An examination of the influence of threat on judgments of contaminant spread

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Psychology)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

May 2013

Abstract

Concern about the spread of infectious agents and associated washing and avoidance behaviour varies widely across individuals. Extremes on either end of the spectrum can have negative consequences: overconcern can lead to undue distress and excessive cautionary behaviour and underconcern can lead to the contraction and spread of disease. The purpose of this series of four studies was to examine variables that contribute to individual differences in judgments of contaminant spread. Specifically, I examined whether threat influenced judgments of spread.

Studies 1 and 2 were conducted with a general (unselected) sample of participants recruited from a university campus (*N* = 75 and *N* = 77 respectively), while Studies 3 and 4 extended the research to two specific populations of interest (49 nursing students in Study 3 and 21 participants with contamination-related OCD in Study 4). Participants were randomly assigned to judge the spread of either a: threatening contaminant (disease-causing bacteria), non-threatening contaminant (harmless bacteria) or non-contaminant (vegetable juice in Study 1, yogurt containing probiotic bacteria in Studies 2, 3 and 4). To ensure participants' safety, these substances were not actually present—rather participants were led to believe that one of these substances was placed on a cutting board and then spread to a series of objects.

Findings varied depending on the specific facet of spread examined and the population under study. Among the general university sample and participants with OCD, identification as a contaminant increased judgments of physical spread, but threat did not. Among nursing students, there was a trend for threat to increase judgments of physical spread. With regard to danger along the chain of contagion, threat increased danger ratings for the general university sample and nursing students, but not for participants with OCD. Rather, the OCD group viewed danger as elevated along the chain of contagion for both contaminants. Threat also increased avoidance for the general university sample and nursing students, but not the OCD group. Participants with OCD tended to engage in high levels of avoidance regardless of which condition they were in. Discussion focuses on the studies' implications for understanding fear of contamination and hygiene behaviour.

Preface

This research was approved by the University of British Columbia Behavioural Research Ethics Board (UBC BREB number: H09-02887), as well as the British Columbia Institute of Technology Research Ethics Board (approval number: 2011-03).

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Acknowledgments

There are many people to whom I am extremely grateful for their help and support on this project. I would like to thank my supervisor, Sheila Woody, for her strong support and guidance throughout my studies. I would also like to thank the members of my supervisory committee, Mark Schaller and Anita DeLongis, for their helpful feedback and suggestions. I am also very grateful to the faculty and staff at the schools of nursing at UBC and BCIT, who made it possible to extend this research beyond the psychology department and who acted from a truly interdisciplinary spirit. I would also like to thank the research assistants who assisted with data collection for these studies, as well as all of the research participants, without whom this research would not have been possible. Last, but certainly not least, I would like to thank my incredibly supportive family, friends and Bogdan for their encouragement, help and laughter.

Chapter 1: Introduction

1.1 Introduction

Bacteria and viruses have been around longer than the human race, and although some live symbiotically in the human body, others can lead to illness or death. Humans have therefore had to deal with the potential for contracting infectious diseases since their beginning and have evolved mechanisms and behaviours in order to manage this threat. For example, the body's immune system evolved to protect itself from parasites that invade the body. Another example is hygiene behaviours (behaviours aimed at reducing the risk of being infected by parasites). Humans have engaged in hygiene behaviours throughout much of their history. Artifacts from early human civilizations suggest that Neanderthals may have removed facial hair, perhaps to remove facial parasites, and that civilizations dating back as early as 3000 BC used grooming implements and built latrines (Curtis, 2007). There are also examples of hygiene behaviour in some animals. Many mammals and birds groom to remove parasites, and within a colony of ants, certain ants have the task of cleaning the nest and removing dead ants (Curtis, 2007). These observations suggest perhaps an instinctual component to hygiene behaviour. One can see how hygiene behaviour would have been selected for through the course of evolution: animals or people who could avoid becoming contaminated by harmful microorganisms or substances would have been more likely to survive and reproduce (Curtis, 2007). In humans, the emotion of disgust may have evolved to motivate humans to avoid disease (Curtis, 2007; Matchett & Davey, 1991; Oaten, Stevenson, & Case, 2009).

However, hygiene behaviour in humans is complex and influenced by beliefs about the transmission of disease, as well as by social and cultural influences and by habits. Throughout history, people have developed various theories to explain the transmission of disease and these beliefs can have an important impact on hygiene behavior and health status. The idea that diseases could be spread by microscopic organisms that carry diseases, *germ theory*, only became accepted and widespread in the latter half of the 19th century. Prior to that, for nearly 2000 years, miasma theory, the idea that diseases spread through bad air or vapours was commonly accepted (Curtis, 2007). The relatively recent acceptance of germ theory has had a considerable impact on medicine, hygiene practices and health status in the Western world (Pittet, Allegranzi, & Sax, 2007).

Infectious diseases are still a real threat to human health and survival. Infectious diseases are the most common cause of death globally and the 3rd most common cause of death in North America (World Health Organization, WHO, as cited in Sattan, Tetro & Springthorpe, 1999; estimates include AIDS). Although some estimate that the rate of infectious diseases will decrease over the next 20 years (WHO, 2008), others point to factors that may lead to increasing rates of infectious diseases such as increasing population density, greater movement and travel, increasing numbers of immunosuppressed populations (e.g., people living with AIDS or undergoing chemotherapy) and the problem of microorganisms developing antibiotic resistance (Sattan et al., 1999). Therefore, it is still important to understand people's beliefs about infectious diseases and related behaviours. Of particular interest to the present series of studies are people's judgments of the spread of contamination, such as germs.

1.2 Variability and Uncertainty Inherent in Threat of Contamination

Although contracting an infectious disease is a significant health threat, assessing the level of threat in any given situation can be extremely difficult. There is a great deal of variability and uncertainty with respect to an infectious agent's (bacterium, virus, fungus or parasite) pathogenicity (the ability of the microorganism to induce disease, including the severity of the disease and the ability of the microorganism to invade tissue), infective dose (quantity of agent necessary to cause infection), infectivity (ability to spread from a source to a host), and ability to survive outside the source (Ostrovsky, 2007). Hepatitis B, for example, can remain viable for 7 days on an inanimate surface at room temperature (Bond et al, 1981), whereas respiratory syncytial virus survives several hours (Ostrovsky, 2007). There is also variability in the modes of transmission, with some infectious agents being transmitted through direct or indirect contact, while others are transmitted via droplets (sneezes or coughs), through the air, through a common-vehicle (food, water, medication), or through vectors (such as mosquitoes, flies or rats; Ostrovsky, 2007).

Furthermore, there is variability with respect to how susceptible different people are to contracting diseases, depending, for example, on age and immune system (Ostrovsky, 2007). There is even evidence that people may differ with respect to how easily they pick up infectious agents. For example, Rheinbaben, Schunemann, Groß and Wolf (2000) found that people varied in terms of how contaminated their hands became after touching a contaminated doorknob and these differences could not be accounted for by behavioural differences. Environmental factors can also modulate the activity of the infectious agent, its transmission or the host/recipient. Humidity, for example, can affect replication of the infectious agent, while dryness can decrease the ability of a person's mucous membranes to protect against microbial invasion (Ostrovsky, 2007). The greater a person's understanding of the various factors involved in the transmission of an infectious agent and the variables that modulate it, the better able that person should be to determine effective and appropriate ways of controlling and preventing transmission. However, there is still much that is unknown, and the variability can be overwhelming and confusing to a person trying to assess the level of contamination in any particular situation.

1.3 Variability in the Fear of Contamination and Associated Behaviour

Not surprisingly, people vary in their degree of concern about the spread of infectious agents and in their associated washing and avoidance behaviour. Some people are not sufficiently aware of the possibility of contagion or do not engage in sufficient washing. Many public health campaigns aim to educate people about contagion and to promote effective preventative behaviours. For example, in low-income countries, diarrheal disease and acute respiratory infections are the leading causes of childhood mortality (Black, Morris, & Bryce, 2003), yet their transmission can be prevented by washing hands with soap and water (Curtis & Cairncross, 2003; Ryan et al., 2001). As such, campaigns have been developed to target handwashing with soap in these countries (Scott et al., 2008). Even among health care workers, compliance with hand hygiene procedures has been found to be unacceptably poor with an average adherence rate of 38.7 % (WHO, 2009). Therefore, strategies have been developed to improve hand hygiene behaviour within this population in order to reduce the incidence of nosocomial infections (infections that either patients acquire while receiving treatment for another condition or that health care workers acquire while working within a health care setting; WHO, 2009). Strategies have included education, as well as the introduction of handrub dispensers throughout the health care setting and at points of care (Pittet et al., 2007).

On the other end of the spectrum, however, are those who are excessively concerned with contamination and engage in excessive washing behaviour. For example, approximately 50% of patients with Obsessive-Compulsive Disorder (OCD) report excessive contamination concerns and washing behaviour (Rachman & Hodgson, 1980; Rasmussen & Eisen, 1992;

Summerfeldt et al., 1997). The anxiety and fear brought on by these concerns and the time and effort required to carry out the washing behaviour can lead to significant disruptions in social and occupational functioning and can therefore be quite debilitating.

At times, the general population can develop excessive concerns or even panic about a particular infectious disease and engage in excessive and maladaptive behaviours. For example, during the SARS epidemic in 2002-3, there was a great deal of anxiety about contracting the disease. While some people engaged in adaptive behaviours that were recommended by the Centre of Disease Control, others engaged in ineffective behaviours (such as avoiding people with cold symptoms, health care workers or people of certain nationality or recent travel history; Lee-Baggley et al., 2004), which had unnecessary negative social and economic consequences (Smith, 2006). Furthermore, some everyday behaviours aimed at reducing risk of contagion, such as the use of antibiotic soaps, can have unintended negative consequences, such as antibiotic resistance. In recognition of this, a campaign has recently been developed, the "Do bugs need drugs" campaign, to educate people about the overuse of antibiotics and antibacterial soaps and their role in engendering antibiotic resistance (www.dobugsneeddrugs.org). Thus, although the threat of spreading contamination is real and people must learn to manage it, these concerns can sometimes become inflated and the behaviours aimed at reducing them can be excessive and misguided.

Thus, there is great variability in concerns about contamination and associated precautionary behaviour (e.g., washing and avoidance). Either extreme is associated with negative outcomes. Being insufficiently cautious can lead to the contraction of (and further spread of) disease. Being overly cautious can lead to negative emotional, social and economic consequences and may facilitate the development of antibiotic resistant pathogens. The aim of the present series of studies is to better understand variability in concern about contamination and associated behaviour. More specifically, this series of studies will extend previous research by exploring variables that influence judgments of how easily contamination spreads.

1.4 Fear of Contamination Defined

The fear of contamination has been defined as the fear of being "polluted or infected or endangered as a result of contact, direct or indirect, with a person/place/object that is perceived to be soiled, impure, infectious or harmful" (Rachman, 2004, p. 1229). Feared consequences of contamination include harm to one's physical, mental or social well-being (Rachman, 2004; Woody & Teachman, 2000). For example, individuals may worry about contracting an illness, losing emotional control, or repulsing others by their state of contamination. Furthermore, while some people may worry about becoming contaminated themselves, others may worry about spreading the contamination to others (e.g., loved ones or people under their care).

One of the unique aspects of contamination fear is the ability of the threat (contaminant) to spread. As noted above, there is a concern that the feared contaminant will come into contact with other objects or people, and, in so doing, pass along some of its negative properties, such that the previously neutral object or person becomes contaminated. Although spread is an important aspect of the threat and fear in contamination, little is known about people's subjective judgments of spread or what contributes to variability in these judgments. The purpose of this paper is to begin to try to answer this question.

1.5 Objective Spread

Objectively, contamination can spread to various objects and surfaces. However, as noted earlier, there is a great deal of variability in the modes of, and ease of, transmission and therefore a considerable amount of uncertainty in the degree of contaminant spread in any specific situation (Ostrovsky, 2007). Studies have shown, for example, how germs can spread from one object in the home to a series of other objects and people. Rheinbaben et al. (2000) looked at the spread of viruses through direct and indirect contact. They contaminated a doorknob with a virus and then had 14 different people touch it. All 14 subjects showed evidence of contamination, although the degree of contamination tended to decrease over successive people. They conducted a similar test, but had the 14 people touch another person's finger that had been contaminated by the virus, rather than the doorknob. They found similar results except the degree of spread was not as strong as with the doorknob. They also examined *vertical transmission*. They contaminated person 1. Person 1 then touched person 2, who in turn touched person 3, etc. They found that the contaminant transferred to the 5th person when there was a 15 minute pause between each contact, and transferred to the 6th person when there was only a 1 minute pause between each contact. They also contaminated the doorknob, and had 4 participants touch it and then proceed to touch various other objects in the apartment. Although the number of objects subsequently contaminated varied across participants, in one participant, the virus was found on up to 9 other surfaces. This study demonstrates how infectious agents can be spread around a household setting. Similar studies have examined how microorganisms from contaminated food can spread to various surfaces around a kitchen (Meredith, Lewis, & Haslum, 2001).

Rheinbaben et al. (2000) and Meredith et al. (2001) did not examine whether participants became ill as a result of contact with the contaminated objects. Other research has, however, found evidence that people can become ill as a result of contact with an object previously contaminated by someone else. For example, Hall and Douglas (1981; as cited in

Hall, 1982) found evidence of direct and indirect transmission of respiratory syncytial virus (RSV). Volunteers were divided into three groups: one group cuddled an RSV infected infant, another group touched various objects in the infant's room while the infant was out of the room, and a third group sat in the room at a distance from the infant and without touching anything in the room. The researchers found that volunteers who cuddled the infant and those who touched the objects in the room were more likely to become infected with RSV than those who sat in the room without touching any objects. The findings suggest that some germs, such as RSV, can be transmitted not only through direct contact with an infected person, but also through indirect contact (contacting objects previously contaminated by that person's germs).

1.6 Subjective Judgments of Spread

There is also variability in subjective judgments of spread: while some people have tendency to view contaminants as spreading exceedingly easily, others have insufficient appreciation for spread. For example, people with contamination-related OCD have been found to have excessive judgments of spread (Tolin, Worhunsky, & Maltby, 2004). OCD is a psychological disorder characterized by recurrent obsessions and/or compulsions. Obsessions are intrusive thoughts, images or impulses that are experienced as unwanted and inappropriate, yet recognized as a product of the person's own mind (First, 2000). Compulsions are repetitive behaviours or mental acts (e.g., repeating in one's mind, counting) performed in order to reduce anxiety and distress, usually in response to an obsession (First, 2000). To be considered clinically significant, the obsessions and compulsions must cause the individual significant distress and interfere with his or her life (First, 2000). The specific content of a person's obsessions and compulsions varies. Approximately 50 % of OCD patients report obsessions related to contamination and compulsions of excessive washing (First, 2000). Other themes of OCD include doubting about whether an action was performed and compulsive checking, needing to have things in a particular order or arrangement, and unwanted aggressive impulses (First, 2000).

Although most people recognize that, as a substance is spread from one object to another, the level of contamination decreases, people with contamination-related OCD tend to judge the level of contamination as remaining high (Tolin et al., 2004). Tolin et al. (2004) developed an interesting methodology to examine this phenomenon empirically. They recruited people with contamination-related OCD, an anxious control group consisting of people with panic disorder and a non-clinical control group. They first asked each participant to identify the most contaminated object or person in the building. The researchers then took a brand new, clean pencil, rubbed it on the object identified by the participant as most contaminated and asked the participant to rate how contaminated the pencil was. The experimenter then took a second brand new pencil, rubbed it against the first pencil and asked the participant to rate how contaminated the second pencil was. They then took a third pencil, rubbed it against the second pencil and continued in this way until they reached 12 pencils. Tolin et al. (2004) found that, although the anxious and non-anxious controls recognized that the level of contamination decreased across successive pencils (i.e., across successive points of removal from the source), the participants with OCD rated the level of contamination as remaining consistently elevated. Thus, participants with contamination-related OCD tended to perceive a persistent chain of contagion, meaning that, as the substance was spread from one object to another along the chain of contagion, they tended to view the level of contamination as non-degrading. Interestingly, this effect was specific to contaminants. When participants were asked to make judgments about the spread of a piece of candy, there were no differences between participants with or without OCD; all rated the level of candy as decreasing across successive points of removal from the source.

Why people with OCD view contaminants as spreading more persistently is not known. It is an important question, however. The view of contamination as spreading easily, rapidly and widely can lead to a rapidly expanding area of threat and rapidly decreasing number of safe areas. As a result, more and more places are avoided or endured with distress, significantly interfering with a person's functioning (Rachman, 2006).

Not much is known about how most people in the general population make judgments about contaminant spread. In the Tolin et al. (2004) study, non-anxious control participants evidenced a fairly rapid decrease in their ratings of contamination. Some studies within the health psychology area have assessed beliefs about spread, although these studies have tended to focus on knowledge of specific health threats rather than broader judgments about spread. For example, during the SARS epidemic in 2003, several studies were conducted that assessed people's knowledge of the modes by which SARS is transmitted and what kinds of precautionary behaviours were appropriate or being used (Blendon, Benson, DesRoches, Raleigh, & Taylor-Clark, 2004; Leung et al., 2003). However, again, the focus was on a specific health threat and its modes of transmission, rather than beliefs about the ease of spread more generally.

Although judgments of contaminant spread among the general population are not well understood, public health campaigns that increase people's appreciation for spread have been shown to be effective at increasing handwashing behaviour. For example, the Global Public-Private Partnership for Handwashing with Soap (GPPPHS) is an organization comprised of government agencies, academics and the private sector (soap manufacturers, marketing agencies) whose goal is to find the most effective ways of promoting handwashing with soap. This organization has conducted studies in numerous countries, such as Ghana, Peru, Madagascar and others. Through qualitative studies, they first asked people (mostly mothers) what motivates them to wash their hands. Participants cited a number of motivators for handwashing, such as disgust, fear of contamination, wanting to care for their children, social acceptance and wanting to be seen as clean. Participants also noted that one of the barriers to handwashing was the lack of sensory cues of contamination on hands (Curtis, Garbrah-Aidoo, & Scott, 2007). The GPPPHS then developed campaigns that tried to tap into these motivators and overcome the barrier. For example, in Ghana, they launched a campaign that included public service announcements (PSA) on television and radio, as well as other community events and activities. The televised PSA featured a mother and her children. The mother is preparing dinner, and takes a break to use the washroom. She does not wash her hands afterward, and a digitalized purple stain appears on her hand. Everything she touches thereafter, including the food she is preparing for her family, becomes marked with the purple stain. The ad closes with one of her children about to eat food with a purple stain on it. The ad is meant to make contamination visible, appeal to mothers wanting to care for their children and to evoke a disgust response. An evaluation conducted one year after the Ghana campaign was launched found that handwashing had increased by 13% after using the toilet and 41% before eating (Curtis et al., 2007). Although the study was not a tightly controlled experiment, the findings suggest that making the spread of contamination visible, appealing to mothers' desires to care for their children and evoking disgust can increase handwashing.

1.7 Variables associated with fear of contamination

Judgments of contaminant spread are relevant both to understanding OCD and to public health. An important question is what variables lead to greater judgments of spread. Understanding what increases judgments of spread may provide insight into the cognitive mechanisms that lead to excessive judgments of spread in OCD, as well as ways in which public health campaigns can be improved to better people's appreciation for spread. Before addressing this question, however, it is useful to first consider variables that have been associated with contamination fear more generally. This question can be approached from two perspectives: the clinical psychology perspective with the goal of understanding excessive contamination concerns seen in obsessive-compulsive disorder and the health psychology perspective focusing on understanding the general population's response to health threats and adoption of hygiene behaviours.

Cognitive theories of emotion focus on the role of appraisals (i.e., subjective evaluations of a stimulus or situation) in evoking specific emotions. Cognitive theories of anxiety disorders, including OCD, hold that appraisals of threat play an important role in the development and maintenance of anxiety disorders (Barlow, 2004). Carr (1974) postulated that overestimation of threat plays a key role in OCD, evoking anxiety which the person then tries to reduce by engaging in compulsions that are believed to reduce the likelihood of the perceived danger occurring. "In the case of compulsive handwashing, this unfavorable outcome is one of contamination and by treating those areas of the body that are thought to be at risk in a specific manner and specific order, the person can be sure that they have all been treated appropriately and none has been overlooked" (Carr, 1974, p. 316). Foa and Kozak (1986) noted that people with OCD tend to view situations as dangerous until proven safe, making their beliefs about harm resistant to disconfirming evidence (e.g., “just because I did not get sick after touching those 100 cancer patients, does not mean cancer is not contagious”). People with OCD have been found to overestimate threat (Obsessive Compulsive Cognitions Working Group; OCCWG, 2005) and this appears to be particularly true in regard to threats related to the content of their obsessions and compulsions, as well as to their personal sense of vulnerability to harm (Moritz & Jelinek, 2009). Salkovskis (1985) further argued that an inflated sense of responsibility for preventing harm (to one’s self or someone else) is central to understanding OCD.

Other beliefs have also been implicated in OCD. The OCCWG is an international group of researchers that formed in order to better understand cognition in OCD. They outlined six belief domains implicated in OCD: overestimation of threat, inflated responsibility, over-importance of thoughts, need to control thoughts, intolerance of uncertainty and perfectionism (OCCWG, 1997). Factor analysis on a questionnaire measure developed to assess these 6 domains found that they tend to fall into three subscales: 1) inflated responsibility/overestimation of threat, which represents a person’s belief that they are personally responsible for bringing about or preventing negative outcomes and a tendency to exaggerate the probability or severity of negative outcomes; 2) perfectionism/intolerance of uncertainty, which represents a person’s belief that it is desirable and possible to do things perfectly, that even minor mistakes are unacceptable, and that certainty is desirable and possible, and that one copes poorly with unpredictable change or ambiguous situations; and 3) importance/control of thoughts, which captures a person’s belief that the presence of a thought means it is important and that it is possible and desirable to control one’s thoughts (OCCWG, 2005). In a large scale questionnaire study, Taylor et al. (2010) found that the Overestimation of Threat/Inflated Responsibility dimension was the only of these subscales that predicted all subtypes of OCD symptoms (i.e., washing, checking, ordering, etc).

Focusing more specifically on contamination concerns and washing compulsions, Jones and Menzies (1997) examined the association between various proposed cognitive vulnerability factors (e.g., perfectionism, danger expectancies, self-efficacy and perceived responsibility) and emotional and behavioural responses to a contamination exposure task among participants with contamination-related OCD. They found that appraisals of threat were most strongly associated with anxiety, urge to wash, time spent in contact with the contaminant and time spent washing afterward. Other cognitive variables were only weakly and mostly non-significantly associated with these outcomes. This group of researchers holds that danger expectancies play a key role in contamination-related OCD (Jones & Krochmalik, 2003). Rachman (2006) similarly holds that appraisals of threat are central to contamination fear. He furthermore notes that the perceived threat may involve threat to one's physical, social or emotional well-being. There is evidence to suggest that threat appraisals play a causal role in distress and washing behaviour. Manipulating threat has been shown to decrease time spent touching a contaminant and increase time spent washing afterward within a non-clinical sample (Jones & Menzies, 1998) and appraisals of danger have been found to prospectively predict behavioural avoidance and disgust in response to a contaminant (Dorfan & Woody, 2011).

Recent research has also explored the role of disgust in contamination fear. Disgust, in its most basic form, has been defined as "revulsion at the prospect of (oral) incorporation of an offensive object" (Rozin & Fallon, 1987, p. 23) and has been conceptualized as an adaptive emotion that evolved to help motivate humans to avoid disease (Curtis, 2007; Matchett & Davey, 1991; Oaten, Stevenson, & Case, 2009). Disgust sensitivity is a person's tendency to respond with disgust to a variety of stimuli. Numerous studies have shown that people who score higher on self-report measures of disgust sensitivity also tend to report greater fear of contamination (Mancini, Gragnani, & D'Olimpio, 2001; Thorpe, Patel, & Simonds, 2003; Tsao & McKay, 2004). Woody and Teachman (2000) hold that the fear of contamination represents the intersection between disgust and fear, noting that although people may feel disgusted by a range of stimuli, they only become anxious and afraid when they perceive a threat of contamination. Cisler, Brady, Olatunji and Lohr (2010) hold that disgust interacts with obsessive beliefs (particularly overestimation of threat) to motivate compulsive washing and avoidance. More specifically, they suggest that disgust is associated with appraisals focusing on the possibility of contamination and that people with a higher propensity to feel disgusted will experience contamination-related appraisals more frequently. How people respond to those contamination-related appraisals will then be influenced by obsessive beliefs (e.g., whether the individual overestimates the threat associated with, or the importance of, these appraisals).

There is also some research suggesting that disgust and anxiety may be differentially related to different types of contamination threats. There have been mixed findings as to whether standard treatment for contamination fear (exposure and response prevention) addresses disgust to the same extent as it does anxiety. Two studies found that, during habituation, disgust decreased to a lesser extent than did anxiety (Adams, Willems, & Bridges, 2011; Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009) while another study found no such difference (Cougle, Wolitzky-Taylor, Lee, & Telch, 2007). Interestingly, findings from the Cougle et al. (2007) study suggest that the discrepancy may depend on the feared consequences of contamination. Cougle et al. (2007) found no significant difference in decline in slope during habituation for anxiety versus disgust. However, they found that, for participants whose fear of contamination was primarily related to a fear of becoming ill, decline in anxiety significantly predicted decline in urge to wash ratings. On the other hand, for participants whose fear of contamination was related to other fears (e.g., becoming overwhelmed by feelings of disgust or anxiety), decline in disgust significantly predicted decline in urge to wash. It should be noted, however, that although participants in these three studies had elevated OCD symptoms, the samples were non-clinical. Nonetheless, the findings are consistent with theories suggesting that disgust plays a role in contamination fear and suggest interesting relationships with the type of threat feared.

Looming vulnerability refers to the perception or appraisal that a threatening stimulus is rapidly spreading, approaching or increasing in speed, as opposed to remaining static (Riskind, Abreu, Strauss, & Holt, 1997). Riskind and colleagues have proposed that looming vulnerability is a cognitive vulnerability factor for a number of anxiety disorders, including contamination fear. People with elevated fear of contamination tend to endorse greater looming appraisals of contamination (Elwood, Riskind, & Olatunji, 2011; Tolin et al., 2004; Riskind, Abreu, Strauss, & Holt, 1997). Furthermore, when people are instructed to imagine a contaminant as looming (advancing, spreading and increasing in strength), as opposed to remaining static, they tend to experience greater worry and urge to wash (Riskind, Wheeler, & Picerno, 1997) and less habituation (Dorfan & Woody, 2006).

From a health psychology perspective, many theories, although not addressing contamination concerns or hygiene behaviours specifically, have noted the importance of threat appraisals in motivating health behaviours. The idea that people's beliefs about the likelihood and severity of harm influence their motivation to engage in a health behavior is a component of numerous health behaviour models (Weinstein, 1993), such as the Health Belief

Model (Rosenstock, 1974), Protection-Motivation Theory (Rogers, 1975) and Parallel Process Model (Witte, 1992). The impact of threat appraisals on health behaviour has received considerable research interest, although methodological issues and the broad array of health behaviours examined have led to mixed results regarding the strength of this relationship (Brewer et al. 2007). With regard to contamination concerns, there is evidence to support a relationship between perceived threat and the adoption of safe food handling practices (Hanson & Benedict, 2002; Schafer, Schafer, Bultena, & Hoiberg, 1993), although not all studies have replicated this finding (McArthur, Hobert, & Forsythe, 2009).

1.8 Variables that influence judgments of spread

The previously described study by Tolin et al. (2004) that compared people with OCD to those without the disorder examined whether looming vulnerability accounted for the excessive judgments of spread among people with OCD. They found that when looming vulnerability was included as a covariate in their analyses, differences in the chain of contagion between the OCD group and the control groups were no longer significant. The authors suggested that looming vulnerability may be a cognitive mechanism behind the chain of contagion. However, one of the challenges of this interpretation is that there is considerable conceptual overlap between looming vulnerability and judgments of spread. Both involve perceiving or appraising a stimulus as spreading and moving. The looming of contamination measure is composed of the following three items: “How slow or fast do you feel the contamination could spread in this situation? To what extent does the contamination seem to be rapidly approaching moment-by-moment? Does the speed with which contamination is spreading seem constant or does it seem to be accelerating and speeding up?” (Riskind, Abreu et al., 1997). There is much similarity between these items and judgments of spread.

Furthermore, although looming vulnerability was measured before chain of contagion was measured, neither was manipulated making it difficult to draw conclusions about the direction of this relationship. It is possible, for example, that participants' tendency to perceive a longer chain of contagion led them to believe that contamination was spreading, moving and increasing, rather than vice versa.

Cisler et al. (2011) found that disgust propensity (the general ease or frequency with which an individual experiences disgust) and difficulty disengaging attention from disgust cues was associated with elevated judgments of spread. The study was conducted among a non-clinical sample of university undergraduates and they used the same chain of contagion task as Tolin et al. (2004). However, instead of having participants choose a contaminant, Cisler et al (2011) presented everyone with a bedpan filled with apple juice and dog hair and proceeded to spread that substance to a series of pencils. They found that disgust propensity predicted participants' ratings of how contaminated the first pencil was and the decline in contamination ratings across pencils, while delayed disengaging from disgust cues at 500 ms (as measured using a spatial cueing task) predicted sustained elevations of contamination ratings along the chain of contagion. Difficulty disengaging attention from disgust cues at 100 ms and from fear cues at 100 and 500 ms were not related to contamination ratings along the chain of contagion. Cisler et al. (2011) therefore suggest that disgust propensity and difficulty disengaging from disgust cues contribute to elevations in judgments of contaminant spread. It should be noted, however, that the substance used to investigate the chain of contagion in the Cisler et al. (2011) study was a disgusting, but not necessarily threatening, stimulus, which may explain the relationship with disgust. Furthermore, the study was correlational in nature making it unclear whether disgust propensity or difficulty disengaging attention from disgust cues play a causal role in judgments of spread.

To further advance research in this area, experimental studies are needed in order to determine the cognitive or affective factors that causally contribute to elevated judgments of spread. The purpose of this series of studies was to begin such an investigation. Although there are many candidate variables to consider, given the centrality of threat to cognitive models of contamination fear, I chose to focus on threat.

Objectively, there should be no causal relationship between how dangerous a substance is to one's health and the ease with which it spreads. However, there are various ways in which threat appraisals may contribute to greater judgments of spread. First, threat may elicit a cognitive bias that influences people's judgments of spread. Previous research has found that presenting people with a threatening or anxiety-provoking stimulus can bias their interpretations of subsequent stimuli (even unrelated stimuli), such that they appraise them as more threatening (Davey, Bickerstaffe, & MacDonald, 2006; Mathews & Mackintosh, 2000; Salemink, van den Hout, & Kindt, 2007). Following this line of reasoning, presenting people with a contaminant that is dangerous to their health may bias their interpretation of other qualities of that contaminant, such that they appraise it as spreading more easily. Second, previous research has also found that fear can evoke perceptual distortions. Intense fear has been shown to be associated with perceptual distortions of movement in spiders and snakes (Rachman & Cuk, 1992) and perceptions of increased height or slope (Stefanucci, Proffitt, Clore, & Parekh, 2008; Teachman, Stefanucci, Clerkin, Cody, & Proffitt, 2008). Following this line of reasoning, fear brought about by a threatening contaminant may lead to perceptual distortions of germ movement or of enhanced transmission, leading to judgments of greater spread. Thus, these theories might suggest that threat leads to judgments of greater spread.

There are reasons, however, to hypothesize that threat would not be associated with judgments of spread. As noted previously, there is great variability in the degree to which substances spread and many environmental factors can influence spread in any given situation. Logically, there is no reason why a threatening contaminant would spread more than a non-threatening contaminant if all other properties are equal. Thus, threat may have no influence on people's judgments of spread. On the other hand, it is possible that while people might not judge a substance to physically spread more, that they judge even small quantities of it as dangerous. Thus, even if they do not view the physical amount of the substance as spreading more, that they judge objects further along the chain of contagion as contaminated because even small quantities of it are seen as dangerous.

Four experimental studies were conducted in order to examine whether threat influences people's judgments of contaminant spread. Studies 1 and 2 were conducted within a general university sample, while Study 3 examined this hypothesis with a sample of nursing students and Study 4 within a sample of people with contamination-related OCD. These studies and their findings are described in the chapters that follow.

Chapter 2: Studies 1 and 2 (General UBC Sample)

2.1 Study 1

2.1.1 Introduction. The purpose of Study 1 was to examine whether threat influences people's judgments of contaminant spread. More specifically, the study manipulated threat information and examined whether this would increase judgments of spread. The method of assessing spread that I used was similar to, and built upon, the method developed by Tolin et al. (2004). However, the present study extended previous research by addressing important questions that had remained unanswered.

First, given that the purpose of the study was to examine whether threat increases judgments of spread, it was important to manipulate threat information, while holding other properties of the substances constant. Tolin et al. (2004) had employed an idiographic approach whereby participants chose the contaminant themselves—each participant was asked to identify the most contaminating object or person in the building. However, in my study, participants were provided with a description of a substance whose degree of spread they were to judge. Although idiographic approaches certainly have their strengths, especially in studying contamination fear where there is variability in the kinds of substances people find contaminating, I chose to provide participants with a substance in order be able to manipulate threat while controlling for other qualities of the substance. The present study also controlled for any visible cues of contaminant spread by only having participants judge the spread of substances that would not be visible to the naked eye. In many situations where judgments of spread need to be made (for example in the spread of germs around a kitchen or in a hospital), there are no reliable visible indicators of the level of contamination present. In order to ensure that no visible cues were present in this study, none of the described substances were actually present in the experimental setting—rather participants were led to believe that a particular substance had been placed on a cutting board, but the cutting board was in fact clean. It also made it possible to have participants make judgments about disease-causing bacteria without placing them at any actual risk of harm. As described in the method section, special care was taken to ensure that the scenario appeared believable to participants.

Second, one of the questions that arose from previous research was whether greater judgments of spread were due to greater judgments of how much the substance physically spread or to a tendency to rate even small amounts of a substance as contaminating. Tolin et al. (2004) asked participants to rate how *contaminated* each pencil was. However, this rating is rather ambiguous: it is not clear whether the rating refers to the amount of the substance or the level of danger or both. It is possible, for example, that participants with OCD did not judge the amount of the substance as remaining high at further points of removal from the original source, but rather that even small amounts of it were deemed dangerous and therefore their ratings of contamination did not decrease. The present study therefore sought to separate judgments of physical spread from danger by asking participants to rate each separately. Furthermore, in order to facilitate comparison of judgments across substances, questions were formulated in such a way that they could be answered by participants in all experimental conditions. Tolin et al. (2004) asked participants slightly different questions in each condition: in the experimental condition, participants rated how contaminated each pencil was, while in the control condition, wherein the contaminant was replaced with a piece of candy, participants rated "how much candy was transferred". Having these different questions made it difficult to interpret the meaning of differences between the two conditions. In my study, therefore, I sought to formulate questions such that they could be answered by participants in all three experimental conditions.

Third, one of the outcomes of interest to clinicians and public health officials is actual behaviour. To clinicians, excessive safety behaviours, such as washing and avoidance, can be an important indicator of severity, functional disturbance and clinical significance. To public health officials, behaviour is crucial to prevent the spread of disease. This study therefore included measures of behavioural avoidance at various points along the chain of contagion.

2.1.2 Method

2.1.2.1 Research design. To assess my hypothesis that threat would increase judgments of contaminant spread, a between-subjects experimental study was conducted with three conditions. Participants were randomly assigned to assess the spread of either a (a) threatening contaminant, (b) harmless contaminant or (c) non-contaminant. As noted earlier, a contaminant is something that renders another object, person or place “soiled, impure, infectious or harmful” (Rachman, 2006). In this study, the role of threat on participants’ judgments of spread was explored within a food preparation context. A food preparation context was chosen for several reasons: (a) it is a context where issues of contamination often arise and to which most people can relate, (b) it allowed for a plausible cover story, (c) it evokes thoughts of possibly ingesting the substances and therefore is capable of eliciting a strong emotional response, and (d) it allowed for the inclusion of behavioural avoidance tasks. Given this food preparation context, non-contaminants were safe food substances, whereas contaminants were non-food substances (bacteria that were either harmless or that caused food poisoning-like symptoms). In order to ensure participants’ safety, none of the three substances were actually used—rather participants were led to believe that one of these substances had been placed on a cutting board and then spread to a series of drinking straws. Drinking straws were used (rather than pencils as in Tolin et al., 2004) in order to facilitate participants' ability to imagine ingesting the purported substance and to allow for behavioural avoidance tests within the food preparation context.

2.1.2.2 Participants. Seventy-five people participated in this study. Participants were recruited by means of the Psychology Subject Pool, as well as by posters placed at various locations on the University of British Columbia (UBC) campus. Advertisements for the study described it as a study on hygiene and safety in the kitchen, and more specifically an examination of people's beliefs about the effectiveness of different cleaning methods. The reason for advertising the study as such, rather than as a study on contaminant spread, was to reduce the likelihood that participants would guess our hypotheses and that this would bias their responses. Participants did, however, receive an accurate description of the study procedures before consenting to participate. In order to be eligible to participate, participants had to be fluent in English given that the language in the questionnaires required a good grasp of the English language. People who were interested in participating in the study either contacted the lab to schedule an appointment or scheduled an appointment online through the UBC Psychology Research Participation System (UBC's website for the Psychology Subject Pool).

Participants' mean age was 22.57 years old (SD = 4.66), and most were students (n = 65, 87 %). Twenty-six participants (35 %) worked part-time and eleven (15 %) worked full-time (more than 30 hours per week). There were more women (n = 55, 73 %) than men (n = 20, 27 %). Most participants were either of Asian (45 %) or of European (37 %) origin. The remaining 17 % were of Indian, African, Hispanic, Native Canadian, Middle Eastern or mixed ethnic origin.

2.1.2.3 Materials. Several self-report questionnaires (demographics, Padua Inventory and Obsessive Beliefs Questionnaire) were included in order to assess the sample's general level of concern with contamination and to ensure that participants did not differ across conditions on traits associated with contamination concerns.

2.1.2.3.1 Demographic information. Participants were asked to provide basic demographic information, such as their age, gender, and cultural background, on a self-report form designed for this study.

2.1.2.3.2 Contamination fear and washing behaviour. Individual differences in contamination fear and washing behaviour were assessed using the contamination subscale of the Padua Inventory (PI). The PI is a 39-item self-report questionnaire designed to assess OCD symptoms. Participants rate their agreement with each statement on a scale from 0 (*not at all*) to 4 (*very much*). The PI includes five subscales assessing obsessional thoughts of harm, obsessional impulses of harming, contamination, checking, and dressing/grooming. Although there are several measures of OCD symptoms, the PI was chosen because it contains that largest contamination subscale (containing 10 items), which was the main interest in the present study, and it has been shown to have good psychometric properties. Factor analyses support the distinction among the five subscales. The contamination subscale has been shown to have good internal consistency (coefficient $\alpha = .85$) and test-retest reliability (r across 6-7 months is .72), as has the whole scale (coefficient $\alpha = .92$ and test-retest $r = 76$). The PI has also been shown to have good discriminant validity from measures of general worry (Burns, Keortge, Formea, & Sternberger, 1996). Burns et al (1996) found the mean for the contamination subscale to be 6.54 ($SD = 5.53$) in a normative sample and 13.87 ($SD = 7.96$) in a sample of OCD patients. The means for the whole scale were 21.78 ($SD = 16.33$) in the normative sample and 54.93 (*SD* = 16.72) in the clinical sample. Although for the purposes of this study I was primarily interested in the contamination subscale, participants completed the whole questionnaire.

2.1.2.3.3 OCD-related beliefs. The Obsessive-Beliefs Questionnaire (OBQ) is a 44-item self-report questionnaire designed to measure beliefs that are thought to be integral to the development and maintenance of OCD. It was developed by the OCCWG to assess 6 different belief domains: inflated responsibility, overimportance of thoughts, need to control thoughts, overestimation of threat, intolerance of uncertainty and perfectionism (OCCWG, 1997). Factor analysis has indicated that these 6 domains tend to fall into three subscales: 1) inflated responsibility/overestimation of threat, 2) perfectionism/intolerance of uncertainty and 3) importance/control of thoughts (OCCWG, 2005). The OBQ has been shown to have good internal consistency (α for the three subscales range from .89 to .95), and good convergent validity, correlating with measures of OCD symptoms (OCCWG, 2005).

2.1.2.3.4 Appraisal of threat. In order to ensure that the manipulation was effective in influencing participants' appraisals of how threatening the substance on the cutting board was, three questions assessing appraisals of threat were included in the Pre-Washing Rating Form. These questions asked participants to rate how safe/dangerous the substance was, how likely it was to make them sick and how serious that illness would be. Each of these questions was rated on a scale from 0 (*Not at all*) to 100 (*Extremely dangerous/likely/serious*). Since coefficient alpha for the three items was high at .91, a composite threat appraisal score was calculated by averaging participants' scores on these three items.

Furthermore, participants' emotional response to the manipulation was also explored. Participants were asked to rate how anxious and how disgusted they felt, each on a scale from 0 (*Not at all*) to 100 (*Extremely*).

2.1.2.3.5 Judgments of spread. As described in the procedure below, the experimenter spread the substance from the cutting board to a series of straws. For each straw, participants were asked to rate: "How much of the substance from the cutting board is on it" on a scale from 0 (*None*) to 100 (*Covered by it*), "How safe/dangerous it would be to use the straw" on a scale from 0 (*Safe*) to 100 (*Extremely dangerous*), and "Would you be willing to use the straw" on a scale from 0 (*No*) to 100 (*Definitely would use*). For the purpose of analyses and to facilitate interpretation, participants' ratings on willingness to use were reversed, such that higher scores came to indicate greater avoidance. This reversed score is referred to as *reluctance to use* throughout this document. Thus, in our analyses, higher scores on each of these three questions indicate judgments of greater contamination.

2.1.2.4 Procedure. The study was conducted in the Kenny Psychology Building at UBC. Special care was taken to ensure that the room where the experiment was conducted was set up in a way that would make it believable that real bacteria were present. Pilot work was done in order to help refine the set-up and procedure to make it more believable. In keeping with regulations present in microbiology laboratories, the experimenter wore a white lab coat throughout the experiment, if her hair was long, it was tied back and she was not permitted to wear dangling jewelry or open-toed shoes. When touching the cutting board and going through the procedure to assess spread, the experimenter wore disposable latex or vinyl gloves. Tables were covered with a layer of plastic and then an absorbent paper layer on top, to present a clean surface and to give the impression that any spills could be contained. A black circle was drawn on the cutting board to indicate where the substances were purportedly placed and this area was covered by a glass plate. Cutting boards were then kept in a Ziploc bag on a metal trolley.

Upon arrival at the laboratory, participants heard the cover story indicating that the purpose of the study was to examine how people think about hygiene and safety in the kitchen, and more specifically to examine beliefs about the efficacy of different cleaning methods. As noted earlier, the reason for presenting the study in this context was to reduce the likelihood of participant bias. The study consisted of two components: the questionnaire package and the experimental task assessing judgments of spread. The order in which participants completed the questionnaires and experimental procedures were counterbalanced, such that half the participants completed the questionnaires first, while the other half completed the experimental task first. The questionnaire package included the demographics form, the Padua Inventory and the Obsessive Beliefs Questionnaire.

The experimental task assessed participants' judgments of spread. Participants were randomly assigned to one of three conditions: (a) threatening contaminant, (b) harmless contaminant or (c) non-contaminant. In each of these conditions, participants were presented with a cutting board (which was actually new and clean) and told that it had one of three substances on it. In the threatening contaminant condition, participants were told that the cutting board had been brought to a food microbiology lab at UBC and that bacteria had been placed on it. The bacteria were described as causing temporary food poisoning-type symptoms. Furthermore a picture of the fictional bacteria was provided (in actuality, it was a picture of E. coli bacteria taken using an electron microscope). In the harmless contaminant condition, participants were again told that the cutting board had been brought to a food microbiology lab at UBC and that bacteria had been placed on it. However, in this condition, participants were told that the bacteria were harmless, safe to ingest and did not cause illness. They were shown the same picture as participants in the threatening contaminant condition. In the non-contaminant condition, participants were told that a research assistant had cut celery on the cutting board and that it had celery juice on it. Participants were told about the health benefits of eating celery and were shown a picture of celery cells taken using an electron microscope. A verbatim script of what participants were told is provided in Appendix A.

Following this manipulation, participants were then asked to complete the manipulation check, which included questions assessing participants' appraisals of how threatening the substance was, their emotional response to it, as well as filler questions that were included to cue participants to imagine interacting or ingesting the substance (e.g., asking about their willingness to eat off of the cutting board and how good/bad the substance would taste).

Participants in each condition then made judgments regarding the spread of the substance on the cutting board. To assess spread, the experimenter took a new clean drinking straw and rubbed it over the area of the cutting board that was purportedly contaminated (this area was demarcated by a black circle). Participants were then asked to complete the first three questions on the Spread Rating Form, which asked them to rate whether any of the substance from the cutting board was on *Straw 1*, how safe/dangerous it would be to use Straw 1 and whether they would be willing to use Straw 1. Participants were told that we were not asking them to actually use Straw 1 right now, but simply to imagine whether they would be willing to do so. The experimenter then took a second straw and rubbed it over Straw 1. Participants were then asked to answer the same three questions with respect to Straw 2 (i.e., how much of the substance from the cutting board is on Straw 2, how safe/dangerous it would be to use

Straw 2 and whether they would be willing to use Straw 2). Straw 1 was then placed in an empty glass labeled *1*. The experimenter then took a third straw and rubbed it over Straw 2. Participants were then asked to answer the same three questions with respect to Straw 3. Straw 2 was then placed in another empty glass labeled *2*. The experimenter then took a fourth straw and rubbed it over Straw 3. This same process was repeated, with participants rating each straw, until 20 straws were used.

Participants were then asked whether they would be willing to touch any of the straws with their hand. They were reminded (as they were informed of this during consent) that if they did decide to touch any of the straws, that it is our policy that we would ask them to wash their hands afterward. Antibacterial hand sanitizer and wet wipes were available in the laboratory. Beginning at the 20th straw, the experimenter asked the participant if they would be willing to touch it. If they said *yes*, then they were asked whether they would be willing to touch the 19th straw, then 18th, etc. until either they indicated they are not willing to touch the straw or until they reached Straw 1. If a participant said *no* to a straw, they would be asked to touch the last straw to which they said *yes* and not asked about any remaining straws in that set. For example, if a participant said *yes* to the 20th, 19th, 18th and 17th straws, but said *no* to the 16th straw, then they would have been asked to touch the 17th straw and would not be asked about their willingness to touch straws 15 through 1. If a participant said *yes* to all of the straws, then they would be asked to touch Straw 1. If a participant said *no* to Straw 20, then they would not touch any straws. For those participants who did touch one of the straws, they were then asked to clean their hands.

