socially distant. The finding aligns with the collectivist values of Chinese society. Even when health messages indicated that antibiotic risks are more relevant to other social groups, participants still perceived the risks as severe and were willing to take action to reduce them. In summary, our findings suggest that tailoring messages based on group affiliation may be ineffective and even counterproductive in preventing antibiotic abuse when targeting audiences from collectivist societies.

3.6.4 Spatial Distance

The results of the independent samples t-test showed that spatial distance did not significantly affect the perceived likelihood (t = .38, p = .707), severity (t = -.30, p =.769), and susceptibility (t = .56, p < .576) of antibiotic risks, as well as preventive behavior intention (t = 1.30, p < .197).

Table 5

Effect of spatial distance on risk perception

Construct	Close distance (n = 41)	Far distance (n = 39)	*t*	*p*
Perceived likelihood	5.59 (.95)	5.50 (1.08)	.38	.707
Perceived severity	4.85 (.88)	4.91 (.92)	-.30	.769
Perceived susceptibility	4.30 (1.37)	4.14 (1.24)	.56	.576
Preventive behavior intention	5.15 (1.16)	4.84 (.94)	1.30	.197

Unlike many previous studies, spatial distance cues did not significantly affect antibiotic risk perception and prevention. Most previous studies found that spatial distance is an important factor in predicting health risk perception, and closer spatial distance could promote public awareness of health risks. However, these studies often focused on infectious diseases such as Ebola (van Lent et al., 2017) and COVID-19 (Liu et al., 2020; Lu et al., 2022). For infectious diseases, closer spatial distance indicates a higher possibility of infection (Lessler et al., 2016), and the public naturally perceives the risk as more severe if infectious diseases are geographically closer. Although the risks posed by antibiotic abuse are infections caused by drug-resistant bacteria, the public's understanding of them is still similar to drug abuse rather than infectious diseases (World Health Organization, 2015). Most drug abuse problems only affect the health of the abusers and are not as contagious as an infectious disease. Since the risk of drug

abuse is often independent of geographical distance, risk perception could not be affected by spatial distance cues in the context of antibiotic abuse.

3.7 Conclusion

In summary, our initial experiment successfully addressed the first research question, demonstrating that various dimensions of distance cues exhibit distinct influences within this context. Intriguingly, some dimensions of distance even produced opposing effects on perceptions of antibiotic risk and subsequent behaviors. These findings suggest that the effect of distance is not unanimous; rather, the specific characteristics of a risk can influence how each single-dimensional distance impacts risk perception and behavior. However, the potential for varying effects when multiple distance dimensions coexist, as proposed in RQ2, requires further investigation. To address this, Study 2 will examine the effects of coexisting multidimensional distances on antibiotic risk perception and preventive behavior.

Chapter 4

Study 2

4.1 Procedure

The purpose of Study 2 is to examine the effectiveness of coexisting multidimensional distance cues on antibiotic risk perception. Previous studies have indicated a certain degree of connection between social distance construct and other distances, and manipulating other distances would affect individuals' social distance perception (Stephan et al., 2011). Therefore, due to the low degree

of discrimination between social distance manipulation and other distances, this study excludes social distance when examining the possible interaction between multidimensional distances. A post-test only experiment with 2 (hypothetical distance: low/high) × 2 (temporal distance: low/high) × 2 (spatial distance: low/high) groups was conducted to examine the possible interactions between different distance dimensions. Participants were randomly assigned to different groups and were asked to read a public health advertisement about antibiotic abuse. Each participant received the stimuli of three dimensions of distance cue. After reading the experiment material, participants completed a questionnaire to measure antibiotic risk perception and preventive behavior intention.

4.2 Participants

Before the experiment, ethical approval was obtained from the Research Ethics Committee of Hong Kong Baptist University. We disguised the experiment as a survey and distributed it through an online survey platform through Tencent survey. Tencent Survey is a well-known survey platform with more than one million registered users in the sampling pool. The sampling pool contains one million preregistered users from different provinces or autonomous regions of China. We recruited 371 participants from the platform in April 2024. Participants received compensation for participating in the experiment through the Tencent Survey platform. Although we hoped to recruit a representative sample by sampling platforms with users of all ages, the final participants were still mainly young people. Participants of all ages were recruited (M = 26.02, SD = 7.32).

Among the participants, 74.1% were females and 25.9% were males.

4.3 Stimuli

Eight experiment stimuli were designed to manipulate participants' psychological distance to antibiotic risk. We manipulated participants' psychological distance from antibiotic risks by using various distance cues in health messages, such as the likelihood of the consequences (hypothetical distance), when those consequences will occur (temporal distance), and the main regions affected by it (spatial distance). The distance cues adopted in Study 2 were similar to Study 1. However, different dimensions of distance cues were combined to coexist in one single health message.

4.4 Measures

4.4.1 Dependent Variables

The measurements used in Study 2 are consistent with those in Study 1, with minor modifications. Details of the items can be found in Table 6.

4.4.2 Covariates

Apart from the demographics, we also include resistance to persuasion and health status in covariates. Resistance to persuasion can significantly influence individuals' acceptance of health information. Additionally, substance abuse is often more pronounced in individuals with poor health (Montamat & Cusack, 1992; Parry-Jones et al., 2006). Therefore, this study includes the evaluation of their own health status as a covariate affecting antibiotic risk perception and preventive behavior intention. Participants will be asked to rate their health status

over the past year on a 7-point scale (very poor-very good). Details of the items can be found in Table 7.

