**How Ecological Conditions Impact Sociality**

by

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## DEDICATION

To my husband, John Marion, without whom I would not be the person I am today.

To my family and friends for being my inspiration.

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## ABSTRACT

This dissertation examines the impact of ecological conditions on sociality. I posit that ecological conditions affect each step of the process of forming a social partnership, from entry into social situations to evaluating potential partners. Depending on environmental conditions, social relationships can pose threats or opportunities. In Chapter one, I examine the role disease threat plays in evaluations of dense social scenes. Across eight studies and an internal meta-analysis, I demonstrate that disease threat leads people to view dense social environments as more crowded, aversive, and less desirable ("The infectiousness of crowds: Crowding experiences are amplified by disease threats"). This is because socially dense environments pose a greater risk for disease transmission. In Chapter two, I examine the role ecological threats of disease and sex ratio imbalance play in shaping the traits people desire in their potential friends. Across three studies, I demonstrate that while people do universally value traits associated with social exchange, like warmth and trustworthiness, there is some evidence that people do tailor the traits that they desire in their friends to the affordances of the environments that they inhabit ("Ecologies impact friendship preferences"). That is, when people imagine living in an environment that is high in disease threat, they are more likely to prefer that their friends be clean, healthy, and low in risk. The thirteen studies in this dissertation converge on the finding that environmental conditions play a role in our social behavior and social choices.

# INTRODUCTION

Humans are fundamentally social animals (e.g., Baumeister & Leary, 1995; Neuberg & Cottrell, 2008). Other people afford opportunities for goal fulfillment—they can be helpful buffers against uncertainty and threat (e.g., Trivers, 1971; Aktipis et al., 2016; Richerson & Boyd, 1995), but they themselves also pose threats—they can directly harm or cheat us, transmit diseases, or compete with us for resources and mating partners. Therefore, people have developed adaptations for managing other people in a way that minimizes costs and maximizes benefits.

My idea that people seek to minimize costs and maximize benefits from social interactions stems from an affordances perspective. Affordance-management theories in cognition (e.g., Gibson, 1979) posit that people's goals and needs shape the affordances people perceive in the environment. That is, people are motivated to focus on the possible actions that are possible in an environment. For example, for someone who is cold, a fire affords an opportunity for warmth. For someone who is seeking to protect themselves from wild animals, a fire affords protection. In the context of a home, an unwanted fire poses a threat. From a social affordances perspective (e.g., Neuberg & Cottrell, 2008; Neuberg & Schaller, 2014), people evolved also to evaluate and perceive other people through the lens of active goals and needs.

Here I posit that environmental conditions shape active goals, and these active goals impact the affordances of other people. In order to manage these affordances, people may engage in social avoidance, or when they do seek out social relationships, they engage in careful vetting

of potential friends. For instance, in an environment where disease is an active threat, other people also pose a threat because they are the vectors of disease transmission. In this environment, people may avoid a party at a friends' house. In an environment where mating is highly competitive, such as one with an unfavorable sex ratio (where one sex outnumbers the other), people may seek to befriend those who will help them attract mates, but not those who will steal the show.

This dissertation therefore explores how ecological threats shift social behavior from a functional perspective. I focus on two ecological dimensions that have been demonstrated to impact survival and reproduction in a host of organisms (Sng et al., 2018): disease threat, and sex ratio (the ratio of males relative to females in a group). We also focus on two social responses—avoidance of crowded social situations, and friendship vetting. Chapter one explores how infectious disease threats influence evaluation and avoidance of dense social situations. I review a series of studies designed to show that people's evaluations and responses towards socially dense situations are functionally specific to disease avoidance. Chapter two explores how disease threat and unfavorable sex-ratio influence how people select the personal characteristics of their potential friends. I review a series of studies designed to show that although people agree on some universal qualities of friends, people's criteria for friendship is also dependent on ecological condition. Through these two investigations, I demonstrate that people tailor their social behavior and social standards to fit the affordances of the environments in which they inhabit.

# CHAPTER I

## Disease Threats Impact Perceptions of Social Density

This chapter is taken from my original paper, "The Infectiousness of Crowds: Crowding Experiences are Amplified by Pathogen Threats" (Wang & Ackerman, 2019).