The experimenter then put away the first cutting board and took out a second cutting board, which looked identical to the first. The experimenter told participants that the second cutting board was prepared in the same way as the first, but was then washed with hot water and soap for 20 seconds. Participants were then asked to rate how much of the substance that was originally put on it still remained on a scale from 0 (*none left; cutting board is completely clean now*) to 100 (*all of it is still there*). Participants were also asked again about appraisals of threat and their emotional responses. This portion of the experimental procedure was primarily included in order to maintain the study's cover story, which was that we were studying beliefs about the effectiveness of cleaning methods.

The experimenter then reminded participants that they were free to refuse any task. The experimenter then asked whether, if they poured a glass of fresh cold water, the participant would be willing to drink from any of the straws. The method of assessing participants' willingness to drink with the straws was similar to the method used to assess their willingness to touch the straws. Thus the experimenter asked the participant whether they would be willing to drink with the 20th straw. If they said *yes*, they were then asked whether they would be willing to drink with the 19th straw, then 18th, etc. until either they indicated they are not willing to drink with the straw or until they reached Straw 1. If a participant said *no* to a straw, then they were asked to drink with the last straw to which they said *yes* and not asked about any remaining straws in that set. If a participant said *yes* to all of the straws, then they were asked to drink with Straw 1. If a participant said *no* to Straw 20, then they would not drink from any of the straws.

The experimenter then debriefed the participant in both oral and written form, and participants were given the opportunity to ask any questions they had about the study. Participants were also remunerated with either 1 course credit or $10.

2.1.2.5 Overview of statistical analyses for all studies. The purpose of this study was to examine whether threat influences judgments of contaminant spread. It was hypothesized that participants would judge the threatening contaminant (disease-causing bacteria) to spread more than the harmless contaminant (harmless bacteria) and non-contaminant (celery). As noted above, various facets of spread were examined. The three self-report indicators of spread consisted of participants' ratings of physical residue, dangerousness and reluctance to use, while the two behavioural avoidance indicators included the number of straws before participants were willing to touch and drink from one.

With regard to the three self-report indicators, participants were asked to rate each straw in terms of the amount of the substance on it (physical residue), how safe/dangerous it would be to use (dangerousness) and whether they would be willing to use it (reluctance to use). These three ratings were assessed for each of the 20 straws. Judgments of spread were operationalized as the area under the curve (AUC) of participants' ratings of physical residue, dangerousness and reluctance to use along the chain of contagion. Thus, if one were to plot a participant's rating of physical residue for each straw across all 20 straws along the chain of contagion, the AUC of the physical residue ratings (AUC-Physical Residue) would be the area under the curve formed by these ratings of physical residue along the chain of contagion. Given that each straw represents one unit of measurement, the AUC was calculated by summing the participant's physical residue ratings across all 20 straws.

The AUC was used in all four of the studies I conducted and it is therefore important to have a clear understanding of what this value indexes. To this end, I am providing examples of how the AUC was calculated for three participants. Figure 1 illustrates the AUC of these three participants' physical residue ratings along the chain of contagion, as well as the AUC value. As can be seen, Participant A rated the amount of physical residue as quite high to begin with and this amount gradually decreased and levelled off at a value of 10 (which represents very little of the substance). From a conceptual point of view, this AUC-Physical Residue value also captures the degree to which this participant's surroundings have become covered by the substance. Thinking of each straw as an object in that participant's environment, the sum of the physical residue ratings represent how much the substance has spread to the objects in that person's environment. In the case of Participant A, the first five straws had a moderate to high amount of the substance on them, and the remaining 15 straws had a very low amount of the substance on them. Thus, the overall amount of the substance in this participant's environment was in the lower range—with possible scores ranging from 0 to 2000, this participant's AUC value was 470.

Participant B rated the physical residue as high on the first straw and this participant's ratings decreased very gradually along the chain of contagion, never reaching zero. In fact, this participant rated the amount of physical residue on the 20th straw as moderate (with a rating of 50 on a scale from 0 to 100). This participant's AUC value was moderately high at 1300. Thus, the process of rubbing the straws against one another led to judgments of moderately high levels of the substance on the objects in this participant's environment. Participant C, in contrast, rated the initial level of physical residue on the first straw as moderately high and their ratings then decreased quite rapidly to zero. This participant only judged the substance to leave physical residue on five of the straws—the remaining 15 straws were rated as having no physical residue on them. Participant C's AUC value was 130, which is very low and reflects this participant's judgment that the amount of physical residue in their environment was very low.

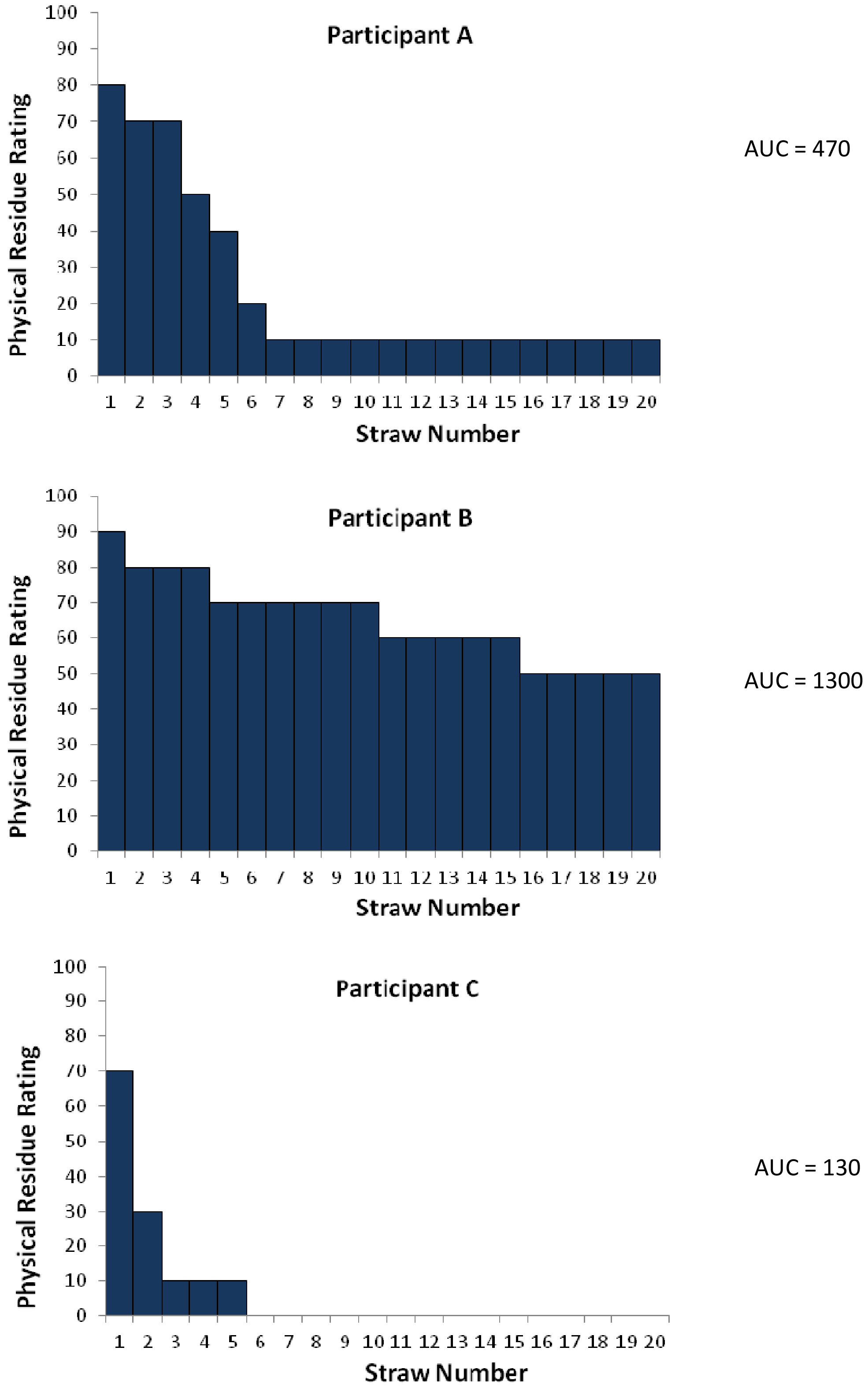


Figure 1: Sample AUC-Physical Residue Data for Three Participants.

The advantage of calculating the AUC is that this measure takes into account, not only participants' judgments of how far the substance spreads, but also the level of physical residue (or dangerousness and reluctance to use) along the chain of contagion. One of the limitations of the AUC approach, however, is that it cannot differentiate participants whose ratings reach zero from those whose ratings never reach zero. This question is of interest, however, because it captures whether there is any reluctance to indicate that spread has ended. For example, some participants may view the level of physical residue as very low, but be reluctant to ever indicate with certainty that it has stopped spreading. In order to address this issue, participants were categorized into whether or not their ratings reached zero. Chi square analyses were then performed to examine differences between the three experimental conditions on the likelihood that participants' ratings would reach zero.

With regard to the behavioural avoidance tasks, these variables tended to have bimodal distributions (the frequency distributions of these variables are provided for the reader throughout Section 2.7). Participants tended to either touch or drink from the first straw or no straws at all, with a smaller percentage of participants engaging in varying levels of avoidance by touching or drinking from straws at different points along the chain of contagion. As such, participants were divided into whether or not they touched or drank from a straw and chi square analyses were performed to examine differences between conditions in the likelihood of participants touching or drinking from a straw.

Throughout this document, I have presented the distribution of relevant outcome variables when describing the analyses and results of each study. Although it is not customary to present data in this way, the distributions influenced my method of data analysis so I felt it important for the reader to see the distributions. I describe alternative data analytic methods considered in section 6.8.

Power analyses were conducted to estimate appropriate sample size prior to beginning the study. Power calculations were conducted based on the effect size found in Tolin et al. (2004). These authors did not examine the AUC specifically, but rather examined whether the slope of participants' contamination ratings along the chain of contagion differed between diagnostic groups (i.e., participants with OCD, those with another anxiety disorder and non-anxious controls). They found that the slope for the OCD group was significantly different from that of the anxious and non-anxious control groups and that the effect size was $\eta_p^2 = 0.53$. This effect size was therefore used in calculating the number of participants needed in Study 1 in order to detect significant differences across conditions in the AUC. It was found that in order to detect an effect size of $\eta_p^2 = 0.53$ in ANOVA, with power (1 - β) at .80 and α at .05, a total of 69 participants would be needed (23 in each of the three conditions). In Study 1, 25 participants were recruited for each condition (total $N = 75$).

2.1.3 Results

2.1.3.1 Missing data and outliers. For participants who missed items on the questionnaires, their scores for that item were imputed with their mean score on the subscale to which that item belonged. Over the entire study, 6 item scores were imputed (0.00096 % of the data). One participant did not complete an entire page of the PI (items 1-19) and, as such, this participant's scores were not imputed, nor included in analyses on PI scores.

In order to ensure that outliers did not exert undue influence on analyses, multivariate and univariate outliers were identified. There was one multivariate outlier in the celery condition. Examination of this participant's profile indicated that s/he was also an outlier on appraisal of threat, appraising the celery as significantly more threatening than did other participants in this condition (z = 3.66). This participant's scores were therefore omitted from analyses. Univariate outliers are discussed where applicable.

2.1.3.2. Distribution of data across the whole sample. Prior to examining the impact of the experimental manipulation on participants' judgments of spread, participants' threat appraisals and each of the indices of spread were explored across the whole sample. The distribution of each of these variables is discussed below, along with the relationship between them.

2.1.3.2.1. Threat Appraisal. Across the whole sample, the degree to which participants appraised the substance on the cutting board as threatening is displayed in the frequency distribution in Figure 2. As can be seen, there was good variability in threat appraisals (skewness = 0.56, z_s = 1.99). On average, participants tended to rate the level of threat as moderately low: on scale from 0 to 100, the mean was 31.51 (SD = 24.43, n = 74).

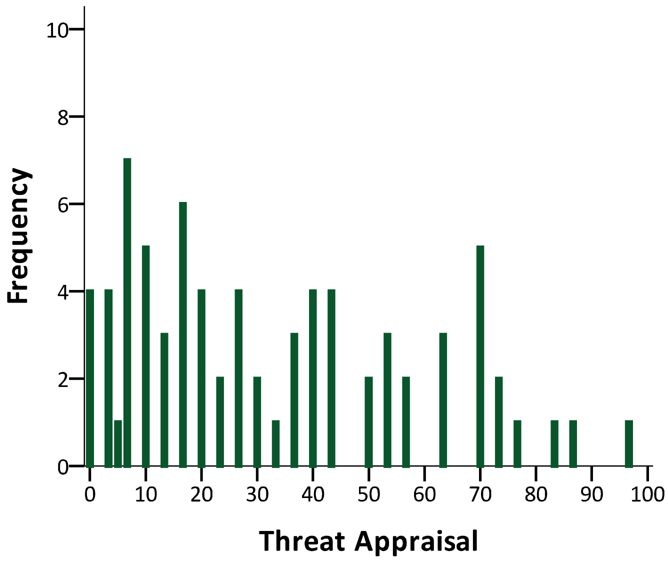


Figure 2. Study 1: Frequency Distribution of Threat Appraisals Across the Whole Sample.

2.1.3.2.2. Physical residue. As noted in Section 2.1.6, the AUC of each participant's physical residue ratings along the chain of contagion (AUC-Physical Residue) was calculated. The frequency distribution of participants' AUC-Physical Residue scores for the entire sample is displayed in Figure 3. As can be seen, the distribution was positively skewed (skewness = 1.54, z_s = 5.52). On average, the AUC of participants' physical residue ratings was fairly low. The mean was 337.91 (*SD* = 320.50, *n* = 74) out of a range of possible values from 0 to 2000. Thus, on the whole, participants tended to rate the level of physical residue on the 20 straws along the chain of contagion as fairly low.

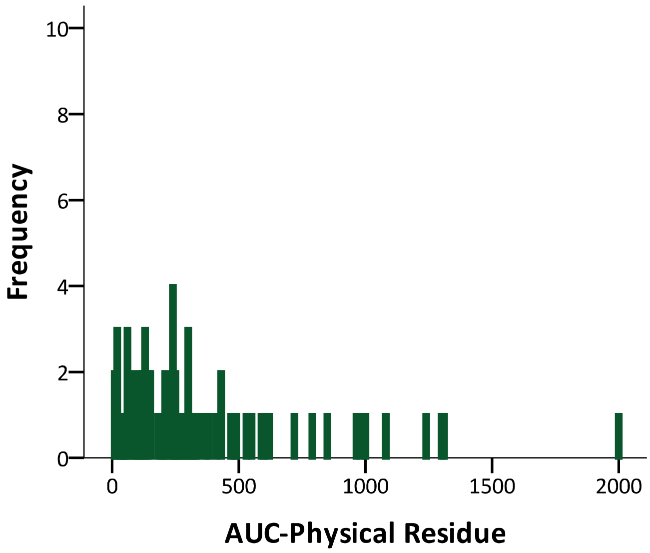


Figure 3. Study 1: Frequency Distribution of the AUC-Physical Residue Across the Whole Sample.

2.1.3.2.3 Dangerousness. The AUC of participants' ratings of how dangerous it would be to use the straws along the chain of contagion (AUC-Dangerousness) was also calculated. The frequency distribution of participants' AUC-Dangerousness scores is presented in Figure 4. As can be seen, the distribution of scores was positively skewed (skewness = 1.99, z_s = 7.14) and, on average, the AUC-Dangerousness ratings tended to be fairly low (*M* = 284.84, *SD* = 407.11, *n*

= 74, on a range from 0 to 2000). Thus, on the whole, participants tended to rate the level of dangerousness of the 20 straws along the chain for contagion as fairly low.

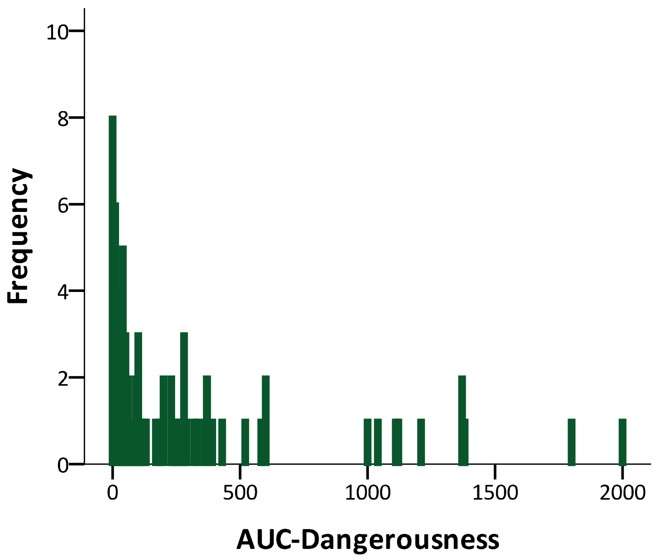


Figure 4. Study 1: Frequency Distribution of AUC-Dangerousness Across the Whole Sample.

2.1.3.2.4 Reluctance to Use. The frequency distribution in Figure 5 displays the AUC of participants' reluctance to use the straws along the chain of contagion (AUC-Reluctance to Use) for the whole sample. There was good variability and, on average, participants' AUC-Reluctance to Use was in the moderate range (M = 808.11, SD = 728.52, n = 74, on a range from 0 to 2000). Thus, on the whole, participants tended to report moderate levels of reluctance to use the 20 straws along the chain of contagion.

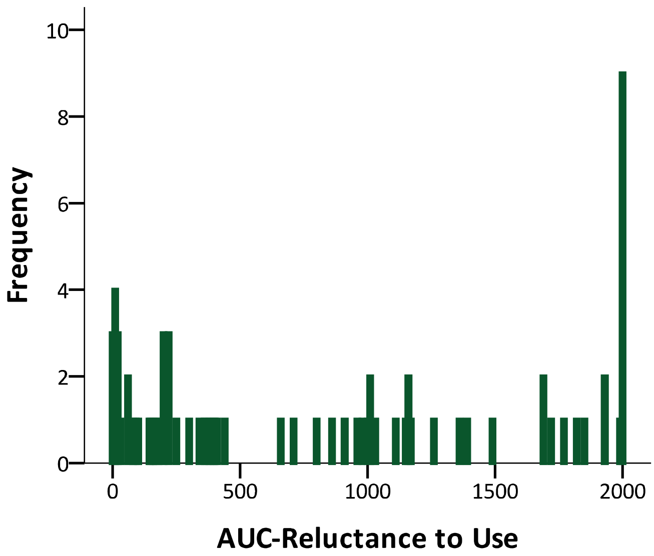


Figure 5. Study 1: Frequency Distribution of AUC-Reluctance to Use Across the Whole Sample.

2.1.3.2.5 Touch The number of straws before which participants, across the whole sample, were willing to touch one is presented in the frequency distribution in Figure 6. As can be seen, there appeared to be a bimodal distribution, with 57 % of participants (42 out of 74) exhibiting no avoidance by touching the first straw, another 19 % (14 out of 74) exhibiting complete avoidance by not touching any of the straws, and the 24 % remaining touching one of the other straws along the chain of contagion. The mean number of straws before participants were willing to touch one was 5.64 (*SD* = 8.12, *n* = 74).

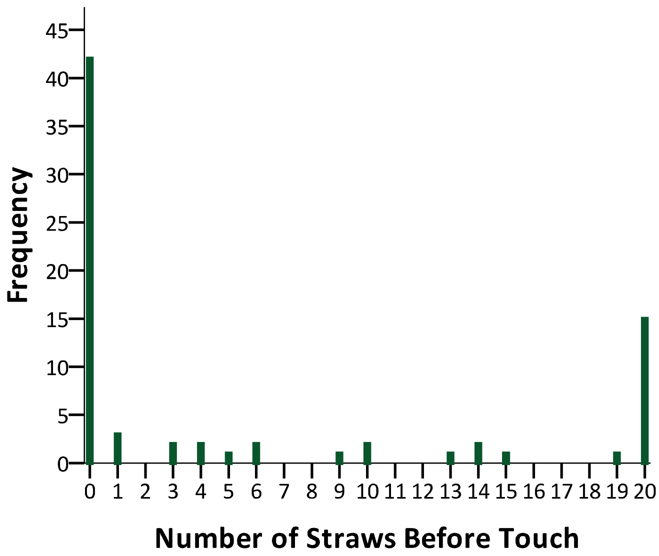


Figure 6. Study 1: Frequency Distribution of Number of Straws Before Participants Touched One.

2.1.3.2.6 Drink. The number of straws before participants were willing to drink from one is presented in the frequency distribution in Figure 7 across the whole sample. There was again a bimodal distribution. Nineteen out of 74 participants (26 %) drank from the first straw, while 28 out of 74 (38 %) did not drink from any of the straws, and the remaining 36 % drank from one of the other straws along the chain of contagion. On average, the number of straws before participants were willing to drink from one was 11.11 (*SD* = 8.56, *n* = 74).

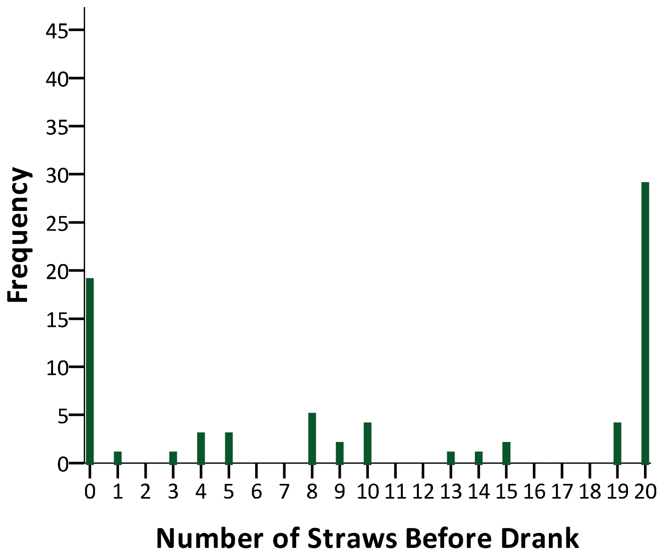


Figure 7. Study 1: Frequency Distribution of Number of Straws Before Participants Drank from One.

2.1.3.3 Relationship between various indicators of spread. The five outcome variables in this study were taken as indicators of judgments of spread. As such, one would expect them to be related to one another. However, very high correlations might suggest that they do not in fact represent different facets of spread, but rather measure the same thing and should be aggregated into a single score. Therefore, relationships between the outcome variables were examined. Pearson correlations were performed on the self-report indicators of spread (the AUC of physical residue, dangerousness and reluctance to use ratings) and are presented in Table 1a. As can been seen, they were significantly correlated with one another. The correlation between physical amount and dangerousness was quite high. However, because this correlation was smaller in magnitude in the three other studies I describe in this manuscript and the distinction was important for theoretical reasons, I deemed it valuable to continue to examine physical residue and dangerousness ratings separately.

Table 1b presents these same intercorrelations by condition. As can be seen, correlations were moderate to strong. However, the correlation between physical residue and dangerousness was very high in the disease-causing bacteria condition, and the correlation between physical residue and reluctance to use was somewhat weaker in the harmless bacteria condition.

Table 1a

Study 1 Intercorrelations (Pearson r) Among Self-Report Indicators of Spread

	1	*2*	*3*
1. AUC-Physical Residue	__	.84	.63
2. AUC-Dangerousness		__	.64
3. AUC-Reluctance to Use			__

Note. All correlations statistically significant at p < .001.

Table 1b

Study 1 Intercorrlations (Pearson r) Among Self-Report Indicators of Spread by Condition

		1	*2*	*3*
Disease-Causing Bacteria	1. AUC-Physical Residue	__	.92*	.73*
	2. AUC-Dangerousness		__	.77*
	3. AUC-Reluctance to Use			__
Harmless Bacteria	1. AUC-Physical Residue	__	.59*	.31
	2. AUC-Dangerousness		__	.47*
	3. AUC-Reluctance to Use			__
Celery	1. AUC-Physical Residue	__	.81*	.70*
	2. AUC-Dangerousness		__	.54*
	3. AUC-Reluctance to Use			__

Note. * indicates that correlation is statistically significant at $p < .05$.

In order to examine the relationship between participants' self-report indicators of spread and their avoidance behaviour, participants who touched or drank and those who did not were compared on the AUC of their physical residue, dangerousness and reluctance to use ratings. Means and standard deviations are presented in Table 2. Independent samples t tests revealed that participants who touched a straw tended to score lower on AUC-Physical Residue, t (73) = -2.03, p = .05, d = 0.60, AUC-Dangerousness, t (73) = -2.54, p = .01, d = 0.75 and AUC-Reluctance to Use, t (49.89) = -6.52, p < .001, d = 1.93, than those who did not touch any straws. Similarly, participants who drank from a straw scored lower than those who did not on

AUC-Physical Residue, t (35.67) = -4.09, $p < .001$, d = 1.13, AUC-Dangerousness, t (31.51) = -4.54, p = .01, d = 1.30 and AUC-Reluctance to Use, t (49.45) = -9.55, $p < .001$, d = 2.39.

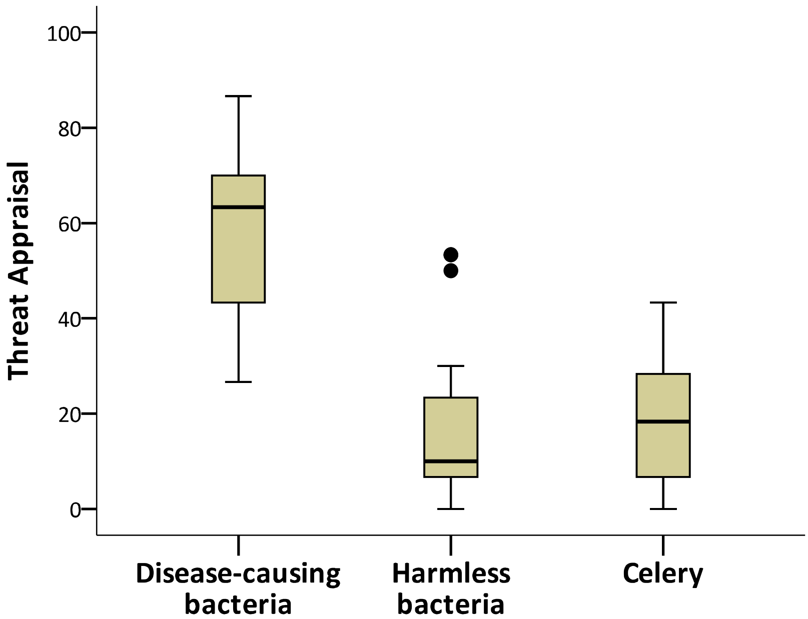
Table 2

Study 1: Mean Self-report Indicators of Spread of Participants Who Touched or Drank From a Straw and Those Who Did Not.

	Touched (n =61)		Did not touch (n = 14)		Drank (n = 46)		Did not drink (n = 29)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
AUC								
Physical Residue	319.10	375.04	538.57	308.41	217.50	210.79	586.21	455.39
Dangerousness	246.56	433.19	574.14	440.32	115.43	179.43	612.69	571.80
Reluctance to Use	611.48	638.20	1750.00	270.16	380.87	431.39	1526.90	548.09

2.1.3.4 Randomization. A series of ANOVAs suggested that randomization was successful. There were no significant differences between conditions on participants' scores on the PI (the whole scale, F (2, 72) = 1.18, p = .31, and the contamination subscale, F (2, 72) = 0.58, p = .56), the OBQ, F (2, 72) = 0.43, p = .65, or in age, F (2, 72) = 0.98, p = .38. Furthermore, chi square analyses indicated that conditions did not differ significantly from one another in the proportion of men and women, χ^2 (2) = 3.82, p = .15, or in ethnicity, χ^2 (2) = 0.91, p = .95.

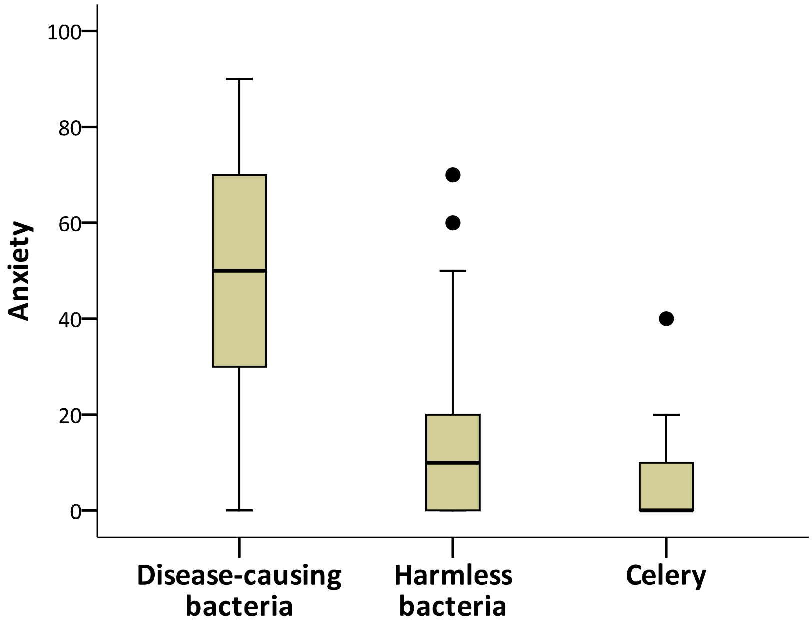
2.1.3.5 Manipulation Check. Participants' appraisals of how threatening the substances in each condition are presented in the boxplot in Figure 8. In order to ensure that participants judged the disease-causing bacteria as more threatening than the harmless bacteria and celery, an ANOVA was performed with condition as the fixed factor and threat appraisal as the dependent variable. Levene's test was not significant, indicating that variances were not significantly different across conditions, F (2, 71) = 0.88, p = .42. There was a significant effect of condition, F (2, 71) = 59.73, p < .001, η_p^2 = 0.63. Post-hoc Tukey tests indicated that the disease-causing bacteria was appraised as significantly more threatening than the harmless bacteria (p < .001) and celery (p < .001), and there was no significant difference between the harmless bacteria and celery conditions (p = .93). Thus, the results suggest that the manipulation was effective in influencing people's appraisals of threat.



M =	58.40	17.00	18.61
SD =	16.28	15.40	13.51
n =	25	25	24

Figure 8. Study 1: Manipulation Check: Boxplot of Threat Appraisals by Condition with Means and Standard Deviations.

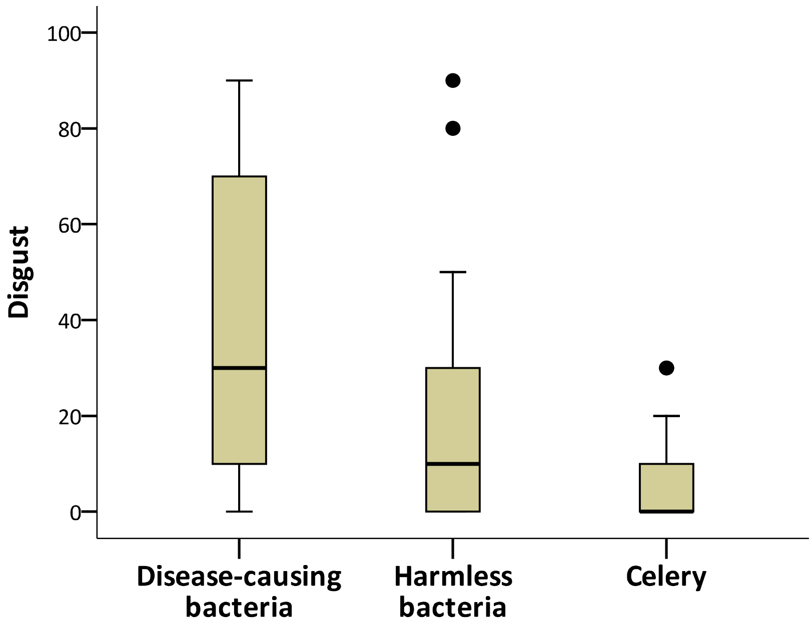
Participants' emotional responses to the manipulation (namely anxiety and disgust) were also explored and are presented in the boxplots in Figures 9 and 10. With regard to anxiety, an ANOVA was performed with condition as the fixed factor and anxiety as the outcome variable. Variances were unequal across conditions, Levene's test: F (2, 71) = 12.17, p < .001. Examination of the standard deviations reveals that variability was greatest in the disease-causing bacteria condition and smallest in the celery condition. The ANOVA revealed a significant effect of condition, F (2, 71) = 24.60, p < .001, $\eta_p^2 = 0.41$. Post-hoc Games-Howell tests indicated that each of the groups was significantly different from one another. Participants in the disease-causing bacteria condition reported higher levels of anxiety than participants in the harmless bacteria (p = .001) and celery (p < .001) conditions, and participants in the harmless bacteria condition reported higher levels of anxiety than those in the celery condition (p = .05). Thus, participants in the celery condition tended to have similarly low levels of anxiety, while those in the disease-causing bacteria tended to differ more in their anxiety and, on average, had the highest level of anxiety.



M	46.80	17.20	5.83
SD	28.39	20.52	10.18
n	25	25	24

Figure 9. Study 1: Boxplot of Anxiety in Response to Experimental Manipulation, with Means and Standard Deviations.

Participants' disgust in response to the experimental manipulation was also examined. An ANOVA was performed with condition as fixed factor and disgust as the outcome variable. Variances were unequal across conditions, Levene's test: F (2, 71) = 11.64, p < .001. Examination of the standard deviation and boxplot suggest that variability was greatest in the disease-causing bacteria condition and smallest in the celery condition. There was a significant effect of condition, F (2, 71) = 12.72, p < .001, η_p^2 = 0.26. Post-hoc Games-Howell tests revealed that participants in the disease-causing bacteria condition were significantly more disgusted than participants in the harmless bacteria (p = .02) and celery (p < .001) conditions. Furthermore, there was a trend for participants in the harmless bacteria condition to be more disgusted than those in the celery condition (p = .07). Thus, disease-causing bacteria were associated with greater variability in the disgust they evoked in participants and, overall, led to higher levels of disgust than the other substances. With respect to celery, participants tended to be more consistent in experiencing low levels of disgust.



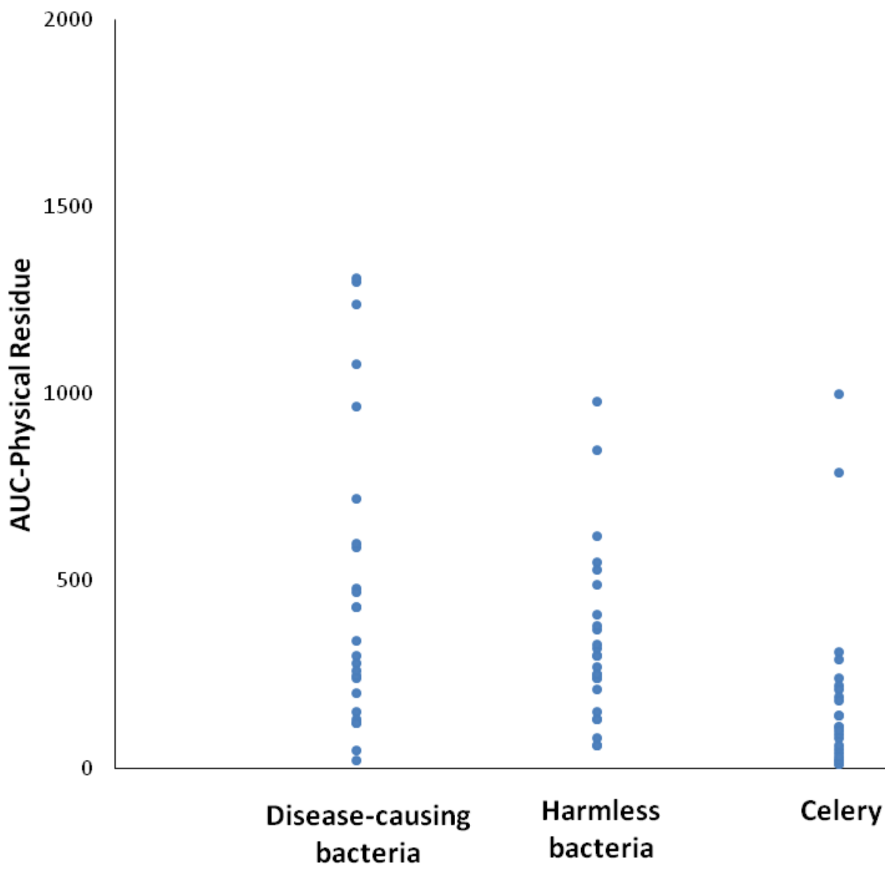
M =	41.20	19.60	7.50
SD =	31.40	23.89	10.74
n =	25	25	24

Figure 10. Study 1: Boxplot of Disgust in Response to Experimental Manipulation, with Means and Standard Deviations.

2.1.3.6 Effect of threat information on judgments of spread. The purpose of this study was to examine whether threat increases judgments of contaminant spread. It was hypothesized that participants would judge the disease-causing bacteria as spreading more than harmless bacteria and celery. Judgments of spread included self-report indicators of spread (ratings of physical residue, dangerousness and reluctance to use the straws along the chain of contagion), as well as behavioural avoidance tests (whether a participant actually touched and drank from one the straws). The impact of the experimental manipulation on each of these facets of spread is described below.

2.1.3.6.1 AUC-Physical residue. The AUC of participants' physical residue ratings along the chain of contagion (AUC-Physical Residue) was compared across conditions. Figure 11 displays the scatterplot of the AUC-Physical Residue by condition with means and standard deviations displayed beneath. Levene's test was significant, F (2, 71) = 5.46, p = .01, indicating that the variances were not equal across conditions. Examination of the standard deviations revealed that the greatest variability in participants' scores occurred in the disease-causing bacteria condition.

Looking more specifically at mean differences in AUC-physical residue across conditions, an ANOVA indicated a significant effect of condition, F (2, 71) = 6.00, p = .004, η_p^2 = 0.14. Post-hoc Games-Howell tests revealed that participants in the disease-causing bacteria condition judged the physical residue as greater along the chain of contagion than participants in the celery condition (p = .01) and there was a trend for participants in the safe bacteria condition to also judge the physical residue as greater than participants in the celery condition (p = .06). The disease-causing and harmless bacteria conditions did not differ significantly from one another (p = .39). These finding suggest that, on average, threat did not influence participants' ratings of physical spread, as the means for the disease-causing and harmless bacteria did not differ from each other. Rather the findings suggest that the disease-causing and harmless bacteria were judged to spread further than the celery. However, as noted, there was greater variability in the AUC-Physical Residue scores within the disease-causing bacteria condition. Thus, although threat did not influence average physical residue ratings along the chain of contagion, there seemed to be some participants whose physical residue ratings were elevated. In each condition, there were a few participants whose AUC-Physical Residue ratings were elevated (although not significant outliers), but the number of such participants seemed to be greater in the disease-causing bacteria condition. These results might suggest a subset of people whose judgments of spread are influenced by threat.

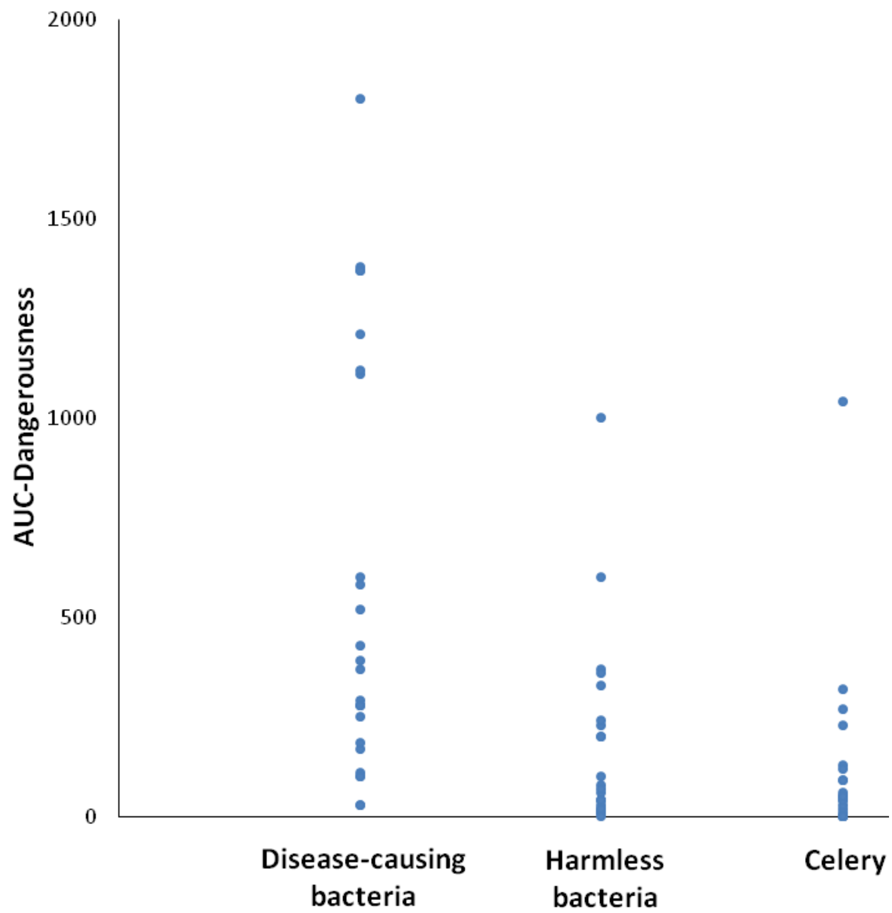


	Disease-causing bacteria	Harmless bacteria	Celery
M	482.60	340.00	185.00
SD	400.32	229.91	237.65
n	25	25	24

Figure 11. *Study 1: Scatterplot of AUC-Physical Residue By Condition with Means and Standard Deviations.*

2.1.3.6.2 AUC-Dangerousness. The effect of the experimental manipulation on participants' ratings of dangerousness along the chain of contagion was also examined. The AUC of participants' dangerousness ratings (*AUC-Dangerousness*) within each condition are presented in the scatterplot in Figure 12, with the means and standard deviations presented beneath. The variability in participants' scores differed significantly across conditions, as indicated by Levene's test, F (2, 71) = 15.12, $p < .001$. Examination of the standard deviations and scatterplot suggests that variability was greatest among participants in the disease-causing bacteria condition.

Turning now to mean differences between conditions in dangerousness ratings along the chain of contagion, an ANOVA was performed with condition as the fixed factor and AUC-Dangerousness as the outcome variable. There was a significant effect of condition, F (2, 71) = 12.76, $p < .001$, $\eta_p^2 = 0.26$. Post hoc Games-Howell tests revealed that participants in the disease-causing bacteria condition judged the level of dangerousness as greater along the chain of contagion than participants in the harmless bacteria and celery conditions ($p = .003$ and $p = .001$ respectively). The harmless bacteria and celery conditions did not differ significantly from one another ($p = .69$). What these findings suggest is that, on average, threat led to higher ratings of dangerousness along the chain of contagion. However, there also appeared to be a subgroup of participants whose dangerousness ratings were particularly influenced by threat—it may be fruitful for future research to further examine this possibility.

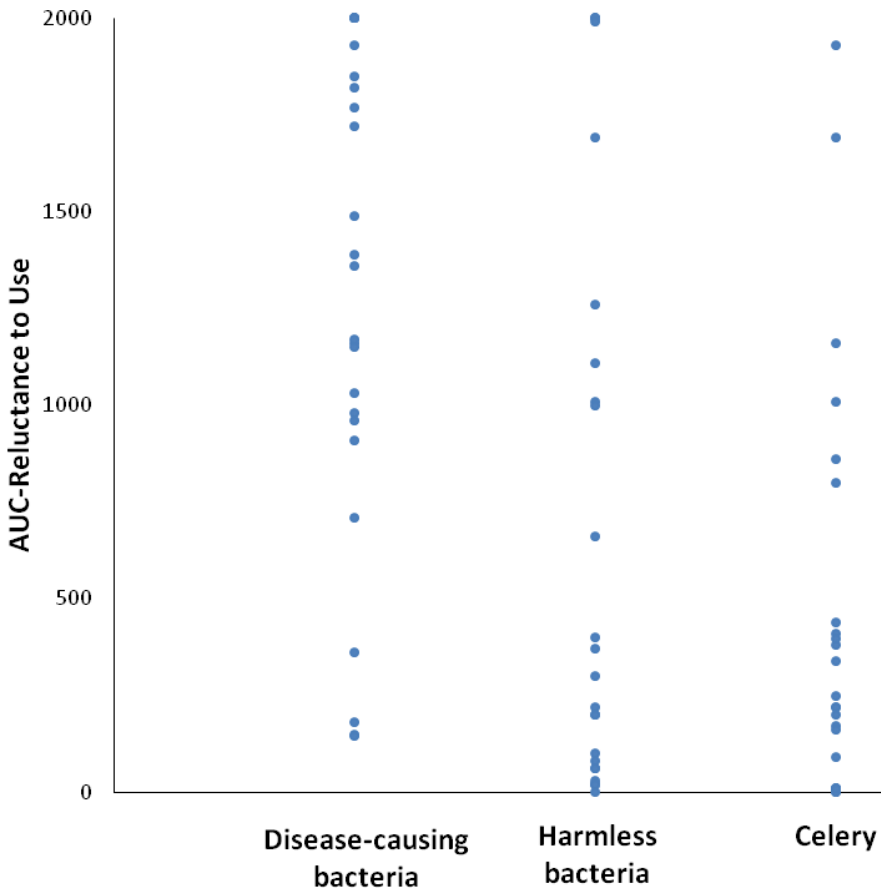


	Disease-causing bacteria	Harmless bacteria	Celery
M	574.32	163.20	110.00
SD	521.45	232.02	216.96
n	25	25	24

Figure 12. Study 1: Scatterplot of AUC-Dangerousness by Condition with Means and Standard Deviations.

2.1.3.6.3 AUC-Reluctance to Use. Participants' willingness or reluctance to use the straws along the chain of contagion was examined across the three conditions. The AUC of participants' ratings of reluctance (AUC-Reluctance to Use) within each condition is presented in the scatterplot in Figure 13, with means and standard deviations provided beneath. Levene's test indicated that variances differed across conditions, F (2, 71) = 3.08, p = .05. The standard deviation was quite large in all of the conditions, although was greatest in the harmless bacteria condition. This finding suggests that, although participants varied greatly in their reluctance to use the straws in all conditions, differences among participants seemed to be most pronounced when rating the harmless bacteria.

With regard to the effect of the experimental manipulation on participants' mean AUC-Reluctance to Use ratings, an ANOVA revealed a significant effect of condition, F (2, 71) = 11.30, $p < .001$, $\eta_p^2 = 0.24$. Post-hoc Games-Howell tests indicated that participants in the disease-causing bacteria condition reported greater avoidance along the chain of contagion than participants in the harmless bacteria and celery conditions (p = .008 and $p < .001$ respectively). The harmless bacteria and celery conditions did not differ significantly from one another (p = .45). Thus, overall, participants were more reluctant to use straws in the disease-causing bacteria condition.