4.5 Manipulation Check

We used attention check questions to ensure that participants received the experimental stimulus. Participants who answered multiple attention check questions incorrectly, completed the questions in an unreasonably short time, or selected the same answer for most questions were excluded from the data analysis.

4.5.1 Hypothetical Distance

After reading the experiment material, participants were asked to evaluate the probability of antibiotic resistance based on the content of the stimuli (very small, very large, or none at all).

4.5.2 Temporal Distance

After reading the experiment material, participants were asked: On what time scale does the material you read mainly emphasize the dangers of antibiotic resistance (in the next few years or in the next few decades)?

4.5.3 Spatial Distance

After reading the experiment material, participants were asked to choose which region antibiotic resistance mainly affects based on the above information (Mainland China, Latin America, or Europe).

4.6 Result

4.6.1 Regression Analysis

Perceived likelihood was regressed on the three dummy variables (1 =

close distance, 2 = far distance) representing the independent variables along with the covariates (resistance to persuasion and the other four demographics). We observed a negative significant relationship between hypothetical distance and perceived likelihood ($\beta = -.17$, $p < .01$). However, temporal distance ($\beta = .03$, $p = .604$) and spatial distance ($\beta = .04$, $p = .456$) did not have a significant effect on perceived likelihood.

Perceived severity was regressed on the three dummy variables (1 = close distance, 2 = far distance) representing the independent variables along with the covariates (resistance to persuasion and the other four demographics). We observed a negative significant relationship between hypothetical distance and perceived severity ($\beta = -.16$, $p < .01$). However, temporal distance ($\beta = .08$, $p = .132$) and spatial distance ($\beta = .03$, $p = .619$) did not have a significant effect on perceived severity.

Perceived susceptibility was regressed on the three dummy variables (1 = close distance, 2 = far distance) representing the independent variables along with the covariates (resistance to persuasion, health status, and the other four demographics). We observed a negative significant relationship between hypothetical distance and perceived susceptibility ($\beta = -.13$, $p < .05$). However, temporal distance ($\beta = -.01$, $p = .895$) and spatial distance ($\beta = -.01$, $p = .865$) did not have a significant effect on perceived susceptibility.

Preventive behavior intention was regressed on the three dummy variables (1 = close distance, 2 = far distance) representing the independent variables along

with the covariates (resistance to persuasion, health status, and the other four demographics). Hypothetical distance (β = -.04, p = .475), temporal distance (β =.07, p = .160), and spatial distance (β = -.04, p = .443) did not have a significant effect on perceived susceptibility.

4.6.2 Interaction Effect

A 2 × 2 × 2 MANCOVA was conducted to determine the impact of close vs. far hypothetical distance, close vs. far temporal distance, and close vs. far spatial distance along with the covariates on dependent variables (perceived likelihood, perceived severity, perceived susceptibility, preventive behavioral intention), as well as possible interaction effects.

Table 9 shows the obtained multivariate results. The MANCOVA test yielded significant main effects of hypothetical distance on perceived likelihood ($F = 12.24$, $p < .01$), perceived severity ($F = 1.20$, $p < .01$), and perceived susceptibility ($F = 6.59$, $p < .05$). Further, the analysis revealed a marginally significant two-way interaction of temporal distance and spatial distance on perceived likelihood ($F = 3.31$, $p = .070$) and perceived severity ($F = 3.45$, $p = .064$).

When the spatial distance is close, individuals at close temporal distance have stronger perceived likelihood (close temporal distance groups: $M = 5.49$, $SD = 1.03$, far temporal distance groups: $M = 5.35$, $SD = 1.19$) and severity (close temporal distance groups: $M = 5.25$, $SD = .88$, far temporal distance groups: $M = 5.20$, $SD = 1.02$) of antibiotic risks than at far temporal distance. However, when

the spatial distance is far, individuals at far temporal distances have stronger perceived likelihood (close temporal distance groups: M = 5.37, SD = 1.23, far temporal distance groups: M = 5.59, SD = 1.15) and severity (close temporal distance groups: M = 5.09, SD = 1.16, far temporal distance groups: M = 5.38, SD = 1.01) of antibiotic risks than those at close temporal distances. Details of the interaction effect between temporal distance and spatial distance can be found in Table 10. All remaining two-way or three-way interactions were non-significant.

4.7 Discussion

Results from study 2 indicated that coexisting multidimensional distance cues affect antibiotic risk perception differently compared to single-dimensional distances. Furthermore, coexisting distances are ineffective in promoting preventive behaviors.

These results align with our initial speculations, suggesting that only individual dimensions of psychological distance remain effective when multidimensional distances coexist. This result differs from previous research on persuasive cues, which suggested that audiences tend to be persuaded when multiple cues are presented simultaneously (Harkins & Petty, 1981a, 1981b; Johnson & Eagly, 1989). However, some studies have noted that the advantages of multiple cues in persuasion arise only when multiple sources of information are presented together (Harkins & Petty, 1981a). This phenomenon could stem from the individual's limited capacity to process external information. As each new source is introduced, the individual is compelled to engage thoroughly with the

content, meaning, and implications of the cues. Conversely, when additional cues derive from a previously engaged source, less cognitive effort is invested in processing this information since it has already been assimilated (Harkins & Petty, 1981a). Thus, when multiple distance cues come from a single source, extra cues fail to enhance risk perception effectively.