Think of the last time you were taking a subway during rush hour, shopping in a mall during holiday season, or going dancing in a club on a Saturday night. What do these situations have in common? They are all everyday experiences in which people congregate in large groups, or crowd together. Now imagine that you happened to find yourself in one of these places during a bad flu season or following a terrorist attack. Would your perceptions of how crowded this situation is change, and if so, why? In five studies, we contribute to literature on the psychological experience of crowding by identifying how social perceptions are influenced by environmental threats, in particular the threat of infectious disease.

## Psychological States of Crowding

The psychology of human crowding first received widespread empirical attention in the 1970s, as contexts associated with overcrowding (e.g., prisons) and population density grew (e.g., Cox et al., 1984; Galle et al., 1972) and following the rise of environmental psychology (see Oishi & Graham, 2010 for a brief history). By the 1990s, however, research on crowds, and environmental psychology more generally, had waned. Today, research examining socioecological influences on human behavior has breathed new life into this and related topics (e.g., Sng et al., 2017; Varnum & Grossman, 2016)).

Crowding is commonly defined as a state of psychological stress resulting from a high ratio of people to amount of space in the surrounding environment (Stokols, 1972; Stockdale, 1978, Altman, 1975). Historically, crowding has included dimensions such as confinement (decreases in spatial freedom inhibiting the feeling of goal achievement; Harrell & Hurt, 1976; though see Machleit et al., 1994). Crowding produces a range of negative outcomes, including increased discomfort and withdrawal from social interactions (Baum & Valins, 1979), heightened competition and aggression (Stokols et al., 1973), interpersonal hostility and mortality (Cox et al., 1984; Galle et al., 1972; Griffit & Veitch, 1971), and reduced shopper satisfaction (Machleit et al., 1994). In one recent study, for example, exposure to crowded images was enough to activate self-protective motivations that decreased risk-taking and increased prevention-focus (Maeng et al., 2013).

Given the potential impact of such adverse outcomes, researchers have cast a broad net in exploring predictors of crowding experiences well beyond straightforward increases in social density. Some early work showed that crowding perceptions are affected by features incidental to the experience, such as high ambient temperatures (Griffit & Veitch, 1971) or momentary hunger and arousal (Stokols, 1972). However, most research has focused on features central to social interaction. This work shows that crowding is elevated by group-specific factors, such as the composition of the social environment (e.g., ingroup vs. outgroup members; Novelli et al., 2013) and person-specific factors, such as current motivations. Active goals can boost perceptions of crowding when those goals conflict with aspects of the social setting (Cozby, 1973). For instance, a person at a party may enjoy interactions with many others but be uncomfortable with the distractions caused by the same number of people while studying. A crowded dance club may

be exciting and fun whereas a crowded subway may be distressing. Similarly, expectations guide reactions to crowds. Accordingly, shoppers express more satisfaction when their expectations of store crowdedness are met than when crowdedness exceeds their expectations (Machleit et al., 2000).

Existing work on crowding has thus focused on features of the person and the situation inherent to experiences within dense social environments. Research considering incidental influences has been limited to general states like annoyance (e.g., hunger, warmth). Yet, crowds afford additional threats and opportunities to individuals, ones that exist because other people can act as agents (even unwitting ones) of harm and safety. Here, we argue that incidental cues of infectious disease are especially likely to shift appraisals of dense social situations toward threat, resulting in elevated perceptions of these situations as crowded and confining.

## Crowding and Infection Risk

Why might infectious disease cues be especially connected to such perceptions? An emerging literature has highlighted the specialized psychological mechanisms by which people manage pathogenic threats through perceptual biases and avoidance of potential carriers of infectious agents (e.g., Wang et al., 2019; Mortensen et al., 2010; Schaller & Park, 2011). Perhaps the most common bias involves over-perception of dangers associated with infection. This occurs for two reasons. First, detection of pathogens is imprecise; we can only observe their symptoms in most cases. Second, in contexts of uncertainty, threat detection mechanisms are adapted to prioritize minimization of relatively costly detection errors (Haselton & Nettle, 2006); here, the error of missing a pathogenic cue and becoming infected is greater than that of perceiving pathogen threats where none actually exist. Consistent with this idea, people concerned about germs are more lenient in categorizing targets along dimensions heuristically,

but not truly, associated with disease such as physical disfigurement and obesity (Miller & Maner, 2012), and these people find it more difficult to look away from targets displaying such cues (e.g., Ackerman et al., 2009). Such prior studies have focused entirely on how pathogen threats influence perception of individuals or abstract conceptual groups (e.g., illegal immigrants), but we suggest that perceptions of social environments should also be susceptible to these threat management processes.