	Disease-causing bacteria	Harmless bacteria	Celery
M	1289.40	672.00	448.54
SD	629.38	745.63	533.15
n	25	25	24

Figure 13. Study 1: Scatterplot of AUC-Reluctance to Use by Condition with Means and Standard Deviations.

2.1.3.6.4. Effect of experimental manipulation on likelihood of self-report indicators of spread reaching zero. The proportion of participants whose self-report indices of spread (physical residue, dangerousness and reluctance to use) reached zero is presented in Table 3. With regard to physical residue ratings, a chi square analysis was performed to examine differences between conditions in the likelihood of participants' physical residue ratings reaching 0 (*None*). There was a significant effect of condition, χ^2 (2) = 9.21, p = .01, two-tailed Fisher's exact test, Cramer's V = .35. Examination of the adjusted standardized residuals revealed an elevated likelihood of indicating that the substance stopped physically spreading among participants in the celery condition.

With regard to dangerousness ratings, chi square analyses were performed to examine the effect of threat information on the likelihood that participants' dangerousness ratings would reach *Safe*. There was also a significant effect of condition, χ^2 (2) = 8.21, p = .02, two-tailed Fisher's exact test, Cramer's V = .33. Examination of the adjusted standardized residuals revealed an increased likelihood of indicating that the danger ended among participants in the celery condition and a decreased likelihood of indicating so among participants in the disease-causing bacteria condition.

Chi square analyses were also performed to examine the effect of threat information on the likelihood that participants' reluctance to use would reach zero (i.e., would reach *Definitely would use*). There was a significant effect of condition, χ^2 (2) = 10.21, p = .004, two-tailed Fisher's exact test, Cramer's V = .39. Examination of the adjusted standardized residuals revealed that participants in the celery condition were more likely to say that they would definitely use one of the straws, while participants in the disease-causing bacteria condition were less likely to say so.

Table 3.

Study 1: Percentage of Participants Whose Spread Ratings Reach Zero and Who Touch or Drank from a Straw.

		Percentage who indicated that:			**Percentage who:**	
	n	Physical residue reached *None*	Dangerousness rating reached *Safe*	*Would Definitely* use a straw	Touched straw	Drank with straw
Disease-causing bacteria	25	40%	44%	16%	64%	36%
Harmless bacteria	25	44%	60%	40%	80%	64%
Celery	24	79%	83%	63%	100%	88%

2.1.3.6.5 Touch. The percentage of participants in each condition who touched at least one of the straws along the chain of contagion is presented in Table 3. A chi square test indicated that there was a significant effect of condition on participants' willingness to touch the straws, χ^2 (2) = 11.45, *p* = .002, two-tailed Fisher's exact test, Cramer's *V* = .37. Examination of adjusted standardized residuals revealed an increased likelihood of touching a straw among participants in the celery condition and a decreased likelihood of touching a straw among participants in the disease-causing bacteria condition.

2.1.3.6.6 Drink. The percentage of participants in each condition who drank from at least one of the straws is presented in Table 3. There was a significant effect of condition on participants' willingness to drink from a straw, χ^2 (2) = 14.02, *p* = .001, two-tailed Fisher's exact test, Cramer's $V = .43$. Examination of adjusted standardized residuals revealed that an elevated likelihood of drinking in the celery condition and a reduced likelihood of drinking in the disease-causing bacteria condition.

2.1.3.7 Relationship between threat appraisals and judgments of spread across the whole sample. In addition to examining the impact of the experimental manipulation of threat on participants' judgments of spread, I also examined the relationship between participants' subjective evaluations (i.e., appraisals) of how threatening the substances on the cutting boards were (regardless of which condition they were in) and their judgments of spread. With regard to the three self-report indicators of spread (AUC of physical residue, dangerousness and reluctance to use), Pearson correlations were performed with threat appraisals. Threat appraisal was moderately correlated with each of the self-report indicators of spread: AUC-Physical Residue ($r = .41$, $p = .001$), AUC-Dangerousness ($r = .62$, $p < .001$) and AUC-Reluctance to Use ($r = .59$, $p < .001$).

With regard to the two behavioural avoidance tasks, independent samples t-tests were performed to examine whether participants who touched or drank from one of the straws differed from those who did not touch or drink from any of the straws on their appraisals of threat. With regard to touch, participants who touched a straw tended to appraise the substances as less threatening than those who did not touch any of the straws, $t\ (72) = -3.64$, $p = .001$, $d = 1.08$. On average, the threat appraisal of participants who touched a straw was 26.89 ($SD = 22.43$, $n = 61$) on a scale from 0 to 100, while those who did not touch any straws had an average threat appraisal of 51.31 ($SD = 23.41$, $n = 13$). With regard to drinking with the straws, there was also a significant difference in the threat appraisals of those who drank versus not, $t\ (45.44) = -4.97$, $p < .001$, $d = 1.27$. Participants who drank from one of the straws had a mean threat appraisal of 21.45 (*SD* = 18.33, *n* = 46), while those who did not had a mean threat appraisal of 48.04 (*SD* = 24.46, *n* = 28). Thus, when examining the sample as a whole, regardless of the experimental condition participants were in, threat appraisals were associated with each index of judgments of spread.

2.1.4 Discussion. The purpose of this study was to examine whether threat influences people's judgments of contaminant spread. In order to examine this hypothesis, participants were asked to judge the degree of spread of either: disease-causing bacteria, harmless bacteria or celery juice. Furthermore, various facets of spread were examined: the physical amount of the substance along the chain of contagion, dangerousness along the chain of contagion, as well as reported avoidance and actual behavioural avoidance.

On average, participants tended to rate the two types of bacteria (disease-causing and harmless) as leading to higher levels of physical residue along the chain of contagion than the celery. Furthermore, although participants in the celery condition were most likely to indicate that the substance had stopped physically spreading, there was no effect of threat on the likelihood of participants indicating that the physical spread had ended.

There are two competing explanations for why participants may have judged the two contaminants (bacteria) to spread further than the non-contaminant (celery juice). First, it may be that people judge living organisms (i.e., bacteria) to physically spread more than non-living organisms. The non-contaminant used in this experiment was celery juice which does not contain living organisms, whereas the two contaminants both involved bacteria, which can move and reproduce. Therefore, participants may simply have judged the substances containing living organisms as physically spreading more than those which did not.

A second possibility is that people judge contaminants to spread further than non-contaminants, regardless of whether the non-contaminant contains living organisms or not. If so, this might suggest that people hold different beliefs about the spread of contaminants or that a cognitive bias exists that applies to the spread of contaminants. As noted previously, a contaminant is defined as a substance that renders another object, person or place “soiled, impure, infectious or harmful” (Rachman, 2006). Thus, even if participants know that a substance is not dangerous, the fact that it tarnishes their food might bias their judgments of how much that substance spreads. In order to examine these competing hypotheses, it was important to conduct a follow-up study that replaced the celery with a food substance that contained bacteria—this follow-up study (Study 2) is outlined in Section 2.2 of this chapter.

Although manipulating threat information did not, on average, increase judgments of physical spread, there was greater variability in the AUC-Physical Residue among participants in the disease-causing bacteria condition. This finding might hint at perhaps a subgroup of participants whose physical residue ratings were increased by threat. However, future research would be needed to examine this possibility further.

There was also a significant correlation between participants’ appraisals of threat and the AUC of their physical residue ratings. There are several possible explanations for this relationship. First, the correlation might be due to methodological overlap between the two measures—both threat appraisals and judgments of physical spread were assessed using paper-and-pencil self-report questionnaires. The correlations may reflect similarities in how people respond to such questionnaires, rather than a true relationship between the constructs. Second, it may be that an individual’s subjective appraisal of how threatening a substance has a stronger impact on their judgments of spread than objective indictors of how threatening the substance is. Although possible, the fact that participants in the threatening contaminant condition appraised the substance as significantly more threatening than the harmless contaminant and non-contaminant, as well as the fact that differences were found between threatening and non-threatening contaminants on other outcomes variables (such as dangerousness and avoidance), weakens this argument. Nevertheless, future research may wish to examine this possibility. Third, it may be that threat appraisals and physical amount are correlated, but the direction of the relationship is reversed. For example, it might be that judgments of greater physical spread lead to greater judgments of threat. In this study, participants' threat appraisals with regard to the substances were measured prior to judgments of spread; however, it is possible that participants made their own instantaneous judgments of spread that then influence their judgments of threat. However, if this were the case, one would expect threat appraisals to be elevated in the harmless bacteria condition, which they were not.

With regard to dangerousness ratings, it is not surprising that threatening contaminants were judged to be more dangerous along the chain of contagion than non-threatening substances. This finding could almost be viewed as a manipulation check. However, there was also greater variability in the AUC-Dangerousness scores among participants in the disease-causing bacteria condition. This finding could suggest perhaps a subgroup of people whose danger ratings are more influenced by the threat of disease.

With regard to participants' reported reluctance to use the straws, as well as their actual avoidance of touching or drinking from a straw, avoidance was greatest in the disease-causing bacteria condition. This finding is consistent with cognitive theories of anxiety disorders that posit that threat appraisals lead to greater distress, which in turn lead to greater avoidance. Indeed participants' reported anxiety and disgust were also highest in the disease-causing bacteria condition.

There was, however, also an increased tendency for participants in the celery condition to touch and drink from the straws. It is difficult to interpret the meaning of this latter finding given the previously discussed confound between the presence of bacteria versus identification as a contaminant. As such, Study 2, which addressed this confound, will be described next.

2.2 Study 2

2.2.1 Introduction

The purpose of Study 2 was to replicate Study 1 while addressing the confound between the presence of bacteria and identification as a contaminant in interpreting increased judgments of physical spread. In Study 1, the two contaminants (disease-causing and harmless bacteria) were judged to physically spread more than the non-contaminant (celery). However, since the contaminants contained live bacteria that could move and replicate, it was unclear whether the findings were due to the presence of bacteria or to identification as a contaminant. In order to address this confound, Study 2 replicated Study 1, replacing the non-contaminant with a food substance that contained bacteria (i.e., yogurt containing probiotic bacteria). Thus, Study 2 tested two competing explanations for the findings of Study 1: that judgments of spread were increased by the presence of bacteria versus by identification as a contaminant.

2.2.2 Method

2.2.2.1 Participants. Seventy-seven people participated in this study. Participants were recruited by means of the Psychology Subject Pool, as well as by posters placed at various locations around UBC campus. Participants' mean age was 22.73 years old (SD = 5.06), and most were students (n = 64, 85 %). Twenty-six participants (35 %) worked part-time and 9 (12 %) worked full-time (more than 30 hours per week). There were more women (n = 55, 73 %) than men (n = 20, 27%). Most participants were of Asian (n = 33, 43 %) or of European (n = 24, 31 %) origin. The remaining 34 % were of Indian, Middle Eastern, African, Hispanic or mixed ethnic origin. As a token of our appreciation for their time (1 hour), participants received either 1 course credit or $10.

2.2.2.2 Materials. As in Study 1, several self-report questionnaires were included in order to assess the sample's general level of concern with contamination and to ensure that participants did not differ across conditions on traits associated with contamination concerns. In addition to the questionnaires used in Study 1 (i.e., demographics form, Padua Inventory [PI] and Obsessive Beliefs Questionnaire [OBQ]), Study 2 also included the Disgust Sensitivity Scale (DSS) and the Perceived Vulnerability to Disease Questionnaire (PVD). For a description of the demographics form, PI and OBQ, the reader is referred to section 2.1.4 of this chapter.

2.2.2.2.1 Disgust Sensitivity Scale (DSS; Haidt, McCauley, & Rozin, 1994)***.*** This 32-item self-report questionnaire measures individual differences in sensitivity to disgust. It includes items sampling seven domains of disgust: animals, body products, death, envelope violations (injuries, wounds, etc.), food, hygiene and sex, as well as an eighth subscale assessing sympathetic magic. Half the items on this scale are in true/false format, while the other half are answered on a 3-point Likert scale from 0 (*not disgusting at all*) to 2 (*very disgusting*). Higher scores indicate greater disgust sensitivity. It has been shown to have good internal consistency ($\alpha = 0.84$) and test-retest reliability ($r = .79$). Rozin, Haidt, MacCauley, Dunlop and Ashmore (1999) found that it correlated significantly with a behavioural measure of disgust sensitivity ($r = -.51$). In a recent study conducted among a general (non-selected) sample of UBC students, the mean score on this scale was 17.06 ($SD = 5.07$; Dorfan & Woody, 2006).

2.2.2.2.2 Perceived Vulnerability to Disease (PVD; Duncan, Schaller, & Park, 2009)***.*** This is a 15-item self-report questionnaire that assesses perceived vulnerability to disease. Participants rate their agreement with each item on a 7-point scale, from 1 (*strongly disagree*) to 7 (*strongly agree*). Factors analyses revealed two subscales: one assessing beliefs about personal susceptibility to the transmission of infectious diseases (*Perceived Infectability*) and the other assessing emotional discomfort in the presence of potential disease transmission (*Germ Aversion*). It has been shown to have good internal consistency (α for Perceived Infectability was .87 and for Germ Aversion was .74), as well as good convergent validity, correlating with related constructs, such as health anxiety and disgust sensitivity (Duncan, Schaller, & Park, 2009).

2.2.2.3 Procedure. The study was presented to participants in the same way as Study 1, as a study on the effectiveness of different cleaning methods. The order in which participants completed the questionnaire package and the experimental task assessing spread was again counterbalanced. The questionnaire package included the demographics questionnaire, PI, OBQ, DSS and PVD.

The experimental task assessing spread was completed in a similar way as Study 1. However, in the non-contaminant condition, participants were told that yogurt with probiotic bacteria had been placed on the cutting board (rather than celery juice as participants in Study 1 had been told). Participants in this condition were told that the yogurt contained probiotic bacteria and that these bacteria are what convert milk into yogurt. Furthermore, the health benefits of consuming such yogurt were described to them. They were also shown an image purportedly of the probiotic bacteria (the image was the same image that was shown to participants in the disease-causing and harmless bacteria conditions—an image of E. coli). The script of what participants were told in this condition is included in Appendix B. The scripts for participants in the disease-causing and harmless bacteria conditions were the same as Study 1. Piloting had indicated that some participants raised concerns about the yogurt spoiling. In order to ease these concerns and ensure that participants viewed the yogurt as fresh and non-threatening, the cutting boards were kept in a cooler.

Judgments of spread were assessed in the same manner as in Study 1 with some minor modifications. First, in Study 1, the glasses to hold “contaminated” straws had been laid out on the table beforehand and labeled so participants could easily guess how many straws would be used. In Study 2, glasses were not laid out and labeled beforehand, but rather taken out as needed making it less easy for participants to guess how many straws would be used. Second, there was a slight alteration to the Pre-Wash Rating Form: in asking participants to rate their anxiety and disgust in response to the substance, these words were changed to *nervous* and *grossed out* and the terms were described in more detail on the scale. The reason for this alteration was to try to help participants better distinguish these emotions. In Study 1, the correlation between anxiety and disgust was quite high (r = 0.74). Previous research using the terms *nervous* and *grossed out* had produced lower correlations (Dorfan & Woody, 2011; Woody, McLean & Klassen, 2005).

2.2.3 Results

2.2.3.1 Missing Data and Outliers. Over the entire study, there were 10 instances of participants missing a questionnaire item (0.001 % of items). Missing items were imputed with participants’ mean score on the subscale of the specific questionnaire. There was one participant whose missing item was her age and given that this value could not be imputed, this participant was omitted from analyses conducted on age. There were no multivariate outliers. Univariate outliers are discussed where applicable.

2.2.3.2 Distribution of Data Across Whole Sample

2.2.3.2.1 Threat Appraisal. Participants’ appraisals of how threatening the substance on the cutting board was across the whole sample are presented in the frequency distribution in Figure 14. As can be seen, there was good variability in participants’ threat appraisals (skewness = 0.75, z_s = 2.73) and overall participants tended to rate the level of threat as moderately low (on a scale from 0 to 100, *M* = 30.74, *SD* = 26.42, *n* = 77).

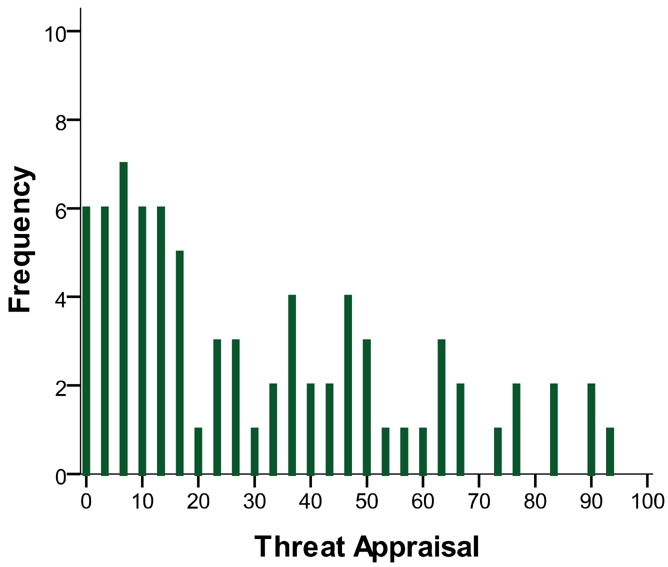


Figure 14. Study 2 Frequency Distribution of Threat Appraisals Across the Whole Sample.

2.2.3.2.2 Physical Residue. The frequency distribution of participants' AUC-Physical Residue scores for the whole sample is presented in Figure 15. As can be seen, the distribution was positively skewed (skewness = 2.03 and z_s = 7.39) and, overall, participants tended to rate the physical residue along the chain of contagion as low (with possible scores ranging from 0 to 2000, *M* = 311.86, *SD* = 310.39, *n* = 77).

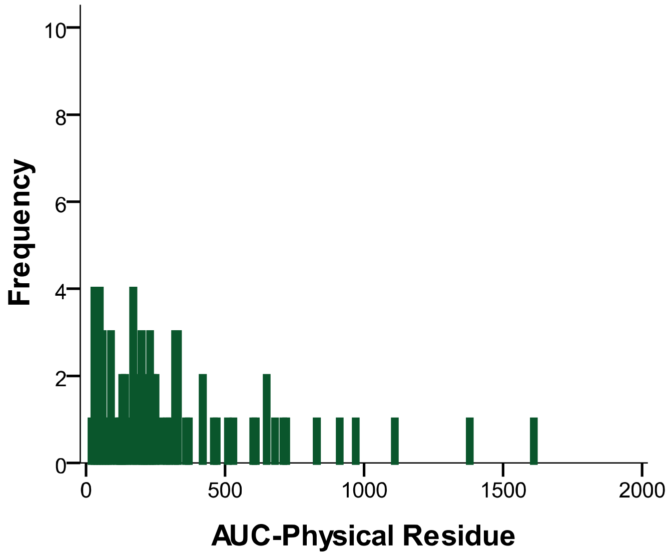


Figure 15. Study 2 Frequency Distribution of AUC-Physical Residue Across the Whole Sample.

2.2.3.2.3 Dangerousness. The frequency distribution of participants' AUC-Dangerousness scores for the whole sample is presented in Figure 16. The distribution of scores was positively skewed (skewness = 3.15 and z_s = 11.49), and the mean was fairly low (with possible scores ranging from 0 to 2000, *M* = 223.58, *SD* = 331.24, *n* = 77). Thus, on the whole, participants tended to rate the level of dangerousness along the chain of contagion as low.

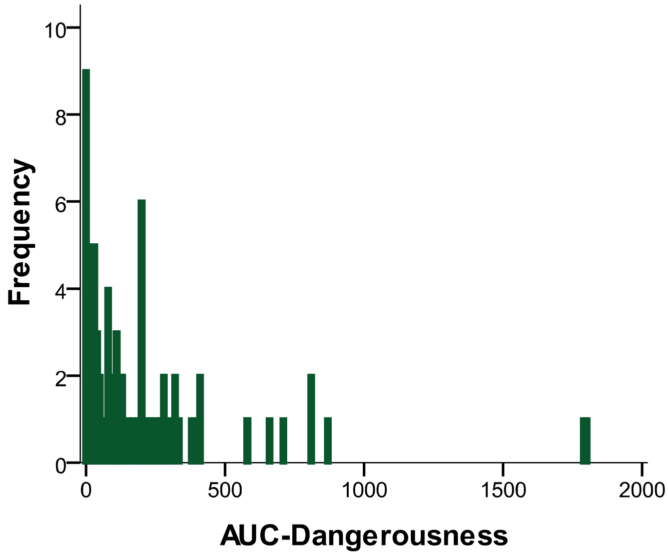


Figure 16. Study 2 Frequency Distribution of AUC-Dangerousness Across the Whole Sample.

2.2.3.2.4 Reluctance to Use. The AUC of participants' reluctance to use ratings is presented in the frequency distribution in Figure 17. As can be seen, there was good variability (skewness = 0.46, z_s = 1.67) and on average, participants expressed moderate reluctance to use the straws (with possible scores ranging from 0 to 2000, *M* = 810.31, *SD* = 682.91, *n* = 77).

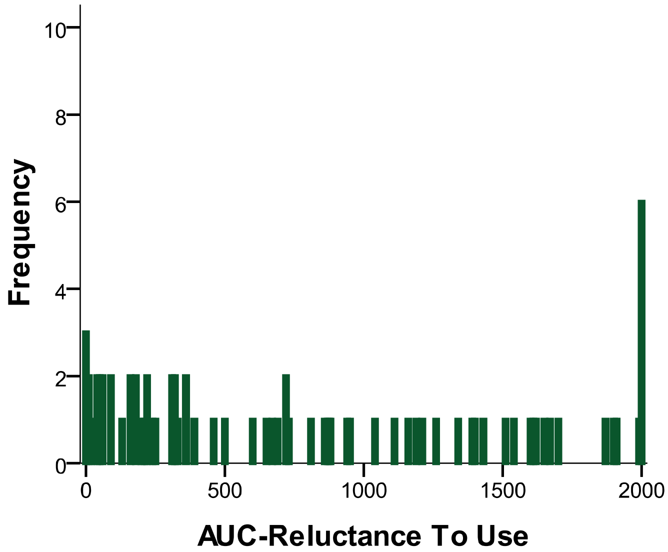


Figure 17. *Study 2 Frequency Distribution of AUC-Reluctance to Use Across the Whole Sample.*

2.2.3.2.5 Touch. With regard to the number of straws before participants were willing to touch one of them, the frequency distribution of participants' scores across the whole sample is presented in Figure 18. As can be seen, there was a bimodal distribution with 55 % of participants touching the first straw, 14 % not touching any straws, and the remaining participants touching one of the other straws along the chain of contagion. The mean number of straws before participants were willing to touch one was 5.53 (*SD* = 7.57, *n* = 77).

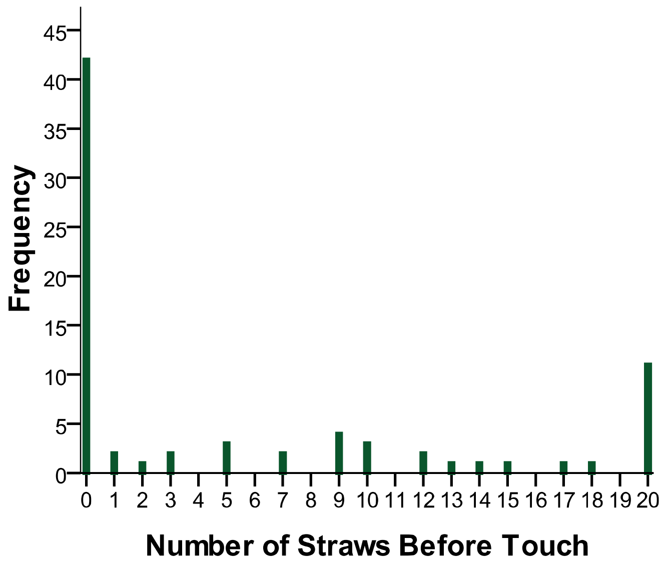


Figure 18. Study 2   Frequency Distribution of the Number of Straw Before Touched One, Across the Whole Sample.

2.2.3.2.6 Drink. The number of straws before participants were willing to drink from one is presented in the frequency distribution in Figure 19. As can be seen, there was also a bimodal distribution with 21% drinking from the first straw, 43% not drinking from any straws and the remaining participants drinking from one of the other straws along the chain of contagion. On average, the participants required 12.16 straws (*SD* = 8.57) before they were willing to drink from one.

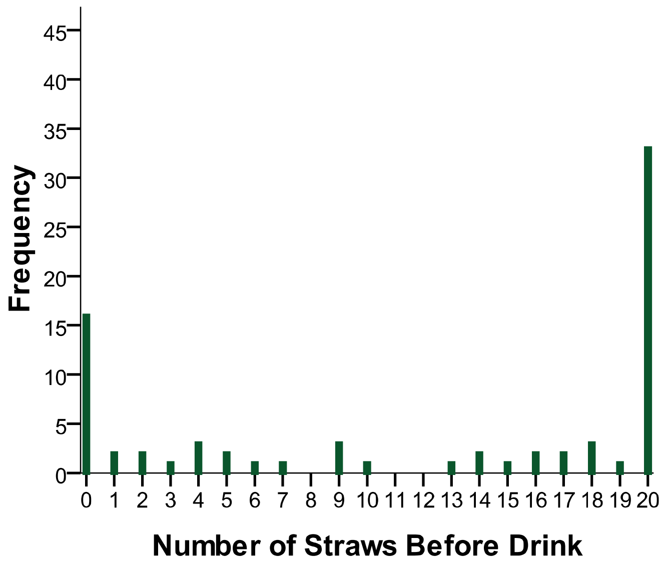


Figure 19. Study 2 Frequency Distribution of the Number of Straws Before Drank From One, Across the Whole Sample.

2.2.3.3 Relationship among indices of spread. Pearson correlations between the self-report indices of spread are presented in Table 4a. All three variables were significantly correlated with one another. Table 4b presents these same intercorrelations by condition. As can be seen, most correlations were moderate to strong. However, the relationship between physical residue and dangerousness was very high in the disease-causing bacteria condition, and the relationship between physical residue and reluctance to use ratings was low in the harmless bacteria condition.

Table 4a

Study 2 Intercorrelations (Pearson r) Among Self-report Indicators of Spread.

	1	*2*	*3*
1. AUC-Physical Residue	__	.78	.46
2. AUC-Dangerousness		__	.60
3. AUC-Reluctance to Use			__

Note. All correlations statistically significant at $p < .001$.

Table 4b

Study 2: Intercorrelations (Pearson r) Among Self-report Indicators of Spread by Condition

		1	*2*	*3*
Disease-Causing Bacteria	1. AUC-Physical Residue	__	.97*	.58*
	2. AUC-Dangerousness		__	.52*
	3. AUC-Reluctance to Use			__
Harmless Bacteria	1. AUC-Physical Residue	__	.40*	.11
	2. AUC-Dangerousness		__	.38*
	3. AUC-Reluctance to Use			__
Yogurt	1. AUC-Physical Residue	__	.64*	.52*
	2. AUC-Dangerousness		__	.80*
	3. AUC-Reluctance to Use			__

Note. * indicates that correlation is statistically significant at $p < .05$.

The mean AUC of participants' physical residue, dangerousness and reluctance to use ratings is presented in Table 5 contrasting participants who touched and drank from those who did not. Independent samples t-tests revealed that participants who touched a straw scored lower than those who did not on AUC-Reluctance to Use, t (17.70) = -5.97, $p < .001$, d = 1.51, and there were trends for them to score lower on AUC-Physical Residue t (10.82) = -1.78, p = .10, d = 0.93, and AUC-Dangerousness, t (10.34) = -2.03, p = .07, d = 1.31. Similarly, participants who drank from a straw scored higher than those who did not on AUC-Physical Residue, t (56.64) = -2.52, p = .02, d = 0.60; AUC-Dangerousness, t (37.25) = -3.68, p = .001, d = 0.93; and AUC-Reluctance to Use, t (61.26) = -10.15, $p < .001$, d = 2.40.

Table 5

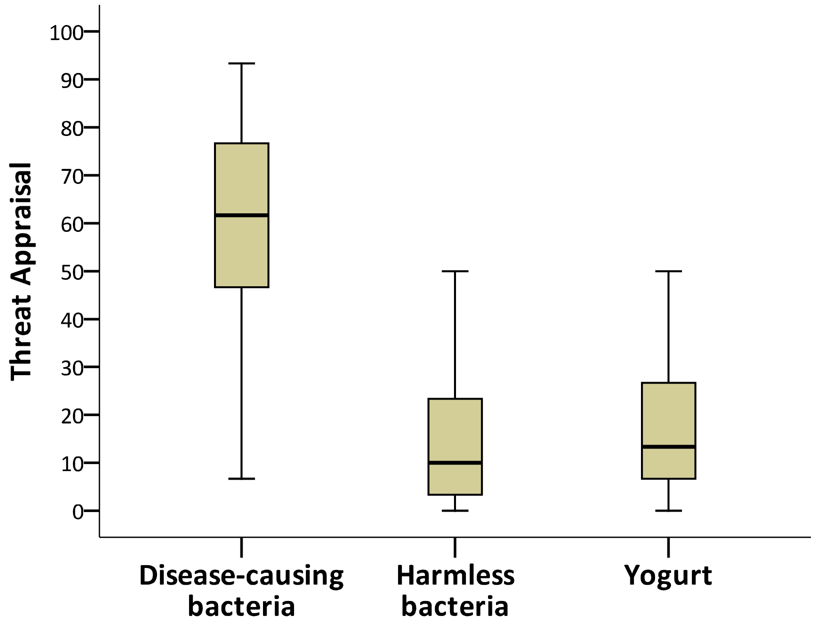
Study 2: Mean Self-Report Indicators of Spread for Participants Who Touched Or Drank From a Straw and Those Who Did Not.

	Touched (n =66)		Did not touch (n = 11)		Drink (n = 43)		Did not drink (n = 34)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
AUC								
Physical Residue	272.32	249.25	549.09	506.13	232.33	246.92	412.44	354.42
Dangerousness	166.89	204.73	563.73	642.60	99.07	123.36	381.06	433.09
Reluctance to Use	679.76	628.16	1593.64	438.41	345.81	387.29	1397.76	496.45

2.2.3.4 Randomization. A series of ANOVAs was conducted to examine whether participants across conditions differed significantly from one another on contamination-related symptoms, beliefs and/or traits (i.e., to examine whether randomization was successful). There were no significant differences between conditions on scores on the OBQ, F (2,72) = 1.67, p = .20; DSS, F (2, 72) = 1.08, p = .35; or PVD, F (2, 72) = 0.98, p = .38; nor on age, F (2, 70) = 0.72, p = .49; gender, χ^2 (2) = 1.66, p = .57; or ethnicity, χ^2 (2) = 0.65, p = .71. There was, however, a trend for conditions to differ on the PI, F (2, 72) = 3.00, p =.06, which post-hoc Tukey tests revealed was due to participants in the yogurt condition scoring lower than those in the harmless bacteria condition (p = .04) on this scale. Participants in the disease-causing bacteria condition did not differ from those in either the harmless bacteria (p = .48) or yogurt (p = .40) conditions. Subsequent analyses conducted across conditions were therefore re-run with PI entered as a covariate and are presented below where applicable.

2.2.3.5 Manipulation Check. Participants' threat appraisals of the purported substance on the cutting boards are presented in the boxplot in Figure 20. In order to test whether participants appraised the disease-causing bacteria as more threatening than the harmless bacteria and yogurt, an ANOVA was performed with condition as the fixed factor and threat appraisal as the dependent variable. There was a trend for variances to differ across conditions, as indicated by Levene's test, F (2, 73) = 2.58, p = .08. Examination of the standard deviations suggests that variability was greatest in the disease-causing bacteria condition. Thus, there tended to be somewhat greater disagreement among participants when judging the degree of threat posed by the disease-causing bacteria, but, as noted, these differences did not reach statistical significance.

With regard to mean differences between conditions, there was a significant effect of condition, F (2, 74) = 53.62, p < .001, η_p^2= 0.59. Post-hoc Games-Howell tests indicated that participants rated the disease-causing bacteria as significantly more threatening than the harmless bacteria and yogurt ($p < .001$ for both). There were no significant differences between the harmless bacteria and the yogurt ($p = .81$). When the ANOVA was repeated with PI entered as a covariate, the effect of condition remained significant, F (2, 72) = 51.59, $p < .001$, $\eta_p^2 = 0.59$. Thus, the results suggest that participants in the disease-causing bacteria condition judged the level of threat as greater than participants in the harmless bacteria and yogurt conditions. Furthermore, this was true regardless of whether differences between conditions in OCD symptoms (PI scores) were controlled for.



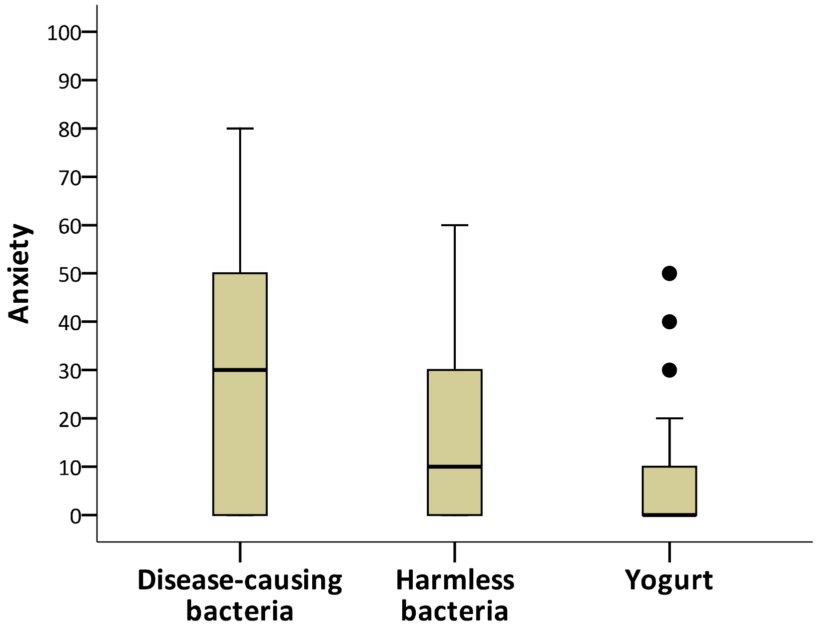
M =	58.40	15.07	17.56
SD =	21.73	14.24	14.47
n =	26	25	26

Figure 20. Study 2: Boxplot of Threat Appraisals by Condition With Means and Standard Deviations.

Participants' anxiety and disgust in response to the experimental manipulation were also examined and are presented in the boxplots in Figure 21 and 22. With regard to anxiety, variances were not equal across conditions, Levene's test: F (2, 73) = 3.26, p = .04. Examination of the standard deviations suggests that variability was greatest in the disease-causing bacteria condition. Thus, there was greater variability among participants in their experienced anxiety when faced with disease-causing bacteria.

In terms of mean differences between conditions, an ANOVA was performed with condition as the fixed variable and reported anxiety as the outcome variable. There were significant differences between conditions, F (2, 74) = 6.83, p = .002, η_p^2= .16. Post hoc Games-Howell tests revealed that participants in the disease-causing bacteria condition reported greater anxiety than participants in the yogurt condition (p = .002) and there was a trend for them to report greater anxiety than those in the harmless bacteria condition (p = .09). There was no significant difference between the harmless bacteria and yogurt conditions (p = .34).

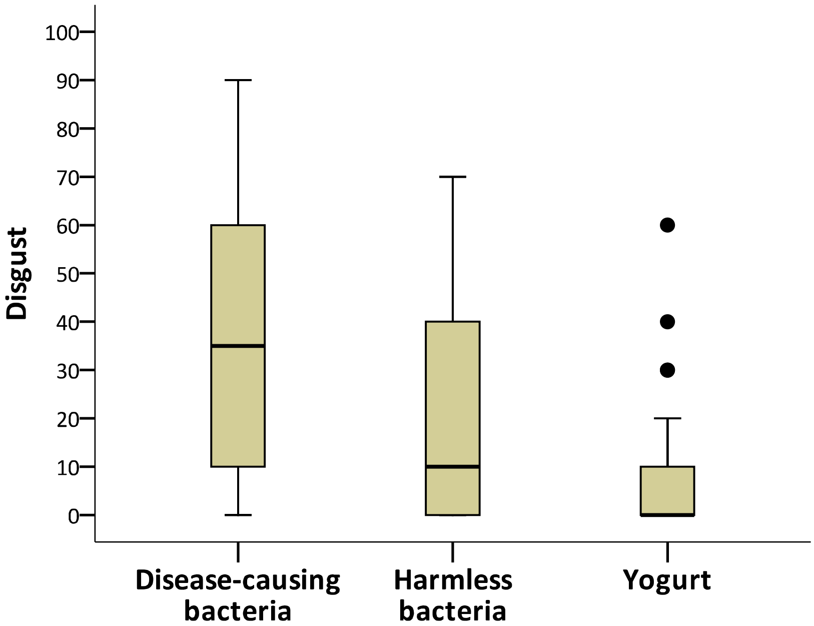
When the above ANOVA was repeated with PI entered as a covariate, the effect of condition remained significant, F (2, 72) = 5.65, p = .005, η_p^2= 0.14. Post-hoc simple contrasts indicated that participants in the disease-causing bacteria condition reported higher levels of anxiety than participants in the harmless bacteria (p = .01) and yogurt (p = .003) conditions. There was no significant difference between participants in the harmless bacteria and yogurt conditions (p = .61). Thus, in terms of the level of anxiety experienced by participants in this study, those in the disease-causing bacteria condition experienced the greatest anxiety and those in the yogurt condition the least. After controlling for differences between conditions in OCD symptoms, the effect of the manipulation was to increase anxiety among participants in the disease-causing bacteria condition.



M =	29.20	16.80	9.62
SD =	24.65	19.94	15.87
n =	26	25	26

Figure 21. Study 2: Anxiety in Response to Experimental Manipulation by Condition with Means and Standard Deviations.

With regard to disgust, the distribution of participants' scores in each condition is presented in the boxplot in Figure 22. Variances were not equal across conditions, Levene's test, F (2, 73) = 6.02, p = .004. Examination of the standard deviations and boxplot suggest that variability was smallest in the yogurt condition and greatest in the disease-causing bacteria condition. To examine differences between conditions on mean levels of disgust, an ANOVA was performed with condition as the fixed factor and disgust as the outcome variable. There was a significant effect of condition, F (2, 74) = 10.36, p < .001, η_p^2= 0.22. Posthoc Games-Howell tests revealed that participants in the disease-causing bacteria condition reported significantly greater disgust than participants in the yogurt condition (p < .001) and nearly significantly greater disgust than those in the harmless bacteria condition (p = .057). There was no significant difference in the disgust reported by participants in the harmless bacteria and yogurt conditions (p = .10). When the ANOVA was repeated with PI entered as a covariate, the effect of condition remained significant, F (2, 72) = 8.78, p < .001, η_p^2= 0.20. Post-hoc simple contrasts revealed that participants in the disease-causing bacteria condition reported significantly higher levels of disgust than participants in the harmless bacteria (p = .01) and yogurt (p < .001) conditions. There was no significance difference in the disgust reported by participants in the harmless bacteria and yogurt conditions (p = .19). Thus, in terms of the level of disgust experienced by participants in this study, those in the disease-causing bacteria condition experienced the greatest disgust and participants in the yogurt condition the least disgust.



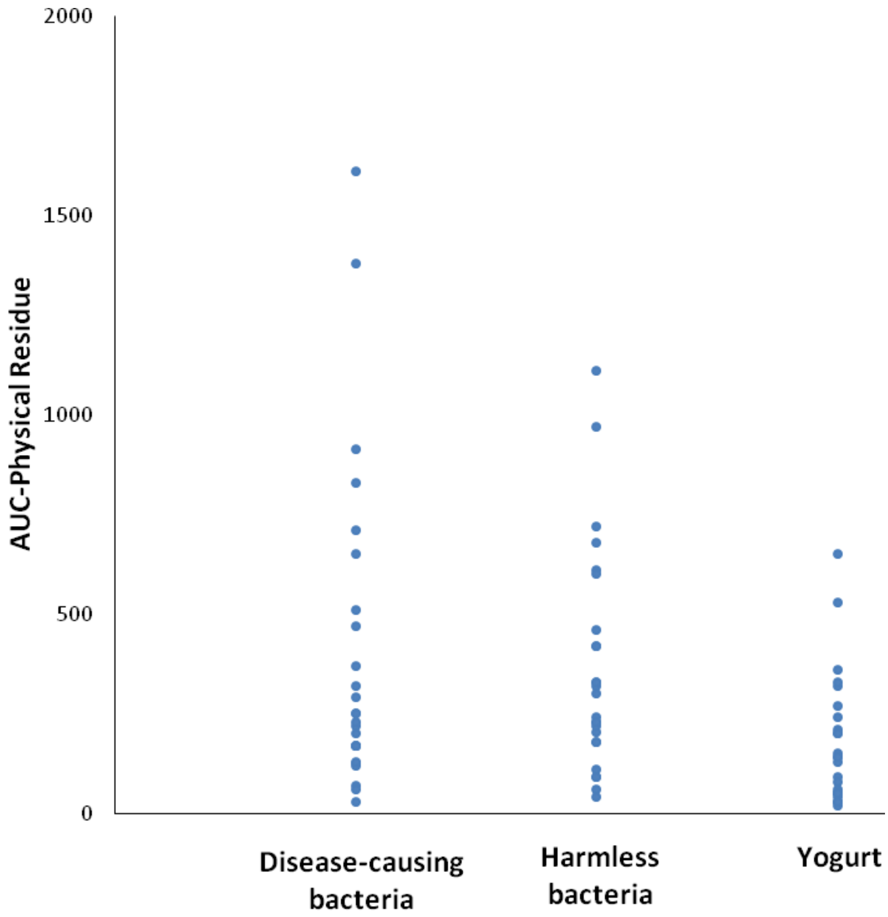
M =	36.80	20.80	9.23
SD =	28.10	23.08	15.21
n =	26	25	26

Figure 22. *Study 2: Disgust in Response to Experimental Manipulation by Condition with Means and Standard Deviations.*

2.2.3.6 Effect of experimental manipulation on judgments of spread. The purpose of this study was to examine whether threat information or identification as a contaminant increases people's judgments of spread. In keeping with our findings from Study 1, it was hypothesized that participants would judge the threatening and harmless contaminants to spread further than the non-contaminant. As in Study 1, judgments of spread included self-report indicators of spread (ratings of physical residue, dangerousness and reluctance to use along the chain of contagion), as well as behavioural avoidance tests (whether a participant touched and drank from a straw).

2.2.3.6.1 AUC-Physical residue. The amount of residue that participants believed was on the straws along the chain of contagion was compared across conditions. The AUC of participants' physical residue ratings (AUC-Physical Residue) is presented in the scatterplot in Figure 23 for each condition with means and standard deviations presented beneath. The variability in participants' AUC-Physical Residue scores was not equal across conditions, as indicated by Levene's test, F (2, 73) = 6.07, p = .004. Examination of the standard deviations and scatterplot reveals that variability was greatest in the disease-causing bacteria condition.

Focusing on mean differences between conditions on the AUC-Physical Residue, an ANCOVA was performed with condition as the fixed factor, AUC-Physical Residue as the outcome variable and PI entered as a covariate. There was a significant effect of condition, F (2, 72) = 4.11, p = .02, η_p^2 = 0.10. Post hoc simple contrasts revealed that participants in the disease-causing and harmless bacteria conditions judged the physical amount of the substance as greater along the chain of contagion than participants in the yogurt condition (p = .01 and p = .04 respectively). The disease-causing and harmless bacteria conditions did not differ significantly from one another (p = .57). Thus, on average, threat did not influence people's ratings of the physical residue along the chain of contagion as there was no difference between the disease-causing and harmless bacteria. However, threat did seem to be associated with greater disagreement among participants in their ratings of physical residue. This finding may suggest that there is a subgroup of people whose physical residue estimates are perhaps influenced by threat.

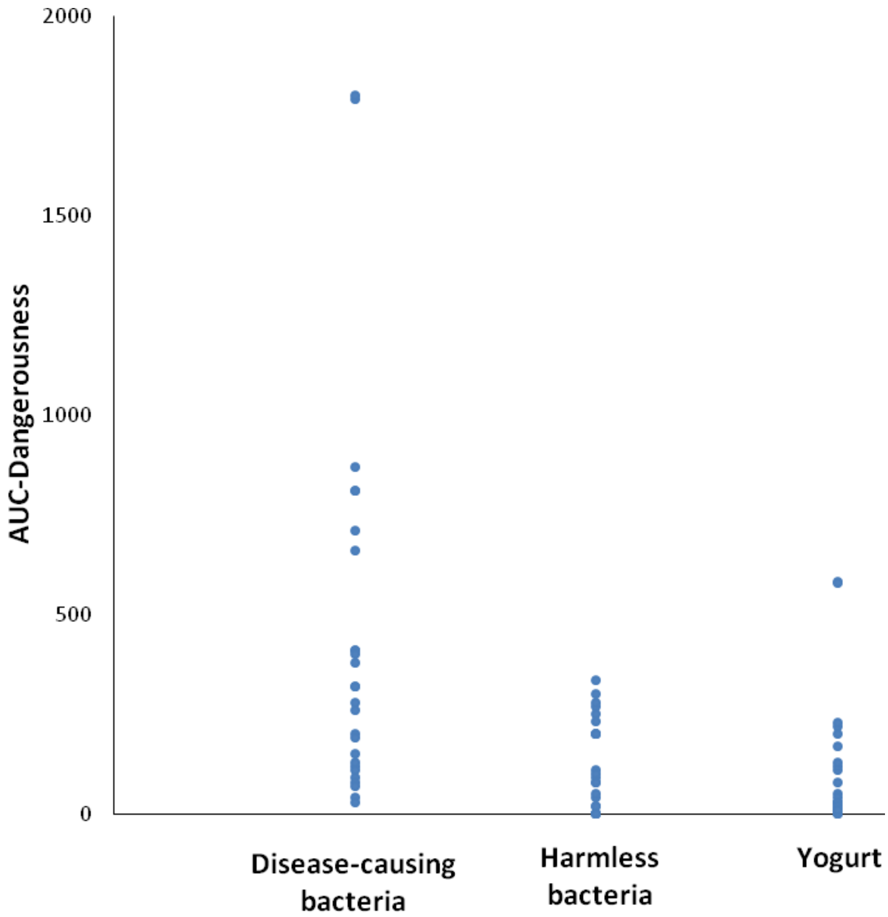


M	400.65	365.84	171.15
SD	400.64	278.98	161.08
n	26	25	26

Figure 23. *Study 2: Scatterplot of AUC-Physical Residue by Condition with Means and Standard Deviations.*

2.2.3.6.2 AUC-Dangerousness. The AUC of participants' dangerousness ratings along the chain of contagion is presented in the scatterplot in Figure 24 by condition with means and standard deviations presented beneath. Levene's test was significant, F (2, 73) = 11.63, $p < .001$, indicating that variability in participants' scores was not equal across conditions. Inspection of the standard deviations and scatterplot revealed that variability was greatest in the disease-causing bacteria condition. There was one univariate outlier in the yogurt condition who scored 3.36 standard deviations above the mean on AUC-Dangerousness. In order to reduce undue influence of this score on analyses, this score was windsorized (changed to one unit greater than the next highest score).