Hypothetical distance, unlike other dimensions, is the only effective dimension of distance, as consistent with our findings from Study 1: When single-dimensional distance stimuli were presented, among the four dimensions, hypothetical distance was the only dimension whose effect size and direction remained consistent in the context of antibiotic risk. This reinforces our earlier interpretation that hypothetical distance (probability) is prioritized in individuals' judgments of risk (Baillon et al., 2022).

The impact of the expression of probability on risk perception is multifaceted. When using probabilities to convey information about potential risks, it is crucial to include a measure of population size and a clear denominator. For instance, in the context of surgical mortality, suitable denominators could be the number of deaths per operating hour, per 100,000 surgeries, or per year. These variations in denominators can significantly alter the representation of probability and, consequently, affect individuals' risk assessments (Adams & Smith, 2001). Additionally, probability can intensify negative emotions, thereby exacerbating pessimistic perceptions of risk (Lee et al., 2019).

To summarize, probability (hypothetical distance) affects risk judgment in

many aspects, giving it a primary role in the individuals' risk assessment process. Given that individuals tend to focus on primary cues while potentially disregarding secondary ones when processing multiple persuasive cues simultaneously (Harkins & Petty, 1981a), hypothetical distance stands out as the dimension significantly impacting risk perception among coexisting multidimensional distances.

The current study also revealed a marginally significant interaction effect between temporal and spatial distance on the perceived severity of antibiotic risk. Specifically, when antibiotic risks are geographically close, close temporal distance (i.e., the risk occurring sooner) promotes risk perception more effectively than far temporal distance (i.e., the risk occurring later). Conversely, when the risks are geographically remote, far temporal distance promotes risk perception more effectively compared to close temporal distance.

This result may stem from the differential effects of time immediacy at different levels of spatial distance. The risk of antibiotics is essentially infectious diseases caused by drug-resistant bacteria. Spatial distance determines the relevance of infectious disease risks to individuals (Amiri et al., 2024; Qian et al., 2009). When the spatial and temporal distances are close, individuals perceive risk as immediate and relevant. However, when the spatial distance is far, the geographical remoteness may imply that the risk is less relevant to individuals. Even if it is imminent, it still occurs in regions that are not directly relevant to themselves. Nevertheless, the risk of drug resistance accumulates over time

(Livermore, 2007). The risks of infectious diseases from drug-resistant bacteria can grow and eventually affect individuals, even if initially distant. Thus, in cases of far spatial distances, far temporal distances can still lead to a stronger risk perception.

At last, our result indicated that coexisting multidimensional distance is ineffective in promoting preventive behaviors. This inefficacy may stem from individuals' lack of subjective norms toward preventive behaviors of antibiotic risk. According to the theory of planned behavior, behavior formation is a combined function of behavioral attitudes, perceived behavioral control, and subjective norms (Conner & Armitage, 1998). In scenarios where subjective norms are absent, individuals may still be reluctant to act despite holding positive health behavior attitudes due to the lack of external regulation, encouragement, and support. The influence of subjective norms is particularly pronounced in behaviors that lack widespread societal recognition (Manning, 2009). For antibiotic risks and preventive behaviors, there is a persistent gap in knowledge and prevalent misconceptions (McCullough et al., 2016), resulting in a lack of social consensus and recognition by the general public. Although distance shaped individuals’ attitudes toward antibiotic risk (i.e., risk perception), the absence of subjective norms leads to the ineffectiveness of coexisting multidimensional distances in promoting preventive behaviors.

The results from Study 1 also appear to support this interpretation. Our previous study identified social distance as the sole dimension capable of

effectively encouraging preventive behaviors. However, we excluded social distance manipulation in Study 2 due to its insufficient discrimination from other distances. In our operationalization, social distance refers to how antibiotic risks affect different societal groups. Experiment results indicated that highlighting the impact on disadvantaged social groups (e.g., rare disease patients) was more effective in enhancing risk awareness and preventive behaviors compared to descriptions focusing on in-groups. This focus on protecting vulnerable groups aligns closely with established social norms and values in Chinese culture (Saunders & He, 2017). Hence, employing social distance cues to emphasize the dangers of antibiotic risks to these groups not only improved attitudes (i.e., risk perceptions) but may also have stimulated normative beliefs toward antibiotic risks among our Chinese participants. In contrast, coexisting hypothetical, temporal, and spatial distance in Study 2 did not resonate with disadvantaged social groups or relate to social norms, thus failing to significantly affect the public's subjective norms or foster preventive behaviors.

Chapter 5

General Discussion

Antibiotic abuse is an important issue that requires urgent attention in health communication. Effective health campaigns are key to increasing public awareness of the risks of antibiotics and mitigating antibiotic abuse. However, inappropriate health message design may not only make health campaigns less effective but even mislead or cause harm to the public (Thamlikitkul, 2006).

Therefore, the present research aims to explore the effectiveness of both single-dimensional and multidimensional distance cues in the context of antibiotic abuse.

Our experiments demonstrate that CLT is an important theoretical framework for understanding and promoting antibiotic risk awareness. In general, we found that both single-dimensional and multidimensional distance cues significantly affected antibiotic risk perception, although there are obvious differences in the effects of distance cues of different dimensions. Furthermore, in terms of preventive behaviors, only the social dimension of distance was effective, and the effect was in the opposite direction as its effect on risk perception.