Dense social environments carry a higher likelihood of disease transmission than sparse environments due to the increased potential for human contact and airborne dispersal of germs. Indeed, population density is linked to increased likelihood of parasite and pathogen infection in an array of animals, including humans (Jones et al., 2008; Moller et al., 1993). In such environments, the actual threats are not people per se, but rather the pathogens they potentially harbor. Because most pathogens are essentially invisible, and the symptoms they cause may be delayed or hidden, it can be quite difficult to identify actual pathogen carriers. A simpler solution involves strengthening aversion to social contact with many individuals, a behavior that could be supported by mechanisms that exaggerate the perceived density of social environments one encounters. To produce a functional outcome, this response pattern should also be accompanied by increased negativity to the idea of occupying such environments.

We further predict that this response to infectious disease threat may differ from responses to certain other types of threats. For instance, given that exposure to crowded environments increases accessibility of self-protective concepts and behaviors like prevention focus and risk aversion (Maeng et al., 2013), we might expect that exposure to physical safety-related threats would also evoke strong crowding perceptions and aversions, something previous work has not examined. However, physical safety threats are typically associated with a specific

person or environment rather than an imperceptible cause (e.g., pathogens). For example, the danger of accidental physical harm may be reflected by the structure of the environment (e.g., potholes in the street, unsafe materials in a room), whereas the danger of interpersonal physical aggression may be reflected by explicit behaviors of a violent person (e.g., angry emotional expressions, intimidating actions). Biases to perceive social situations as more crowded would do little to reduce the costs of these targeted threats.

## Current Research

Because other humans are vectors of pathogen transmission, we predict that pathogen threats increase perception of social situations as more crowded and confining, and elevate reluctance to enter these situations. Consistent with existing research which finds that pathogen threat cues most strongly affect people highly concerned about germs (e.g., Duncan et al., 2009), we further examine whether this effect emerges primarily for chronically germ-averse people. To test this, we measure participants' degree of germ aversion, as assessed by the subscale of the Perceived Vulnerability to Disease scale (Duncan et al., 2009). In addition to germ aversion, the PVD scale also captures experiences with previous illnesses through a perceived infectability subscale. Because this subscale focuses on perceptions of internal susceptibility and is thus conceptually less relevant to perceptions of external situations, we focus here on the germ aversion subscale only. Finally, we predict that the expected pattern will emerge when people are primed with the specific threat of infectious disease and be attenuated for other physical threats.

We present one online pilot test as well as five larger tests of these predictions. In the pilot study and Study 1, we test the hypothesis that pathogen threat cues increase crowding perceptions relative to a non-threatening control condition. In later studies, we compare pathogen threats to threats of physical safety involving accidents (Studies 2 and 3) and other dangerous

situations involving personal harm (Studies 4 and 5). Finally, we present an internal meta-analysis of the central findings. The materials for all these studies are in Appendices A-D.

## Pilot Study

### Method

We ran a pilot test on Amazon's Mturk with 64 participants (50% female, age $M = 35.6$; see Appendix E for an additional pilot correlational study). We randomly assigned participants to read either a neutral control story about a person organizing their desk for school, or a story designed to cue disease concern about a person volunteering at a hospital (these stories have been previously validated; White et al., 2013). For example, the neutral story read:

> *Imagine you are in your house, in the room where you study. You have decided to organize your workspace because the semester has just begun and you want to be organized. You have already bought your books for classes and you have a syllabus and some initial paperwork for each class.*

The disease story read as follows:

> *You're not enjoying your biology course. During one week you had to operate on a pig preserved in a foul-smelling formaldehyde solution. The next week's assignment is volunteer work in the geriatric ward of the local hospital. You recall visiting your great-grandmother in the hospital, and remember how the sight of all those elderly patients made you feel a bit queasy.*

Next, participants rated the crowdedness of four visual scenes featuring large numbers of people. These were presented in random order and included images of an airport, subway, store, and pool. Specifically, we asked people to answer the following crowding perception questions: "How likely are the people to bump into or brush against each other?" (1-*Not at all*, 7-*Very*

*likely*), "How crowded do you think this scene is?" (1-*Empty*, 7-*Very crowded*), and "How would you feel in this scene?" (1-*Unconfined*, 7-*Confined*). Following the ratings of the scenes, participants completed the PVD scale. We included a free-response exclusion check question asking people to recall the story they read at the beginning of the study. We also included a manipulation check question which asked participants how worried they felt when they read the story at the beginning of the study (1-Not at all, 7-Very). Participants finally provided demographics.