Focusing on mean differences across conditions on AUC-Dangerousness, an ANCOVA was performed with condition as the fixed factor, AUC-Dangerousness as the outcome variable and PI entered as a covariate. There was a significant effect of condition, F (2, 72) = 10.43, p < .001, η_p^2 = 0.23. Post-hoc simple contrasts revealed that participants in the disease-causing bacteria condition judged the level of dangerousness as greater along the chain of contagion than participants in the harmless bacteria and yogurt conditions (p < .001 for both). The harmless bacteria and yogurt conditions did not differ significantly from one another (p = .88). Thus, these findings suggest that disease-causing bacteria were associated with a higher overall level of dangerousness along the chain of contagion, as well as greater variability among individuals in their dangerousness ratings.

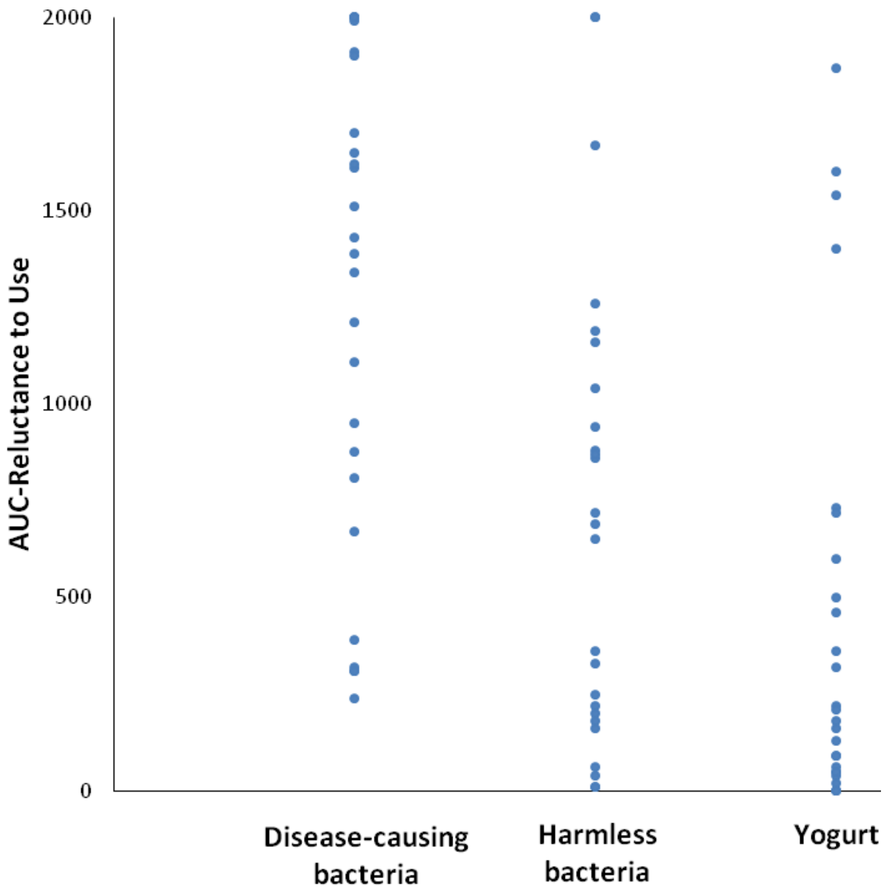


M	440.00	122.00	104.65
SD	472.21	112.42	157.25
n	26	25	26

Figure 24. Study 2: Scatterplot of AUC-Dangerousness by Condition with Means and Standard Deviations.

2.2.3.6.3 AUC-Reluctance to Use. The AUC of participants' reluctance to use ratings along the chain of contagion (AUC-Reluctance to Use) within each condition is presented in the scatterplot in Figure 25 with means and standard deviations presented beneath. Levene's test was not significant, *F* (2, 73) = 0.31, *p* = .73, indicating that variances were not significantly different across conditions. As can be seen, however, variability was large in all conditions.

With regard to mean differences between conditions on reluctance to use the straws, an ANCOVA was performed with condition as the fixed factor, AUC-Reluctance to Use as the outcome variable and PI entered as a covariate. There was a significant effect of condition, F (2, 72) = 14.45, $p < .001$, $\eta_p^2 = 0.29$. Post-hoc simple contrasts revealed that participants in the disease-causing bacteria condition reported greater reluctance to use the straws than participants in the harmless bacteria and yogurt conditions (*p* = .001 for both). The harmless bacteria and yogurt conditions did not differ significantly from one another (*p* = .19).



	Disease-causing bacteria	Harmless bacteria	Yogurt
M	1278.65	709.96	438.46
SD	618.54	600.02	554.59
n	26	25	26

Figure 25. Study 2: Scatterplot of AUC-Reluctance to Use by Condition with Means and Standard Deviations.

2.2.3.6.4 Likelihood of self-report indicators of spread reaching zero. The proportion of participants whose self-report indices of spread (physical residue, dangerousness and reluctance to use) reached zero at some point along the chain of contagion is presented in Table 6, as is the proportion of participants who touched or drank from at least one of the straws. With regard to physical residue ratings, chi square analysis was performed to examine differences between conditions in the likelihood that participants' physical residue ratings would reach zero (*None*) at some point along the chain of contagion. There was a significant effect of condition, χ^2 (2) = 10.54, p = .01, two-tailed Fisher's exact test, Cramer's V = .37. Examination of the adjusted standardized residuals revealed an increased likelihood among participants in the yogurt condition to indicate that the substance stopped physically spreading and a decreased likelihood of indicating so among participants in the harmless bacteria condition.

Turning to dangerousness ratings, chi square analysis was also performed to examine differences between conditions in the likelihood that participants' dangerousness ratings would reach zero (*Safe*) at some point along the chain of contagion. There was a significant effect of condition, χ^2 (2) = 7.12, p = .03, two-tailed Fisher's exact test, Cramer's V = .30. Examination of the adjusted standardized residuals revealed that participants in the yogurt condition had an elevated likelihood of indicating that the danger ended, while participants in the disease-causing bacteria condition had a decreased likelihood of indicating so.

In terms of participants' reluctance to use the straws, a chi square analysis was performed to examine the effect of the experimental manipulation on the likelihood that participants' reluctance ratings would reach zero (*Definitely would use*) at some point along the chain of contagion. There was a significant effect of condition, χ^2 (2) = 9.80, p = .01, two-tailed Fisher's exact test, Cramer's V = .36. Examination of the adjusted standardized residuals revealed an increased likelihood among participants in the yogurt condition to indicate that they *definitely would use* one of the straws, and a decreased likelihood of indicating so among participants in the disease-causing bacteria condition.

Table 6

Study 2: Percentage of Participants Whose Spread Ratings Reached Zero and Who Touched or Drank from a Straw.

		Percentage who indicated that:			Percentage who:	
	n	Physical residue reached *None*	Dangerousness rating reached *Safe*	*Would definitely* use a straw	Touched Straw	Drank with Straw
Disease-causing bacteria	26	50%	50%	19%	73%	23%
Harmless bacteria	25	32%	64%	36%	84%	60%
Yogurt	26	73%	85%	62%	100%	85%

2.2.3.6.5 Touch. The percentage of participants in each condition who touched a straw is presented in Table 6. Chi square analysis revealed a significant effect of condition on the likelihood that participants would touch a straw, χ^2 (2) = 8.51, *p* = .01, two-tailed Fisher's exact test, Cramer's *V* = .32. Examination of adjusted standardized residuals revealed an increased likelihood of touching a straw in the yogurt condition and a decreased likelihood of touching a straw in the disease-causing bacteria condition.

2.2.3.6.6 Drink. Table 6 also shows the percentage of participants in each condition who drank from a straw. There was a significant effect of condition on the likelihood that participants would drink from a straw, χ^2 (2) = 20.72, *p* < .001, two-tailed Fisher's exact test, Cramer's *V* = .51. Examination of the adjusted standardized residuals revealed an increased likelihood of drinking from a straw in the yogurt condition and a decreased likelihood in the disease-causing bacteria condition.

2.2.3.7 Relationship between threat appraisals and judgments of spread across the whole sample. The relationship between participants' appraisals of how threatening the substance on the cutting board was (regardless of which condition they were in) and judgments of spread was also explored. With regard to the three self-report indicators of spread (AUC of the physical residue, dangerousness and reluctance to use ratings), Pearson correlations were performed with threat appraisals. Threat appraisal was moderately correlated with each of the self-report indicators of spread: AUC-Physical Residue (r = .42, p = .001, n = 77), AUC-Dangerousness (r = .65, p < .001, n = 77) and AUC-Reluctance to Use (r = .58, p < .001, n = 77).

In terms of the two behavioural avoidance tasks, t-tests were performed to examine whether participants who touched or drank from one of the straws differed from those who did not touch or drink from any of the straws on their appraisals of threat. With regard to touch, participants who touched a straw tended to appraise the substances as less threatening than those who did not touch any of the straws, t (75) = -2.86, p = .01, d = 0.93. On average, the threat appraisal of participants who touched a straw was 27.37 (SD = 24.86, n = 66) on a scale from 0 to 100, while those who did not touch any straws had an average threat appraisal of 50.91 (SD = 27.65, n = 11). With regard to drinking with the straws, there was also a significant difference in the threat appraisals of those who drank versus not, t (53.59) = -4.97, p < .001, d = 1.20. Participants who drank with a straw had a mean threat appraisal of 18.68 (SD = 17.86, n = 43), while those who did not had a mean threat appraisal of 45.98 (SD = 27.79, n = 34). In sum, therefore, subjective appraisals of threat were associated with the self-report and behavioural indices of spread.

2.2.4 Discussion. The purpose of Study 2 was to further examine the variables that influence judgments of spread. In Study 1, I had found that, although threat information increased ratings of dangerousness and avoidance, it did not influence ratings of physical spread. Rather the disease-causing and harmless bacteria were judged to spread more than the celery. The purpose of Study 2 was to replicate Study 1 while controlling for the presence of bacteria in the non-contaminant condition. In so doing, the study provided insight into whether it was the presence of bacteria or identification as a contaminant that increased judgments of physical spread.

The pattern of findings from Study 2 closely mirrored the findings from Study 1. Participants rated the two contaminants (the disease-causing and harmless bacteria) as physically spread more than the non-contaminant (yogurt). Furthermore, as in Study 1, there was an increased likelihood of participants in the non-contaminant condition to indicate that the substance had stopped physically spreading. In addition, although threat did not increase judgments of physical spread, it did increase judgments of dangerousness and reluctance to use the straws along the chain of contagion.

The findings support the idea that identification as a contaminant increased judgments of physical spread. The findings do not support the idea that it was the presence of bacteria that increased judgments of physical spread, given that yogurt contains bacteria and yet the pattern of results was the same in Study 1.

In Study 2, participants in the harmless bacteria condition were least likely to indicate that the substance had stopped physically spreading. While this finding further suggests that threat did not increase judgments of physical spread, it is not clear why the harmless bacteria were judged to be less likely to stop physically spreading. This elevated perception of spread in the harmless bacteria condition was not found in Study 1, even though the descriptions of the disease-causing and harmless bacteria were the same in both studies. Participants in the harmless bacteria condition did tend to score higher than those in the yogurt condition on the PI, which measures OCD symptoms, suggesting the finding may simply be an anomaly specific to this sample.

Interestingly, as was found in Study 1, variability in AUC-Physical Residue was greatest in the disease-causing bacteria condition. This observation could suggest perhaps a subset of people whose judgments of physical spread are influenced by threat. Furthermore, as in Study 1, there was a moderate correlation between subjective appraisals of threat and the AUC of physical residue ratings.

With regard to ratings of dangerousness and avoidance, the findings again mirror those of Study 1. Threat was associated with higher ratings of dangerousness along the chain of contagion and participants in the disease-causing bacteria condition were least likely to indicate that the danger had ended. Furthermore, variability in the AUC of dangerousness ratings was highest in the disease-causing bacteria condition, suggesting perhaps a subgroup of people whose dangerousness are particularly strongly influenced by threat of disease information.

Threat increased reported reluctance to use the straws, as well as actual behavioural avoidance (both touching and drinking from the straws). This finding is consistent with cognitive theories of anxiety, which hold that appraisals of threat lead to anxiety, which in turn lead to behaviour aimed at reducing that anxiety (avoidance or other safety behaviour).

In addition, participants in the yogurt condition were most likely to indicate that they *would definitely* use one of the straws, and most likely to touch or drink from the straws. This finding mirrors that which was found in Study 1 with the celery and suggests that avoidance was reduced for non-contaminating food substances. The finding was the same regardless of whether bacteria were present or not.

The findings from Studies 1 and 2 provide important insight into how people make judgments about spread and the types of variables that influence those judgments. However there are limits to the generalizability of these findings. For one, these studies were conducted among a general sample of participants from UBC who were not selected for their training or concerns about contamination. Whether the findings extend to other populations of interest is not known. For instance, how health care workers and people with contamination-related OCD make judgments of spread are important to understand. It is generally believed among cognitive theorists that OCD symptoms (including contamination-related symptoms) occur along a continuum, such that individuals whose symptoms are clinically significant fall at the higher end of the continuum. In this view, research with non-clinical samples can provide important insight into the beliefs and cognitive processes integral to the disorder. However, given the findings of Tolin et al. (2004) which show quite marked contrasts in how people with OCD versus those without the disorder make judgments about spread, it is worth exploring whether the same factors do indeed influence the judgments of spread of people with contamination-related OCD.

In order to explore whether findings extend to specific populations of interest, I replicated Study 2 with a sample of nursing students (Study 3) and with a sample of people meeting diagnostic criteria for OCD (Study 4). These studies are described in Chapters 3 and 4 respectively. Comparisons across the three populations (general UBC sample, nursing students and OCD group) are then described in Chapter 5.

Chapter 3: Study 3 (Nursing students)

3.1. Introduction.

The purpose of Study 3 was to examine the variables that influence the judgments of contaminant spread of health care professionals, in particular nursing students. Health care workers, such as nurses, come into direct contact with people carrying infectious diseases and/or whose immune system is compromised on a daily basis. It is widely recognized that hand hygiene is one of the most effective and important methods of reducing the spread of infectious diseases in health care settings (Pittet, Allegranzi, & Sax, 2007). However, adherence with recommended hand hygiene guidelines among health care professionals varies considerably (estimates for adherence rates range from 5-89%) and the average is unfortunately low at 38.7% (WHO, 2009). Improving compliance with hand hygiene guidelines has therefore become a topic of great interest to researchers and public health institutions alike.

Although nurses have higher adherence rates than other health care professionals, there is still room for improvement as their average adherence rate has been estimated at 50% (Pittet et al., 1999) and nurses represent the majority of health care workers and have the greatest number of opportunities for hand hygiene behaviour (WHO, 2009). Education about the spread of germs and about appropriate hand hygiene procedures is an important component of efforts to improve compliance with established guidelines (WHO, 2009). At UBC and the British Columbia Institute of Technology (BCIT), two large educational institutions in Vancouver, nursing students are taught about the spread of germs and appropriate preventative hygiene behaviours within the first few weeks of their program (K. O'Flynn-Magee, personal communication, January 2011; K. Quee, personal communication, April 2011).

Although education is a vital component of efforts to improving hand hygiene compliance, the most significant improvements will likely be the result of multi-faceted approaches. For example, placing frequent reminders to engage in hand hygiene behavior in the health care setting, providing handrub dispensers at points of care, developing handrubs that do not cause skin irritation and creating a culture among health care professionals of adherence to hand hygiene guidelines will likely also be important components of efforts to improve compliance (Pittet, Allegranzi, & Sax, 2007). Nonetheless, education is an important component and understanding how health care professionals, such as nurses, think about and make judgments about the spread of contamination may provide insight into how to improve occupational health campaigns.

In addition to being of interest in their own right, nursing students also provide an informative comparison group with which to compare the judgments of spread of people with OCD. Like people with contamination-related OCD, nursing students must be aware of the potential for spreading germs and conscientious about taking precautions to reduce the risk of spread. As such, they may have beliefs and response tendencies regarding contaminant spread that are more easily accessible and activated than the general population. Due to their role, they may also feel a heightened sense of responsibility to prevent harm, which may mirror the inflated sense of responsibility seen among people with OCD. However, whereas nursing students have professional training in biological sciences and contamination spread and their concerns operate from this perspective, the concerns of people with OCD are driven primarily by fear.

In order to begin an exploration of the variables that influence health care workers' judgments of spread, Study 2 was replicated among a sample of nursing students. Not much is known about the judgments of spread of this population. Most research among nurses has focused on behavioural outcomes, such as whether they wash their hands at appropriate times and whether they follow recommended methods for doing so. These outcomes are clearly very important to monitor. However, a person's beliefs about spread will likely influence his or her behaviour and, as such, understanding how nurses make judgments about spread will add an important piece to the puzzle.

There were several competing hypotheses regarding nursing students' judgments of spread. One hypothesis was that, due to nursing students' specialized training and necessary focus on germs and the potential for spreading disease, they would tend to judge substances as spreading more than the general population. Furthermore, because of nursing students' role in preventing the spread of disease, they may be particularly cautious about disease-causing bacteria and therefore view disease-causing bacteria as spreading more easily. From this perspective, it was hypothesized that nursing students' judgments of spread would be influenced by the threat of disease. An alternative hypothesis was that, because of their education about spread, nursing students may recognize that threat of disease does not influence ease of spread, and therefore view all three substances as spreading equally. The third hypothesis was that nursing students' judgments of spread would be similar to that of the general UBC sample. From this perspective, nursing students' judgments of spread would either not be influenced by their training or role in preventing disease, or the influence of these factors would not extend to outside the healthcare context (in this series of studies, judgments of spread were assessed in a food preparation context).

3.2 Method

3.2.1 Participants. Forty-nine nursing students from UBC and BCIT participated in this study. Because nursing students learn about contaminant spread and hygiene practices in the first semester of their Bachelors of Nursing Science (BSN) degree, I recruited BSN students who had completed at least the first semester of their program. Students completing their Masters or PhD in nursing were also invited to participate. Nursing student participants were on average 27.83 (SD = 7.62) years old and there were more women (n = 47) than men (n = 2). Most participants were either of European (56%) or Asian (27%) origin. The remaining 17% were composed of participants of Indian, African, Middle Eastern or mixed ethnic origin. Participants were paid $10 for their participation.

3.2.2 Materials. Participants completed the same questionnaires as in Study 2: the demographics form, the Padua Inventory (PI), the Obsessive-Beliefs Questionnaire (OBQ), the Disgust Sensitivity Scale (DSS) and the Perceived Vulnerability to Disease questionnaire (PVD).

3.2.3. Procedure. The procedure was essentially the same as Study 2. The only exception is that, in order to accommodate nursing students' schedules, the study was conducted at three different locations: the Douglas Kenny Building (which houses the Department of Psychology at UBC and where Studies 1 and 2 were conducted), UBC Hospital and BCIT.

3.2.4. Statistical Analyses. Statistical analyses were conducted in the same manner as Studies 1 and 2. The number of nursing student participants needed to achieve sufficient statistical power was calculated based on the effect size found in Study 2. In order to detect an effect size of η_p^2 = 0.17, with power (1 - β) at .80 and α at .05, a total of 48 participants were needed (16 in each condition). Forty-nine nursing students participated.

3.3 Results

3.3.1 Missing Data and Outliers. There were no missing data. There was, however, one multivariate outlier in the disease-causing bacteria condition whose pattern of responses appeared to be quite different from the others in this condition. This participant appeared to rate the physical residue as fairly low, but to rate dangerousness as high and to engage in high levels of avoidance. In order to reduce this score having undue influence on the analyses, this participant's data was removed from analyses. Univariate outliers are described where applicable.

3.3.2 Distribution of Data Across the Whole Study

3.3.2.1 Threat Appraisal. Figure 26 shows the frequency distribution of participants' appraisals of how threatening the purported substance on the cutting board was for the entire sample. As can be seen, participants' appraisals of threat tended to be positively skewed (skewness = 0.83, z_s = 2.43). Similar to the general UBC sample in Study 2, nursing students' mean threat appraisal was fairly low (on a scale from 0 to 100, *M* = 26.25, *SD* = 21.40, *n* = 48).

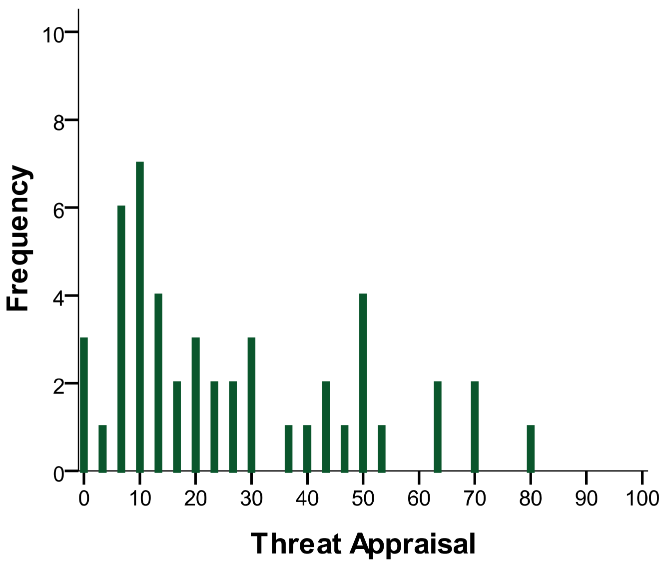


Figure 26. Study 3: Frequency Distribution of Threat Appraisals Across the Whole Sample.

3.3.2.2 Physical Residue. The frequency distribution in Figure 27 shows the AUC of participants' physical residue ratings (AUC-Physical Residue) for the whole sample. As can be seen, participants' scores on this variable tended to be positively skewed (skewness = 1.73, z_s = 4.97) and fairly low (with possible scores ranging from 0 to 2000, M = 401.83, SD = 436.47). Thus, overall, nursing students tended to rate the amount of physical residue along the chain of contagion as fairly low.

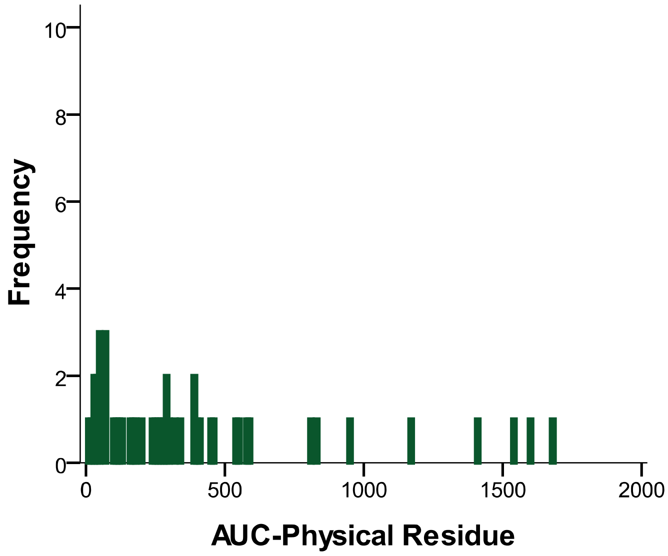


Figure 27. Study 3: Frequency Distribution of AUC-Physical Residue Across the Whole Sample.

3.3.2.3 Dangerousness. The AUC of participants' dangerousness ratings (AUC-Dangerousness) for the whole sample are presented in the frequency distribution in Figure 28. As can be seen, the distribution was positively skewed (skewness = 2.05, z_s = 5.97) and the mean was fairly low (with possible scores ranging from 0 to 2000, M = 257.90, SD = 311.30). Therefore nursing students tended to rate the level of dangerousness along the chain of contagion as quite low.

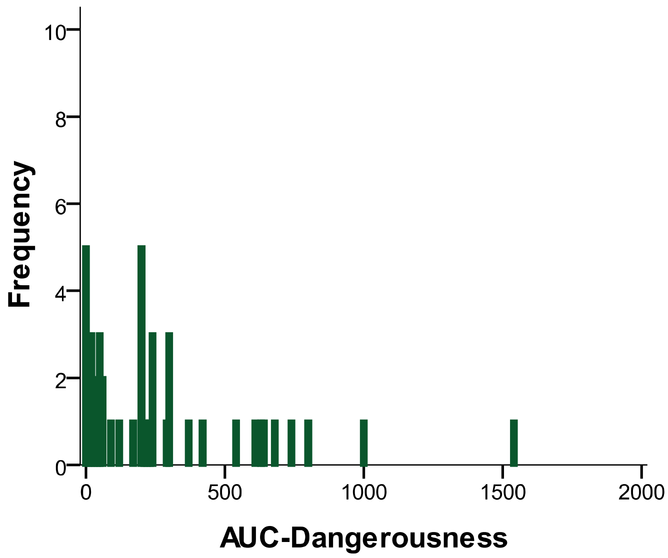


Figure 28. Study 3: Frequency Distribution of AUC-Dangerousness Across the Whole Sample.

3.3.2.4 Reluctance to Use. The frequency distribution in Figure 29 shows the AUC of participants' reluctance to use ratings along the chain of contagion (AUC-Reluctance to Use). There was good variability in participants' scores (skewness = 0.11, z_s = 0.32) and, on average, participants reported moderate levels of reluctance to use the straws (with possible scores ranging from 0 to 2000, *M* = 852.50, *SD* = 646.31). Thus, nursing students reported moderate reluctance to use the straws.

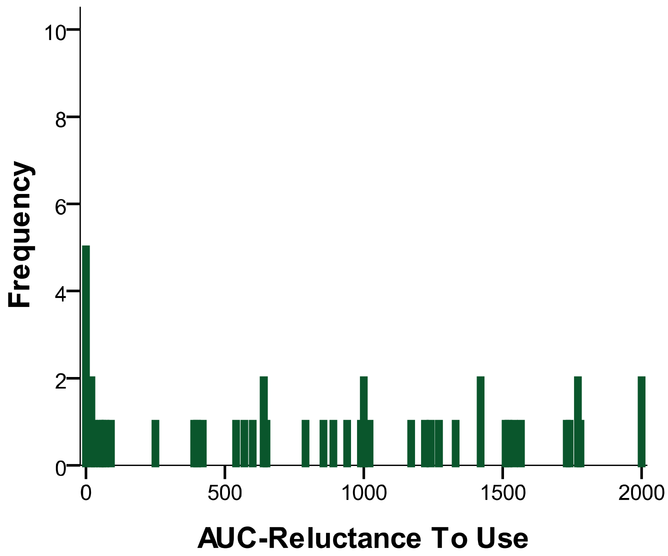


Figure 29. Study 3: Frequency Distribution of AUC-Reluctance to Use Across the Whole Sample

3.3.2.5 Touch. The number of straws before nursing students were willing to touch one is depicted in the frequency distribution in Figure 30. As can be seen, the distribution tended to be bimodal with 71% of nursing students touching the first straw, 13% not touching any of the straws and the remaining touching one of the other straws along the chain of contagion. The mean number of straws before nursing student were willing to touch one was 4.15 (on a scale ranging from 0 to 20, *SD* = 7.41). Thus the majority of nursing students engaged in no avoidance of touching the straws.

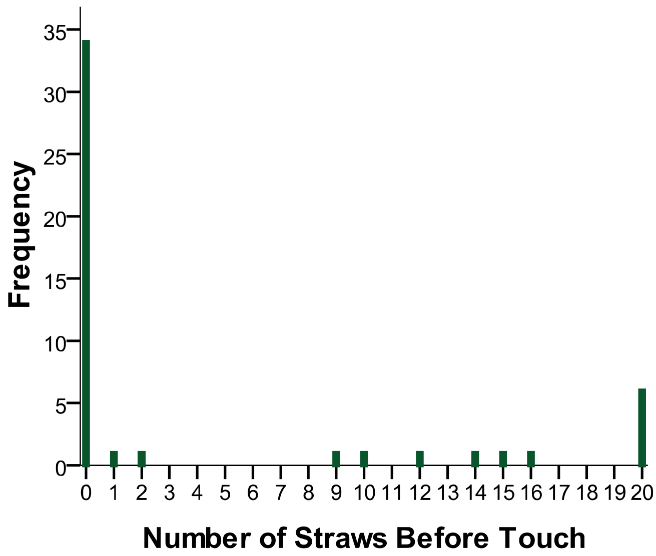


Figure 30. Study 3: Frequency Distribution of the Number of Straws Before Participants Touched One, Across the Whole Sample.

3.3.2.6 Drink. The number of straws before participants were willing to drink from one is shown in the frequency distribution in Figure 31. As can be seen, there was again a bimodal distribution, with 38% of participants not drinking from any of the straws, 29% drinking from the first straw and the remaining drinking from one of the other straws along the chain of contagion. The mean number of straws before nursing students were willing to drink from one was 10.75 (on a scale from 0 to 20, SD = 8.97).

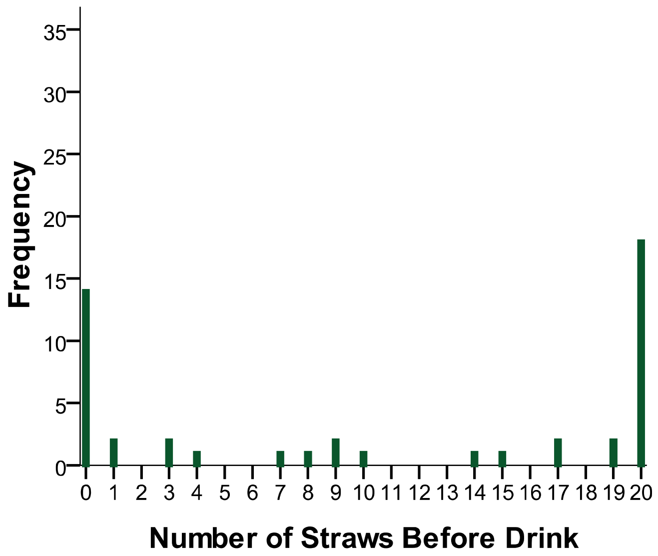


Figure 31. Study 3: Frequency Distribution of Number of Straws Before Participants Drank from One, Across Whole Sample.

3.3.3 Relationship among indices of spread. Pearson correlations between the three self-report indices of spread (the AUC of physical residue, dangerousness and reluctance to use ratings along the chain of contagion) are presented in Table 7a. All three were moderately correlated with one another. Table 7b presents these same intercorrelations by condition. Most correlations were moderate to large, except for the correlation between physical residue and dangerousness which was very high in the disease-causing bacteria condition, and the correlation between physical residue and reluctance to use which was fairly low in the harmless bacteria and yogurt conditions.

Table 7a

Study 3: Intercorrelations (Pearson r) Among Self-report Indicators of Spread

	1	*2*	*3*
1. AUC-Physical Residue	__	.64	.40
2. AUC-Dangerousness		__	.67
3. AUC-Reluctance to Use			__

Note. All correlations statistically significant at p < .05.

Table 7b

Study 3: Intercorrelations (Pearson r) Among Self-report Indicators of Spread by Condition

		1	*2*	*3*
Disease-Causing Bacteria	1. AUC-Physical Residue	__	.95*	.55*
	2. AUC-Dangerousness		__	.62*
	3. AUC-Reluctance to Use			__
Harmless Bacteria	1. AUC-Physical Residue	__	.49*	.32
	2. AUC-Dangerousness		__	.67*
	3. AUC-Reluctance to Use			__
Yogurt	1. AUC-Physical Residue	__	.43	.28
	2. AUC-Dangerousness		__	.65*
	3. AUC-Reluctance to Use			__

Note. * indicates that correlation is statistically significant at p < .05.

Table 8 shows the mean AUC of nursing students' physical residue, dangerousness and reluctance to use ratings contrasting participants who touched or drank with a straw with those who did not. Independent samples t tests revealed a trend for nursing students who touched a straw to score higher on AUC-Physical Residue, t (46) = -1.80, p = .08, d = 0.79, and Dangerousness, t (5.33) = -2.06, p = .09, d = 1.54, than those who did not. Those who touched a straw had significantly higher AUC-Reluctance to Use scores than those who did not, t (11.81) = -6.52, p < .001, d = 1.75. With regard to drinking from the straws, nursing students who drank did not differ from those who did not on AUC-Physical Residue, t (46) = -0.90, p = .38, d = 0.27. They did, however score higher on AUC-Dangerousness, t (24.18) = -3.29, p = .003, d = 1.11, and AUC-Reluctance to use, t (46) = -6.38, p < .001, d = 1.90.

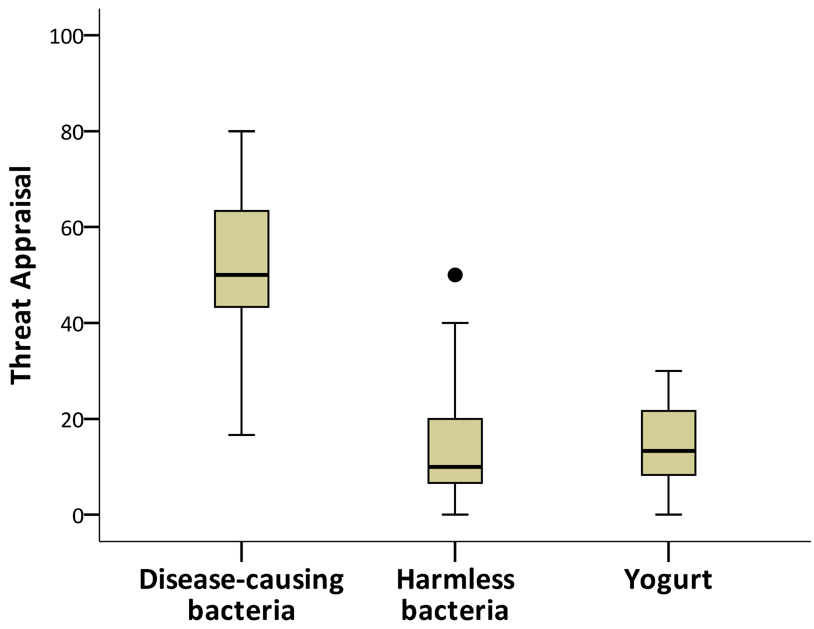
Table 8

Study 3: Mean Self-report Indicators of Spread for Participants Who Touched Or Drank From a Straw and Those Who Did Not.

	Touched (*n* =42)		Did not touch (*n* = 6)		Drank (*n* = 30)		Did not drink (*n* = 18)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
AUC								
Physical Residue	359.95	411.92	695.00	530.61	358.00	471.16	474.89	372.78
Dangerousness	204.26	238.17	633.33	502.46	143.00	211.56	449.39	359.79
Reluctance to Use	729.76	587.18	1711.67	294.92	513.17	514.61	1418.06	401.54

3.3.4. Randomization. A series of ANOVAs suggested that randomization was successful. There were no significant differences between conditions on participants' age, F (2, 45) = 2.17, p = .10; or on scores on the PI, F (2, 45) = 0.55, p = .58; OBQ, F (2,45) = 0.60, p = .55; Disgust Sensitivity Scale, F (2, 45) = 0.72, p = .49; or Perceived Vulnerability to Disease, questionnaire, F (2, 45) = 0.13, p = .88. Furthermore, chi square analyses revealed no significant differences between conditions on gender, χ^2 (2) = 1.29, p = 1.00; or ethnicity, χ^2 (2) = .39, p = .41.

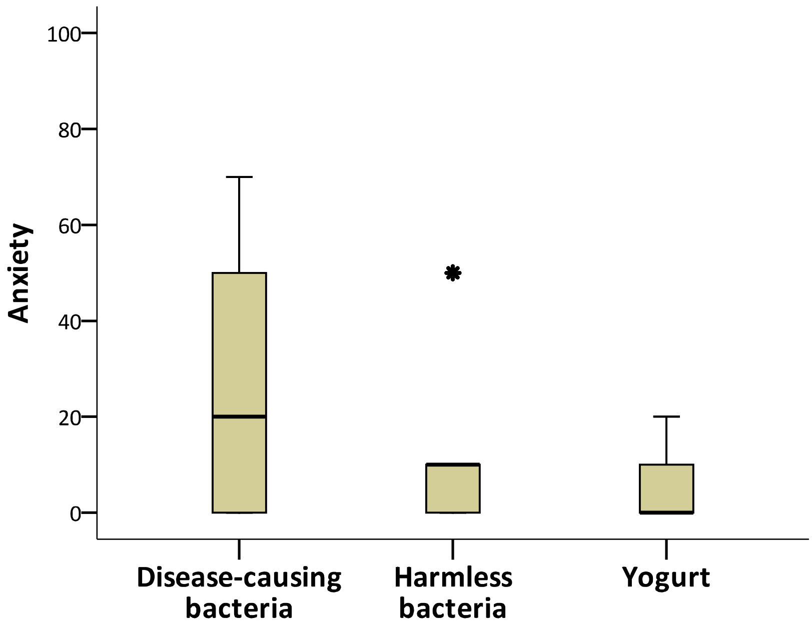
3.3.5 Manipulation Check. Participants' appraisals of how threatening the substance on the cutting board was in each condition are displayed in the boxplot in Figure 32, with means and standard deviations provided beneath. Variances were not significantly different across conditions, as indicated by Levene's test, F (2, 45) = 1.93, p = .16. To ensure participants appraised the disease-causing bacteria as more threatening than the harmless bacteria and yogurt containing probiotic bacteria, an ANOVA was performed with condition as the fixed factor and threat appraisal as the dependent variable. There was a significant effect of condition, F (2, 45) = 32.86, p < .001, η_p^2 = 0.59. Tukey's post hoc test indicated that the disease-causing bacteria was appraised as more threatening than the harmless bacteria and yogurt (p < .001 for both), and there was no significant difference between the harmless bacteria and yogurt (p = .98). Thus, the manipulation was effective in influencing nursing students' appraisals of threat.



M	50.44	14.90	15.63
SD	17.36	14.49	8.84
n	15	17	16

Figure 32. Study 3: Threat appraisals by condition.

Participants' anxiety and disgust in response to the experimental manipulation are displayed in the boxplots in Figures 33 and 34 with means and standard deviations provided beneath. With regard to anxiety, variances were not equal across conditions, Levene's test, F (2, 45) = 12.57, $p < .001$. Examination of the standard deviations and boxplot reveal that variability was greatest in the disease-causing bacteria condition. Focusing on mean differences in anxiety, an ANOVA revealed significant differences among conditions, F (2, 45) = 4.36, $p = .02$, $\eta_p^2 = .16$. Post-hoc Games-Howell tests indicated that participants in the disease-causing bacteria condition were significantly more anxious than participants in the yogurt condition ($p = .03$). Participants in the harmless bacteria condition did not report significantly less anxiety than those in disease-causing bacteria ($p = 0.50$), but there was a trend for them to report greater anxiety than those in the yogurt condition (p = 0.09). Thus, participants in the yogurt condition tended to be consistent in reporting low levels of anxiety, while participants in the disease-causing tended to vary more in their anxiety and, overall, tended to report low-to-moderate levels of anxiety. Participants in the harmless bacteria condition generally reported low anxiety, but there were three participants who reported moderate levels of anxiety (indicated by the black circle in the boxplot), which is likely what accounted for the elevated variability in this condition.

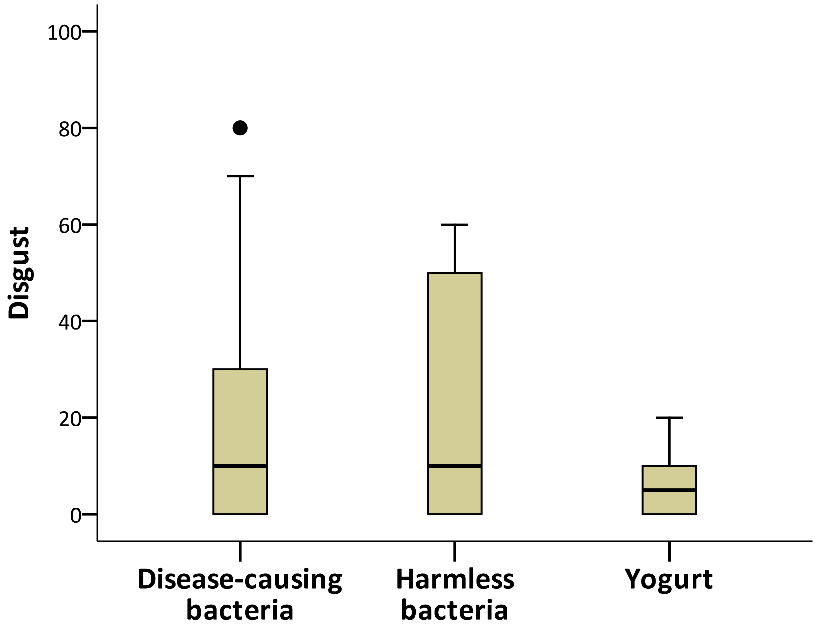


M	26.00	15.88	4.38
SD	28.74	20.02	7.27
n	15	17	16

Figure 33. Study 3: Boxplot of Anxiety in Response to Experimental Manipulation, by Condition with Means and Standard Deviations.

In terms of disgust, Levene's test was significant, F (2, 45) = 8.36, p = .001, indicating that variances differed across conditions. Examination of the standard deviations and boxplot in

Figure 51 reveals that variability was smallest in the yogurt condition. With regard to mean differences between conditions in disgust, an ANOVA found a trend for differences between conditions, F (2, 45) = 2.46, p = 0.10, η_p^2 = .10. Based on the means and distributions of scores, it appears that nursing students in the yogurt condition tended to respond with similarly low levels of disgust, while those in the disease-causing and harmless bacteria conditions tended to vary more and, on average, reported low-moderate levels of disgust.



	Disease-causing bacteria	Harmless bacteria	Yogurt
M	21.33	18.82	6.25
SD	26.42	22.88	7.19
n	15	17	16

Figure 34. Study 3: Disgust in Response to Experimental Manipulation, by Condition with Means and Standard Deviations.

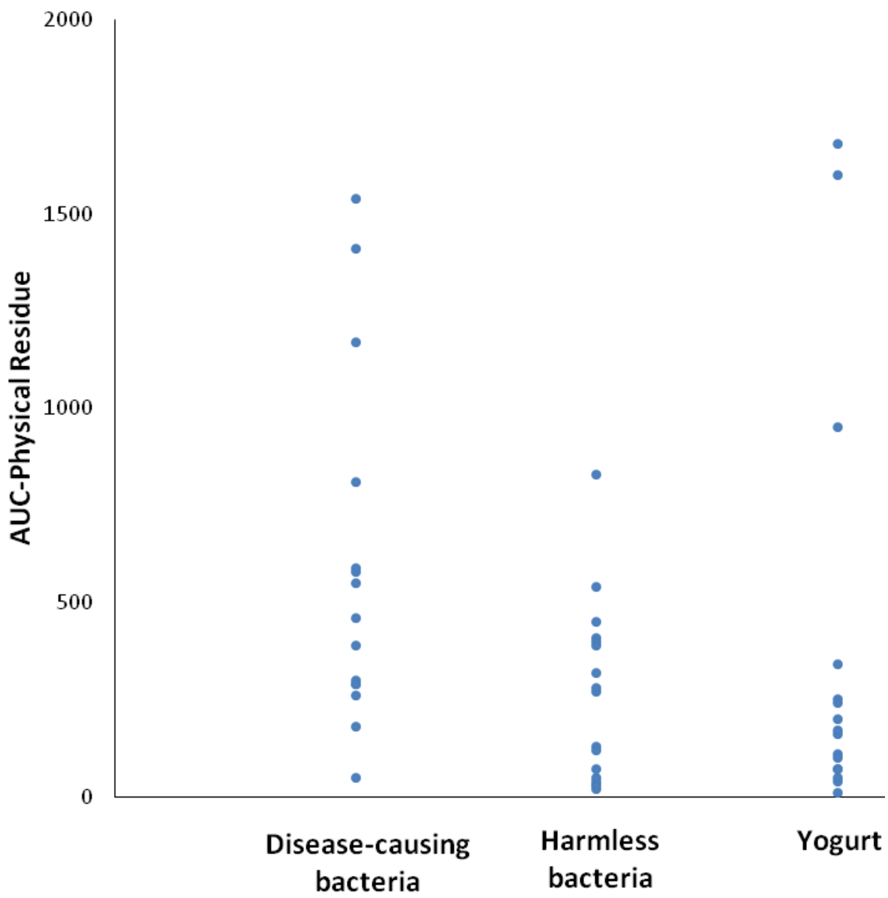
3.3.6 Effect of location. Unlike Studies 1 and 2, nursing students participated in this study at various locations, including the UBC Psychology Department, UBC Hospital and BCIT. In order to ensure that the location did not affect the manipulation, an ANOVA was conducted with location and condition entered as fixed variables and threat appraisal as the outcome variable. Although (as expected) there was a significant effect of condition on nursing students' threat appraisals, F (2, 39) = 15.71, p < .001, η_p^2 = .45, there was no significant effect of location, F (2, 39) = 0.58, p = .57, η_p^2 = .03, nor a significant interaction between location and condition, F (4, 39) = 0.54, p = .71, η_p^2 = .05. Thus, location did not affect nursing students' response to the experimental manipulation.

3.3.7 Effect of experimental manipulation on judgments of spread

3.3.7.1 AUC-Physical Residue. Nursing students' ratings of the physical residue were compared across conditions. The AUC of participants' physical residue ratings (AUC-Physical Residue) within each condition are presented in the scatterplot in Figure 35, with means and standard deviations presented beneath. There was a trend for variances to differ cross conditions as indicated by Levene's test, F (2, 45) = 2.53, p = .09. Examination of the scatterplot suggests that participants across the three conditions tended to rate physical residue as low (with scores of approximately 500 or below, on a scale from 0 to 2000), but there appeared to be a subset of participants, particularly in the disease-causing bacteria and yogurt conditions that tended to rate physical residue as moderate to high.

In order to examine mean differences between conditions on participants' physical residue ratings, an ANOVA was conducted with condition as the fixed factor and the AUC-Physical Residue as the outcome variable. There was a trend for an effect of condition, F (2, 45) = 2.52, p = .09, η_p^2 = 0.10. Posthoc Games-Howell tests revealed that participants in the disease-causing bacteria condition rated the physical residue as greater than participants in the harmless bacteria condition (p = .04), but not differently from the yogurt condition (p = .46). There was no significant difference between the harmless bacteria and yogurt conditions (p =

.69). The results suggest that nursing students tended to agree more in rating the physical residue of the harmless bacteria as low. When rating the disease-causing bacteria and yogurt, there tended to be greater variability in nursing students' physical residue ratings and the scatterplot suggests that there may be a subset of nursing students whose physical residue ratings tended to be elevated in these conditions.