5.1 Theoretical Implications

Theoretically, departing from the construal level theory, this study depicted a fine-grained picture of how distance cues affect individuals' risk perception of and preventive behavior intention toward antibiotic abuse. Most previous studies only considered the impact of a single dimension of psychological distance on health risk perception (Griffioen et al., 2016) or assumed that closer distance would lead to higher risk perception under all circumstances (Liberman et al., 2007). However, the findings of this study suggest that for antibiotic risks, each dimension of distances has differential effects on risk perception. The directions of effects of some distance dimensions were not as predicted by previous research on other health risks, indicating that the effect of construal level and psychological distance is contingent on the specificities of health risk. Furthermore, the experiment on coexisting multidimensional distance also yielded different results,

as hypothetical distance has been the only distance dimension effective in promoting antibiotic risk perception. Further health communication research should thus take the specific context of health risk and co-existing multi-dimensional distances into consideration when applying CLT as the theoretical framework.

At last, although we operationalized risk perception as a three-dimensional concept, given the main purpose of the study, risk perception was considered a single concept, and we did not discuss the differences in the effect of multidimensional distances on different dimensions of risk perception in detail. However, follow-up research can further expand the effect mechanism by scrutinizing the effects of distance cues on each dimension of risk perception.

5.2 Practical Implications

The findings of this study have practical implications for public health institutions. While distance cues are commonly utilized to promote the public's awareness and preventive behavior toward health risks, the specific characteristics of antibiotic risk should also be considered. Distance cues affected each dimension of risk perception differently, and some distance cues even exhibited opposite effects compared to previous studies. These findings suggest that when designing antibiotic risk prevention campaigns, the configuration of distance cues in health messages should depend on the purpose and target groups of the campaign in order to enhance public awareness of antibiotic risks. Additionally, our results also indicate that the effectiveness of distance cues on preventive

behavior intention is limited. Among the four distance dimensions, only social distance significantly affected preventive behavior intention, indicating the importance of constructing normative social influence in preventing antibiotic abuse.

5.3 Limitations

Our studies have limitations. During study 1, in order to manipulate the social distance variable in a more rigorous way, we recruited participants from the same social group (i.e., college students) in the experiment. Although previous studies have shown that antibiotic abuse among college students is one of the highest in mainland China (Pan et al., 2012; Zhu et al., 2016), including only university students as participants may compromise the external validity of the findings. Extending this research to other social groups could test the robustness of the findings. This issue was also observed in Study 2. Despite the survey platform's sample pool comprising registered users across all age groups and regions, the respondents who actively participated in our survey experiment were predominantly young individuals, which is not entirely representative.

Secondly, due to the low degree of discrimination with other distance dimensions, we excluded social distance manipulation when examining the possible interaction effect. In view of the essential role of social distance on behavior exhibited in the current study, future studies can explore the joint influence and interaction of social distance and other distances on health behaviors.

Furthermore, in order to eliminate the influence of pre-test on participants' post-test answers, our experiment had to adopt a post-test only experiment design. This design cannot take into account the influence of prior exposure to related health messages on participants' antibiotic risk perception. This may also be the reason behind the relatively small effect size exhibited in Study 2. Future research can consider incorporating more factors about media exposure into their measurement.

Finally, due to resource constraints, our study was limited to Chinese participants. Considering the significant role of cultural values in our findings, these results might vary in different cultural contexts. Consequently, exploring the impact of distance in diverse cultural settings represents a valuable direction for future research.

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APPENDICES

Appendix A. TABLES & FIGURES

Table 1

Measurements for Study 1

Variable	Questions	Origin
Perceived severity (Cronbach's α = .727)	I think the infection rate of resistant bacteria is very high. I think the morbidity after infection with drug-resistant bacteria is very high. I think the mortality rate after infection with resistant bacteria is very high. I think antibiotic resistance has a huge impact on society. I think antibiotic resistance has a huge impact on the economy.	Li et al., 2020
Perceived likelihood (Cronbach's α = .757)	I think the chances of antibiotic resistance are high. I think it is very likely that resistant bacteria will emerge.	Weinstein, 2000
Perceived susceptibility (Cronbach's α = .848)	I think I am likely to encounter antibiotic resistance-related health problems. I think I am very likely to be affected by antibiotic resistance. I think I have a high chance of getting a drug-resistant bacteria.	Levkovich & Shinan-Altman, 2021
Prevention behavior intention (Cronbach's α = .796)	I will try not to use antibiotics in the future. I will follow my doctor's prescription for antibiotics. I would consider non-antibiotic anti-inflammatories first. I will actively introduce the dangers of antibiotic resistance to those around me. I would ask people around me to try not to use antibiotics. I would advise people around me to use anti-inflammatory drugs other than antibiotics.	Levkovich & Shinan-Altman, 2021

Table 2

Effect of hypothetical distance on risk perception

Construct	Close distance (n = 43)	Far distance (n = 40)	*t*	*p*
Perceived likelihood	5.76 (.86)	5.61 (.77)	.86	.392
Perceived severity	4.99 (.74)	4.66 (.72)	2.06	.043*
Perceived susceptibility	4.65 (1.15)	4.31 (1.05)	1.41	.161
Preventive behavior intention	5.24 (1.00)	5.48 (.96)	-1.07	.288