## Results

Two people failed the exclusion check and were excluded. We averaged all crowding items across all scenes ($a$ = .73). We then conducted a linear regression analysis predicting perceptions of crowding from threat condition (effect coded as -1, 1), germ aversion (centered; $M$ = 4.28, $SD$ = .90), and their interaction. The main effect of threat condition was not significant ($p$ = .15), whereas the main effect of germ aversion was significant, $b$ = .31, $SE$ = .09, 95% CI = [.12, .50], $t(58) = 3.33$ , $p$ = .002, $r$ = .40, such that the higher people scored on germ aversion, the more crowded they perceived the scenes to be.

Notably, a significant interaction between threat condition and germ aversion emerged, $b$ = .20, $SE$ = .09, 95% CI = [.01, .39], $t(58) = 2.09$, $p$ = .04, $r$ = .26 (all $r$ effect sizes refer to partial correlations) (see Figure 1). Simple slopes analysis conducted using the MODPROBE tool (Hayes & Matthes, 2009) revealed that for participants cued with pathogen-threat, germ aversion positively predicted ratings of scene crowding, $b$ = .51, $SE$ = .15, 95% CI = [.22, .80], $t(58) = 3.47$, $p$ = .001, $r$ = .41. In contrast, this did not occur in the no-threat condition, $p > .25$. Simple slopes analysis also revealed that differences between threat conditions were significant when germ aversion was +1SD from the mean, $b$ = .30, $SE$ = .12, 95% CI = [.06, .53], $t(58) = 2.51$, $p$ =

.01, $r$ = .31, and not when germ aversion was -1SD from the mean, $p$ > .25. Thus, initial evidence from the pilot study suggests that, when pathogen threat is salient, high levels of chronic germ concerns predict greater perceptions of crowding. Given the limitations of the pilot study, we examined this finding using larger samples and more expansive experimental methods in the next studies.