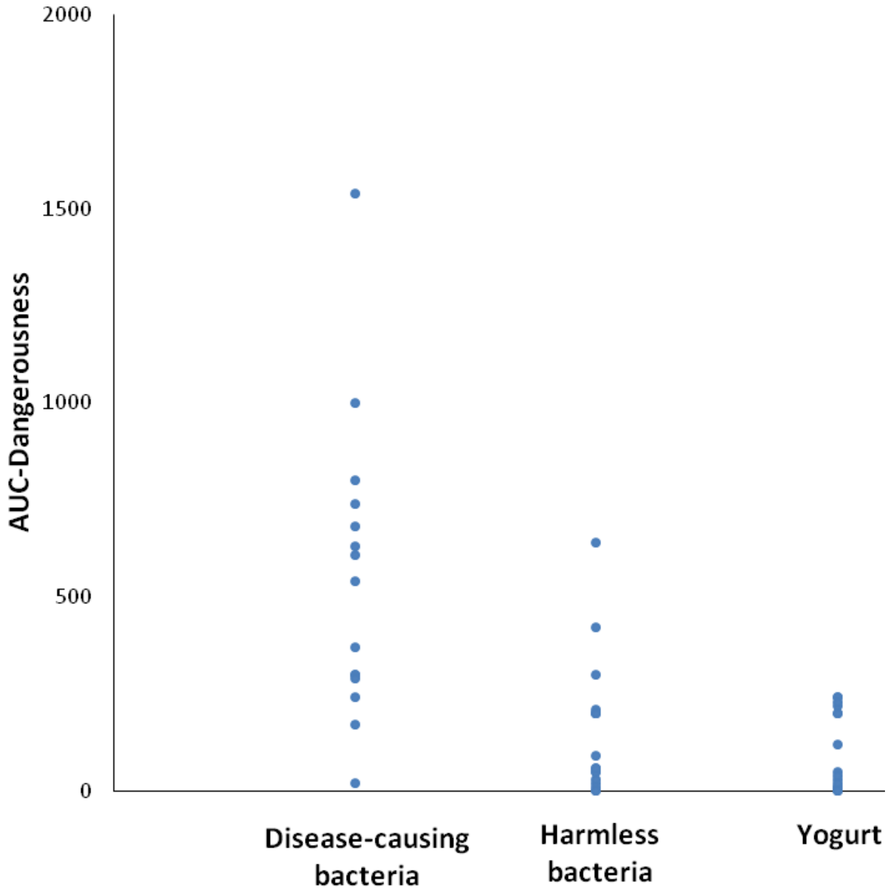


	Disease-causing bacteria	Harmless bacteria	Yogurt
M	591.20	257.65	377.50
SD	451.27	227.89	539.82
n	15	17	16

Figure 35. Study 3: Scatterplot of AUC-Physical Residue, by condition with means and standard deviations.

3.3.7.2 AUC-Dangerousness. Participants' dangerousness ratings were compared across conditions. The AUC of dangerousness ratings (AUC-Dangerousness) within each condition is presented in the scatterplot in Figure 36 with means and standard deviations presented beneath. Levene's test was significant, $F\,(2, 45) = 7.26$, $p = .002$, indicating that variances were not equal across conditions. Examination of the standard deviation and scatterplot reveal that variability was greatest in the disease-causing bacteria condition.

Focusing on mean differences between conditions on their AUC-Dangerousness, an ANOVA was performed with condition as the fixed factor and the AUC-Dangerousness as the outcome variable. There was a significant effect of condition, $F\,(2, 45) = 15.58$, $p < .001$, $\eta_p^2 = 0.41$. Post-hoc Games-Howell tests revealed that participants in the disease-causing bacteria condition judged the level of dangerousness as greater along the chain of contagion than participants in the harmless bacteria ($p = .004$) and yogurt ($p = .001$) conditions. The harmless bacteria and yogurt conditions did not differ significantly from one another ($p = .59$). Thus, the disease-causing bacteria tended to evoke greater variability in nursing students' ratings of dangerousness along the chain of contagion and led to a higher mean rating of dangerous than the harmless bacteria and yogurt containing probiotic bacteria.

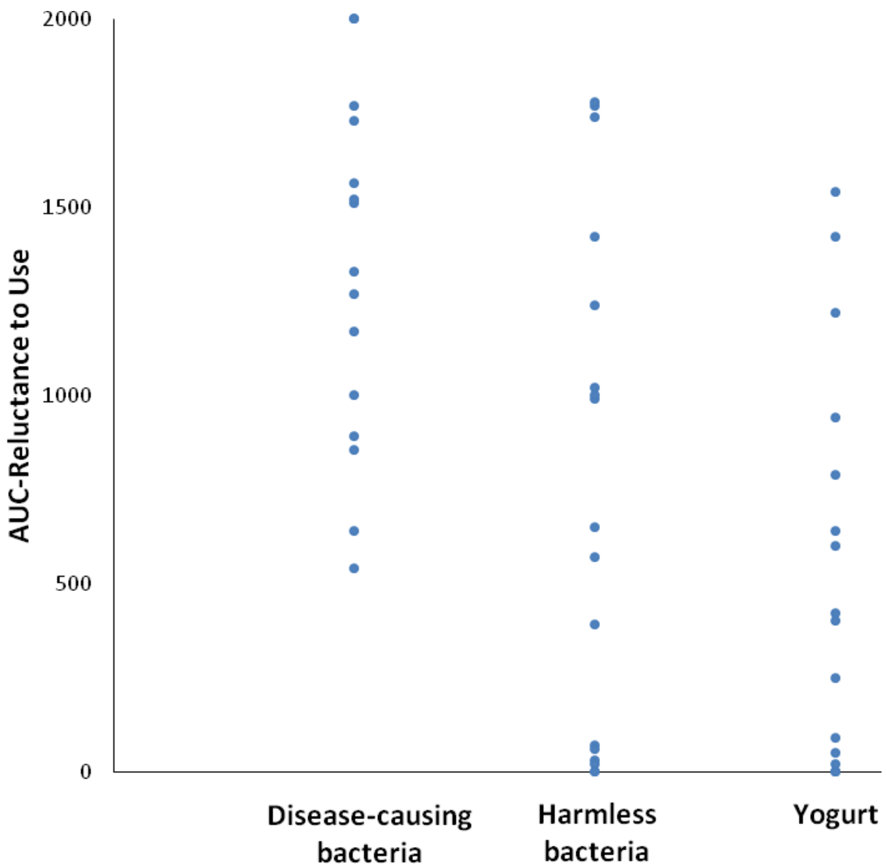


	Disease-causing bacteria	Harmless bacteria	Yogurt
M	548.60	149.41	100.63
SD	383.08	173.62	101.49
n	15	17	16

Figure 36. Study 3: Scatterplot of AUC-Dangerousness Ratings by Condition, with Means and Standard Deviations.

3.3.7.3 Reluctance to Use. Participants' reluctance to use the straws was compared across conditions. The AUC of participants' reluctance to use ratings (AUC-Reluctance to Use) is presented in the scatterplot in Figure 37 with means and standard deviations presented beneath. Variances did not differ significant across conditions, as indicated by Levene's test, F $(2, 45) = 2.31$, $p = .11$.

Focusing on differences in the mean AUC-Reluctance to Use across conditions, an ANOVA was performed with condition as the fixed factor and the AUC-Reluctance to Use as the outcome variable. There was a significant effect of condition, F (2, 45) = 8.06, p = .001, η_p^2 = 0.26. Post-hoc Tukey tests revealed that participants in the disease-causing bacteria condition reported greater reluctance to use the straws than participants in the harmless bacteria (p = .02) and yogurt (p = .001) conditions. There was no difference between the reported reluctance of participants in the harmless bacteria and yogurt conditions (p = .49). Thus threat appeared to increase nursing students' reported reluctance to use the straws.



	Disease-causing bacteria	Harmless bacteria	Yogurt
M	1319.33	750.00	523.75
SD	465.29	673.15	527.55
n	15	17	16

Figure 37. Study 3: Scatterplot of AUC-Reluctance to Use Ratings by Condition, with Means and Standard Deviations.

3.3.7.4 Likelihood of subjective indicators of spread reaching zero. Table 9 displays the percentage of participants in each condition whose spread ratings reached zero (i.e., whose physical amount ratings reached *None*, whose dangerousness ratings reached S*afe* or whose reluctance to use ratings reached *Definitely would use*) at some point along the chain of contagion. Table 9 also displays the percentage of participants in each condition who touched or drank from one of the straws, regardless of how far along the chain of contagion it was. With regard to physical residue, chi square analysis revealed that there was no significant effect of condition on the likelihood that nursing students would indicate that the substance had stopped physically spreading (i.e., that the rating of physical reside would reach *None*), χ^2 (2) = 1.31, p = .59, two-tailed Fisher's exact test, Cramer's V = 0.16. In terms of dangerousness, there was also no difference between conditions on the likelihood of participants' ratings reaching S*afe*, χ^2 (2) = 2.96, p = .24, two-tailed Fisher's exact test, Cramer's V = 0.25. Similarly, with regard to reluctance to use, there was no significant difference between conditions on the likelihood of participants' ratings reaching *Definitely would use*, χ^2 (2) = 2.83, p = .24, two-tailed Fisher's exact test, Cramer's V = 0.25.

3.3.7.5 Touch. The percentage of nursing students who touched one of the straws is presented in Table 9 by condition. As can be seen, most nursing students (88%) touched a straw, and there was no significant difference between conditions on the likelihood that nursing students would do so, χ^2 (2) = 3.67, p = .19, two-tailed Fisher's exact test, Cramer's V = .27.

3.3.7.6 Drink. The percentage of nursing students who drank with one of the straws is presented in Table 9. For this behavioural outcome, there was a significant effect of condition, χ^2 (2) = 7.89, p = .02, two-tailed Fisher's exact test, Cramer's V = .42. Examination of the adjusted standardized residuals revealed an increased likelihood of drinking among participants in the yogurt condition and a decreased likelihood of drinking among participants in the disease-causing bacteria condition.

Table 9

Study 3: Percentage of Participants Whose Spread Ratings Reached Zero and Who Touched or Drank from a Straw.

		Percentage who indicated that:			Percentage who:	
	n	Physical residue reached *None*	Dangerousness rating reached *Safe*	*Would definitely* use a straw	Touched Straw	Drank with Straw
Disease-causing bacteria	15	40%	40%	27%	80%	33%
Harmless bacteria	17	59%	65%	47%	82%	71%
Yogurt	16	56%	69%	56%	100%	81%

3.3.8 Relationship between threat appraisals and judgments of spread across the whole sample. Pearson correlations were performed between nursing students' appraisals of how threatening the substance on the cutting board was and the three self-report indices of spread. Across the whole sample, appraisals of threat were moderately correlated with each of the self-report indices of spread: physical residue (r = .38, p < .001), dangerousness (r = .58, p < .001) and reluctance to use (r = .50, p < .001).

With regard to the behavioural avoidance tasks, t tests were performed to examine whether nursing students who touched or drank from the straws differed in threat appraisals from those who did not. With regard to touch, participants who touched a straw tended to appraise the substances as less threatening than those who did not touch any of the straws, t (46) = -2.09, p = .04, d = 0.91. On average, the threat appraisal of participants who touched a straw was 23.89 (*SD* = 20.64, *n* = 42) on a scale from 0 to 100, while those who did not touch any straws had an average threat appraisal of 42.78 (*SD* = 20.91, *n* = 6). With regard to drinking with the straws, there was also a significant difference in the threat appraisals of those who drank versus not, t (46) = -3.88, $p < .001$, d = 1.16. Participants who drank with one of the straws had a mean threat appraisal of 18.11 (*SD* = 18.27, *n* = 30), while those who did not had a mean threat appraisal of 39.81 (*SD* = 19.62, *n* = 18). Thus, when considering subjective evaluations of threat, regardless of which experimental condition they were in, there was a relationship between threat appraisals and each of the five indices of spread.

3.4 Discussion The purpose of this study was to examine the variables that influence nursing students' judgments of spread. There was a trend for nursing students to judge physical residue as greater in the disease-causing bacteria condition than in the harmless bacteria condition, but no different from the yogurt. Although this effect did not reach statistical significance, the magnitude of the effect size (η_p^2 = 0.11) was similar to that obtained in Study 2 for this same analysis (η_p^2 = 0.10). Furthermore, there was a moderate correlation between nursing students' subjective threat appraisals and their ratings of physical residue along the chain of contagion. These findings suggest that threat might increase nursing students' judgements of physical spread.

However, these differences did not reach statistical significance in this study and should therefore be interpreted with caution. Furthermore, nursing students did not judge the disease-causing bacteria to physically spread more than the yogurt, which one would expect if it was threat that increased judgments of physical spread. There were a couple of participants with particularly elevated scores in the yogurt condition—although these participants were not significant outliers, their scores may have inflated the mean AUC-Physical Residue score in the yogurt condition. There was also no significant effect of condition on the likelihood of nursing students indicating that physical spread had ended. This finding could support the idea that nursing students judged all bacteria-containing substances to spread to an equal number of surfaces, regardless of whether the bacteria were threatening or not. Nursing students, as noted, do receive special education about the spread of germs, which may allow them to make judgments of physical spread that are more independent of characteristics unrelated to spread (such as whether the substance is known to cause disease or is a non-contaminant). Taken together, these findings suggest that although threat did not affect the likelihood of nursing students indicating that physical spread ended, there appeared to be a tendency for threat to increase judgments of the level of physical residue along the chain of contagion.

With regard to judgments of dangerousness along the chain of contagion, threat increased dangerousness ratings along the chain of contagion. Like the general UBC sample, the AUC of nursing students' dangerousness ratings along the chain of contagion was highest in the disease-causing bacteria condition. There was also a moderate correlation between nursing students' subjective evaluations of threat and the AUC of their dangerousness ratings. However, there was no statistically significant difference between conditions in the likelihood of nursing students indicating that the danger had ended.

Similarly, the AUC of nursing students' ratings of their reluctance to use the straws was greatest in the disease-causing bacteria. This finding mirrors that which was found among the general UBC sample and suggests that threat of disease increases intention to avoid. Furthermore, as in Study 2, there was a significant correlation between nursing students' subjective threat appraisals and the AUC of their reluctance to use ratings. However, there were no significant differences between conditions in the likelihood that nursing students would indicate that they would definitely use one of the straws.

With regard to touching the straws, most nursing students touched one of the straws and there was no significant effect of condition on their likelihood of doing so. This finding is not surprising given that nursing students chose a profession, and are being trained, to work in an environment that requires frequent contact with bacteria and other pathogens. Thus, one might reasonably expect nursing students to be willing to touch a range of substances, especially given that all participants were assured that they could wash their hands afterward. However, nursing students who touched a straw tended to have lower subjective appraisals of threat than those who did not. This discrepancy suggests that, although manipulated, objective threat information did not have a significant effect on nursing students' willingness to touch the straws, their subjective evaluations of threat may have influenced their behaviour. If so, such a finding would also be consistent with cognitive theories of anxiety, which tend to emphasize the importance of subjective evaluations over objective information about threat in determining a person's fear and avoidance.

In terms of drinking, however, there was a significant effect of condition. Nursing students were least likely to drink in the disease-causing bacteria condition and most likely in the yogurt condition. Furthermore, nursing students who drank from at least one of the straws had significantly lower appraisals of threat than those who did not. While hands can be washed and disinfected after touching an infectious agent, drinking involves ingestion of the substance and cannot be easily reversed. Therefore, although nursing students were quite willing to touch the straws in the disease-causing bacteria condition, it is not surprising that they would be less likely to drink from them. With respect to their increased likelihood of drinking in the yogurt condition, this finding suggests that nursing students engage in the least avoidance when the substance involves a non-contaminant/food.

Chapter 4: Study 4 (Participants with OCD)

4.1 Introduction

The purpose of Study 4 was to examine the variables that influence the judgments of spread of people with OCD. People with contamination-related OCD tend to have excessive judgments of spread (Rachman, 2006; Tolin et al., 2004). More specifically, Tolin et al. (2004) found that people with contamination-related OCD tend to view the level of contamination as being persistent and non-degrading along the chain of contagion. This view of contamination as spreading very easily can lead to more and more objects and places being judged as contaminated, which, in turn, can lead to greater avoidance, distress and functional impairment (Rachman, 2006).

Examining what factors lead to these increased judgments of spread in OCD is valuable as it may improve our understanding of the various cognitive mechanisms involved in the disorder and perhaps point to additional factors to target in treatment. Contamination concerns have often been conceptualized as occurring along a continuum of severity, ranging from mild, occasional concerns to the severe debilitating concerns seen in OCD (Rachman, 2006) and there is some evidence to support this view (Gibbs, 1996). However, the little research that has been done on judgments of spread among people with OCD suggests that their judgments of spread are quite different from people without the disorder (Tolin et al., 2004). As such, although Studies 1 and 2 provided interesting insight into the variables that influence how a general, unselected sample of people make judgments of spread, it seemed valuable to extend this research to include a group of people with contamination-related OCD. As in much clinical research, the sample size that I was able to obtain for this study was small for logistical reasons and findings should be interpreted in light of accumulating research in the field (Streiner, 2006).

4.2 Method

4.2.1 Participants. Twenty-one people who met diagnostic criteria for OCD participated and were included in analyses in this study. Posters advertising the study were placed on UBC campus inviting people who identified themselves as high in contamination concerns to contact the laboratory. Prospective participants who contacted the laboratory were then assessed over the phone to determine whether they met the study's inclusion and exclusion criteria. There were three inclusion criteria: that participants meet diagnostic criteria for contamination-related OCD, that they be fluent in English and that they be at least 18 years of age. Participants were excluded if they reported current problems with alcohol or substance abuse/dependence or psychosis due to concerns that these conditions might influence participants' perceptions and judgments. Participants were also excluded if they were at moderate-high risk of suicide because I did not want to place these more vulnerable individuals in a potentially distressing situation. One hundred and two people completed the phone screen, 23 of whom met criteria for the study. However, one person did not participate in the study and one person no longer endorsed any symptoms on the self-report Yale-Brown Obsessive Compulsive Scale (YBOCS) upon arrival at the laboratory and was therefore excluded from analysis. As such, a total of 21 participants' data was included in the analysis.

Participants were, on average, 26.10 years old (SD = 9.47) and there were more women (n = 13) than men (n = 8). Most were students (n = 17, 81 %), although some worked full-time (n = 4, 19 %) and part-time (n = 6, 29 %) and one participant was retired. Most participants were either of Asian (52 %) or of European (33 %) origin. The remaining 15 % were composed of participants of Indian and Hispanic origin.

Participants' scores on self-report questionnaires of OCD-related symptoms and beliefs were elevated and within the range of means reported in previous published research among people with OCD. On the self-report YBOCS, which is a measure of OCD symptom severity, the mean for this study's participants was 19.69 (*SD* = 6.72), which is similar to the mean reported in previous research among a treatment seeking sample of people with OCD (*M* = 21.4, *SD* = 5.4; Steketee, Frost, & Bogart, 1996). Similarly, on the Padua Inventory (PI), this study's participants had a mean of 73.82 (*SD* = 22.87) on the total scale, and 27.81 (*SD* = 5.96) on the contamination/washing subscale, while the means reported in previous research among people with OCD were 54.93 (*SD* = 16.72) for the total scale and 13.87 (*SD* = 7.96) for the contamination/washing subscale (Burns, Keortge, Formea, & Sternberger, 1996).

4.2.2 Materials Participants completed the same questionnaires as Study 2: the demographics form, the Padua Inventory (PI), the Obsessive-Beliefs Questionnaire (OBQ), the Disgust Sensitivity Scale (DSS) and the Perceived Vulnerability to Disease questionnaire (PVD). In addition to these questionnaires, participants also completed select modules from the Mini International Neuropsychiatric Interview (MINI) during the phone screen and the self-report version of the YBOCS.

4.2.2.1 Mini International Neuropsychiatric Interview (MINI). Selected modules from the MINI were administered to prospective participants during the phone screen. The MINI is a short structured diagnostic interview that assesses a range of psychiatric disorders (including mood, anxiety, substance use and eating disorders). Each section, which corresponds to a different disorder, begins with 1 or 2 screening questions. If the participant endorses the screening question(s), the interviewer proceeds to ask more detailed questions. If the participant does not endorse the screening question, the interviewer moves on to the next section. In order to keep the phone screen brief, only sections relevant to the inclusion and exclusion criteria were administered (i.e., the sections assessing: OCD, suicidality, substance dependence/abuse and psychotic disorders).

The MINI has been shown to have good reliability and validity. Sheehan et al. (1998) found the interrater reliability to be excellent (for all disorders κ was above 0.75 and for OCD it was 1.00), as well as the test-retest reliability (for most disorders, it was above 0.75 and for OCD it was 0.85). The MINI was also shown to have good convergent validity with the Structured Clinical Interview for DSM Disorders (SCID). The positive predictive value (the proportion of people who had been positively identified as having OCD using the SCID who were also identified as having OCD using the MINI) was good at 0.68 and the negative predictive value (the proportion of people who had been identified as not having OCD using the SCID who were also identified as not having OCD on the MINI) was excellent at 0.98. Sensitivity (the proportion of patients with the disorder that should be detected) was adequate at 0.62 and specificity (the ability to screen out patients without the disorder) was excellent at 0.98. Thus, while use of the MINI during the phone screen may have led to missing some potential participants for this study, it likely screened out most people who did not meet diagnostic criteria for OCD.

4.2.2.2 Yale-Brown Obsessive Compulsive Scale (YBOCS)—Self-Report Version. In order to get a sense of the severity of participants' obsessive-compulsive symptoms, participants completed the self-report YBOCS. The YBOCS is a measure designed to assess the severity of OCD symptoms. It was originally developed as an interview and clinician-rated scale (Goodman et al., 1989), but a self-report version has since been developed (Baer et al., 1993). This self-report version lists 58 obsessions and compulsions organized into different themes (contamination, checking, arranging, etc). Participants place a check mark next to any of the obsessions or compulsions that they have experienced, and to indicate whether each is experienced currently or in the past. They are then asked to circle the two obsessions that are most upsetting and the two compulsions that cause them the most difficulty. They then rate their main obsessions and main compulsions with respect to 5 questions each: the time spent on the obsessions/compulsions, how much the obsessions/compulsions interfere with their functioning, the distress associated with the obsessions/compulsions, how much they try to resist the obsessions/compulsions and how much control they have over the obsessions/compulsions. Thus, there was a total of 10 questions that participants responded to on a scale from 0-4 with higher scores indicating greater symptom severity. The YBOCS has been shown to have good reliability and convergent validity, but weaker criterion-related validity (Steketee, Frost, & Bogart, 1996). It was not developed as a screening tool and therefore does not have established clinical cutoff points. Rather it was used simply as a measure of OCD symptom severity.

4.2.3 Procedure. The procedure was essentially the same as Study 2 with a few exceptions. First, phone screens were performed with all prospective participants to ensure that they met eligibility criteria for the study. Second, participants also completed the self-report YBOCS as part of the questionnaire package.

4.2.4 Statistical analyses. Statistical analyses were conducted in the same manner as Studies 1, 2 and 3, with regard to the statistical tests employed and the independent and dependent variables included. Based on the findings of Tolin et al. (2004) and on the results of

Studies 1 and 2, a larger difference between conditions on judgments of spread was expected for participants with contamination-related OCD (specifically, the expected effect size was estimated to be $\eta_p^2 = 0.74$). Power analyses indicated that a total sample size of 21 participants would be needed to detect this size of effect and, as such, 21 people with contamination-related OCD participated in this study.

4.3 Results.

4.3.1 Missing Data and Outliers. There were no missing data, nor multivariate outliers. Univariate outlying scores are discussed where applicable.

4.3.2 Distribution of Data Across the Whole Sample

4.3.2.1 Threat appraisal. Figure 38 shows the frequency distribution of participants' threat appraisals for the entire sample of OCD participants. As can be seen, there was good variability in appraisals of threat (skewness = 0). Overall, participants tended to rate the substances as moderately threatening; the mean threat appraisal, on a scale from 0 to 100, was 49.84 (*SD* = 23.44, *N* = 21).

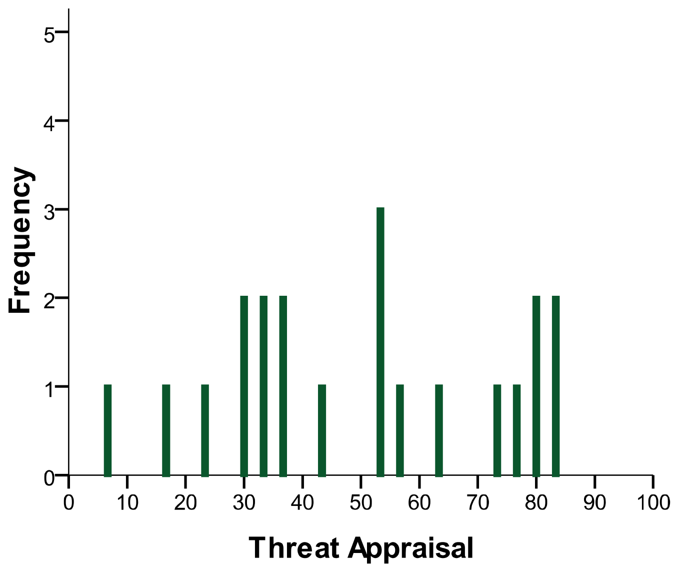


Figure 38. Study 4: Frequency Distribution of Threat Appraisals for the Whole Sample.

4.3.2.2 Physical Residue. The AUC of participants' physical residue ratings across the whole sample are presented in the frequency distribution in Figure 39. There was good variability in participants' AUC-Physical Residue scores (skewness = 0.68, z_s = 1.36) and, overall, participants tended to rate the amount of physical residue in the moderate range (with possible scores ranging from 0 to 2000, *M* = 681.81, *SD* = 456.96, *N* = 21).

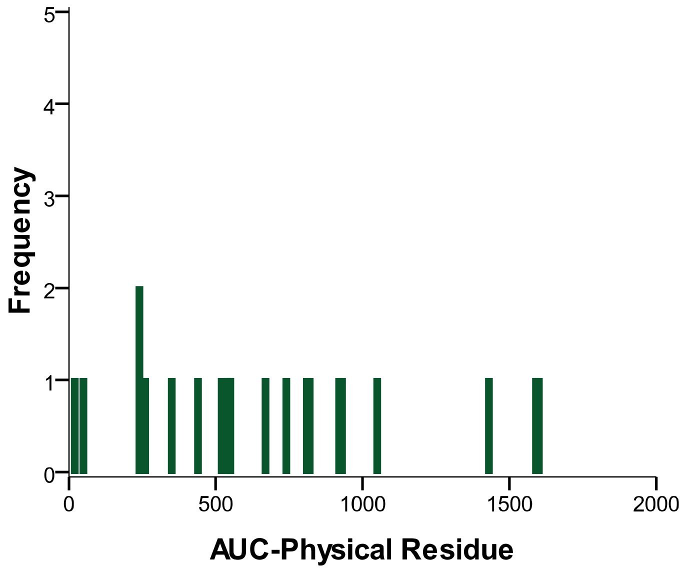


Figure 39. Study 4: Frequency Distribution of the AUC-Physical Residue Across the Whole Sample.

4.3.2.3 Dangerousness. The frequency distribution in Figure 40 depicts the AUC of participants' dangerousness ratings across the whole sample. As can be seen, there was good variability in participants' dangerousness ratings (skewness = 0.46, z_s = 0.92) and participants tended to rate the level of dangerousness as moderate (with possible scores ranging from 0 to 2000, *M* = 632.14, *SD* = 471.08, *N* = 21).

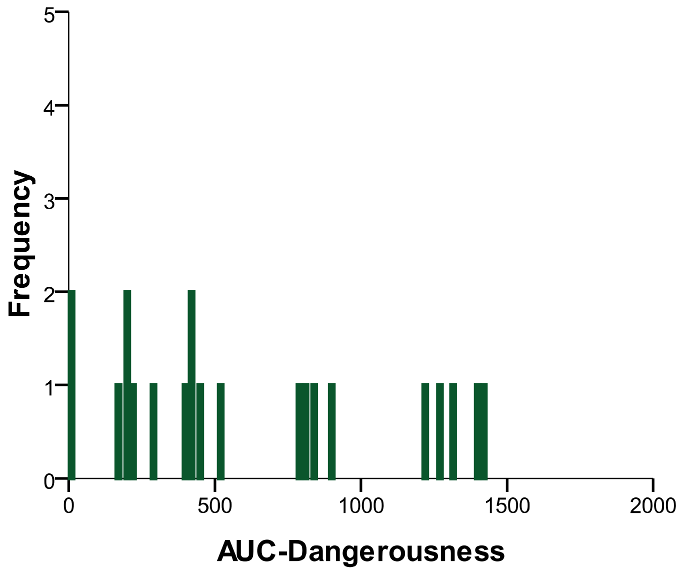


Figure 40. Study 4: Frequency Distribution of the AUC-Dangerousness Across the Whole Sample.

4.3.2.4 Reluctance to Use. The AUC of participants' reluctance to use ratings across the whole sample are presented in the frequency distribution in Figure 41. As shown, there was acceptable variability in participants' reluctance to use ratings (skewness = -0.80, z_s = 0.92) and, overall, participants tended to report fairly high levels of reluctance (with possible scores ranging from 0 to 2000, *M* = 1460.48, *SD* = 581.23, *N* = 21).

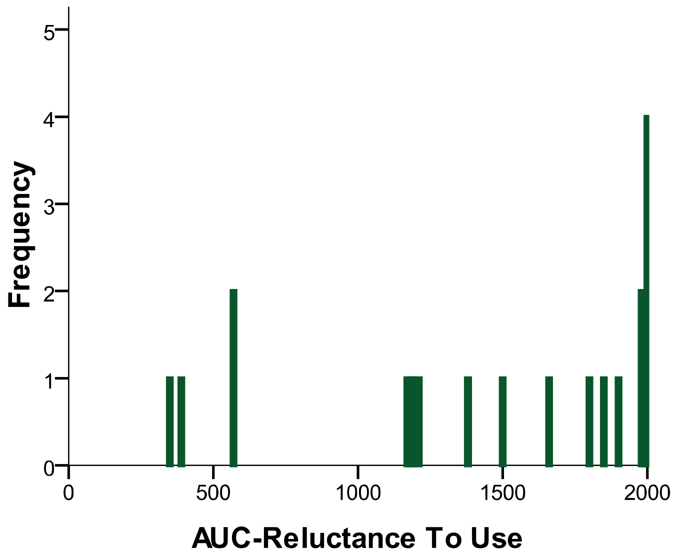


Figure 41. Study 4: Frequency Distribution of the AUC-Reluctance to Use Across the Whole Sample.

4.3.2.5 Touch. The number of straws before participants were willing to touch a straw is depicted in the frequency distribution in Figure 42. As can be seen, 8 out of 21 (38 %) participants did not touch any of the straws, only 1 participant touched the first straw and the remaining participants touched one of the other straws along the chain of contagion. Variability was acceptable (skewness = -0.63, z_s = -1.26) and participants tended to touch straws that were quite far removed from the source: the mean number of straws before participants were willing to touch one was 13 (*SD* = 7.72).

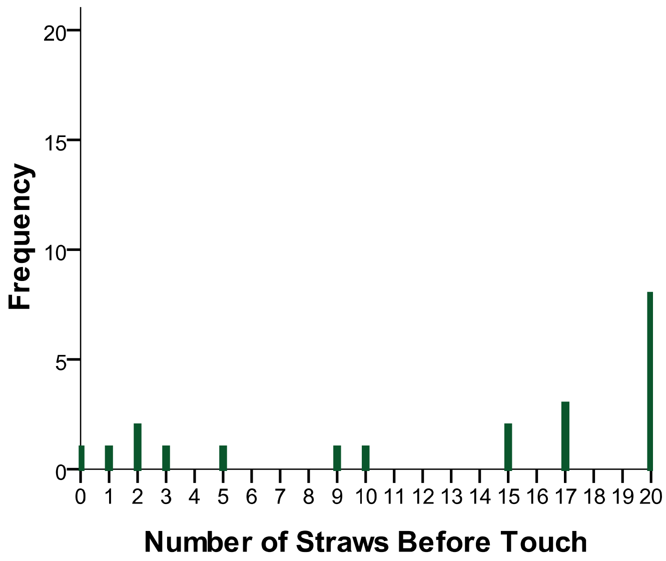


Figure 42. Study 4: Frequency Distribution of the Number of Straws Before Participants Touched One Across the Whole Sample.

4.3.2.6 Drink. The number of straws before participants were willing to drink from one is depicted in the frequency distribution in Figure 43. As can be seen, this variable was highly negatively skewed (skewness = -2.20, z_s = -4.39), and most participants (81 %) did not drink from any of the straws. The mean number of straws before participants were willing to drink from one was 18.33 (*SD* = 4.05).

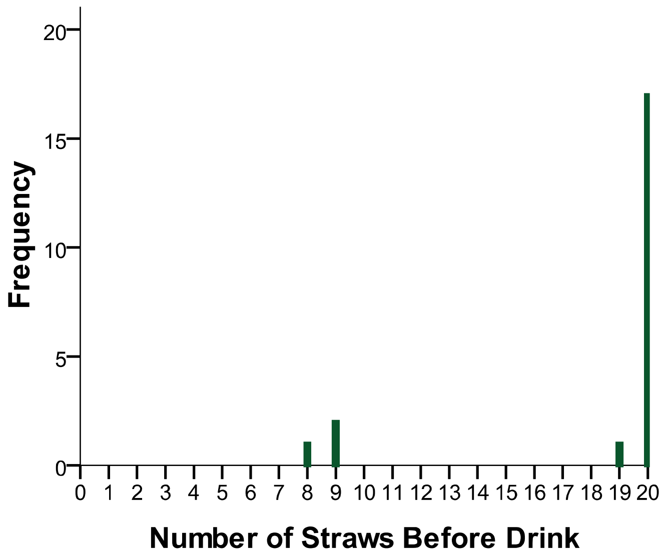


Figure 43. *Study 4: Frequency Distribution of the Number of Straws Before Participants Drank With One, Across the Whole Sample*.

4.3.3 Relationship between indices of spread. Pearson correlations between the self-report indices of spread are presented in Table 10a. All three variables were significantly correlated with one another and, as can be seen, the correlation between AUC-Physical Residue and AUC-Dangerousness was particularly high. This finding suggests that ratings of physical residue and of dangerousness were strongly associated with each other among OCD participants. Table 10b presents these same intercorrelations by condition. Cell frequencies are low and correlations should be interpreted with caution. However, there is suggestion that correlations are fairly strong overall. However, the correlation between physical residue and dangerousness was particularly high in the harmless bacteria and yogurt conditions, and the correlations between reluctance to use and both physical residue and dangerousness were low in the disease-causing bacteria condition.

Table 10a

Study 4 (OCD) Intercorrelations (Pearson r) Among Self-report Indicators of Spread

	1	*2*	*3*
1. AUC-Physical Residue	__	.87	.56
2. AUC-Dangerousness		__	.60
3. AUC-Reluctance to Use			__

Note. All correlations statistically significant at $p < .05$.

Table 10b

Study 4: Intercorrelations (Pearson r) Among Self-report Indicators of Spread by Condition

		1	*2*	*3*
Disease-Causing Bacteria	1. AUC-Physical Residue	__	.76*	-.12
	2. AUC-Dangerousness		__	.23
	3. AUC-Reluctance to Use			__
Harmless Bacteria	1. AUC-Physical Residue	__	.96*	.70
	2. AUC-Dangerousness		__	.70
	3. AUC-Reluctance to Use			__
Yogurt	1. AUC-Physical Residue	__	.90*	.61
	2. AUC-Dangerousness		__	.62
	3. AUC-Reluctance to Use			__

Note. * indicates that correlation is statistically significant at $p < .05$.

OCD participants who touched or drank from a straw were also compared with those who did not on self-report indices of spread. Means and standard deviations are presented in Table 11. Independent samples t-tests were performed to compare those who touched or drank from those who did not. Participants who touched a straw had moderately lower scores on AUC-Physical Residue and AUC-Dangerousness than those who did not, although these differences did not reach statistical significance, t (19) = -1.26, p = .22, d = 0.57 and t (19) = -1. 59, p = .13, d = 0.72, respectively. Participants who touched a straw scored lower on AUC-Reluctance to Use than those who did not, t (12.74) = - 4.88, p < .001, d = 1.72. With regard to drinking from the straws, those who drank had moderately higher scores on AUC-Physical Residue that those who did not, although this difference did not reach statistical significance, t (19) = -1.23, p = .23, d = 0.68. Furthermore, those who drank with a straw had lower scores on AUC-Dangerousness, t (12.45) = -2.72, p = .02, d = 0.93; and AUC-Reluctance to Use, t (19) = -2.82, p = .01, d = 1.57.

Thus, the performance on the behavioural avoidance tasks (touching and drinking from the straws) was associated with reported reluctance to use the straws. Furthermore, the results suggest that participants who tended to report higher levels of danger along the chain of contagion were less likely to drink from the straws, but not significantly less likely to touch the straws. This discrepancy may be due to the fact that hands can be washed to remove a dangerous substance, but once a substance is ingested, it is much more difficult to remove.

Table 11

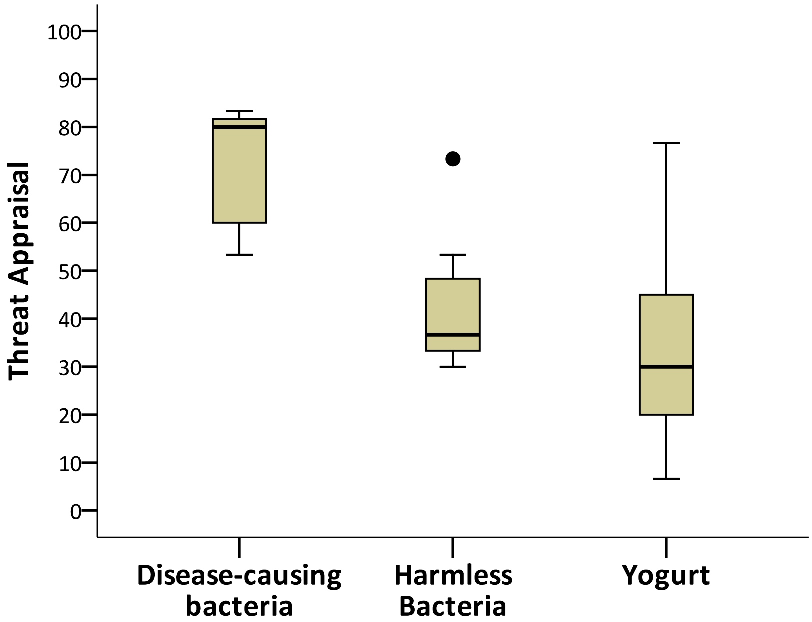
Study 4 (OCD group): Mean Self-report Indicators of Spread for Participants Who Touched Or Drank From a Straw and Those Who Did Not.

	Touched (*n* =13)		Did not touch (*n* = 8)		Drank (*n* = 4)		Did not drink (*n* = 17)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
AUC								
Physical Residue	584.62	416.39	839.75	503.33	432.50	333.30	740.47	470.10
Dangerousness	508.46	432.49	833.13	488.69	292.50	200.73	712.06	483.96
Reluctance to Use	1166.92	560.78	1937.50	77.60	825.00	531.95	1610.00	494.48

4.3.4 Randomization. A series of ANOVAs was conducted to examine whether randomization was successful. There were no significant differences between conditions on age, *F* (2, 18) = 0.04, *p* = .97, gender, χ^2 (2) = 0.40, *p* = .82, or ethnicity, χ^2 (2) = 0.63, *p* > .99. There were also no significant differences on scores on the PI, *F* (2, 18) = 0.60, *p* = .56; OBQ, *F* (2, 46) = 1.00, *p* = .39 or PVD, *F* (2, 18) = 0.25, *p* = .78. However, there were significant differences between conditions on the DSS, *F* (2, 18) = 4.65, *p* = .02. Post-hoc tests revealed that participants in the threatening bacteria condition scored lower than those in the harmless bacteria condition (*p* = .05) and there was a trend for them to score lower than participants in the yogurt condition (*p* = 0.06). Participants in the harmless bacteria and yogurt conditions did not differ significantly from one another (*p* = .99). There were also significant differences between conditions on the self-report YBOCS, *F* (2, 18) = 6.92, *p* = .01. Post hoc tests indicated that participants in the yogurt condition scored significantly higher than participants in the threatening bacteria condition (*p* = .02). The harmless bacteria condition did not differ significantly from either the threatening bacteria condition (*p* = .26) or yogurt condition (*p* = .16). Given these differences, statistical analyses conducted across conditions were conducted with DSS and YBOCS entered as covariates where applicable.

4.3.5 Manipulation Check. To ensure that the experimental manipulation was successful and that participants appraised the disease-causing bacteria as more threatening than the harmless bacteria and yogurt, threat appraisals were compared across conditions. Participants' threat appraisals within each condition are presented in the boxplot in Figure 44, with means and standard deviations provided beneath. There was no significant difference between conditions in variability, Levene's test, F (2, 18) = 0.39, p = .68.

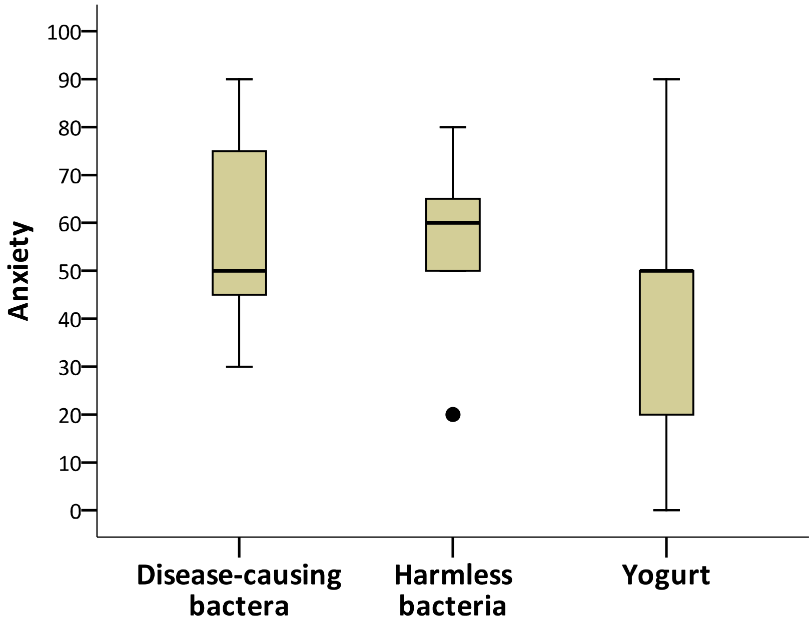
To examine differences between conditions in mean threat appraisals, an ANCOVA was performed with condition as the fixed factor, threat appraisal as the dependent variable and DSS and YBOCS entered as covariates. There was a significant effect of condition, F (2, 16) = 13.23, p < .001, η_p^2 = 0.62. Tukey's post hoc test indicated that the disease-causing bacteria was appraised as more threatening than the harmless bacteria (*p* = .02) and yogurt (*p* = .003), and there was no significant difference between the harmless bacteria and yogurt conditions (*p* = .65).



M	71.43	43.33	34.76
SD	13.17	15.40	23.72
n	7	7	7

Figure 44. Study 4: Boxplot of Threat Appraisals by Condition with Means and Standard Deviations.

Participants' anxiety and disgust in response to the experimental manipulation were also examined and are displayed in the boxplots in Figures 45 and 46. With regard to anxiety, Levene's test indicated that variances were not significantly different from one another, F (2, 18) = 0.88, p = .43. An ANCOVA was performed with condition as the fixed variable, anxiety as the outcome variable and scores on the DSS and YBOCS entered as covariates. There was a significant effect of condition, F (2, 16) = 6.51, p = 0.01, η_p^2 = 0.45. Post-hoc simple contrasts revealed that the disease-causing and harmless bacteria led people to experience more anxiety than the yogurt (p = .01 and p = .05 respectively). There was no difference between the disease-causing and harmless bacteria conditions in reported anxiety (p = .31). Thus, among OCD participants, the two contaminants (regardless of whether they carried a risk of disease or not) seemed to elicit greater anxiety than the non-contaminant.

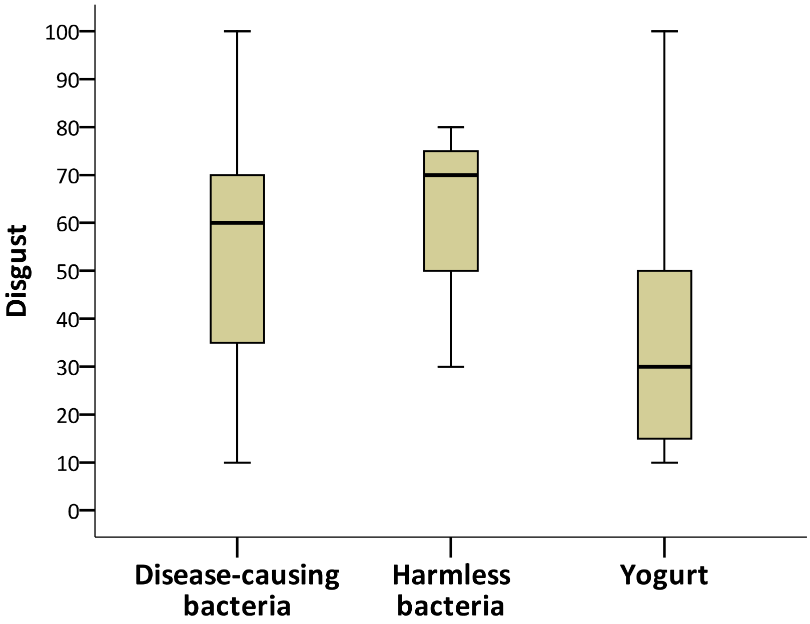


M	58.57	55.71	40.00
SD	21.93	40.00	30.00
n	7	7	7

Figure 45. Study 4: Boxplot of Anxiety Ratings by Condition with Means and Standard Deviations.

With regard to disgust, participants' ratings of disgust are presented in the boxplot in Figure 46 by condition with means and standard deviations presented beneath. Variability was not significantly different across conditions, Levene's test F (2, 18) = 0.69, p = .52. Focusing on mean differences between conditions on reported disgust, an ANCOVA was performed with condition as the fixed variable, disgust as the outcome variable and DSS and YBOCS entered as covariates. There was no statistically significant effect of condition on reported disgust, F (2, 16)

= 2.43, p = 0.12, η_p^2 = 0.23, although the moderate effect size and the obtained power of .42 suggests that power may have been insufficient for this analysis.