Table 3

Effect of temporal distance on risk perception

Construct	Close distance (n = 31)	Far distance (n = 27)	*t*	*p*
Perceived likelihood	5.32 (1.12)	6.06 (.85)	-2.77	.008**
Perceived severity	4.80 (1.02)	5.10 (.93)	-1.15	.256
Perceived susceptibility	4.29 (1.15)	4.44 (1.23)	-.49	.625
Preventive behavior intention	4.84 (.92)	5.04 (.96)	-.83	.413

Table 4

Effect of social distance on risk perception

Construct	Close distance (n = 51)	Far distance (n = 33)	*t*	*p*
Perceived likelihood	5.24 (1.30)	5.64 (1.08)	-1.48	.144
Perceived severity	4.70 (.99)	5.15 (.83)	-2.17	.033*
Perceived susceptibility	3.99 (1.11)	4.23 (1.19)	-.94	.352
Preventive behavior intention	4.75 (.87)	5.36 (1.03)	-2.92	.005**

Table 5

Effect of spatial distance on risk perception

Construct	Close distance (n = 41)	Far distance (n = 39)	*t*	*p*
Perceived likelihood	5.59 (.95)	5.50 (1.08)	.38	.707
Perceived severity	4.85 (.88)	4.91 (.92)	-.30	.769
Perceived susceptibility	4.30 (1.37)	4.14 (1.24)	.56	.576
Preventive behavior intention	5.15 (1.16)	4.84 (.94)	1.30	.197

Table 6

Measurements of Dependent Variables for Study 2

Variable	Questions	Origin
Perceived severity (Cronbach's α = .838)	I think the infection rate of resistant bacteria is very high. I think the morbidity after infection with drug-resistant bacteria is very high. I think the mortality rate after infection with resistant bacteria is very high. I think antibiotic resistance has a huge impact on society. I think antibiotic resistance has a huge impact on the economy.	Li et al., 2020
Perceived likelihood (Cronbach's α = .826)	I think the chances of antibiotic resistance are high. I think it is very likely that resistant bacteria will emerge.	Weinstein, 2000
Perceived susceptibility (Cronbach's α = .883)	I think I am likely to encounter antibiotic resistance-related health problems. I think I am very likely to be affected by antibiotic resistance. I think I have a high chance of getting a drug-resistant bacteria.	Levkovich & Shinan-Altman, 2021
Prevention behavior intention (Cronbach's α = .869)	I will try not to use antibiotics in the future. I will follow my doctor's prescription for antibiotics. I would consider non-antibiotic anti-inflammatories first. I will actively introduce the dangers of antibiotic resistance to those around me. I would ask people around me to try not to use antibiotics. I would ask people around me to follow the doctors' prescriptions for antibiotics. I would advise people around me to use anti-inflammatory drugs other than antibiotics.	Levkovich & Shinan-Altman, 2021

Table 7

Measurements of Covariates for Study 2

Variable	Questions	Origin
Resistance to persuasion (Pearson's r = .509***)	I consider advice from others to be an intrusion. Advice and recommendations usually induce me to do just the opposite.	(Shen & Dillard, 2005)
Health status	Please evaluate your personal health status in the past year.	

Table 8

Effect of multidimensional distances on antibiotic risk perception and preventive behavior intention

	β	95%CI	T	Adjusted R^2
DV: Perceived likelihood, F (9,361) = 2.68, p < .01				.04**
Age	.17**	[.01, .05]	2.88	
Sex	-.03	[-.35, .20]	-.51	
Education	.02	[-.11, .16]	.32	
Income	.01	[-.06, .07]	.16	
Resistance to persuasion	-.03	[-.12, .07]	-.52	
Health status	-.03	[-.14, .08]	-.55	
Hypothetical distance	-.17**	[-.63, -.16]	-3.35	
Temporal distance	.03	[-.17, .29]	.52	
Spatial distance	.04	[-.14, .32]	.75	
DV: Perceived severity, F (9,361) = 3.37, p < .01				.06**
Age	.17**	[.01, .04]	2.96	
Sex	.00	[-.24, .24]	.00	
Education	-.04	[-.17, .07]	-.80	
Income	.09	[-.01, .10]	1.46	
Resistance to persuasion	.03	[-.06, .11]	.61	
Health status	.04	[-.06, .14]	.85	
Hypothetical distance	-.16**	[-.52, -.12]	-3.07	
Temporal distance	.08	[-.05, .37]	1.51	
Spatial distance	.03	[-.15, .26]	.50	
DV: Perceived susceptibility, F (9,361) = 3.60, p < .001				.06
Age	.21***	[.02, .06]	3.54	
Sex	.04	[-.20, .48]	.80	
Education	.05	[-.09, .25]	.98	
Income	-.13*	[-.17, -.01]	-2.15	
Resistance to persuasion	.14**	[.05, .28]	2.77	
Health status	-.07	[-.23, .05]	-1.32	
Hypothetical distance	-.13*	[-.66, -.08]	-2.53	
Temporal distance	-.01	[-.31, .27]	-.13	
Spatial distance	-.01	[-.32, .27]	-.17	
DV: Preventive behavior intention, F (9,361) = 1.62, p = .109				.02
Age	.10	[.00, .03]	1.66	
Sex	.02	[-.20, .31]	.43	
Education	-.01	[-.13, .12]	-.15	
Income	.06	[-.03, .09]	1.00	
Resistance to persuasion	-.05	[-.13, .04]	-.97	
Health status	.11*	[.00, .21]	2.04	
Hypothetical distance	-.04	[-.29, .14]	-.72	
Temporal distance	.07	[-.06, .37]	1.41	
Spatial distance	-.04	[-.30, .13]	-.77	

Table 9

Multivariate results of the 2 (close vs. far hypothetical distance) x 2 (close vs. far temporal distance) x 2 (close vs. far spatial distance) MANCOVA.