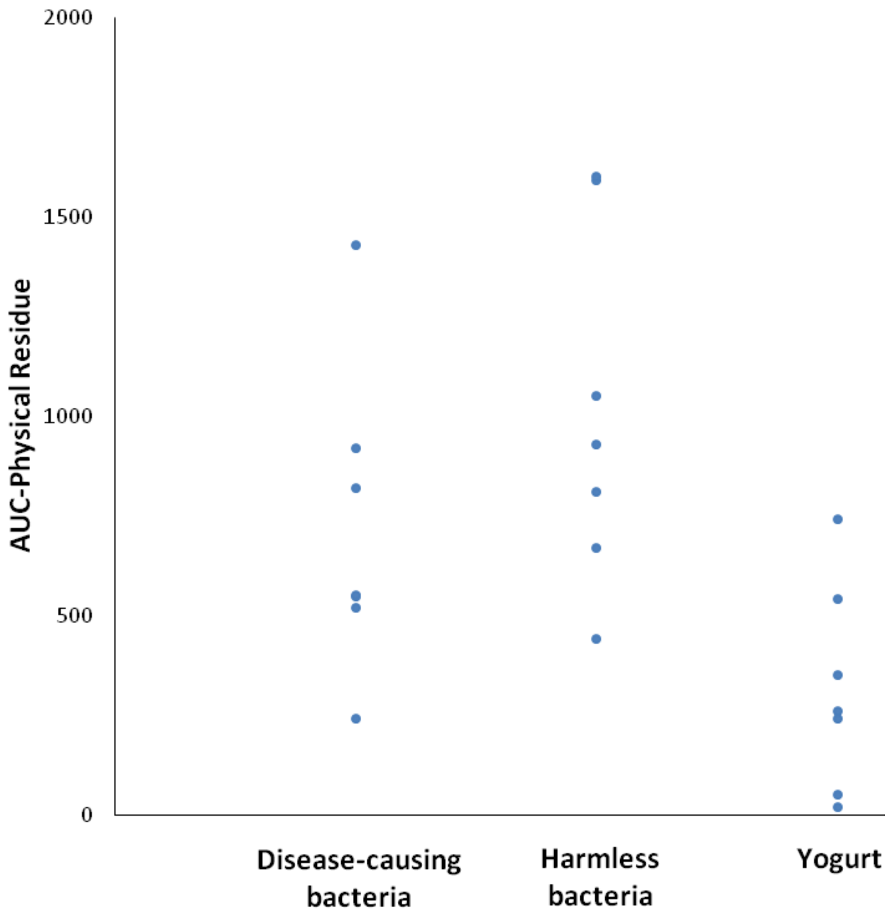
M	54.29	61.43	38.57
SD	30.47	19.52	31.85
n	7	7	7

Figure 46. Study 4: Boxplot of Disgust Ratings by Condition with Means and Standard Deviations.

4.3.6 Effect of experimental manipulation on judgments of spread*.* The purpose of this study was to explore the variables that influence the judgments of spread of people with contamination-related OCD. More specifically, as in Studies 1, 2 and 3, this study examined whether threat information or identification as a contaminant would increase judgments of spread. Judgments of spread included self-report indicators of spread (ratings of physical residue, dangerousness and reported avoidance) along the chain of contagion, as well as behavioural avoidance tests (whether a participant actually touched and drank from one the straws).

4.3.6.1 Physical residue. The effect of threat and/or identification as a contaminant on participants' judgments of physical spread was examined in several ways. First, an ANCOVA was performed to examine differences between experimental conditions on the AUC of participants' physical residue ratings. Second, a chi square analysis was performed to examine differences across conditions in the likelihood of participants indicating that the substance had stopped physically spreading. Finally correlations were performed between participants' subjective appraisals of threat (regardless of which condition they were in) and their AUC-Physical residue scores.

The AUC of participants' physical residue ratings (AUC-Physical Residue) is presented in the scatterplot in Figure 47 by condition with means and standard deviations presented beneath. Levene's test was not significant, F (2, 18) = 1.90, p = .18, indicating that variability did not differ significantly across conditions. Focusing on mean differences between conditions on their AUC-Physical Residue ratings, an ANCOVA was conducted with condition as the fixed factor, AUC-Physical Residue as the outcome variable and DSS and YBOCS entered as covariates. There was a significant effect of condition, F (2, 16) = 5.62, p = .01, η_p^2 = 0.41. Post-hoc simple contrasts revealed that participants in the disease-causing and harmless bacteria conditions judged the physical residue as greater than participants in the yogurt condition (p = .05 and .01 respectively). The disease-causing and harmless bacteria conditions did not differ significantly from one another (p = .53).



	Disease-causing bacteria	Harmless bacteria	Yogurt
M	718.29	1012.86	314.29
SD	383.62	442.14	257.67
n	7	7	7

Figure 47. Study 4: Scatterplot of the AUC-Physical Residue Ratings by Condition with Means and Standard Deviations.

With regard to the likelihood of participants' physical residue ratings reaching zero (i.e., indicating that the substance had stopped physically spreading), the percentage of participants in each condition who indicated as such are presented in Table 12. Chi square analyses revealed no significant difference between conditions in the likelihood of indicating that the physical spread ended, χ^2 (2) = 1.42, *p* = .83, two-tailed Fisher's exact test, Cramer's *V* = .26. Most participants with OCD (81%) did not view the physical residue as ever reaching 0. When correlations were performed between participants' subjective appraisals of threat and their AUC-Physical Residue scores, the correlation was small and non-significant, *r* = .25, *p* = .28.

Table 12

Study 4 (OCD group): *Percentage of Participants Whose Ratings Reached Zero or Who Touched or Drank From a Straw.*

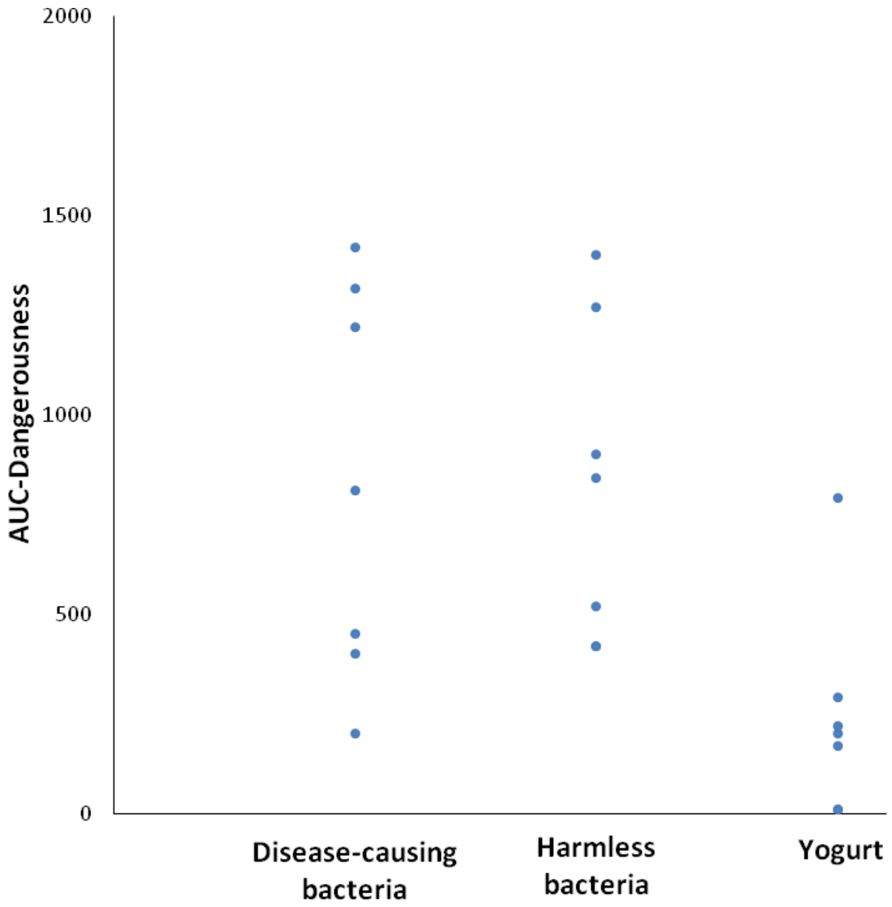
		Percentage who indicated that:			**Percentage who:**	
	n	Physical residue reached *None*	Dangerousness rating reached *Safe*	*Would definitely* use a straw	Touched Straw	Drank with Straw
Disease-causing bacteria	7	29%	43%	14%	57%	14%
Harmless bacteria	7	14%	14%	0%	43%	14%
Yogurt	7	14%	43%	29%	86%	29%

Thus, taken together these results suggest that participants with OCD viewed the level of physical residue along the chain of contagion as greater for the contaminants than non-contaminant. This finding mirrors the results found among the general UBC sample in Studies 1 and 2. Most participants with OCD (81%) did not view the substances as having stopped physically spreading, even after 20 points of removal from the source. Furthermore, this was true regardless of whether the substance was harmless or involved a non-contaminant—there were no differences across conditions in the likelihood of participants indicating that physical spread had ended. Furthermore, participants' appraisal of threat was not associated with the AUC of participants' physical residue ratings. Therefore, while identification as a contaminant appeared to increase OCD participants' judgments of the overall level of physical residue along the chain of contagion, it did not affect the likelihood of indicating that the substance had stopped physically spreading. Threat did not appear to increase judgments of physical spread among OCD participants.

4.3.6.2 Dangerousness. The effect of threat and identification as a contaminant on participants' judgments of dangerousness along the chain of contagion was also examined. The AUC of participants' dangerousness ratings (AUC-Dangerousness) is presented by condition in the scatterplot in Figure 48 with means and standard deviations presented beneath. There was a trend for variances to differ across conditions, as indicated by Levene's test, F (2, 18) = 3.10, p = .07. Examination of the standard deviations and scatterplot suggest that variability was smallest in the yogurt condition and greatest in the disease-causing bacteria condition. Thus participants with OCD tended to agree more when assessing the dangerousness along the chain of contagion of the yogurt and to vary more when assessing the dangerousness along the chain of contagion of the disease-causing bacteria.

Focusing on mean differences in AUC-Dangerousness across conditions, an ANCOVA was conducted with condition as the fixed factor, AUC-Dangerousness as the outcome variable and DSS and YBOCS entered as covariates. There was a significant effect of condition, F (2, 16) = 3.78, p = .05, η_p^2 = 0.32. Post-hoc simple contrasts revealed that participants in the disease-causing and harmless bacteria conditions judged the level of danger as greater along the chain of contagion than participants in the yogurt condition (p = .03 and p = .02 respectively). There was no significant difference in the dangerousness ratings of participants in the disease-causing and harmless bacteria conditions (p = .68).

What these results suggest then is that participants with OCD tended to agree that there was little danger from using the straws along the chain of contagion in the yogurt condition. Furthermore, while these participants' ratings varied more in the disease-causing bacteria condition, on average, they tended to judge the level of danger along the chain of contagion for the disease-causing and harmless bacteria conditions as similar to one another and higher than that of yogurt. Thus their dangerousness ratings along the chain of contagion appeared to be influenced by identification as a contaminant, regardless of whether that contaminant carried a risk of disease or not. This pattern of findings is quite different from that found among the general UBC sample and nursing students.



	Disease-causing bacteria	Harmless bacteria	Yogurt
M	830.71	824.29	241.43
SD	493.63	399.08	263.85
n	7	7	7

Figure 48. *Study 4: Scatterplot of the AUC-Dangerousness Ratings by Condition with Means and Standard Deviations*.

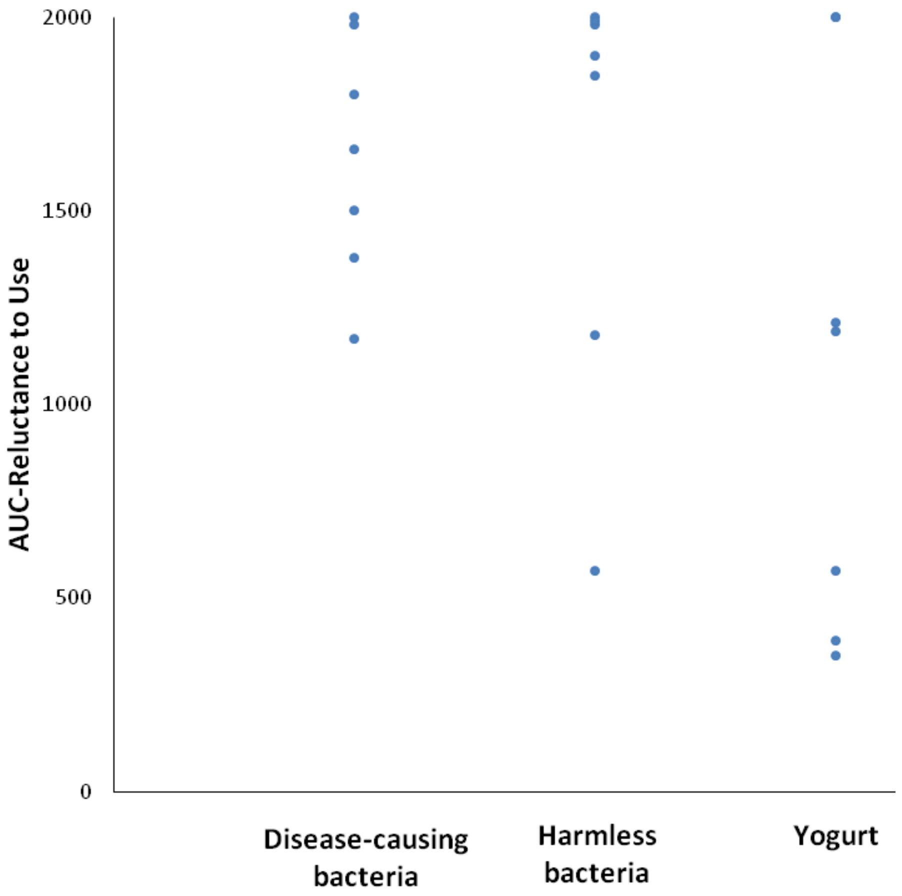
Moving to the likelihood of participants indicating that the danger ended at some point along the chain of contagion, the proportion of participants within each condition who indicated that the danger ended are provided in Table 12. There were no significant differences across conditions, χ^2 (2) = 1.75, *p* = .60, two-tailed Fisher's exact test, Cramer's *V* = .29, and overall, the majority of participants with OCD (67%) did not view the danger as ending. There was, however, a significant correlation between appraisals of threat and the AUC of participants' dangerousness ratings, $r = .50$, $p = .02$.

Taken together the findings suggest that, although threat appraisals were correlated with the AUC of dangerousness ratings along the chain of contagion, manipulating threat information did not increase the AUC-Dangerousness. Rather identification as a contaminant appeared to increase ratings of dangerousness along the chain of contagion. This pattern of findings is different from that which was found among the general UBC sample and nursing students (who viewed dangerousness along the chain of contagion as higher for the disease-causing bacteria). Furthermore, there appeared to be no significant effect of threat information or identification as a contaminant on the likelihood of OCD participants indicating that the straws became safe to use.

4.3.6.3 Reluctance to Use. The effect of threat and/or identification as a contaminant on participants' reported reluctance to use the straws was also examined. The AUC of participants' reluctance to use ratings (AUC-Reluctance to Use) within each condition are presented in the scatterplot in Figure 49 with means and standard deviations presented beneath. Although variability appeared to be smallest in the disease-causing bacteria condition and greatest in the yogurt condition, these differences did not reach statistical significance, Levene's test, $F(2, 18) = 2.39$, $p = .12$.

In order to examine mean differences across conditions in participants' reluctance to use the straws, an ANCOVA was conducted with condition as the fixed factor, AUC-Reluctance to use as the outcome variable and DSS and YBOCS entered as covariates. There was no significant effect of condition on participants' reluctance to use to the straws, $F(2, 16) = 0.76$, p

$= .47$, $\eta_p^2 = 0.09$. This finding seems to suggest that participants with OCD reported high levels of reluctance to use the straws, regardless of which condition they were in. This finding should be interpreted with caution, however. As can be seen in the scatterplot, variability was highest in the yogurt condition, and there appeared to be one participant whose AUC-reluctance to use score was quite a bit higher than the rest of participants in that condition. Although this participant's score was not a significant outlier, given the small sample size, this participant's score may have had undue influence on the mean within that condition. Nonetheless, the findings do not support the idea that threat of disease increased OCD participants' reluctance to use the straws, as participants in the disease-causing and harmless bacteria conditions did not differ from one another on this variable.



	Disease-causing bacteria	Harmless bacteria	Yogurt
M	1641.43	1638.57	1101.43
SD	310.72	553.16	705.65
n	7	7	7

Figure 49. Study 4: Scatterplot of the AUC-Reluctance to Use Ratings by Condition with Means and Standard Deviations.

With regard to the likelihood of participants' reluctance to use ratings reaching zero (i.e., of participants reporting that they *would definitely use* one of the straws), the proportion of participants in each condition whose ratings reached zero are presented in Table 12. There was no significant effect of condition, χ^2 (2) = 2.14, *p* = .74, two-tailed Fisher's exact test, Cramer's *V* = .33. Most participants with OCD (86 %) never indicated that they *would definitely* *use* one of the straws. Furthermore, there was no correlation between threat appraisals and the AUC of participants' ratings of reluctance to use the straws (r = .08, p = .73).

Taken together these findings suggest that neither threat nor identification as a contaminant had a significant impact on OCD participants' reported reluctance to use the straws. Reluctance was high in all conditions and very rarely reached zero. This pattern of findings is quite different from that which was found among the general UBC sample and the nursing students. In these non-OCD populations, threat was associated with greater reluctance to use the straws.

4.3.6.4 Touch. The question of whether threat or identification as a contaminant influenced OCD participants' willingness to touch the straws was examined from two perspectives. First, chi square analyses were performed to examine differences between conditions in the likelihood of participants touching one of the straws. Second, t-tests were performed comparing those who touched a straw with those who did not on appraisals of threat.

The percentage of participants who touched a straw in each condition is presented in Table 12. Chi square analyses revealed that there was no significant difference across conditions in the likelihood of participants touching a straw, χ^2 (2) = 2.75, p = .39, two-tailed Fisher's exact test, Cramer's V = .37. However, the magnitude of the effect size was moderately large and greater than the significant effect obtained in Study 2 for this same analysis. Examination of Table 6 suggests an increased likelihood of touching a straw among participants in the yogurt condition.

Independent samples t-tests revealed that there was no significant difference between participants who touched a straw versus those who did not on threat appraisals, t (19) = 0.10, p

= .92, *d* = 0.05. On average, the threat appraisal of participants who touched a straw was 50.26 (*SD* = 24.28, *n* = 13) on a scale from 0 to 100, while those who did not touch any straws had an average threat appraisal of 49.17 (*SD* = 23.62, *n* = 8).

Taken together, these findings suggest that although OCD participants may have been somewhat more likely to touch a non-contaminant than a contaminant, this difference was not statistically significant. Furthermore, threat did not appear to be associated with participants' avoidance of touching the straws. This pattern of findings is different from that which was found among the general UBC sample and nursing students, whose avoidance of touching the straws did tend to be associated with threat.

4.3.6.5 Drinking from the straws. The impact of threat and identification as a contaminant on OCD participants' willingness to drink from the straws was examined using chi square analysis and independent samples t-tests. The percentage of participants in each condition who drank from a straw is presented in Table 12. There was no significant difference between conditions in the likelihood of OCD participants drinking from a straw, χ^2 (2) = 0.79, *p* = 1.00, two-tailed Fisher's exact test, Cramer's *V* = .17. Most OCD participants (81 %) did not drink from any of the straws. Furthermore, there was no difference between those who drank from a straw and those who did not on appraisals of threat, *t* (19) = -0.14, *p* = .89, *d* = 0.08. Participants who drank with a straw had a mean threat appraisal of 48.33 (*SD* = 26.87, *n* = 4), while those who did not had a mean threat appraisal of 50.20 (*SD* = 23.47, *n* = 17).

Taken together these findings suggest that participants with OCD generally avoided drinking from the straws, and their avoidance did not appear to be influenced by threat, nor by identification as a contaminant.

4.4 Discussion

The purpose of Study 4 was to examine the variables that influence the judgments of spread among people with OCD. With regard to physical spread, identification as a contaminant appeared to increase OCD participants' judgments of the overall level of physical residue along the chain of contagion. This finding mirrors that which was found among the general UBC sample. However, there was no significant difference across conditions in the likelihood of participants indicating that the substance stopped physically spreading, and no significant correlation between threat appraisal and judgment of physical spread.

In terms of dangerousness, although threat appraisal was moderately correlated with dangerousness ratings along the chain of contagion, manipulating threat did not increase dangerousness ratings. Rather identification as a contaminant appeared to increase ratings of dangerousness along the chain of contagion. Furthermore, there were no significant differences across conditions on the likelihood of OCD participants indicating that the straws became safe to use. This pattern of findings is quite different from that which was found among the general UBC sample and nursing students. The dangerousness ratings of these non-OCD groups were influenced by threat. This finding is quite interesting and counter-intuitive. The manipulation check demonstrated that the OCD participants in this study did indeed rate the disease-causing bacteria as more threatening than the harmless bacteria, so it is intriguing that those differences in threat were not extended to dangerousness ratings along the chain of contagion. One possibility is that there is a ceiling effect on this outcome variable, but that does not appear to be the case—the maximum value of the AUC for the dangerousness ratings was 2000, and the means for the disease-causing bacteria ($M = 830.71$, $SD = 493.63$) and harmless bacteria ($M = 824.39$, $SD = 399.08$) were well below that limit.

An alternative explanation is that perhaps the dangerousness ratings along the chain of contagion were capturing a different phenomenon than the appraisals of threat participants made of the substance on the cutting board. This finding may be due to the manner in which threat was operationalized. In this study, threat was manipulated by informing participants in one condition that the bacteria caused physical illness, while informing those in the other conditions that the bacteria were either harmless or had health benefits. As such, threat involved threat of physical disease. On the other hand, ratings of dangerousness along the chain of contagion were assessed by asking participants to rate how safe or dangerous it would be to use the straw. Thus, the question captured a more general assessment of danger that could extend beyond the danger imposed by threat of disease. People with OCD may have feared consequences other than illness from the contaminants. As noted earlier, the feared consequences of contamination can include, not only harm to one's physical well-being, but also to one's mental or social well-being (Rachman, 2004; Woody & Teachman, 2000). For example, while some people may worry about contracting an illness, others may worry about losing emotional control or repulsing others by their state of contamination. Thus, participants with OCD in this study, may have found the harmless bacteria dangerous for reasons other than threat of illness and this could explain why ratings of dangerousness were high along the chain of contagion for the harmless bacteria. Consistent with this view, OCD participants reported elevated anxiety in both conditions involving contaminants (i.e., the disease-causing and harmless bacteria).

With regard to avoidance, neither threat nor identification as a contaminant influenced participants' reported reluctance to use ratings along the chain of contagion, nor their likelihood of drinking from the straws. However, there may have been an increased likelihood of touching the straws among participants in the yogurt condition. Although this effect did not reach statistical significance, the effect size was moderately large.

There are several possible explanations for the lack of relationship between threat and avoidance among participants with OCD in this study. For one, participants with OCD may have judged the entire experimental setting as contaminated, which could have led to their high levels of avoidance across conditions. The tendency of people with OCD to overestimate threat might have led them to judge objects that were meant to be clean, such as the straws and glasses prior to being used, as contaminated. If so, avoidance might have been driven by participants perceiving threat in the overall experimental setting, rather than the particular substance of the condition to which they were randomly assigned.

An alternative possibility is that people with OCD have lower thresholds at which they avoid substances. While they might recognize that a substance does not pose a great deal of threat, the belief that it poses any threat (regardless of how small) might be enough to lead them to avoid it. The tendency of people with OCD to have difficulty tolerating uncertainty (Myers, Fisher, & Wells, 2008; OCCWG, 2001, 2005; Steketee, Frost, & Cohen, 1998) could perhaps contribute to such a phenomenon.

A third possibility is that OCD participants' avoidance was motivated by disgust rather than fear. Disgust, in its most basic form, has been described as "revulsion at the prospect of (oral) incorporation of an offensive object" (Rozin & Fallon, 1987, p. 23). Disgust is conceptualized as an adaptive emotion that promotes avoidance of contaminated material (Matchett & Davey, 1991) and there is some empirical support for this theory (Oaten, Stevenson, & Case, 2009). In the present study, OCD participants reported moderate levels of disgust in response to all of the substances and there was no significant difference between conditions. Thus, the high levels of avoidance seen across all conditions may also have been due to feelings of disgust.

A fourth possibility is that there may be a habit effect. Given a greater tendency to avoid contaminants in their daily lives, people with contamination-related OCD may have simply become accustomed to avoiding unfamiliar objects and do so partly out of habit without necessarily considering the level of actual threat in each situation. Curtis, Danquah and Aunger (2009) have noted the importance of habit in determining hand washing behaviour within the general population. Although Curtis et al (2009) did not examine contamination-related OCD, it is possible that the role of habit extends to this population and may explain the high levels of avoidance across all conditions seen in this OCD population.

Fifth, the lack of differences across conditions may be due to a ceiling effect. Participants with OCD tended to engage in high levels of avoidance across all conditions. Differences across conditions began to emerge with the easier task of touching the straws, but were not present for the more difficult task of drinking with the straws.

Taken together, there are both similarities and differences in the variables that influence judgments of spread among people with contamination-related OCD as compared to the general UBC sample and nursing students. Like the general UBC sample, judgments of physical spread were influence by identification as a contaminant. However, unlike the general UBC sample and nursing students, neither dangerousness, nor avoidance, was increased by threat of disease. Rather, participants with OCD viewed dangerousness as highest along the chain of contagion for both contaminants (regardless of whether they carried a risk of disease or not), and also to engage in high levels of avoidance of all substances.

Chapter 5: Comparisons across studies

5.1 Introduction

The main purpose of the previously described four studies was to examine the variables that influence judgments of spread. Study 1 examined whether threat increased judgments of spread, Study 2 corrected for a confound in Study 1 and examined whether identification as a contaminant (as opposed to the presence of bacteria) increased judgments of spread, and Studies 3 and 4 extended the question to two populations of interest: nursing students and people with contamination-related OCD. In all of these studies, the main question was what factors increase judgments of spread. After completing these studies, a secondary question arose of how these various populations compared to one another in their judgments of spread. Although there were some procedural differences between the studies, for example, with respect to recruitment, the location of the study and some of the questionnaires, the experimental manipulation and measured outcome variables in Studies 2, 3 and 4 were essentially the same. As such, it was possible to compare and contrast the judgments of spread of these three populations: the general UBC sample, the nursing students and people with contamination-related OCD. Because the studies were not specifically powered for these comparisons, however, findings should be interpreted with caution and in light of accumulating evidence in the field. This section begins with a description of differences across populations on demographics and OCD-related traits and symptoms, and then moves on to describe differences in response to the experimental manipulation and finally to explore differences in judgments of spread.

5.2 Analyses comparing study populations

5.2.1 Comparisons across populations on contamination-related beliefs and behaviours. The samples included in these studies were selected because of specific properties of the participants in them. Participants in Studies 1 and 2 were recruited to represent a non-selected sample of people from the general population. Participants in Study 3 were selected because they had received training in the dangers of contaminant spread and were being trained to work in an environment where it was extremely important for them to take appropriate cautions to prevent the spread of contamination. Participants in Study 4 were selected because they met diagnostic criteria for contamination-related OCD. Thus, given that the participants in Study 4 were selected because they met criteria for contamination-related OCD, it was expected that they should score higher on measures of contamination-related beliefs and behaviours. To this end, ANOVAs were conducted on each of the questionnaire measures with population and condition entered as fixed variables and each of the questionnaire measures entered as outcome variables. Means and standard deviations are presented in Table 13. For each questionnaire, there was a significant effect of population, but no main effect of condition, nor a significant interaction effect. Thus, there were significant differences between the samples on the Padua Inventory (PI), both the whole scale, $F\ (2, 136) = 74.08$, $p < .001$, $\eta_p^2 = .52$) and the contamination subscale, $F\ (2, 137) = 49.11$, $p < .001$, $\eta_p^2 = .42$); on the Obsessive Beliefs Questionnaire (OBQ), $F\ (2, 136) = 29.74$, $p < .001$, $\eta_p^2 = .30$); on the Disgust Sensitivity Scale (DSS), $F\ (2, 136) = 37.13$, $p < .001$, $\eta_p^2 = .35$; and the Perceived Vulnerability to Disease Questionnaire (PVD), $F\ (2, 137) = 18.71$, $p < .001$, $\eta_p^2 = .22$. For each of these questionnaires, the OCD group scored significantly higher than the general UBC sample and nursing students (all p values < .001). In addition, for disgust sensitivity, nursing students scored significantly lower than people from the general UBC sample ($p < .001$).

In considering these results, however, it should be noted that all of the questionnaire measures (except the YBOCS which was not included in analysis) were significantly correlated with one another (r's ranging from .45 to .80, with an average correlation of .58). Nonetheless, the differences across populations in questionnaire scores provide further corroborating evidence that participants with contamination-related OCD differed from the general UBC and nursing student participants on traits and symptoms related to contamination concerns.

Table 13

Questionnaire Measures Means (and Standard Deviations) for Each Study

	n	PI contamination subscale	PI total scale	OBQ	DSS	PVD	YBOCS*
Study 1 Gen. UBC Population*	74	12.54 (8.64)	30.67 (21.18)	145.09 (38.21)	---	---	---
Study 2 Gen. UBC Population	77	11.12 (6.03)	27.85 (12.22)	144.52 (31.39)	19.11 (4.32)	56.68 (4.31)	---
Study 3 Nursing students	48	12.65 (8.52)	27.33 (18.07)	145.10 (38.40)	15.41 (4.80)	54.44 (16.12)	---
Study 4 OCD group	21	27.81 (5.96)	73.82 (22.87)	210.90 (47.77)	25.19 (3.25)	75.19 (13.20)	19.69 (6.72)

Note: * Study 1 questionnaires and YBOCS not included in statistical analyses conducted across populations.

5.2.2 Demographics across studies. Demographic variables of participants in each of the three studies are presented in Table 14 and include age, gender and ethnicity. An ANOVA and chi square analyses were conducted in order to assess whether populations differed on these demographic variables. There were significant differences between populations on age, F (2, 140) = 21.12, $p < .001$, $\eta_p^2 = .23$. Post hoc Games-Howell tests indicated that the general UBC sample was significantly younger than the OCD group ($p = .03$) and nursing students ($p < .001$). There were also significant differences between populations on the proportion of male and female participants, χ^2 (2) = 12.21, $p = .002$, two-tailed Fisher's exact test, Cramer's $V = .30$. Although the majority of participants were female across all studies, examination of adjusted standardized residuals revealed that there was a higher proportion of men in the OCD group and a higher proportion of women in the nursing student sample. Furthermore, there were significant differences in ethnicity, χ^2 (2) = 7.16, $p = .03$, two-tailed Fisher's exact test, Cramer's $V = .25$. Examination of adjusted standardized residuals revealed that the general UBC sample had a smaller proportion of participants of European descent, while the nursing student sample had a smaller proportion of participants of Asian descent and a higher proportion of participants of European descent. These studies were not designed to examine cultural differences in judgments of spread and therefore detailed examination of this variable's influence was not possible. Nonetheless, ethnicity was included along with gender and age, as covariates in analyses conducted across studies where applicable.

Table 14

Age, Gender and Ethnicity by Study (i.e., population)

		Age		Gender		Ethnicity	
	n	M	SD	% Women	% Caucasian	% Asian	% Other
Study 2: General UBC sample	77	20.31	4.40	82	31	43	26
Study 3: Nursing students	48	27.83	7.62	96	55	29	16
Study 4: OCD group	21	26.10	9.47	62	33	52	14

5.2.3 Differences between populations in response to the experimental manipulation.

Participants' appraisals of threat and their emotional response to the experimental manipulation are presented by population and condition in Figures 50 through 52. Means and standard deviations are presented beneath each graph. An ANOVA was conducted in order to examine whether populations differed in their response to the experimental manipulation. Population and condition were entered as fixed factors and participants' threat appraisal as the outcome variable. There were significant main effects of population, F (2, 137) = 15.21, p < .001, η_p^2 = .18 and condition, F (2, 137) = 64.27, p < .001, η_p^2 = .48, but no significant interaction, F (4, 137) = 0.87, p = .49, η_p^2 = .03. Examination of simple main effects indicated that the OCD group appraised all substances as significantly more threatening than the nursing students (p < .001) and people from the general population (p < .001). There was no significant difference between nursing students and people from the general population (p = .24) on appraisals of threat. Consistent with previously reported manipulation checks within each study, participants in the disease-causing bacteria condition judged the substance as more threatening than participants in the harmless bacteria ($p < .001$) and yogurt containing probiotic bacteria ($p < .001$) conditions. There was no significant difference between the harmless bacteria and yogurt with probiotic bacteria conditions on their appraisals of threat (p = .99). When this analysis was rerun with age, gender and ethnicity entered as covariates, the main effects of population, F (2, 133) = 14.73, $p < .001$, $\eta_p^2 = 0.18$, and condition, F (2, 133) = 62.36, $p < .001$, $\eta_p^2 = 0.48$, remained significant and there was no significant interaction, F (4, 133) = 0.59, $p = .67$, $\eta_p^2 = 0.02$. Thus, the OCD group tended to rate all the substances as more threatening.

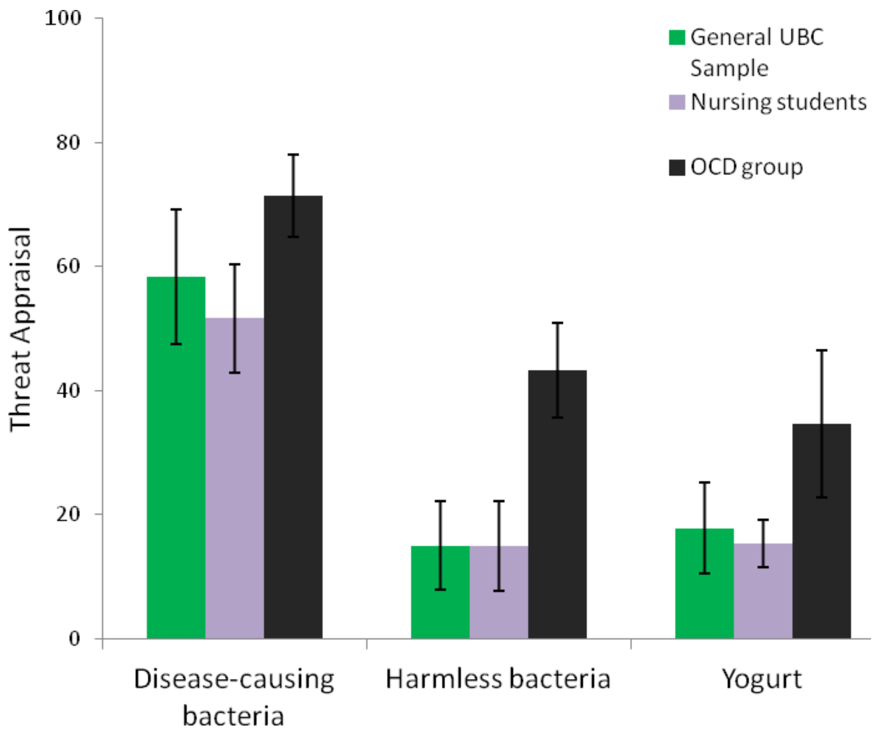


Figure 50. Threat Appraisals by Population and Condition. Error bars represent standard deviation.

Differences between populations in their emotional responses to the experimental manipulation were also examined. With regard to anxiety, there were significant main effects of population, F (2, 137) = 23.70, $p < .001$, $\eta_p^2 = .26$, and condition, F (2, 137) = 8.60, $p < .001$, $\eta_p^2 = .11$, but no significant interaction between the two, F (4, 137) = 0.22, $p = .93$, $\eta_p^2 = .01$. Examination of simple main effects revealed that the OCD group reported higher levels of anxiety than both the general UBC group ($p < .001$) and nursing students ($p < .001$). There was no significant difference between the general UBC group and nursing students ($p = .37$). With regard to condition, participants in the disease-causing bacteria condition reported greater anxiety than those in the harmless bacteria condition ($p = .04$) and in the yogurt condition ($p < .001$), and those in the harmless bacteria condition reported greater anxiety than those in the yogurt condition ($p = .04$). When this analysis was rerun with age, gender and ethnicity entered as covariates, the main effects of population, F (2, 133) = 24.16, $p < .001$, $\eta_p^2 = 0.27$, and condition, F (2, 133) = 8.57, $p < .001$, $\eta_p^2 = 0.11$, remained significant and there was no significant interaction, F (4, 133) = 0.22, $p = .93$, $\eta_p^2 = 0.01$. Thus, participants with OCD tended to experience greater anxiety than the general UBC sample and nursing students.

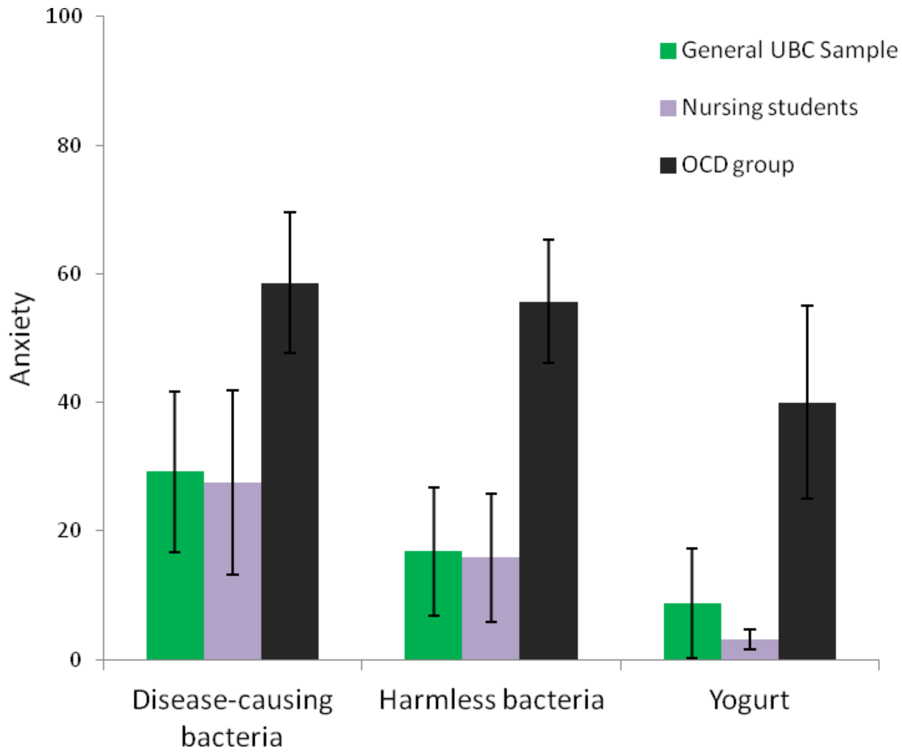


Figure 51. Reported Anxiety by Population and Condition. Error bars represent standard deviation.

With regard to disgust, there were also main effects of population, *F* (2, 135) = 17.51, $p < .001$, $\eta_p^2 = .21$, and condition, *F* (2, 135) = 7.84, $p = .001$, $\eta_p^2 = .10$, and no significant interaction between the two, *F* (4, 135) = 0.87, $p = .49$, $\eta_p^2 = .03$. Examination of simple main effects revealed that the OCD group reported significantly greater disgust than the general UBC sample ($p < .001$) and nursing students ($p < .001$). There was no difference between the level of disgust reported by nursing students and the general UBC sample ($p = .37$). With regard to condition, participants in the disease-causing and harmless bacteria conditions reported greater disgust than those in the yogurt condition ($p < .001$ and $p = .01$ respectively). There was no difference in disgust between those in the threatening and harmless bacteria conditions ($p = .17$). When this analysis was rerun with age, gender and ethnicity were entered as covariates, the main effects of population, F (2, 133) = 19.72, $p < .001$, $\eta_p^2 = 0.23$, and condition, F (2, 133) = 7.18, $p = .001$, $\eta_p^2 = 0.10$, remained significant and there was no significant interaction, F (4, 133) = 1.19, $p = .32$, $\eta_p^2 = 0.03$. Thus, the results suggest that participants with contamination-related OCD tended to experience greater disgust in response to all of the substances.

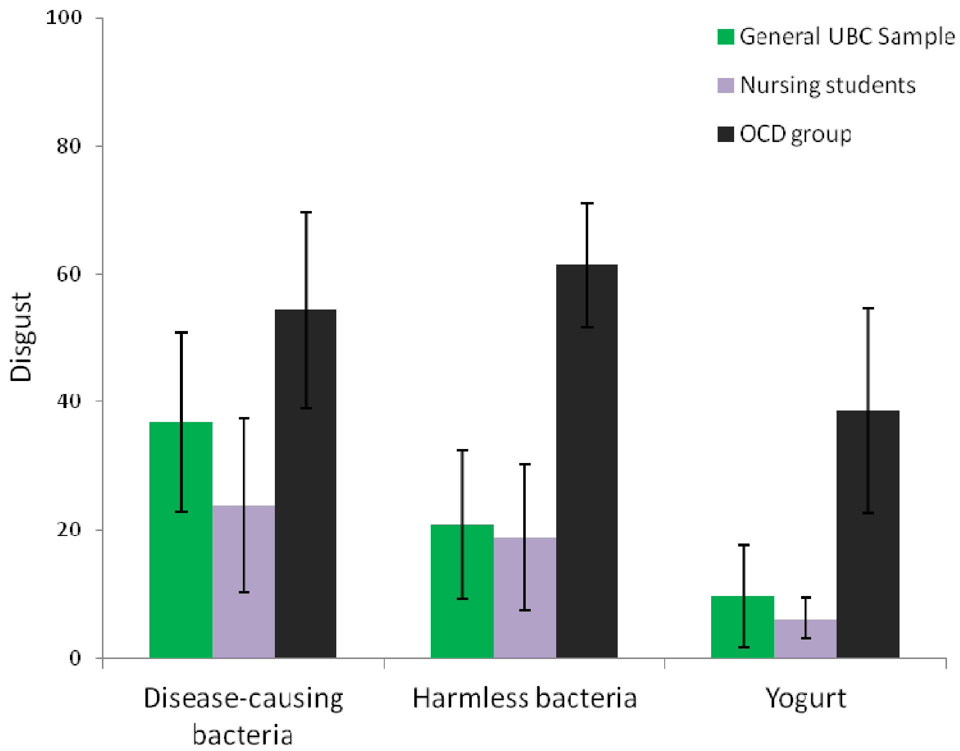


Figure 52. Reported Disgust by Population and Condition. Error bars represent standard deviation.

5.2.4 Comparisons of populations in their judgments of spread.

5.2.4.1 AUC-Physical residue. The mean AUC of participants' physical residue ratings along the chain of contagion (AUC-Physical Residue) are presented in Figure 53 by population and condition. Differences between populations in their judgments of how much the substances physically spread were explored. An ANOVA was conducted with population and condition as fixed factors and the AUC-Physical Residue as the outcome variable. There was a significant interaction between population and condition, F (4, 137) = 3.78, p = .01, η_p^2 = .10. Examination of simple main effects revealed that this effect was due to the OCD group in the harmless bacteria condition judging the physical amount as greater than the nursing students (p < .001) and people from the general UBC sample (p = .001). Nursing students and the general UBC sample (p = .99) did not differ from one another within the harmless bacteria condition. Furthermore, the populations did not differ significantly from one another in either the disease-causing bacteria condition or yogurt conditions. When the analysis was rerun with age and gender as covariates, the interaction remained significant, F (4, 133) = 4.07, p = .004, η_p^2 = 0.11. These findings suggest that people with contamination-related OCD judge the physical spread of harmless bacteria differently than the general UBC sample and nursing students. However, given the small sample size of the OCD group, the meaning of this interaction should be interpreted with caution.

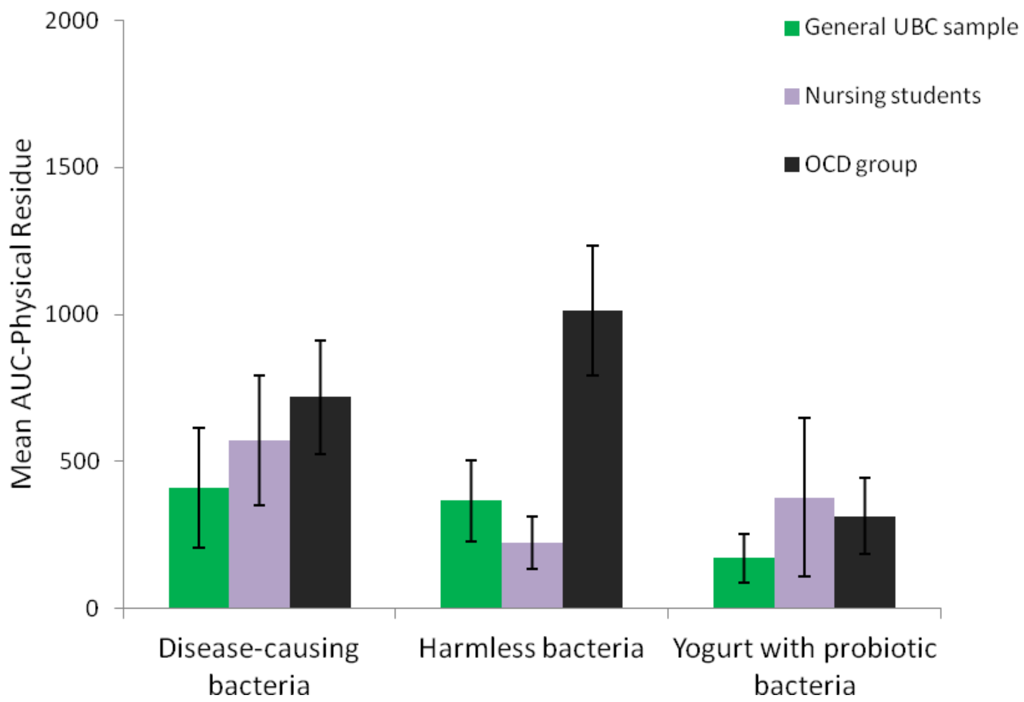


Figure 53. AUC-Physical Residue by Population (Study) and Condition. Error bars represent standard deviation.

***5.2.4.2 AUC-Dangerousness*.** Figure 54 shows the AUC of participants' dangerousness ratings along the chain of contagion by population and condition. To examine whether populations differed in their ratings of dangerousness along the chain of contagion, an ANOVA was conducted with population and condition as fixed factors and the AUC of dangerousness ratings along the chain of contagion (AUC-Dangerousness) as the outcome variable. There was a significant interaction between population and condition, F (4, 137) = 2.86, p = .03, η_p^2 = .08. Examination of simple main effects revealed that in the threatening condition, the OCD group rated the level of danger along the chain of contagion as higher than people in the general UBC sample (p = .01), but not higher than nursing students (p = .35). Nursing students and the general UBC sample did not differ significantly from one another in this condition (p = .24). In the safe bacteria condition, the OCD group rated the level of danger as significantly higher than both the nursing students ($p < .001$) and the general UBC sample ($p < .001$). Nursing students and the general UBC sample did not differ from one another in this condition ($p = 1.00$). There were no significant differences between populations in the yogurt condition (p values all greater than .89). When the analysis was rerun with age, gender and ethnicity entered as covariates, the interaction remained significant, F (4, 133) = 3.33, $p = .01$, $\eta_p^2 = 0.09$.