IV	DV	Mean square	F	p
Age	Perceived likelihood	11.37	8.98	.003**
	Perceived severity	9.45	9.51	.002**
	Perceived susceptibility	24.92	12.49	.000***
	Preventive behavior intention	3.02	2.78	.096
Sex	Perceived likelihood	.27	.21	.648
	Perceived severity	.00	.00	.968
	Perceived susceptibility	1.44	.72	.397
	Preventive behavior intention	.19	.17	.678
Education	Perceived likelihood	.13	.10	.753
	Perceived severity	.48	.49	.486
	Perceived susceptibility	1.36	.68	.411
	Preventive behavior intention	.00	.00	.956
Income	Perceived likelihood	.00	.00	.963
	Perceived severity	1.74	1.76	.186
	Perceived susceptibility	9.05	4.53	.034*
	Preventive behavior intention	1.01	.93	.337
Resistance to persuasion	Perceived likelihood	.50	.39	.531
	Perceived severity	.24	.24	.624
	Perceived susceptibility	15.18	7.61	.006**
	Preventive behavior intention	1.01	.93	.335
Health status	Perceived likelihood	.26	.21	.651
	Perceived severity	.86	.87	.353
	Perceived susceptibility	3.27	1.64	.202
	Preventive behavior intention	4.46	4.10	.044*
Hypothetical distance	Perceived likelihood	15.50	12.24	.001**
	Perceived severity	1.13	1.20	.002**
	Perceived susceptibility	13.16	6.59	.011*
	Preventive behavior intention	.54	.50	.481
Temporal distance	Perceived likelihood	.39	.31	.579
	Perceived severity	2.43	2.45	.119
	Perceived susceptibility	.05	.03	.871
	Preventive behavior intention	2.17	2.00	.159
Spatial distance	Perceived likelihood	.89	.70	.402
	Perceived severity	.29	.29	.591
	Perceived susceptibility	.01	.01	.942
	Preventive behavior intention	.72	.66	.416

Hypothetical distance * Temporal distance	Perceived likelihood	1.27	1.00	.318
	Perceived severity	.02	.02	.888
	Perceived susceptibility	3.76	1.88	.171
	Preventive behavior intention	.52	.48	.489
Hypothetical distance * Spatial distance	Perceived likelihood	.30	.24	.628
	Perceived severity	.49	.49	.485
	Perceived susceptibility	.51	.25	.615
	Preventive behavior intention	.00	.00	.993
Temporal distance * Spatial distance	Perceived likelihood	4.19	3.31	.070
	Perceived severity	3.42	3.45	.064
	Perceived susceptibility	.06	.03	.863
	Preventive behavior intention	.01	.00	.947
Hypothetical distance * Temporal distance * Spatial distance	Perceived likelihood	.33	.26	.613
	Perceived severity	.79	.79	.374
	Perceived susceptibility	.52	.26	.610
	Preventive behavior intention	.36	.33	.568

Table 10

Univariate results of the 2 (close vs. far hypothetical distance) x 2 (close vs. far temporal distance) x 2 (close vs. far spatial distance) MANCOVA for all four dependent variables

	Hypothetical distance				Temporal distance				
DV	M close	M far	F	η_p^2	M close	M far	F	η_p^2	M close
Per. likelihood	5.64 (1.07)	5.26 (1.20)	12.24**	.03	5.43 (1.13)	5.47 (1.17)	.31	.00	5.43 (1.11)
Per. severity	5.37 (1.00)	5.07 (1.03)	1.2**	.03	5.16 (1.03)	5.28 (1.02)	2.45	.01	5.22 (.95)
Per. susceptibility	4.64 (1.38)	4.29 (1.51)	6.59*	.02	4.48 (1.43)	4.45 (1.49)	.03	.00	4.50 (1.43)
Beh. intention	5.66 (1.08)	5.60 (1.01)	.50	.00	5.57 (1.15)	5.70 (.92)	2.00	.01	5.69 (.98)

	Interaction Temporal distance x Spatial distance			
	M close T close S	M far T close S	M close T far S	M far T far S
Per. likelihood	5.49 (1.03)	5.35 (1.19)	5.37 (1.23)	5.59 (1.15)
Per. severity	5.25 (.88)	5.20 (1.02)	5.09 (1.16)	5.38 (1.01)
Per. susceptibility	4.52(1.34)	4.49 (1.52)	4.44 (1.51)	4.41 (1.46)
Beh. intention	5.62(1.04)	5.76(.92)	5.53 (1.23)	5.62 (.93)

Figure 1

Stimuli 1A for Study 1: Close Hypothetical Distance

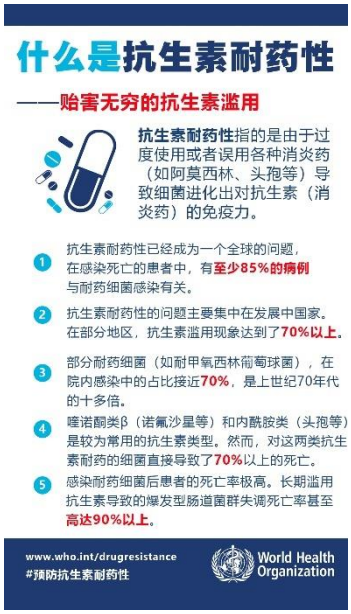


Figure 2

Stimuli 1B for Study 1: Far Hypothetical Distance

Figure 3

Stimuli 2A for Study 1: Close Temporal Distance

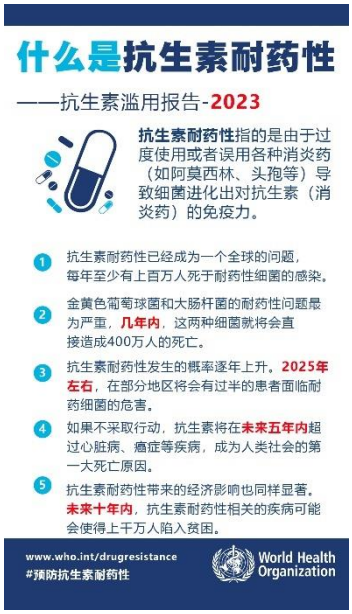


Figure 4

Stimuli 2B for Study 1: Far Temporal Distance

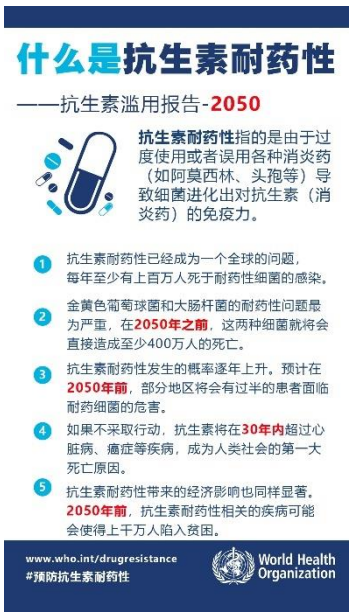


Figure 5

Stimuli 3A for Study 1: Close Social Distance

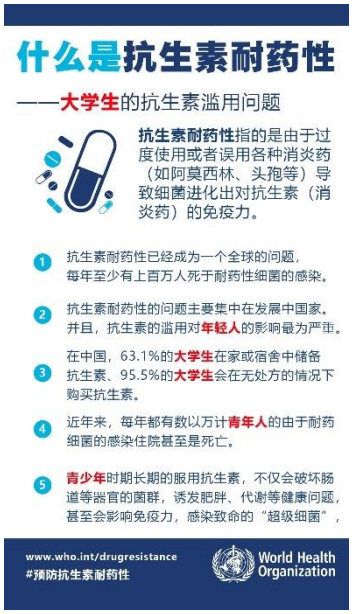


Figure 6

Stimuli 3B for Study 1: Far Social Distance

Figure 7

Stimuli 4A for Study 1: Close Spatial Distance

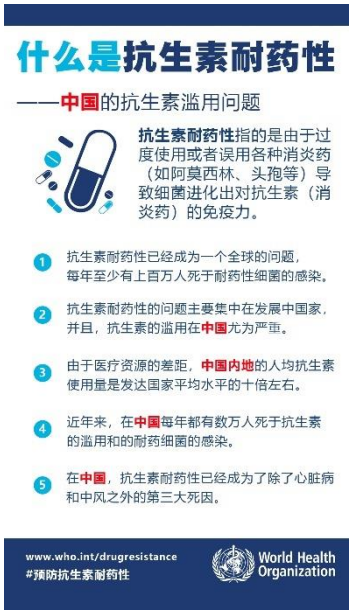


Figure 8

Stimuli 4B for Study 1: Far Spatial Distance

Figure 9

Stimuli 1 for Study 2: Close Hypothetical Distance-Close Temporal Distance-Close Spatial Distance

Figure 10

Stimuli 2 for Study 2: Close Hypothetical Distance-Far Temporal Distance-Close Spatial Distance

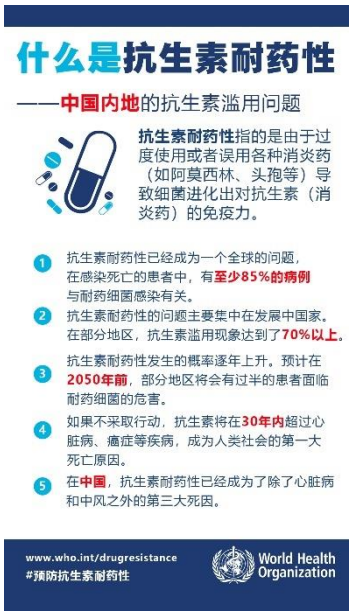


Figure 11

Stimuli 3 for Study 2: Close Hypothetical Distance-Close Temporal Distance-Far Spatial Distance

Figure 12

Stimuli 4 for Study 2: Close Hypothetical Distance-Far Temporal Distance-Far Spatial Distance

Figure 13

Stimuli 5 for Study 2: Far Hypothetical Distance- Close Temporal Distance-Close Spatial Distance

Figure 14

Stimuli 6 for Study 2: Far Hypothetical Distance- Far Temporal Distance-Close Spatial Distance