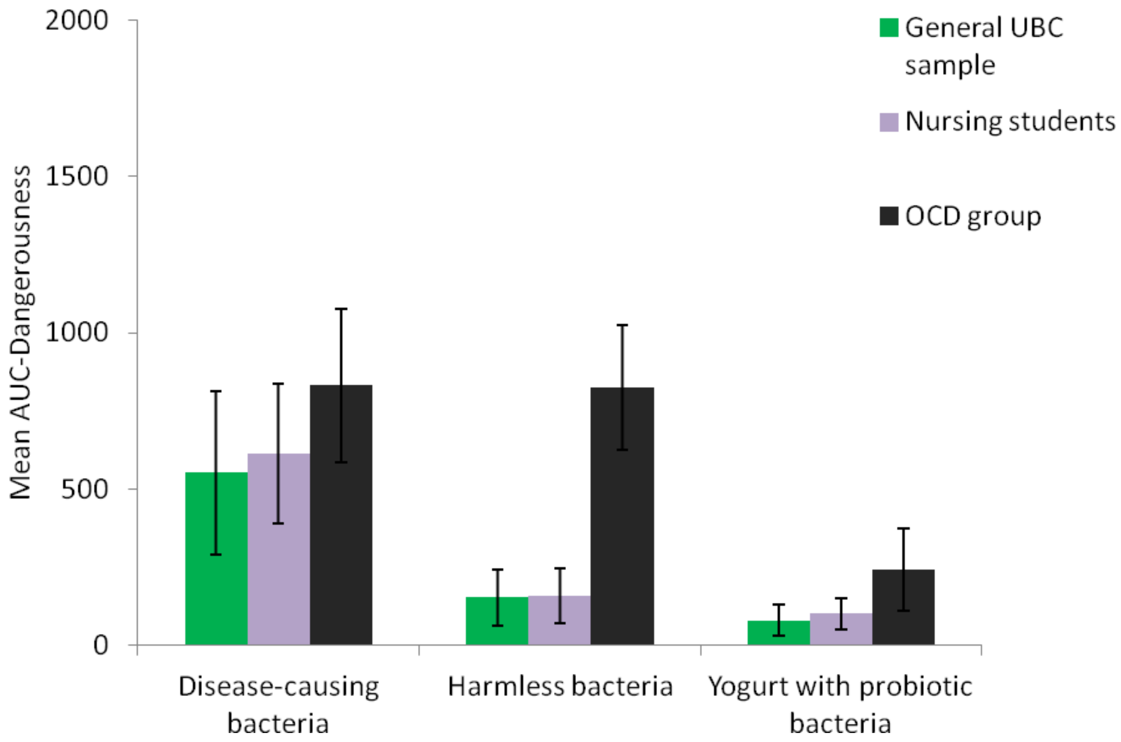


Figure 54. AUC-Dangerousness by Population (Study) and Condition. Error bars represent standard deviation.

5.2.4.3 AUC-Reluctance to use. The AUC of participants' dangerousness ratings along the chain of contagion by population and condition are presented in Figure 55. In order to examine differences between populations on reluctance to use the straws, an ANOVA was conducted with population and condition as fixed factors and the AUC of reluctance to use ratings along the chain of contagion (AUC-Reluctance to Use) as the outcome variable. There were significant main effects of population, F (2, 137) = 10.83, $p < .001$, $\eta_p^2 = .14$ and condition, F (2, 137) = 14.42, $p < .001$, $\eta_p^2 = .17$, and no significant interaction between population and condition, F (4, 137) = 0.73, $p = .57$, $\eta_p^2 = .02$. Examination of simple main effects revealed that the OCD group reported significantly more avoidance than nursing students ($p < .001$) and people from the general UBC sample ($p < .001$). Nursing students and the general UBC sample did not differ significantly from one another on reported reluctance to use the straws ($p = .83$). With regard to the effect of condition, consistent with previously reported findings, participants in the disease-causing bacteria condition reported greater avoidance than participants in the harmless bacteria ($p < .001$) and yogurt conditions ($p < .001$). When analyses were rerun with age, gender and ethnicity entered as covariates, the main effects of population F (2, 133) = 12.95, $p < .001$, $\eta_p^2 = .16$ and condition, F (2, 133) = 15. 39, $p < .001$, $\eta_p^2 = .19$, remained significant and there was no interaction between population and condition, F (4, 133) = 0.81, $p = .52$, $\eta_p^2 = 0.02$.

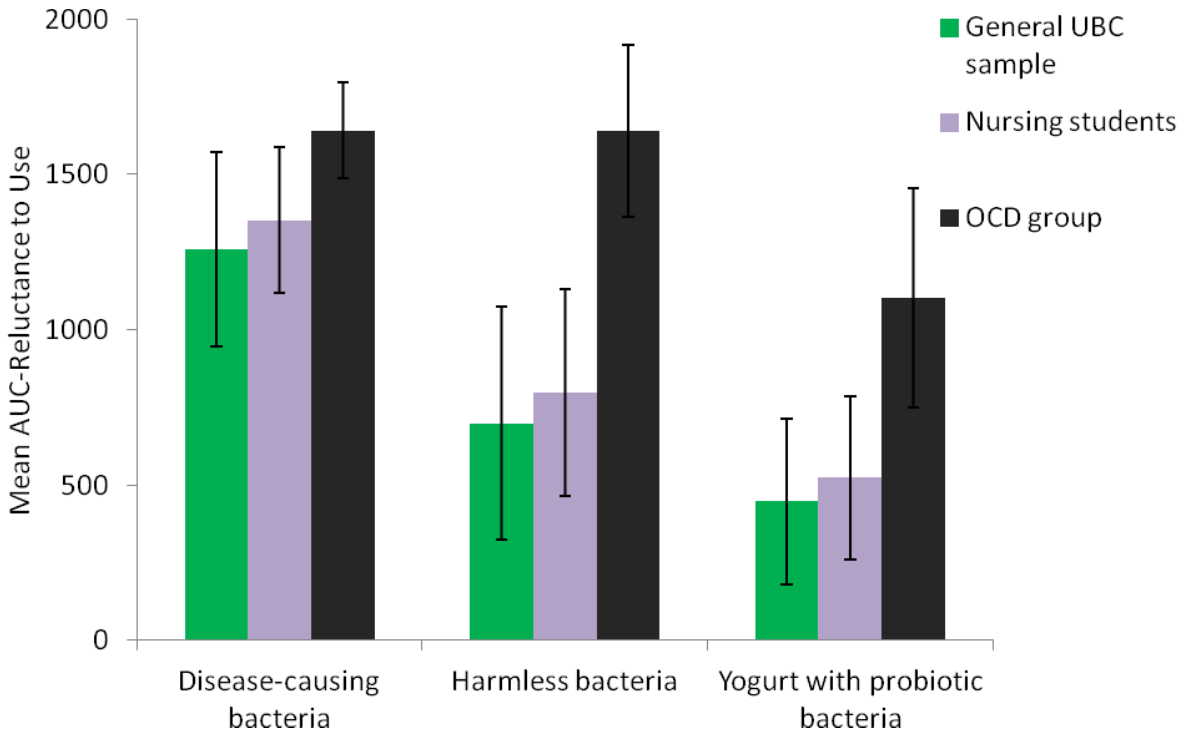


Figure 55. AUC-Reluctance to Use by Population (Study) and Condition. Error bars represent standard deviation.

5.2.4.4 Differences between populations in the likelihood of their spread ratings reaching zero. The percentage of participants within each population whose spread ratings reached zero (i.e., whose physical residue ratings reached *none*, dangerousness ratings reached *safe* and reluctance to use ratings reached *definitely would use*) is presented in Figures 56. Chi square analyses were performed to examine differences between populations in the likelihood of their ratings reaching zero. Due to small expected cell frequencies, it was not possible to examine interactions between the population under study and the experimental condition. With regard to physical residue ratings, there was no significant difference across populations in the likelihood of participants indicating that physical spread had ended, χ^2 (2) = 3.92, p = .15, two-tailed Fisher's exact test, Cramer's V = 0.17. In terms of dangerousness ratings, however, there was a significant effect of population on the likelihood of participants' dangerousness ratings reaching safe, χ^2 (2) = 6.81, *p* = .03, two-tailed Fisher's exact test, Cramer's *V* = 0.22. Examination of adjusted standardized residuals revealed a decreased likelihood among participants with OCD to indicate that danger ended. Similarly, with respect to reluctance to use ratings, there was also a significant effect of condition, χ^2 (2) = 5.92, *p* = .05, two-tailed Fisher's exact test, Cramer's *V* = 0.20. Examination of adjusted standardized residuals revealed a decreased likelihood among the OCD group to indicate that they would definitely use the straws.

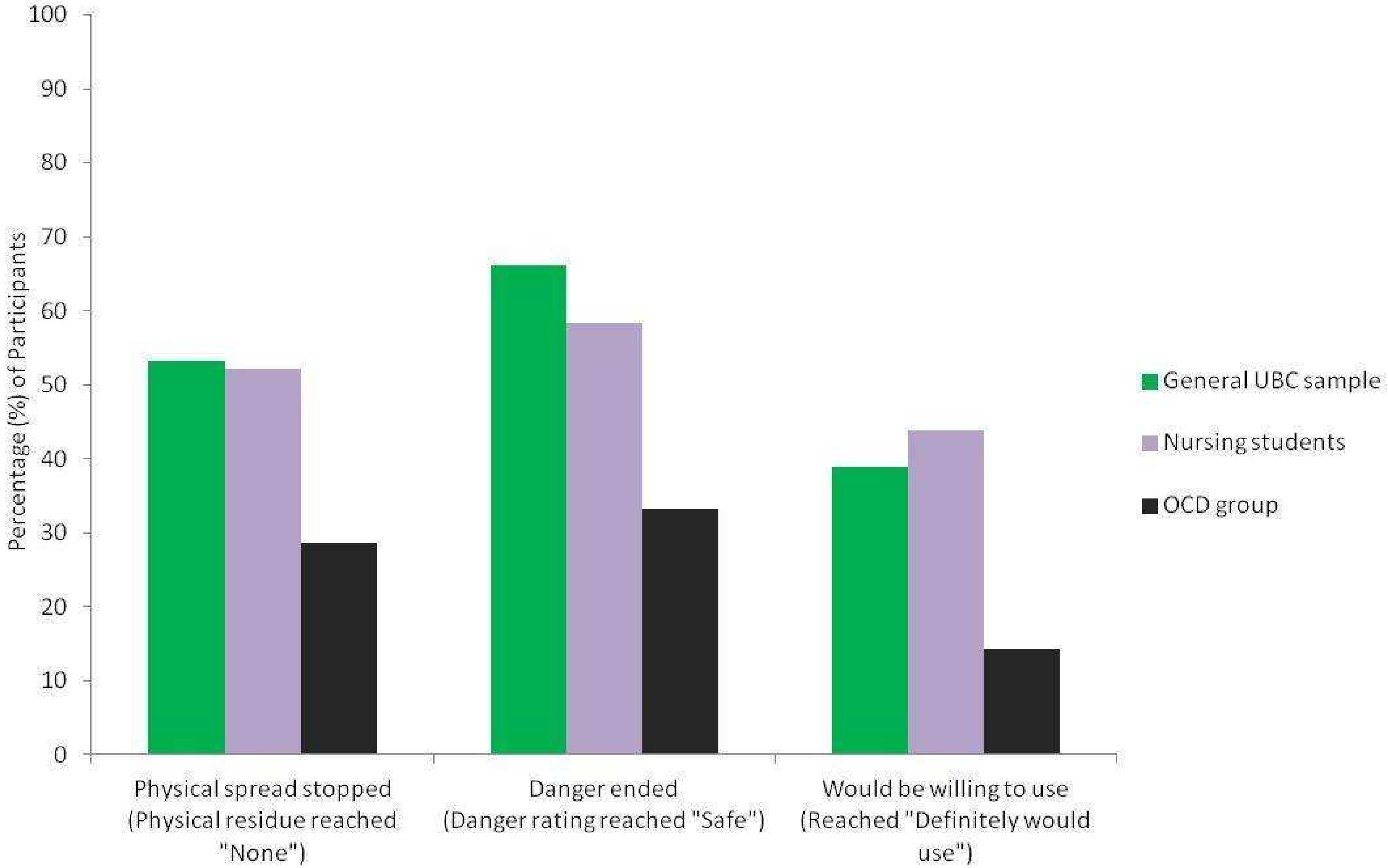


Figure 56. Percentage of Participants Whose Self-Report Ratings of Spread Reached Zero by Population.

5.2.4.5 Behavioural avoidance across populations. The percentage of participants in each population who touched or drank from a straw is presented in Table 57. Chi square analyses were performed to examine differences between populations on these behavioural outcomes. In terms of touching the straws, there was a significant effect of population, χ^2 (2) = 6.61, p = .04, two-tailed Fisher's exact test, Cramer's V = 0.23. Examination of adjusted standardized residuals revealed a decreased likelihood among participants in the OCD group to touch a straw. There was also a significant effect of population on the likelihood of participants drinking from one of the straws, χ^2 (2) = 11.82, p = .003, two-tailed Fisher's exact test, Cramer's V = 0.28. Examination of adjusted standardized residuals again revealed a decreased likelihood among participants in the OCD group to drink from one of the straws. Therefore, there was a moderately strong tendency for participants with OCD to engage in greater avoidance of both touching and drinking from the straws.

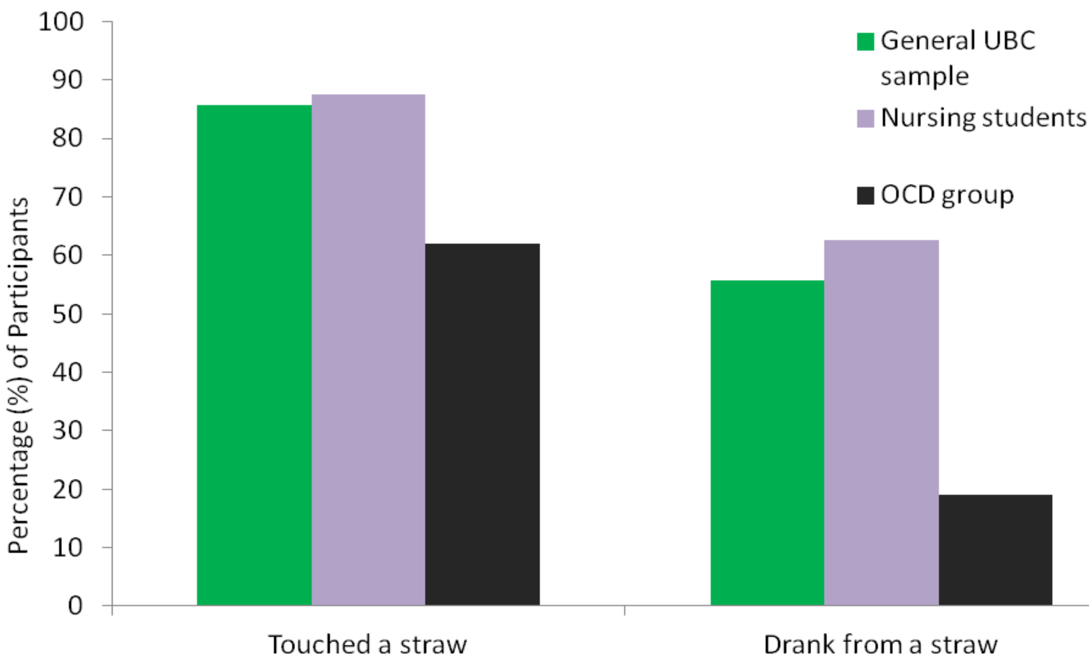


Figure 57. *Percentage of Participants Who Touched or Drank From a Straw by Population.*

5.2.5 Relationship between questionnaire measures of OCD symptoms/beliefs and judgments of spread. As noted, one of the aims of this study was to better understand the judgments of spread of people with contamination-related OCD. In addition to comparing people with contamination-related OCD to people without the disorder, an additional way of approaching this question is to examine the relationship between questionnaire measures of OCD symptoms, beliefs and traits (across all populations) and judgments of spread. Therefore, Pearson correlations were performed between participants' scores on the PI (including the PI-contamination subscale), OBQ, DSS and PVD and their self-report indicators of spread. These are presented in Table 15. All questionnaire measures were moderately correlated with the three outcome variables.

In addition, a series of ANOVAs was performed to compare those who touched or drank from a straw from those who did not on the questionnaire measures. Means and standard deviations are presented in Table 16. There were significant differences between those who touched a straw from those who did not on each of the questionnaire measures: PI-Contamination subscale, $F\,(1, 144) = 24.32$, $p < .001$, $d = 1.08$; PI-Total scale, $F\,(1, 143) = 12.48$, $p = .001$, $d = 0.78$; OBQ, $F\,(1, 143) = 8.01$, $p = .005$, $d = 0.62$; DSS, $F\,(1, 143) = 10.53$, $p = .001$, $d = 0.71$; PVD, $F\,(1, 143) = 13.16$, $p < .001$, $d = 0.80$. Similarly, there were significant differences on each of the questionnaire measures between participants who drank from a straw compared to those who did not: PI-Contamination subscale, $F\,(1, 144) = 29.91$, $p < .001$, $d = 0.91$; PI-Total scale, $F\,(1, 143) = 8.78$, $p = .004$, $d = 0.49$; OBQ, $F\,(1, 143) = 7.08$, $p = .01$, $d = 0.44$; DSS, $F\,(1, 143) = 32.65$, $p = .001$, $d = 0.95$; PVD, $F\,(1, 143) = 18.85$, $p < .001$, $d = 0.72$.

Thus, the results suggest that OCD symptoms and related beliefs and traits (as measured by questionnaires) are associated with judgments of spread. This finding adds further support to the previously noted findings of increased judgments of spread among those with contamination-related OCD.

Table 15

Pearson Correlations Between Questionnaire Measures and Self-Report Ratings of Spread

	AUC Physical Residue	AUC Dangerousness	AUC Reluctance to Use
PI Contamination Subscale	.35	.36	.43
PI Total scale	.37	.31	.31
OBQ	.27	.20	.23
DSS	.21	.23	.39
PVD	.35	.34	.44

Note. All correlations significant at $p < .05$; Studies 2, 3 and 4 included in analyses (Study 1 not included)

Table 16

Questionnaire Measure Scores Comparing Those Who Touched or Drank From a Straw to Those Who Did Not.

	Touched (*n* = 121)		Did not touch (*n* = 25)		Drank (*n* = 77)		Did not drink (*n* =69)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
PI-Contamination subscale	12.48	8.09	21.48	9.33	10.52	6.82	17.93	9.46
PI-Total scale	31.39	20.66	48.48	27.72	29.11	18.77	40.09	25.59
OBQ	149.81	41.40	176.00	45.32	145.44	38.83	164.12	45.66
DSS	18.16	5.34	21.84	4.17	16.61	5.01	21.20	4.62
PVD	56.64	14.97	68.12	11.10	53.76	14.00	63.97	14.29

5.3 Discussion

Based on previous research, it was hypothesized that participants with OCD would judge contaminants to spread to a greater degree than participants without OCD. This hypothesis was partially supported. Participants with OCD did tend to rate the level of dangerousness along the chain of contagion for the two contaminants as greater than the general UBC sample. The OCD group was also less likely to indicate that the danger had ended, even after 20 points of removal (i.e., straws) from the source. It is interesting that the OCD group rated the level of dangerousness as elevated for both contaminants, regardless of whether they carried a risk of disease or not, and this finding is consistent with the findings in Section 4.1, which found that identification as a contaminant increased dangerousness ratings within the OCD group.

With regard to avoidance, participants with OCD tended to report greater reluctance to use the straws and were less likely to touch or drink from the straws than both the general UBC sample and nursing students. This greater tendency to avoid was seen in all three conditions (i.e., regardless of whether the substances were harmless or a non-contaminant). This finding is consistent with the results of Chapter 4 conducted within the OCD group, which found high levels of avoidance across conditions. As noted, this high tendency toward avoidance among OCD participants may be due to various reasons, including lower threshold for avoidance, intolerance of uncertainty, disgust or habit.

The comparisons across populations with respect to judgments of physical spread are somewhat unusual and difficult to interpret at present. The OCD group was found to judge the level of physical residue along the chain of contagion as greater for the harmless bacteria than the non-OCD groups, but not for the disease-causing bacteria or yogurt. It is not clear why this difference was exclusive to the harmless bacteria and did not extend to the disease-causing bacteria for example. In Chapter 4, the OCD group was found to judge both the disease-causing and harmless bacteria as physically spreading more than the yogurt and there was no difference between the disease-causing and harmless bacteria. However, when conducting analyses within the OCD group, differences across conditions in disgust sensitivity (DSS) and OCD symptom severity (YBOCS) were included as covariates, whereas this was not the case for analyses conducted across populations. It was not appropriate to include these variables as covariates in the analyses conducted across populations given that these variables represent important distinguishing traits of the OCD group and including them as covariates would confound interpretation of results. This difference, however, may explain why the OCD group's AUC-Physical Residue ratings were not also elevated for the disease-causing bacteria.

Furthermore, although the OCD group appeared to be less likely than the general UBC sample and nursing students to indicate that the substance had stopped physically spreading, this difference did not reach statistical significance. This non-significant finding, as well as the unusual pattern of results for the AUC-Physical Residue data, may also be related to the small sample size of the OCD population. There was a small but significant correlation between OCD symptom measures and the AUC of participants' physical residue ratings when examining the data across all populations and conditions. Taken together, the findings suggest that there might be a tendency for participants with OCD to judge substances as physically spreading more than the general UBC sample and nursing students. However, this suggestion is very tentative and interpretation should be reserved until corroborated by further research.

There were no significant differences between nursing students and the general UBC sample on judgments of physical spread, dangerousness or avoidance along the chain of contagion. This lack of significant difference might suggest that nursing students' education about the spread of germs and experience working in a healthcare setting did not have a great impact on their judgments of contaminant spread. Alternatively, this lack of difference may be due to the context: in this study, judgments of spread were examined in a food preparation context. Findings may vary in another context, such as a health care setting where nursing students might be cued to respond with greater caution or feel greater responsibility to prevent harm. It would be interesting to examine this possibility in future research.

OCD participants also tended to differ from nursing students in much the same way as they differed from the general UBC sample. The only exception to this pattern was that the OCD group did not differ significantly from nursing students on assessments of dangerousness along the chain of contagion for the disease-causing bacteria (although they did differ significantly on the harmless bacteria). Thus, in rating the dangerousness of disease-causing bacteria along the chain of contagion, nursing students tended to fall in-between the general UBC sample and OCD group, not differing significantly from either. This might suggest that nursing students perceive slightly more danger along the chain of contagion than the general UBC sample, although, as noted, this difference was not statistically significant. It would be interesting for future research to examine this possibility, and as noted above, perhaps examine it in different contexts as well.

Although the comparisons across studies that have been described provide interesting insight into some of the similarities and differences in how different populations make judgments about spread, the results should be interpreted with caution and in light of accumulating evidence in the field. The sample of OCD participants in this study was fairly small. Small sample sizes are a ubiquitous problem in research utilizing clinical samples given the difficulty of obtaining such samples (Gibbs, 1996; Streiner, 2006). Although contamination concerns and washing compulsions are some of the most frequently reported symptoms among people with OCD, OCD itself has a relatively low prevalence rate in the general population. The lifetime prevalence rate has been estimated at 2.5 % and the 1-year prevalence rate at 0.5 - 2.1 % (First, 2000). Furthermore, without access to a hospital-based treatment population, obtaining a very large sample of people from the community who met diagnostic criteria for OCD was simply not feasible. Despite the limitations of a small sample size, it was still deemed valuable to include a group of people with contamination-related OCD, in order to provide some additional insight into how these individuals make judgments about spread and contribute to the larger body of research on the phenomenon.

Furthermore, although power analyses were conducted using an effect size calculated based on the findings from Studies 1 and 2 and on the findings from Tolin et al. (2004), the method of analysis was slightly different than that which was originally planned. As will be discussed further in Section 6.8, the initial data analysis plan for this series of studies was to operationalize judgments of spread as the number of straws before participants' ratings (of physical residue, dangerousness or reluctance to use) reached zero. This analytic approach was originally employed for Studies 1 and 2 and the plan was to extend this approach to Studies 3 and 4. For this reason, my power analyses were based on this method of data analysis. However, once data was collected for Studies 3 and 4, the observed distributions were not appropriate for the original data analytic plan. As such, the area under the curve of participants' ratings (of physical residue, dangerousness or reluctance to use) along the chain of contagion was employed instead, as it allowed for comparisons to be made across studies. In addition, with regard to the behavioural avoidance tasks, the original plan was examine the number of straws before participants were willing to touch or drink from one. However, once data was collected, it became clear that these variables tended to have a bimodal distribution and the mean number of straws before participants touched or drank from one was not an accurate measure of participants' performance on these tasks. As such, chi square analyses were employed instead.

Due to these necessary changes in how the data was analyzed, there was some reduction in the power of select analyses. For the most part, obtained power was acceptable, $(1 - \beta) > .80$. However, on certain outcome variables, obtained power was reduced, such as the

ANOVA on AUC-Physical Residue among nursing students (obtained power = .45), disgust within the OCD group (obtained power = .42), as well as in chi square analyses among the nursing students and the OCD group.

Chapter 6: Summary and Discussion

6.1 Introduction

Over- or under-concern about the spread of contamination (such as germs) can have detrimental consequences on a person's functioning. Overconcern can lead a person to experience undue distress and engage in unnecessary avoidance and cautionary behaviour. Underconcern, however, can lead to the contraction and further spread of disease. People vary in their judgments of contaminant spread, and the purpose of this series of studies was to examine variables that may contribute to these differences. First, I examined whether threat information or identification as a contaminant increased judgments of spread. Second, I examined whether the pattern of findings found among a general (unselected) sample of UBC students would extend to specific populations of interest: people with contamination-related OCD and health care professionals. In the process of examining these questions, I measured various facets of spread in order to separate judgments about how much a substance physically spread from how dangerous people judged it to be from how much they wanted to avoid it. I also included preliminary analyses comparing judgments of spread across the three populations. Findings suggest that what influences judgments of contaminant spread depends on the specific facet of spread examined and the population under study. This chapter includes first a summary and discussion of the studies' main findings, and then moves to a broader discussion of the implications of these findings, limitations of the studies and directions for future research.

6.2 Summary of findings

6.2.1 Physical spread. In the general UBC sample, it was identification as a contaminant rather than threat that increased judgments of physical spread. Participants in the disease-causing and harmless bacteria conditions rated the physical residue along the chain of contagion as greater than those in the non-contaminant condition. This was true regardless of whether the non-contaminant contained bacteria (yogurt in Study 2) or not (celery in Study 1). This finding suggests that identification as a contaminant increased judgments of physical spread within the general UBC sample. Furthermore, the likelihood of participants indicating that physical spread had ended was elevated among participants in the non-contaminant condition in both Studies 1 and 2, but was not decreased by threat.

There was not strong evidence to suggest that threat increased judgments of physical spread in this population. However, there was greater variability in AUC-Physical Residue scores in the disease-causing bacteria condition, as well as a moderate correlation between subjective appraisals of threat and the AUC-Physical Residue scores. These findings might suggest perhaps a subgroup of people whose physical residue ratings were influenced by threat. However, further research would be needed to confirm this suggestion, as well as to examine moderators that might account for such an effect.

Similarly, participants with contamination-related OCD judged the physical residue along the chain of contagion as greater for the disease-causing and harmless bacteria than for the yogurt, and there was no difference between the disease-causing and harmless bacteria. This finding suggests that identification as a contaminant, but not threat, increased judgments of physical spread among participants with OCD. However, unlike the general UBC sample, there was no significant difference between conditions in the likelihood of OCD participants indicating that the physical spread had ended. The majority of participants with OCD were reluctant to say that the physical spread had ended even after 20 straws. Threat information did not increase judgments of physical spread among the OCD sample. There was a small, non-significant correlation between threat appraisals and AUC-physical residue ratings and a trend for variances to differ across conditions, with variability being greatest in the disease-causing bacteria condition.

Why or how identification as a contaminant increased judgments of physical spread is not yet clear. One possibility is that participants may have felt more disgusted by the bacteria (regardless of whether they caused disease or not) than the yogurt and that it is disgust that contributed to greater judgments of spread. If disgust influenced judgments of spread, one would expect participants to rate the disease-causing and harmless bacteria as more disgusting than the yogurt, but not different from one another. However, examination of reported disgust does not provide compelling support for such a relationship. The general UBC sample tended to rate their level of disgust in response to the harmless bacteria as midway between that of the disease-causing bacteria and yogurt. In Study 1, disgust was significantly higher in the disease-causing bacteria than harmless bacteria, and in Study 2, there was a nearly significant trend for such a difference. Within the OCD group, participants rated the non-contaminant as less disgusting than the two contaminants, although this effect did not reach statistical significance. Furthermore, although nursing students rated both contaminants as more disgusting than the non-contaminant, their AUC-Physical Residue scores tended to be higher in the disease-causing bacteria condition, but not in the harmless bacteria condition. Thus, the findings do not provide strong evidence that disgust accounts for the increased judgments of physical spread seen for contaminants.

Alternatively, perhaps simply the perception of a substance as tarnishing or out of place within a context (regardless of whether it poses any actual threat or not) somehow increases judgments of physical spread. The exact mechanism, however, is not yet clear. Insight into possible mechanisms may perhaps be obtained by considering broader research on heuristics and biases that people employ when making judgments about uncertain situations or events. For example, people tend to assess the likelihood of an event or the frequency of a class by how easily instances or occurrences come to mind, termed the *availability heuristic* (Tversky & Kahneman, 1974). Thus, if instances of class A events are easier to imagine than instances of class B, people will tend to assume that class A has a greater frequency than class B. Applying this principle to the present context, instances of contaminants spreading may be easier to imagine than instances of safe food spreading and this, in turn, might lead people to judge contaminants as spreading more easily. Another possibility may involve the *representativeness heuristic*, whereby people judge the probability of an instance as coming from a particular class based on how representative it is of that class, regardless of other more pertinent information that would influence that probability (such as base rates and sample size; Tversky & Kahneman, 1974). In the present context, people may have mental representations of contaminants as spreading easily, but may not as readily associate spread with safe food substances and as such judge contaminants as spreading more easily. It would be fruitful for future research to explore these possibilities.

The investigation into the judgments of spread of nursing students produced somewhat mixed results. There was a trend for nursing students to judge physical residue as greater in the disease-causing bacteria condition than in the harmless bacteria condition, but no different from the yogurt. Although this effect did not reach statistical significance, the magnitude of the effect size was similar to that obtained in Study 2. Furthermore, although nursing students did not judge the disease-causing bacteria as physically spreading more than the yogurt (which one would expect if it was threat that increased judgments of physical spread), there were several high scorers in the yogurt condition. Although these high scorers were not significant outliers, they may have had undue influence on the mean, thereby reducing the power of the analysis to detect significant differences. There was also a moderate correlation between nursing students' subjective threat appraisals and their ratings of physical residue along the chain of contagion.

These findings might suggest that threat increased nursing students' judgments of physical spread. However, these findings should be interpreted with caution, given that they did not reach statistical significance. In addition, there was no significant effect of condition on the likelihood of nursing students indicating that physical spread ended. Taken together, these findings seem to suggest that threat increased nursing students' judgments of the level of physical residue along the chain of contagion, but not the likelihood of them indicating that physical spread ended.

There are various possible reasons why threat may increase judgments of physical spread among nurses. One possibility is that nursing students may be more cautious about the spread of disease-causing bacteria and therefore err on the side of caution when making judgments about its physical spread. Another possibility is that nursing students recognize that microorganisms are in fact everywhere and may not identify harmless bacteria as contaminants, but rather as a normal part of the environment. As such, they may only view the disease-causing bacteria as contaminants and consequently judge them as spreading more easily. Future research should explore these possibilities.

Preliminary analyses comparing populations revealed somewhat mixed findings with regard to differences between populations in their judgments of physical spread. The OCD group judged the level of physical residue along the chain of contagion as higher than the general UBC sample and nursing students, but this was only true in the harmless bacteria condition. There were no significant differences between populations in the disease-causing bacteria and yogurt conditions. Furthermore, there was no effect of population on participants' likelihood of indicating that physical spread had ended. The reason for this pattern of findings is not yet clear, although it is likely due to sampling error. The OCD sample was fairly small and there were differences between conditions in disgust sensitivity and YBOCS scores. When conducting analyses within the OCD group, these measures were included as covariates and both the disease-causing and harmless bacteria were judged to spread more than the yogurt. However, it was not possible, nor appropriate, to include these as covariates in analyses conducted across populations. With a larger sample, it would seem likely that the OCD group would be found to have elevated judgments of spread for both contaminants.

If, however, future research confirms the pattern of results found in these studies, whereby differences between populations emerge only for the harmless bacteria, one might wonder whether such an effect could be due to the harmless bacteria condition being a more ambiguous situation. Lissek, Pine and Grillon (2006) describe experimental conditions as being *strong* or *weak*. Strong situations refer to experimental conditions involving unambiguous stimuli that tend to elicit similar responses from all individuals. As such, individual difference variables exert less of an influence on responses and variability in outcomes tends to be low. Weak situations, on the other hand, refer to experimental conditions that involve ambiguous stimuli. As such, they tend to lead to greater variability in responses and responses tend to be more influenced by individual difference variables. In the present context, one might wonder whether the harmless bacteria represent the weak situation and disease-causing bacteria the strong situation, and this discrepancy is why differences between populations were only found for the harmless bacteria condition. However, there is not compelling evidence for such an interpretation. Variability in physical residue ratings tended to be greater in the disease-causing bacteria condition than harmless bacteria condition in Studies 1, 2 and 3, which is inconsistent with the notion that strong situations elicit more uniform responses.

6.2.2 Dangerousness. Threat increased judgments of dangerousness along the chain of contagion for both the general UBC sample and nursing students. In both populations, participants in the disease-causing bacteria condition rated dangerousness as higher than participants in the harmless bacteria and non-contaminant (celery in Study 1, yogurt in Studies 2 and 3) conditions. Participants in the disease-causing bacteria condition were also least likely to indicate that danger had ended. Furthermore, there was a moderate correlation between subjective appraisals of threat and ratings of dangerousness along the chain of contagion (r ranging from .58 to .65). Variability in dangerousness ratings along the chain of contagion was greatest in the disease-causing bacteria condition, suggesting perhaps that some participants' dangerousness ratings were particularly influenced by the threat information.

The relationship between threat and ratings of dangerousness along the chain of contagion seems very logical. One would expect that the residue left behind by threatening substances to be judged as more dangerous than the residue left behind my non-threatening substances. There was also an increased likelihood of participants in the non-contaminant condition (celery in Study 1, yogurt in Studies 2 and 3) indicating that danger had ended.

Interestingly, the pattern of findings was quite different among participants with OCD. Participants with OCD judged dangerousness along the chain of contagion as greater in both the disease-causing and harmless bacteria conditions as compared to the yogurt condition. Of note, the disease-causing and harmless bacteria conditions did not differ significantly from one another. These findings suggest that it was identification as a contaminant, rather than threat information, that increased judgments of dangerousness among OCD participants. This finding may be due to the manner in which threat was operationalized. In these studies, threat was manipulated by informing participants in one condition that the bacteria caused physical illness and those in the other condition that the bacteria were harmless. As such, threat was directly tied to threat of physical disease. However, participants with OCD may have perceived other types of threat associated with the contaminants. Feared consequences of contamination can include, not only physical consequences (such as getting sick), but also social (e.g., being rejected by others) and emotional consequences (e.g., losing emotional control; Rachman, 2006; Woody & Teachman, 2000). Because ratings of dangerousness, on the other hand, simply involved rating how safe or dangerous it would be to use a straw on a scale from 0-100, it may have captured a broader array of feared consequences. Participants with OCD may have rated dangerousness as high for the two contaminants because they perceived them both as having other negative consequences, not simply the risk of disease.

It is interesting, however, that the increased dangerousness associated with both contaminants was only noted within the OCD group and it raises the question of whether people with OCD tend to perceive a broader array of feared consequences from contamination than do people without the disorder. This question would be interesting to examine in future research. Olatunji, Connolly, Lohr, and Elwood (2008) found that people with elevated OCD symptoms tend to generate more ways in which a situation might be contaminating than people with fewer OCD symptoms. However, the differences appeared to relate more to the variety of potential sources of contamination in a given situation (e.g., the variety of stimuli in a public washroom), rather than the underlying threat associated with contamination. The finding also highlights the importance of accurately assessing the consequences feared by patients with OCD in order to properly target these concerns in treatment. As noted earlier, Cougle et al. (2007) found that the type of threat participants feared (whether it was illness-related or not) influenced whether decreases in urge to wash during habituation were driven by decreases in anxiety or disgust.

In contrast to the above findings, however, there was a moderate correlation ($r = .50$) between the OCD group's subjective threat appraisals and their dangerousness ratings. Threat appraisals were also measured in a way that focused on physical disease as a consequence (participants were asked to rate: "how safe or dangerous is the substance on the cutting board", "how likely is it that you would get sick from it" and "if you did get sick, how serious would that illness be"). The correlation may suggest that subjective judgments of disease threat that include assessment of one's own personal risk have a greater impact on dangerousness ratings than objective information about risk. Alternatively, the correlation may be due to methodological overlap between paper-and-pencil rating scales.

Despite rating dangerousness as higher for the contaminants as compared to the non-contaminant, a majority of participants with OCD were reluctant to indicate that danger ever ended (66.7% never rated the straw as safe to use), regardless of which condition they were in. This reluctance to rate any of the straws as safe could be due to a number factors. Participants with OCD may have perceived the straws as dangerous for reasons unrelated to the substances used in the experimental manipulation. For example, they may have judged the entire experimental setting, including the straws before being used, as potentially contaminated and dangerous. This could relate to the tendency among people with OCD to overestimate threat and to view situations as dangerous until proven safe (Foa & Kozak, 1986). In addition, it could relate to a difficulty reframing any possibility of negative consequences as insignificant, regardless of how small (Woody & Teachman, 2000).

Comparing populations, the OCD group rated dangerousness along the chain of contagion as greater than the general UBC sample for the contaminants (disease-causing and harmless bacteria), but not for the non-contaminant (yogurt). The OCD group also had higher ratings of dangerousness than nursing students for the harmless bacteria, but not for the disease-causing bacteria condition or yogurt. Furthermore, participants with OCD were less likely than both the general UBC sample and nursing students to indicate that danger ended (i.e. that at least one of the straws became safe to use). These findings are consistent with cognitive theories and empirical findings holding that people with OCD tend to overestimate threat (see Sookman & Pinard, 2002 for a review). The lack of significant difference in the disease-causing bacteria condition between the OCD group and nursing students may suggest slight elevations in dangerousness ratings among nursing students (as compared to the general UBC sample) or may be related to reduced statistical power.

6.2.3 Avoidance.

6.2.3.1 Reported reluctance to use the straws. Participants with OCD were highly reluctant to use any of the straws, regardless of which condition they were in, whereas the general UBC sample and nursing students were more influenced by threat of disease.

Among the non-clinical groups (i.e., the general UBC sample and nursing students), threat increased reluctance to use the straws. Participants in the disease-causing bacteria condition reported significantly greater reluctance to use the straws along the chain of contagion than participants in the harmless bacteria and non-contaminant (celery in Study 1, yogurt in Studies 2 and 3) conditions. There was also a moderate correlation between participants' appraisals of how threatening the substance was and their reluctance to use the straws along the chain of contagion. When faced with indicating with certainty whether they would be willing to use one of the straws, participants in the disease-causing bacteria condition were less likely to indicate that they would definitely use one of the straws, while participants in the non-contaminant condition (celery in Study 1, yogurt in Studies 2 and 3) were more likely to indicate so. Taken together, these findings suggest that threat of disease increased reluctance to use the straws for the general UBC sample and nursing students.

Interestingly, for participants with OCD, neither threat nor identification as a contaminant affected reluctance to use the straws. Rather, reluctance to use ratings did not differ across conditions and were not correlated with subjective appraisals of threat. Furthermore, there was no effect of condition on the likelihood of participants with OCD indicating that they would definitely use one of the straws. Most participants with OCD (85.7 %) never indicated with certainty that they would use one of the straws. Comparisons across populations revealed that participants with OCD reported greater reluctance to use the straws along the chain of contagion and were less likely to indicate that they would definitely use one of the straws than the general UBC sample and nursing students.

6.2.3.2 Touch. With regard to touching the straws, among the general UBC sample and nursing students, most participants touched at least one of the straws (86% of the general UBC sample, 88 % of the nursing students). For the UBC sample, there was an increased likelihood of touching a straw in the yogurt condition and a decreased likelihood of touching a straw in the disease-causing bacteria condition. Among nursing students, there was no significant difference between conditions in their likelihood of touching a straw. Among both populations, however, threat appraisals were higher among those who did not touch any straws compared to those who did. Thus, for the general UBC sample, threat increased avoidance. For nursing students, subjective appraisals of threat were associated with avoidance, but objective threat information did not increase avoidance behaviour.

The majority of participants with OCD also touched at least one of the straws (62%), although compared to the general UBC sample and nursing students, there was a decreased likelihood of the OCD group doing so. Among participants with OCD, there appeared to be an increased likelihood of touching a straw in the yogurt condition, although this effect did not reach statistical significance in this study. There were no differences in subjective appraisals of threat between OCD participants who touched a straw and those who did not. Thus, avoidance of touching the straws among participants with OCD did not appear to be influenced by threat of disease.

6.2.3.3. Drink*.* With regard to drinking from the straws, 62% and 56% of the general UBC sample drank from one of the straws in Studies 1 and 2 respectively. Within this population, there was an increased likelihood among participants in the non-contaminant condition to drink from a straw and a decreased likelihood of drinking from a straw in the disease-causing bacteria condition. Among nursing students, 63% of participants drank from one of the straws and the likelihood of drinking from a straw was decreased in the disease-causing bacteria condition. Furthermore, among both the general UBC sample and nursing students, appraisals of threat were significantly greater among participants who did not drink than those who did. Thus, within these non-clinical samples, threat increased avoidance of drinking from the straws.

The pattern of results for the OCD group, however, was quite different. Among participants with contamination-related OCD, most did not drink from any of the straws (only

19% drank from a straw) and there was no significant difference between conditions in the likelihood of participants drinking from the straws. Furthermore, those who drank from a straw did not differ from those who did not on appraisals of threat. Comparing across populations, participants with OCD had a decreased likelihood of drinking from the straws. Thus, the OCD group was highly reluctant to drink from the straws, regardless of which condition they were in or how threatening they appraised the substance to be.

6.2.3.4 Discussion of avoidance findings. The observed relationship between threat and avoidance (as evidenced by reluctance to use ratings and willingness to touch and drink from the straws) among the general UBC sample and nursing students is as one would predict. When faced with a threatening substance, people feel compelled to avoid it. It is interesting, however, that this relationship was not found within the OCD group. There are several possible explanations for this finding.

First, participants with OCD may have judged the entire experimental setting as contaminated, even objects that were meant to be clean (such as the glasses and straws prior to being used). Participants with OCD do have a tendency to overestimate threat (Sookman & Pinard, 2002) and appraisals of threat have been shown to prospectively predict avoidance behavior (Dorfan & Woody, 2011). Furthermore, as noted in the comparisons across studies, people with OCD tended to rate all three substances as more threatening than the general UBC sample and nursing students. If participants with OCD were in fact judging the entire experimental setting as contaminated, it may suggest that future research go to greater lengths to present the environment as sterile. The experimenters in these studies reassured participants that the glasses and straws were new and clean, and efforts were made to ensure that the laboratory setting was tidy and clean. However, I did not have access to a completely sterile environment. Given the tendency among people with OCD to view everyday objects and places as contaminated, however, it may be beneficial for future research to attempt to create a more sterile testing environment. It would also be helpful to assess participants' appraisals of threat with respect to a broader array of objects in the experimental setting.

Second, it could be due to participants with OCD having a lower threshold for avoidance. They may feel that a substance that poses any threat (regardless of how small) should be avoided. Such an effect could be due to the elevated intolerance of uncertainty seen among people with OCD (Myers, Fisher, & Wells, 2008; OCCWG, 2001, 2005; Steketee, Frost, & Cohen, 1998). Intolerance of uncertainty refers to a cognitive bias whereby people view uncertainty or unexpected situations negatively, distressing and to be avoided (Dugas, Hedayati, Karvides, Buhr, Francis, & Phillips, 2005, p. 58). Faced with the uncertainty inherent in making judgments about contamination, participants with OCD may seek certainty about their own risk (i.e., reassurance of being safe) by simply avoiding all objects.

Third, OCD participants' avoidance could be driven by disgust. In the present study, OCD participants reported moderate levels of disgust, regardless of which condition they were in, and greater disgust than the general UBC sample and nursing students. As noted earlier, disgust has been conceptualized as an adaptive emotion that promotes avoidance of contaminated material (Curtis, 2007; Matchett & Davey, 1991; Oaten, Stevensen, & Case, 2009). It is possible that the greater avoidance observed in the OCD group was driven partly by disgust.

Fourth, people with contamination-related OCD may simply avoid interacting with most objects out of habit. Habitual behaviour refers to behaviour that is firmly established and that often occurs automatically and without awareness (Sarafino, 2006). Habit can be a powerful determinant of whether people engage in health behaviour (Sarafino, 2006) and is one of the reasons cited by people for handwashing (Curtis, Danquah, & Aunger, 2009). People with contamination-related OCD may engage in such a high level of avoidance in their daily lives that they begin to avoid simply out of habit without necessarily considering the actual level of danger in any given situation.

In the general UBC sample and nursing students, avoidance of touching and drinking from the straws was influenced by threat. This finding is consistent with cognitive theories of anxiety disorders, which hold that threat increases anxiety, which in turn leads to efforts to reduce that anxiety through avoidance or other safety behaviour.

The likelihood of participants drinking from a straw tended to be lower than their likelihood of touching a straw. This observation likely relates to the fact that hands can be washed and disinfected after touching an infectious agent, but once a substance is ingested through drinking, it cannot be easily reversed. In other words, participants likely felt better able to cope with touching the straws than drinking from the straws. Lack of perceived control has been associated with anxiety (Beck, Emery, & Greenberg, 1985), and there is evidence that elevated OCD symptoms are associated with a tendency to underestimate coping abilities (Steketee, Frost, & Cohen, 1998; Woods, Frost, & Steketee, 2002). Furthermore, numerous health psychology models hold that the perceived efficacy of a health behaviour influences whether or not people engage in those behaviours (Rogers, 1975; Rosenstock; 1974; Witte, 1992). In the present context, participants' perceived ability to cope after touching the straws versus drinking from them may help explain their greater willingness to touch the straws.