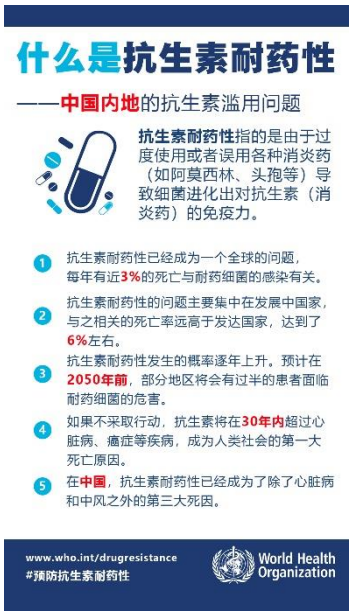


Figure 15

Stimuli 7 for Study 2: Far Hypothetical Distance-Close Temporal Distance-Far Spatial Distance

Figure 16

Stimuli 8 for Study 2: Far Hypothetical Distance-Far Temporal Distance-Far Spatial Distance

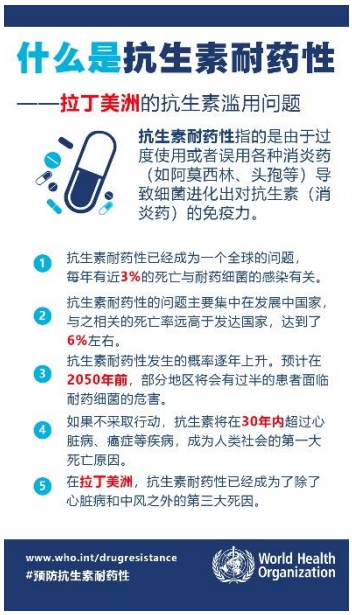


Figure 17

Interaction between temporal distance and spatial distance on perceived likelihood

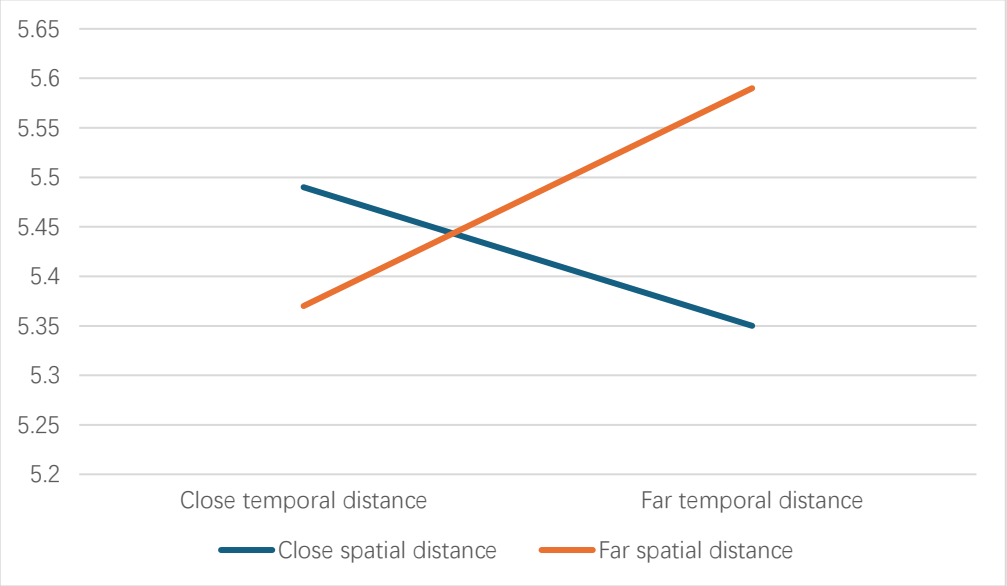
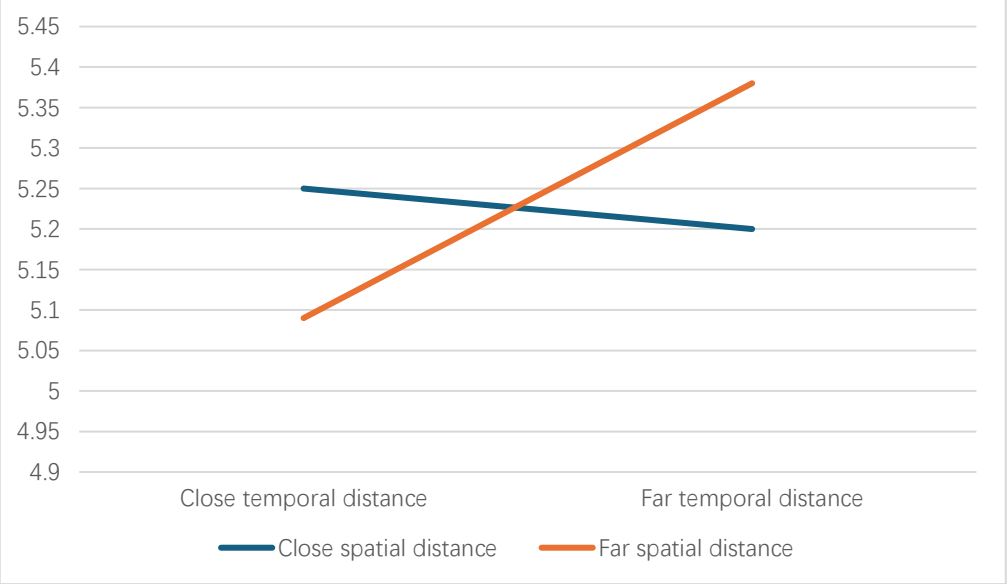


Figure 18

Interaction between temporal distance and spatial distance on perceived severity



CURRICULUM VITAE

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August 2024