6.3 Summary of results by population. With regard to the general UBC sample, judgments of physical spread were influenced primarily by identification as a contaminant, while ratings of dangerousness and reluctance to use were primarily influenced by threat.

Actual behaviour (touching or drinking from the straws) was decreased in the presence of threatening bacteria and increased in the presence of non-contaminating food. In contrast, for nursing students, there was a trend for threat to increase judgments of physical spread. Similar to the general UBC sample, threat increased nursing students' ratings of dangerousness and reluctance to use the straws among nursing students. Furthermore, although most nursing students were willing to touch the straws regardless of which condition they were in, threat decreased their willingness to drink from the straws. With respect to the OCD group, identification as a contaminant influenced both judgments of physical spread and dangerousness along the chain of contagion. OCD participants' self-reported reluctance to use the straws and their actual avoidance was high, regardless of which condition they were in. Comparing populations, the OCD group rated dangerousness along the chain of contagion as higher for the contaminants than did the general UBC sample and nursing students. There was no difference between populations for the non-contaminant. The OCD also group reported, and engaged in, greater avoidance across all conditions. As noted earlier, findings regarding differences across populations in physical spread are mixed.

6.4 Relationship between indices of spread

Although the various indicators of spread (physical residue, dangerousness and avoidance along the chain of contagion) have been discussed separately, it is important to note the strong relationship between them. For instance, the correlation between physical residue and dangerousness ratings was high within the general UBC sample (r = .78) and OCD group (r = .87), although it was somewhat lower among nursing students (r = .64). There are various explanations for this strong relationship.

First, people may recognize that having a larger quantity of a disease-causing substance means that one is more likely to reach its infective dose (the amount of the substance necessary to cause infection) and therefore the more of the substance that is present, the greater the danger. If so, one would anticipate that the correlation to be greatest in the disease-causing bacteria condition. Correlations conducted within conditions revealed that this was the case for the general UBC sample and nursing students, but not the OCD group. The alternative—that judgments of dangerousness increase judgments of physical spread—did not receive support from my experimental manipulation in the current studies. Interestingly, among participants with OCD, the correlation between physical residue and dangerousness was very high in both the harmless bacteria and yogurt condition. While these results should be interpreted with caution given the small sample size, the findings might suggest that people with OCD consider physical residue as dangerous regardless of the nature of the substance.

Second, the correlation between physical residue and dangerousness may also be due to methodological overlap. Both physical residue and dangerousness ratings were assessed at the same time on a similar 100-point scale and participants were asked to make these ratings 20 times (once for each straw along the chain of contagion). The act of repeatedly asking participants to rate these two constructs at the same time on a similar scale may have inflated their relationship.

A third possibility is that the distinction between physical residue and dangerousness is not one that people normally make when rating contamination. In other studies on judgments of spread, participants were asked to rate how *contaminated* each object was along the chain of contagion. One of the aims of this series of studies was to try to tease apart the various components of these ratings in order to arrive at a better understanding of the cognitive processes involved in judgments of spread. However, it may be that people simply do not normally make these distinctions. Rather, perhaps people make a more global judgment of whether an object is contaminated or not and then base their ratings of physical residue and dangerousness on these global assessments. If this were the case, one would expect the magnitude of the correlation to be consistently high across conditions and populations. However, it was not: the correlation between physical residue and dangerousness ratings ranged from .40 to .97 depending on the condition and population.

Throughout this document, I have discussed physical residue, dangerousness and avoidance as indicators or facets of spread. My reasons for presenting these outcome variables in this way and treating them similarly in the statistical analyses were twofold. First, I wanted to clarify that the dangerousness and reluctance ratings were taken along the chain of contagion and not of the source substance, and, second, I wanted to provide continuity with previous research which had used a term that combined these various constructs. However, the question arises of whether a multi-faceted perspective is the best way of conceptualizing judgments of spread. For instance, ratings of physical residue along the chain of contagion could be interpreted as representing true spread, whereas ratings of dangerousness and reluctance to use the straws as something separate.

With regard to dangerousness ratings along the chain of contagion, one possibility is that these ratings are similar to threat appraisals and therefore serve as a form of manipulation check. Indeed, AUC-Dangerousness scores tended to be elevated in the disease-causing bacteria condition (for the general UBC and nursing student samples) and were significantly correlated with threat appraisals. It seems logical that the more threatening a substance is, the more dangerous its residue is judged to be. However, there is also evidence that the relationship was more complex. Among participants with OCD, dangerousness along the chain of contagion was highest for both contaminants, regardless of whether they carried a risk of disease or not. As noted earlier, due to the way in which these constructs were measured, threat appraisals seemed to capture illness-related concerns, whereas dangerousness ratings captured more general assessments of danger. Alternatively, dangerousness ratings may represent differences in perceived infective dose. In the disease-causing bacteria condition, although participants may recognize that the amount of the substance decreases, they may vary in terms of their beliefs about how much of a substance is needed in order to cause illness or other negative consequences. As such, dangerousness may reflect beliefs about how dangerous decreasing amounts of the substance are along the chain of contagion.

Turning to participants' reluctance to use the straws along the chain of contagion, this outcome could be construed as a measure of risk taking. The presence and amount of the purported substance on each straw was unknown, and, as such, participants (especially those in the disease-causing bacteria condition) faced an unknown threat. Their reported willingness (or lack thereof) to use the straws could represent their willingness to risk potentially ingesting the substance.

6.5 Implications of findings for promoting good hygiene practices in the general population and among health care workers

The current studies were not designed specifically to assess ways of improving public or occupational health campaigns. However, the findings may shed light on variables that could prove fruitful to investigate in future research. The outcome of greatest interest in the context of public and occupational health campaigns is how to affect health behaviour, which generally means increasing hand washing in response to potential contamination. In the current studies, however, I focused on avoidance behaviour, rather than spontaneous hand washing, for several reasons. First, pilot research suggested that informing participants that it was study policy that they wash their hands after touching any straws, increased believability that disease-causing bacteria were actually present in the laboratory setting. Second, because participants responded to other questions after being asked about their willingness to touch the straws, I wanted to ensure that any feelings of dirtiness on their hands would not influence their response to subsequent questions. It will, of course, be important for future research to examine spontaneous hand washing. Nonetheless, findings regarding avoidance in these studies may shed light on variables that increase precautionary behaviour.

As noted earlier, avoidance was greater when possible oral ingestion of the substance was involved (i.e., drinking), rather than simply touching it. This observation is likely due to the fact that ingestion cannot be easily reversed, whereas dirtied hands can be cleaned. The finding, however, highlights the importance of making the possibility of ingestion salient when trying to improve hand hygiene behaviour. Furthermore, the fact that threat of disease increased avoidance of drinking suggests that making threat information salient may also increase avoidance.

To place these suggestions into context, one might consider the televised public service announcement described in the introduction aimed at increasing hand washing among women in Ghana. To recapitulate, the mother is preparing dinner, takes a break to use the washroom and does not wash her hands afterward. A digitalized purple stain appears on her hand and everything she touches thereafter, including the food she is preparing for her family, becomes marked with the purple stain. The ad closes with one of her children about to eat food with a purple stain on it. Based on the current findings, one of the effective components of this ad is that it links hand hygiene behaviour with oral ingestion of contaminated food. What might render this PSA even more effective, however, is also incorporating information about a typical disease that this mother or her child might have. For example, discussing symptoms or showing a person suffering from the disease may increase precautionary behaviour. A similar approach has been used in encouraging other health behaviours, such as the use of graphic images of smoking-related diseases on cigarette packaging to discourage smoking (Hammond, 2011).

It is important to remember, however, that numerous factors influence health behaviours and the most effective approaches to improving hand hygiene will likely be multi-faceted. For example, among health care workers, addressing barriers to hand hygiene, such as including handrub dispensers at points of care to reduce time needed to wash and developing handrubs that do not cause skin irritation, are likely important components of improving hand hygiene (Pittet, Allegranzi, & Sax, 2007).

6.6 Implications for understanding fear of contamination.

Previous research has suggested that people with contamination-related OCD judge contaminants as spreading more easily than people without the disorder. One of the reasons for conducting this series of studies was to better understand the cognitive variables that increase judgments of spread, in order to shed light on potential mechanisms that might account for excessive judgments of spread in OCD. More specifically, given the tendency among people with OCD to overestimate threat, I examined whether threat may play a role in increasing judgments of spread. The findings from this series of studies are complex and depend on the facet of spread that one is considering and the population under study. To illustrate some of the key findings and hypothesized relationships, I have outlined a working model, which is provided in Figure 58. The model includes basic components of cognitive theory of anxiety disorders, along with suggestions on how judgments of spread may fit into this model in the context of contamination fear. Future research will certainly refine these relationships and constructs; the model is meant as a helpful way of illustrating the main findings and hypothesized relationships and perhaps pointing to additional areas for future research. The model is provided below, with a description of the various constructs and relationships provided thereafter.

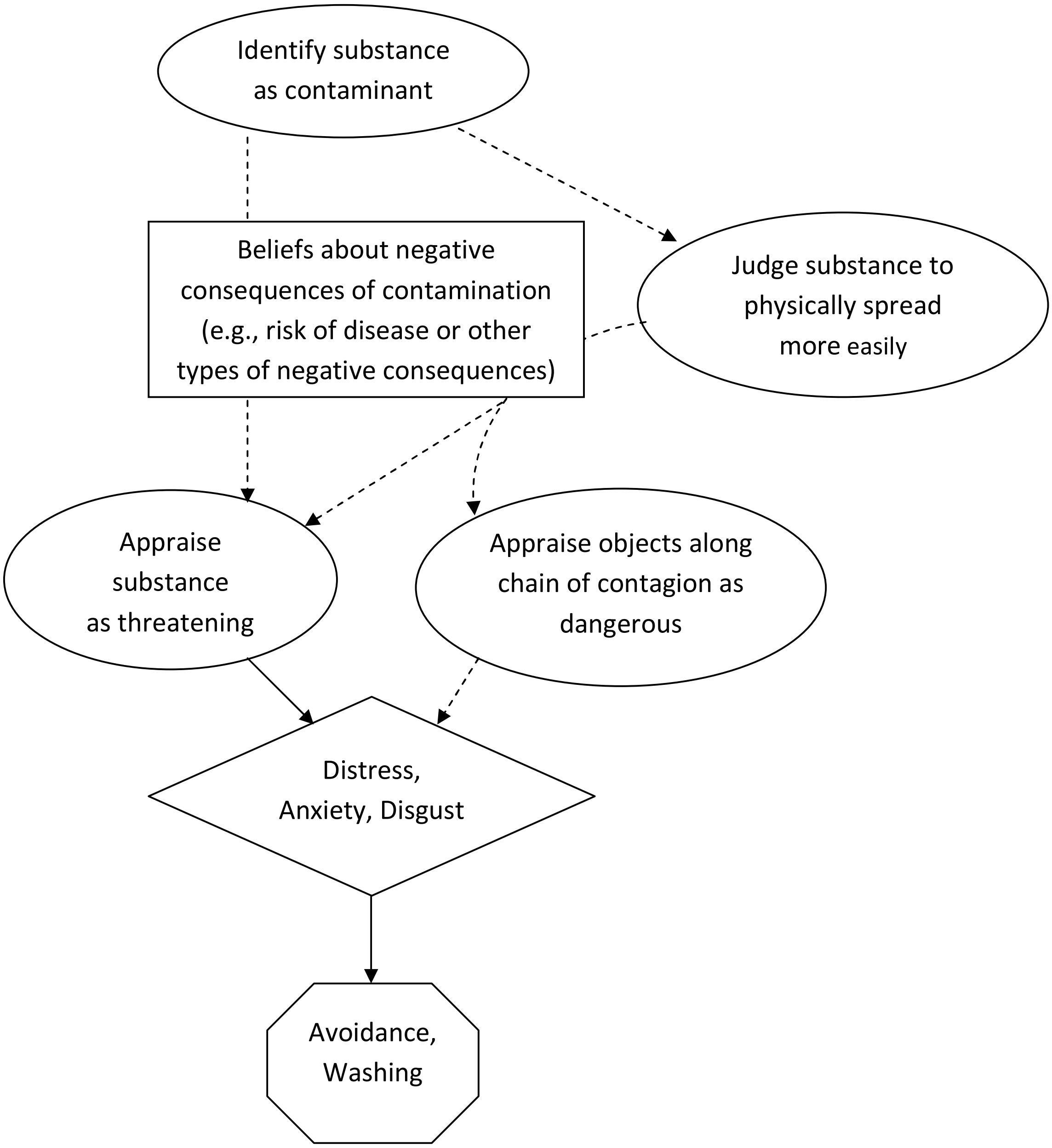


Figure 58. Working model of judgments of spread in contamination fear.

Cognitive theory of anxiety disorders, including fear of contamination, emphasizes the importance of threat appraisals. More specifically, when a person appraises a stimulus (e.g., substance) as threatening, this threat appraisal leads to feelings of anxiety, which in turn, leads to efforts to reduce that anxiety through safety behaviour (e.g., avoidance or washing). These basic elements of the cognitive theory of anxiety disorders are linked in Figure 58 with solid black arrows. Given the context of contamination fear, I have also included feelings of disgust in this model. Where judgments of spread fit into this model is not yet clear. However, based on the current findings and on other research in the area, several hypothesized relationships can be identified.

First, given that the two contaminants (disease-causing and harmless bacteria) were judged to physically spread more than the non-contaminants (celery or yogurt containing probiotic bacteria), identification as a contaminant appears to increase judgments of physical spread. For example, a substance that is perceived to be unclean, tarnishing, dirty or perhaps disgusting, will be judged to physically spread more easily than a desirable food substance. In turn, greater physical spread will tend to increase dangerousness ratings along the chain of contagion for substances that are deemed threatening. For example, in Study 2, although the general UBC sample viewed both contaminants as spreading equally, they rated dangerousness along the chain of contagion as greater for the disease-causing bacteria. Participants with OCD, however, perhaps because they hold more negative beliefs about the consequences of contamination, viewed both contaminants as leading to increased danger along the chain of contagion. These appraisals of high danger along the chain of contagion, in turn, likely increase avoidance and safety behaviour. In the general UBC sample, for example, avoidance was greatest when the disease-causing bacteria were spread to the series of straws. In the OCD group, however, as noted earlier, avoidance may have been driven by a broader appraisal of the entire experimental setting as contaminated. In addition, it is likely that threatening substances that physically spread more easily will be viewed as more dangerous than threatening substances that remain static or are difficult to spread. Previous research has found that imagining contaminants as moving (as opposed to remaining static) leads to greater worry and urge to wash (Riskind, Wheeler & Picerno, 1997) and hinders habituation (Dorfan & Woody, 2006). As such, in addition to increasing dangerousness ratings along the chain of contagion, greater physical spread may also increase threat appraisals of the source substance itself.

The reader may note that identification as a contaminant did not increase nursing students' judgments of physical spread, although there was a trend for threat to do so. As noted earlier, it may be that nursing students were more cautious about the spread of disease-causing bacteria and erred on the side of greater physical spread for these bacteria. Alternatively, nursing students may not have identified harmless bacteria as contaminants. The dangerousness ratings and behaviour of nursing students, however, was similar to that of the general UBC sample.

The reader may also note the arrow connecting identification as a contaminant with appraisals of threat through negative beliefs about the consequences of contamination. The idea is simply that when a contaminant is identified, beliefs about its potential consequences will influence whether or not that contaminant is appraised as threatening. It is recognized, however, that the relationship is not simply unidirectional; beliefs about the negative consequences of contamination will likely influence the types of substances that are identified as contaminants.

The model's implications for understanding judgments of spread in contamination-related depend on the facet of spread examined. With regard to physical spread, there was mixed evidence as to whether the OCD group in fact had elevated judgments of physical spread compared to the general UBC sample. Differences only emerged in the harmless bacteria condition. However, as noted, this was likely due to sampling error.

If future research confirms elevated judgments of physical spread of contaminants among people with OCD, it would be consistent with the looming vulnerability model. As noted earlier, the looming vulnerability model holds that a tendency to view feared stimuli or dangers as rapidly approaching, spreading or increasing in speed is a cognitive vulnerability factor for anxiety disorders and there is evidence that people with elevated contamination fear more strongly endorse looming vulnerability appraisals (Elwood, Riskind, & Olatunji, 2011; Tolin et al., 2004; Riskind, Abreu, et al., 1997). As such, finding that participants with OCD judge contaminants to spread more easily than people without the disorder, would be consistent with this theory. What contributes to these differences in judgments of physical spread in the first place, however, is not yet clear. Riskind, Abreu, et al. (1997) suggest that a looming vulnerability style may develop through modelling, biased interpretations of past events or be influenced by imagination and inappropriate generalizations from past experiences. Whether such factors also play a role in contributing to differences in beliefs about physical spread will be a question for future research to explore.

Furthermore, it will be important to examine whether treatment reduces excessive judgments of spread. Danger Ideation Reduction Therapy is a treatment for contamination-related OCD that focuses on reducing danger appraisals and includes, as one of its components, psychoeducation about contaminant spread (Krochmalik, Jones, & Menzies, 2001). There is evidence supporting the effectiveness of this treatment overall (Krochmalik, Jones, & Menzies, 2001), although it will be important for future research to examine the effectiveness of the psychoeducation about spread component more specifically.

Another related question that arises is whether people with OCD differ in their identification of substances as contaminants. Given the tendency among people with OCD to overestimate threat, they would probably be more likely to identify substances as contaminants. Future research may wish to include a broader array of substances—perhaps those that are ambiguous with regard to whether they are contaminating—in order to capture such differences.

With regard to judgments of dangerousness along the chain of contagion, the OCD group's elevated ratings of dangerousness are likely due to them holding more negative beliefs about the consequences of contamination. People with OCD may also perceive a greater variety of types of threats associated with contamination. It would be insightful for future research to assess, or perhaps experimentally manipulate, a broader array of negative consequences associated with contamination in order to explore this idea further. Finally, the elevated avoidance among participants with OCD across all conditions could be due to a number of factors that have been outlined earlier (e.g., judging the entire experimental setting as contaminated, having a lower threshold for avoidance, disgust, habit). Future research may wish to explore these various possibilities.

A final point to note about this working model is that it highlights the finding that elevated judgments of physical spread are not simply by-products of elevated distress or threat appraisals. Rather, other cognitive processes appear to influence judgments of spread. Developing a better understanding of these variables will help us to better understand the fear of contamination.

6.7 Extending the findings to related theory and research on contamination fear.

The current studies' findings are consistent with accumulating research showing that people's judgments of contamination and disease spread are not always logical. Rozin and Nemeroff (1990) outlined two beliefs that contribute to people judging previously neutral objects as contaminated. These are termed the *laws of sympathetic magic* and include the *law of similarity* and the *law of contagion*. The law of similarity holds that objects that resemble one another share fundamental properties. For example, people are reluctant to eat chocolate if it is shaped to look like feces (Rozin, Millman, & Nemeroff, 1986). The law of contagion holds that once two objects (or people) have contacted one another, they can influence each other for an extended period of time after contact has terminated, and can be summarized as “once in contact, always in contact”. For example, when a sterilized insect is placed in a glass of juice and then removed, the juice is rated less favorably (Rozin, Millman, & Nemeroff, 1986). The laws of sympathetic magic were outlined by anthropologists studying rituals and magical practices in traditional cultures, most notably by Sir James Frazer and Marcel Mauss during the turn of the 20^{th} century (Nemeroff & Rozin, 2000). However, these beliefs have been found to influence the thinking of modern-day North Americans as well (Rozin, Millman, & Nemeroff, 1986; Nemeroff & Rozin, 1994).

Although the laws of sympathetic magic can often lead to accurate judgments of contamination—things that look like contaminants often are and germs can spread through physical contact—they can also at times lead to inaccurate judgments of contamination, as can be seen in the examples above. Findings from the present series of studies suggest that the law of contagion is more powerful for contaminants than non-contaminants. In support of this observation, the laws of sympathetic magic tend to be more powerful for the transmission of negative properties than of positive properties (Rozin, Millman, & Nemeroff, 1986). This principle can be summarized with the observation that “a drop of sewage spoils a barrel of wine, but a drop of wine does nothing for a barrel of sewage” (Rozin, Millman, & Nemeroff, 1986). The findings might also suggest that identification as a contaminant influences the type or content of heuristics that people employ when making judgments about physical spread. The question would then arise as to how people come to learn what heuristics to employ. As noted, earlier, some possibilities may include learning, modelling or biased processing of past events.

The current studies' findings may also extend to other types of contaminants, such as contamination from other people, and, if so, may suggest possible cognitive mechanisms contributing to some of the social consequences of contamination fear. It has been proposed that humans evolved cognitive, emotional and behavioural mechanisms that facilitate detection and avoidance of pathogens in one's environment, termed the *behavioural immune system* (Schaller & Park, 2012). For example, seeing visible cues of disease may activate the behavioural immune system, thereby promoting avoidance of the diseased object or person. Given that infectious diseases are often spread through interpersonal contact, concerns about disease can influence social interactions. For example, animals and humans tend to avoid conspecifics with visible cues of disease (Kurzban & Leary, 2001) and rendering threat of disease salient increases avoidance of other people (Mortensen, Becker, Ackerman, Neuberg, & Kenrick, 2010). The behavioural immune system is adaptive in that it promotes avoidance of potential sources of disease. However, it can also lead to false positives. For example, when disease threat is salient, people are also more likely to avoid others with physical anomalies unrelated to infectious disease, such as those with physical disabilities, who are obese or who are elderly (Duncan & Schaller, 2009; Park, Faulkner, & Schaller, 2003; Park, Schaller, & Crandall, 2007). Furthermore, populations living in geographic areas with greater risk of parasitic diseases tend to have elevated levels of xenophobia and ethnocentrism, suggesting that fear of disease from outsiders may be a contributing factor to stigmatization of outgroups (Fincher & Thornhill, 2012; Kurzban & Leary, 2001).

In addition to concerns about disease, there is also evidence to suggest that people avoid contact with others with undesirable characteristics unrelated to disease. For example, people report being less likely to wear a laundered sweater or use a thoroughly cleaned hairbrush if it was previously owned by someone they dislike than if it belonged to a close friend (Nemeroff & Rozin, 1994). Part of this phenomenon may be due to fear of disease, as there is evidence that people judge germs of disliked others as leading to more serious illness than the germs of a friend (Deangelo, 2001; Nemeroff, 1995; Sullivan & Terry, 1998). However, there may also be concern about adopting some of the undesirable characteristics of the disliked other (Nemeroff & Rozin, 1994). Indeed Rachman (2006) has described a subtype of fear of contamination involving the fear of morphing, whereby people fear adopting the characteristics of disliked others.

The results of my studies suggest that people view contaminants (i.e., bacteria that are not an integral part of the food), regardless of whether they pose any risk of disease or not, as physically spreading more than non-contaminants (i.e., bacteria that are an integral part of a food substance). If this cognitive bias is shown to extend to other types of contaminants than those that I studied, this finding might suggest a cognitive mechanism contributing to the interpersonal effects noted above. People who are viewed as perhaps not being part of a social group or not conforming to social norms (as judged by the individual of course), may be considered to carry germs or other characteristics (e.g., immoral values) that spread more easily than those of group members. Examining judgments of the ease of spread associated with certain people would help shed light on this possibility.

6.8 Paths not taken

In designing these studies and analyzing the data, there were several paths that I considered, but ultimately decided not to take. I discuss several here for the interested reader.

6.8.1 Operationalizing judgments of spread and analyzing data. In terms of operationalizing judgments of spread, my original data analytic plan had been to operationalize judgments of spread as the number of straws before participants' ratings (of physical residue, dangerousness or reluctance to use) reached zero. This analytic approach was originally employed for Studies 1 and 2 and the plan was to extend this approach to Studies 3 and 4. However, once data was collected for Studies 3 and 4, it became clear that this data analytic approach could not be used because there was extremely limited (and in some cases, no) variability on some of the outcome variables, as well as ceiling and floor effects. Figure 59 shows boxplots of the number of straws before participants' physical residue ratings reached zero in each of the four studies. As can be seen, variability was good in Studies 1, 2 and, in this case 3, but was extremely limited in Study 4. While the contrast in results is quite striking and interesting to consider, it was not amenable to analyzing the data using ANOVA and led to ceiling and floor effects. As such, an alternative method of operationalizing spread was used: the area under the curve (AUC) of participants' ratings of physical residue, dangerousness and reluctance to use across the chain of contagion.

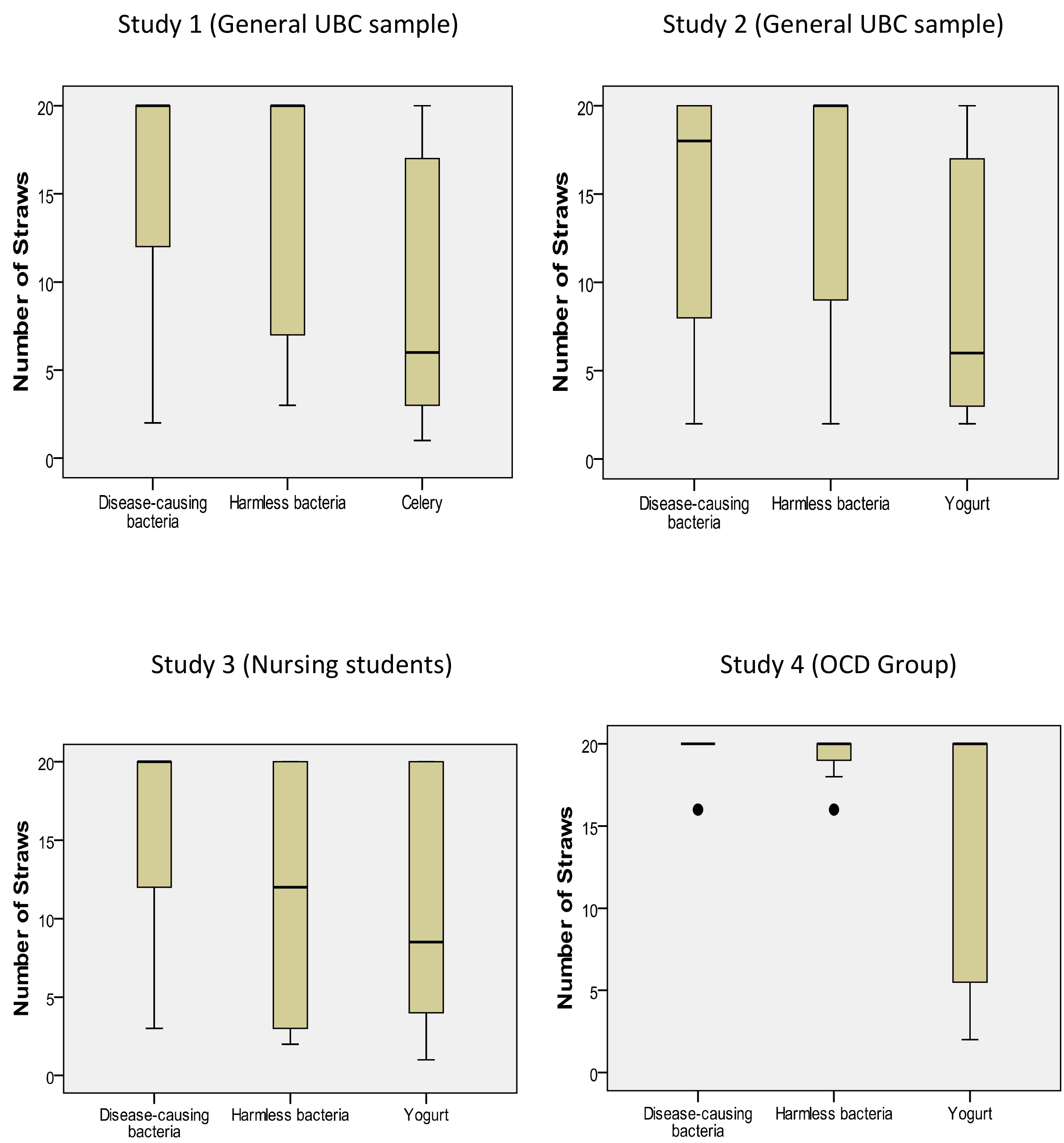


Figure 59. Boxplots of the Number of Straws Before Physical Residue Ratings Reached "None" by Condition and Study Population.

An alternative method of data analysis I had considered was growth curve modeling (GCM). GCM can be a powerful statistical method under certain conditions. For example, when there is variability in the time points at which people are assessed or if there is missing data at one or more time points, it can be powerful, but neither of these conditions was relevant for my studies. GCM can also be useful when one is interested in whether the general pattern is linear or non-linear or whether there are abrupt shifts at substantively interesting points. However, I did not have specific predictions of such patterns. GCM can also be useful when one has time-varying predictors or when the effect of a predictor might vary across time, but again I did not have such predictions in my studies.

GCM can also be useful when one is interested in whether the outcome variable increases, decreases or remains constant over time, or whether slopes differ. Examination of the data, however, revealed that almost all participants' ratings decreased across successive points of measurement. Another question would be whether slopes differ across conditions (i.e., whether threat information influences the rate of degradation of participants' contamination ratings). In order to better understand the data and choose the most appropriate data analytic method, I plotted participants' mean physical residue, dangerousness and reluctance to use ratings for each straw, across all 20 straws. To illustrate this process, a few examples are provided. Figure 60 shows the physical residue ratings across the chain of contagion for the general UBC sample (Study 2) by condition and Figure 61 shows the physical residue ratings across the chain of contagion for all three populations (Studies 2, 3 and 4) when rating the disease-causing bacteria. As can be seen from these distributions, the shape and steepness of the slopes was similar across populations. I did not find, as Tolin et al. (2004) had found, striking differences in the shape of the distribution across populations. Despite this, there appeared to be differences in the overall level of contamination across the straws. As such, the AUC appeared to be the most appropriate measure of physical spread, dangerousness and reluctance to use ratings across the chain of contagion.

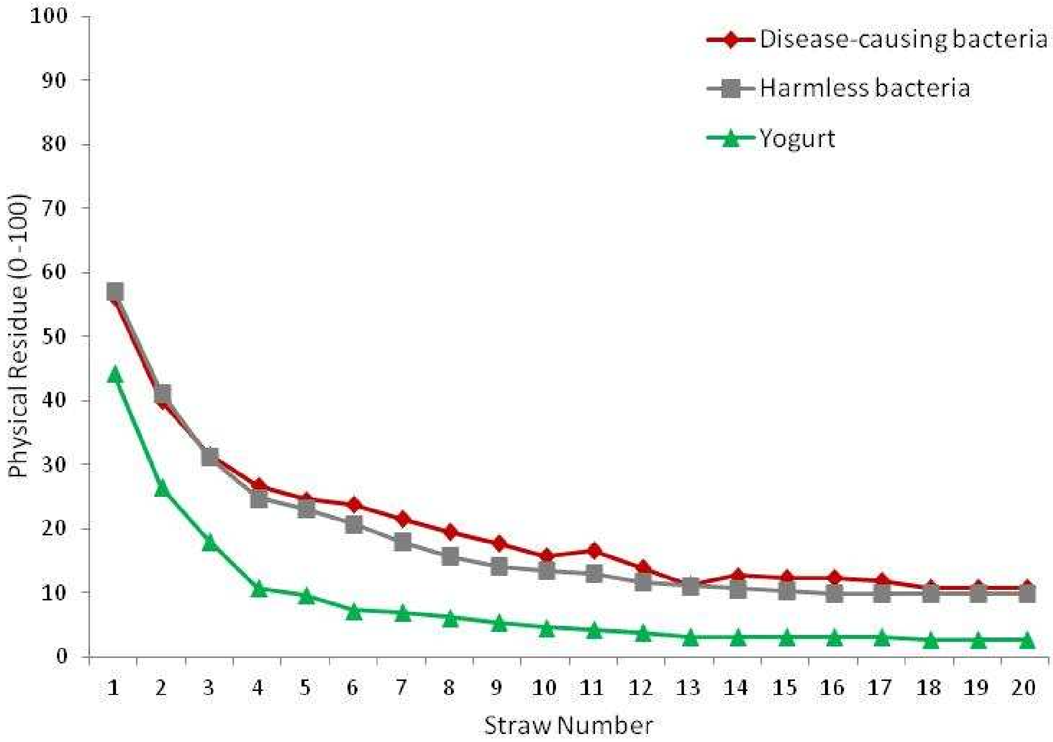


Figure 60. Study 2 Physical residue ratings across the chain of contagion by condition.

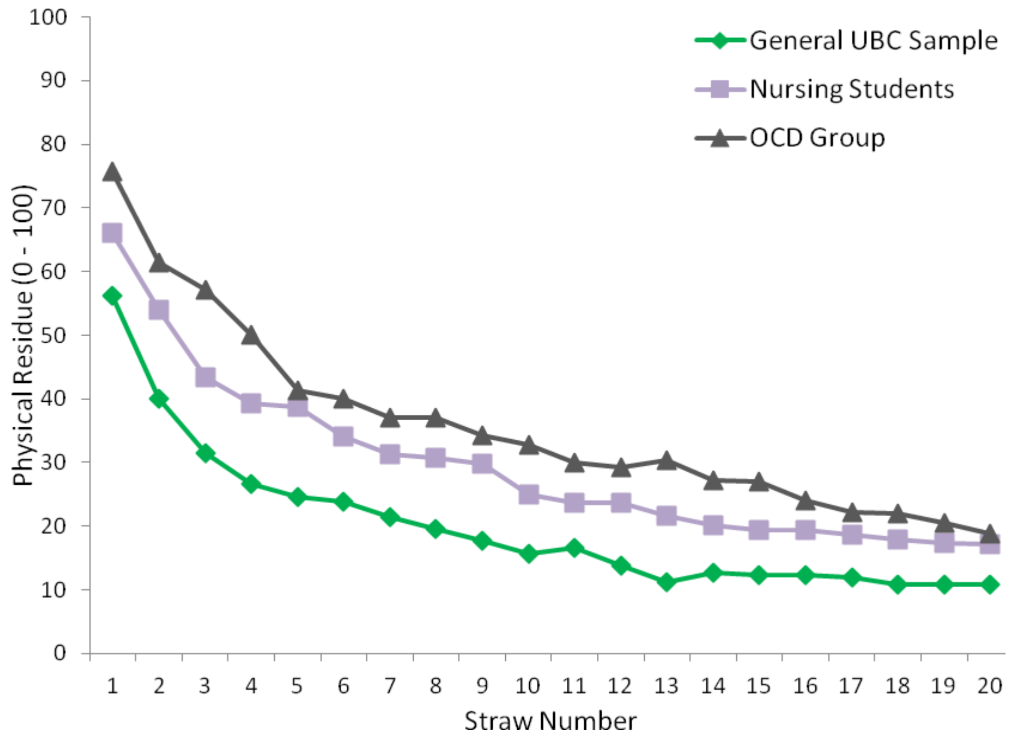


Figure 61. Physical residue ratings across the chain of contagion in the threatening contaminant condition for all three populations (Studies 2, 3 and 4).

6.8.2 Potential moderators. In several places throughout the document, I noted that variability sometimes differed across conditions. For example, in Studies 1 and 2, variability in judgments of physical spread was greatest in the disease causing bacteria condition, which raises the possibility that perhaps there is a subgroup of people whose judgments of physical spread are influenced by threat. One might wonder whether any of the contamination-related beliefs and traits assessed in this study moderated the relationship between the independent variables manipulated and judgments of spread. However, these analyses did not yield meaningful insight into judgments of spread. Analyses conducted within Studies 1 and 2 found none of the self-report questionnaires (i.e., Padua Inventory, Obsessive-Beliefs Questionnaire, Disgust Sensitivity Scale and Perceived Vulnerability to Disease Questionnaire) were significant moderators of physical spread judgments.

In terms of dangerousness ratings along the chain of contagion, there was a significant interaction between scores on the Padua Inventory and AUC-dangerousness in Study 1. This effect was due to a significant correlation between PI scores and judgments of danger in the celery condition. However, examination of the distribution revealed that variability in danger ratings was lowest in the celery condition. There was one participant whose score was elevated compared to the rest of the condition (albeit not a significant outlier). This suggests that this finding is likely due to the outlying score in the distribution rather than to a meaningful effect. The PI was not found to be a significant moderator of danger ratings in Study 2.

Finally, with regard to reluctance to use ratings, there was a significant interaction between scores on the PI-contamination subscale and ratings of reluctance to use in Study 1 and a trend for one in Study 2, although the nature of this interaction was not exactly the same in both studies. In Study 1, PI-Contamination scores were positively correlated with AUC-reluctance to use scores in the disease-causing and harmless bacteria condition, but not in the celery condition. In Study 2, PI-CTN scores were positively correlated with AUC-reluctance to use ratings in the harmless bacteria condition, but not in the disease-causing bacteria or yogurt conditions. In Study 2, there was also a significant interaction between the Perceived Vulnerability to Disease Questionnaire (PVD) and AUC-reluctance to use, which involved a positive correlation between the PVD and AUC-reluctance to use in the harmless bacteria condition, but not in the disease-causing bacteria or yogurt conditions.

Thus, examination of interactions between questionnaire measures and experimental condition in influencing judgments of spread did not provide particularly illuminating insight into variables that influence judgments of spread. However, future research may wish to examine other potential moderators. For example, I did not include a measure of looming vulnerability in these studies. The reason I did not was because I was concerned that the measure might bias participants' judgments of spread, given the conceptual overlap between the measure of looming of contamination and judgments of spread. However, it may be insightful for future research to employ a prospective design or perhaps to include a general (rather than contamination-specific) measure of looming cognitive style.

6.9 Limitations and future directions.

While the current series of studies provide new insight into how judgments of contaminant spread are made, there are some characteristics of the studies that limit generalizability. For one, in order to ensure the greatest control over the experimental manipulation, participants were provided with a description of a purported substance that was then spread to series of straws. As such, the study was not amenable to an idiographic approach that would allow individuals to choose the substance which they found to be most threatening. This may have attenuated the effect of the manipulation on some individuals. However, as noted, it allowed for threat to be manipulated while holding other characteristics of the substance constant.

Similarly, judgments of spread may vary depending on the context. In this series of studies, a food preparation context was chosen because it is one to which most people can relate. However, it would be interesting to replicate the study in other contexts. For example, nursing students might respond differently in a health care setting because they may be more cued to engage in health behaviours and feel a greater sense of responsibility for preventing harm in this setting. Similarly, it will be important to replicate these findings using other types of contaminants (e.g., non-biological substances such as pesticides) in order to determine whether the same pattern of findings emerges.

Second, in order to ensure that participants were in no real danger of harm and to remove any physical cues of residue, no substances were actually used in this study. Rather participants were led to believe that one of the substances had been placed on a cutting board, but the cutting boards were in fact perfectly clean. For participants who may have doubted whether anything was on the cutting board, the power of the manipulation may have therefore been reduced. If so, in the presence of actual substances, one might estimate the effect of the manipulation to be even stronger.

Third, in the present series of studies, participants were deliberately shown the purported substance being spread to a series of objects and asked to make ratings of physical residue, dangerousness and reluctance to use at each point along the chain of contagion. In so doing, the procedures ensured that everyone's attention was focused on the spread of the substances from one object to another. However, in everyday life there is likely great variability in the attention that people pay to the spread of contaminants. Previous research has found, for example, that people with anxiety disorders, including OCD, tend to have an attentional bias toward threat (Bar-Haim, Lamy, & Pergamin, 2007; Foa, Ilai, & McCarthy, 1993; Foa & McNally, 1986) and greater difficulty disengaging attention from threat (Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Vershuere, & De Houwer, 2004; Salemink, van den Hout, & Kindt, 2007; Yiend, & Mathews, 2001). Furthermore, there is evidence that people high in contamination concerns have an attentional bias toward contamination-related threat (Armstrong, Sarawgi, & Olatunji, 2012; Najmi, Hindash, & Amir, 2010). People who are more fearful of contamination may have a tendency to focus their attention on a contaminant and therefore notice its spread to a greater extent than those whose attention is not focused on the contaminant. There is also evidence that difficulty disengaging attention from disgust cues is associated with increased judgments of spread (Cisler et al., 2011). It may be fruitful for future research to further investigate the role of attentional processes in judgments of contaminant spread.

Fourth, as noted earlier, this study sought to separate the various facets of spread by asking participants to rate physical residue, dangerousness and avoidance. Research on judgments of spread is relatively new, however, and the measurement method that most accurately captures how people normally make judgments of spread is not known. Previous research in the area has assessed judgments of spread by asking participants to rate how *contaminated* each object is along the chain of contagion (Cisler et al., 2011; Tolin et al., 2004). It may be that this global assessment of contamination is how judgments of spread are normally made. However, the fact that the current studies' results varied depending on the facet of spread examined is intriguing and suggests that it may be fruitful to continue separating these facets. Nonetheless, the question remains of how best to capture the judgments of spread that people spontaneously make in their everyday lives.

Fifth, sample characteristics may limit generalizability of findings. For example, participants in these studies were of mostly European or Asian heritage. It would be interesting for future research to examine whether the findings generalize to other cultural groups as well, in particular those in the developing world where the spread of infectious diseases is a pressing issue. In addition, although the present studies sought to recruit participants with various characteristics of interest (such as being nursing students or meeting diagnostic criteria for contamination-related OCD), most participants were nonetheless female university students in their 20s. It would, for example, be interesting for future research to explore gender differences in judgments of spread. Furthermore, due to practical constraints, the OCD sample was small and non-treatment-seeking. It will be important for these findings to be replicated in a larger sample of OCD participants and perhaps those with more severe symptoms.

In summary, the purpose of this series of studies was to understand the variables that increase judgments of contaminant spread. The question is important as it may provide insight into the cognitive mechanism that lead to elevated judgments of spread among people with OCD, as well as insight into how to improve public and occupational health campaigns for those insufficiently concerned about spread. The strengths of the current studies include: the experimental manipulation of threat, the examination of various facets of spread separately, the assessment of behaviour and the inclusion of participants with contamination-related OCD and health care professionals. The pattern of findings was complex and dependent on the facet of spread and population under study. The current findings provide new insight into this complex phenomenon and generate interesting directions for future research.

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Appendix A

Study 1 Descriptions of substances

Threatening contaminant condition:

This first cutting board has some bacteria that was placed on it. So this cutting board was bought for the purposes of this study and we brought it over to a food microbiology lab here at UBC and they put a sample of bacteria on it for us. They put a sample of Cibilium bacteria, and they placed it on the area that's outlined by the black circle. Cibilium is a bacteria that's found in things like raw or undercooked meat, poultry, unpasteurized milk, eggs and some vegetables. When humans ingest Cibilium, it can lead to symptoms such as nausea, vomiting, diarrhea, fever and abdominal pain. In the absence of any complications (so in an otherwise healthy person), these symptoms typically last between 4 and 7 days. Now you can't see the bacteria on the board since it's not visible to the naked eye. However, this image shows what Cibilium looks like upclose and it was taken using an electron microscope.

Harmless contaminant condition:

This first cutting board has some bacteria that was placed on it. So this cutting board was bought for the purposes of this study and we brought it over to a food microbiology lab here at UBC and they put a sample of bacteria on it for us. They put a sample of Cibilium bacteria, and they placed it on the area that's outlined by the black circle. Cibilium is a bacteria that's found in things like raw or undercooked meat, poultry, unpasteurized milk, eggs and some vegetables. When humans ingest Cibilium, it does NOT lead to any illness or symptoms. So although it's a bacterium, it is harmless to humans and safe to ingest. Now you can't see the bacteria on the board since it's not visible to the naked eye. However, this image shows what Cibilium looks like upclose and it was taken using an electron microscope.

Non-contaminant/food condition:

This first cutting board has some celery juice that was placed on it. So this cutting board was bought for the purposes of this study and a research assistant here at UBC put a sample of celery on it for us earlier in the day. So they cut up some celery on the area that's outlined by the black circle so there's some fresh celery juice on the board. Celery is a widely used vegetable that's often eaten raw or cooked. When humans ingest celery, it can have various health benefits such as supporting the immune system, reducing blood pressure, reducing cholesterol and helping with weight management. Now you can't see the celery juice on the board since it's clear. However, this image shows what one of the health-promoting compounds in celery, butyl phthalide, looks like upclose. Buytl phthalide is also what gives celery its characteristic smell and taste. And this image was taken using an electron microscope.

Appendix B

Studies 2, 3 and 4 Descriptions of substances

Threatening contaminant condition:

This first cutting board has some bacteria that was placed on it. So this cutting board was bought for the purposes of this study and we brought it over to a food microbiology lab here at UBC and they put a sample of bacteria on it for us shortly before you came in. They put a sample of Cibilium bacteria, and they placed it on the area that's outlined by the black circle. Cibilium is a bacteria that's found in things like raw or undercooked meat, poultry, unpasteurized milk, eggs and some vegetables. When humans ingest Cibilium, it can lead to symptoms such as nausea, vomiting, diarrhea, fever and abdominal pain. In the absence of any complications (so in an otherwise healthy person), these symptoms typically last between 4 and 7 days. Now you can't see the bacteria on the board since it's not visible to the naked eye. However, this image shows what Cibilium looks like upclose and it was taken using an electron microscope.

Harmless contaminant condition:

This first cutting board has some bacteria that was placed on it. So this cutting board was bought for the purposes of this study and we brought it over to a food microbiology lab here at UBC and they put a sample of bacteria on it for us shortly before you came in. They put a sample of Cibilium bacteria, and they placed it on the area that's outlined by the black circle. Cibilium is a bacteria that's found in things like raw or undercooked meat, poultry, unpasteurized milk, eggs and some vegetables. When humans ingest Cibilium, it does NOT lead to any illness or symptoms. So although it's a bacterium, it is harmless to humans and safe to ingest. Now you can't see the bacteria on the board since it's not visible to the naked eye. However, this image shows what Cibilium looks like upclose and it was taken using an electron microscope.

Non-contaminant/food condition

This first cutting board has some yogurt that was placed on it. So this cutting board was bought for the purposes of this study and we brought it over to a food microbiology lab here at UBC and they put a sample of fresh yogurt on it for us shortly before you came in, and it's been kept in the cooler ever since so I can assure that it's fresh and that it hasn't gone bad. The yogurt contains live cultures like all commercial brands, and it was placed on the area that's outlined by the black circle. The cultures in yogurt are probiotic bacteria, and they are what convert milk into yogurt. When humans eat yogurt, it leads to various health benefits such as supporting a healthy digestive system, improving immunity and reducing acne. Now you can't see the yogurt because they put just a thin film of it on the board and you can't see the probiotic bacteria because they're not visible to the naked eye. However, this image shows what the probiotic bacteria in yogurt look like upclose and it was taken using an electron microscope.