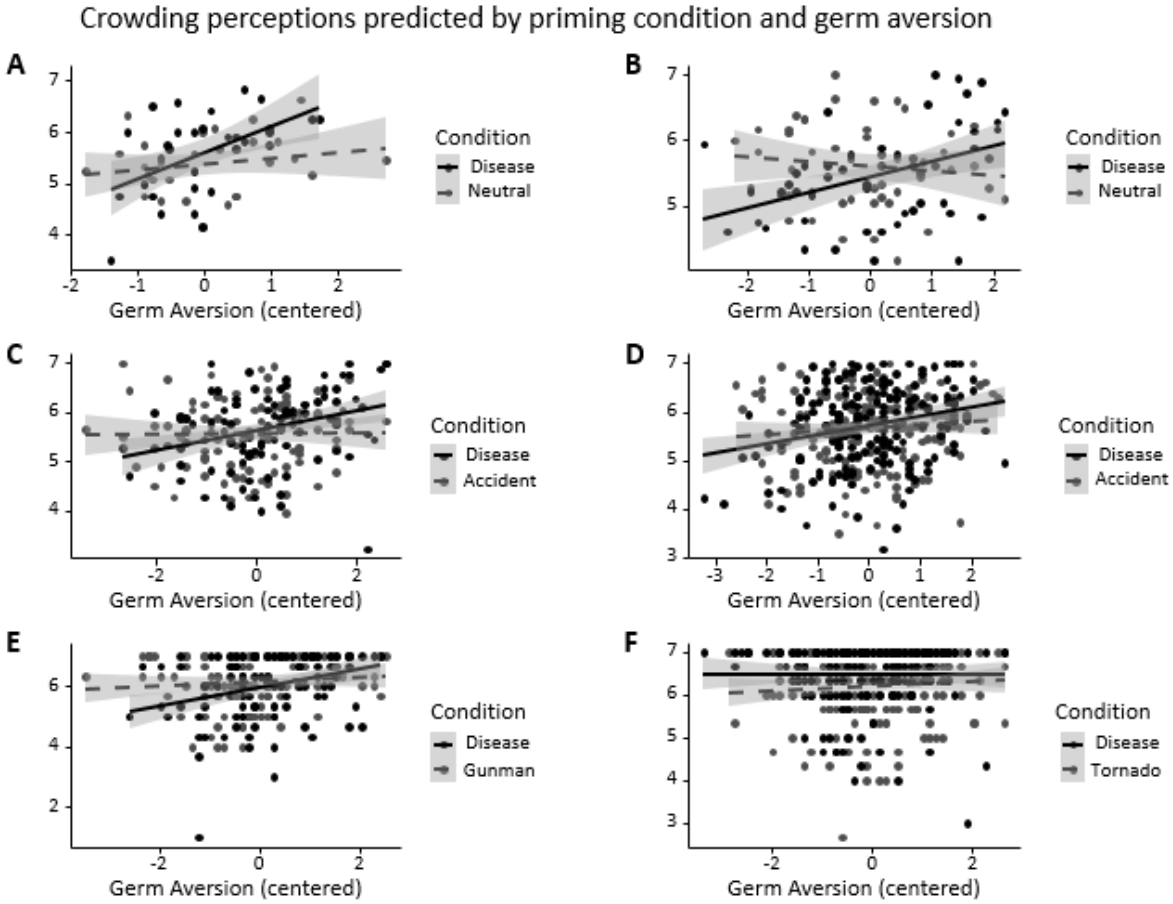



Figure 1. Crowding perceptions as predicted by threat condition and germ aversion for Pilot study (Graph A), Study 1 (Graph B), Study 2 (Graph C), Study 3 (Graph D), Study 4 (Graph E), and Study 5 (Graph F) where higher numbers indicate grater crowding perception. Dark solid line is disease priming condition, and lighter dotted line is control (threat) condition.

## Study 1

### Method

Participants were 102 MTurk workers (52% female, $M_{age}$ = = 38.4) who participated for a small payment. In this study, we used a convention of 50 participants per manipulated condition, but in subsequent studies increased this sample size to a minimum of 100 per condition, providing at least 85% power based on the interaction effect size obtained in the pilot study. Study 1 used a 2 (Threat Condition: pathogen-threat, no-threat; between-subjects) X 2 (Scene Valence: negative, positive; within-subjects) mixed design. Participants were randomly assigned to read one of the two vignettes used in the pilot study.

Participants then viewed pictures of three scenes considered negative when socially dense (taken from the second pilot study: subway, pool, store) and three scenes considered more positive when socially dense (bar, coffee shop, club), each featuring large numbers of people, in random order. In the pilot study, the scenes used were considered negative when crowded, and thus the addition of positive scenes in the current study allowed us to test whether anticipation of a negative experience is necessary for pathogen cues to influence crowding perceptions. Participants responded to the same three questions from the pilot study on crowding perceptions for each context. They also responded to two measures of affective/motivational evaluation: "How much would you want to be present in this situation?" (1-*Not at all*, 7-*Very much*) and "How do you feel when you look at this picture?" (1-*Negative*, 7-*Positive*). These were included to assess motivation to enter or avoid each situation. Finally, participants completed the PVD scale, answered an exclusion check (i.e., "What was the story you read about?"), and demographic questions.

## Results

We excluded two participants for failing the exclusion check. Initial analyses revealed that scene valence did not significantly moderate any of the effects of interest, specifically the interaction between threat condition and germ aversion. We therefore averaged all crowding perception questions (i.e., touch likelihood, confinement, crowding) across positive and negative scenes into one measure of crowding, $a = .90$. We ran a linear regression analysis with threat condition (effect coded -1 1) and germ aversion (centered; $M = 4.57$, $SD = 1.19$) and the interaction between these as predictors of crowding perceptions. No main effect of threat condition ($p = .15$) or germ aversion ($p = .17$) emerged. However, a significant interaction between threat condition and germ aversion emerged, $b = .15$, $SE = .06$, 95% CI = [.04, .27], $t(96) = 2.68$, $p = .01$, $r = .26$. Simple slopes analysis (see Figure 1) demonstrated a similar pattern to our pilot test in which germ aversion positively predicted crowding perception, but only for people cued with pathogen-threat, $b = .24$, $SE = .07$, 95% CI = [.09, .38], $t(96) = 3.27$, $p = .002$, $r = .32$, and not for people in the no-threat condition , $p > .25$. Interestingly, in this study, the difference between the no-threat and threat conditions was greatest for those -1SD in germ aversion, $b = -.27$, $SE = .09$, 95% CI = [-.46, -.09], $t(96) = -2.91$, $p = .004$, $r = .28$, rather than for those +1SD in germ aversion, $p > .25$.

Next, we examined the affective/motivational reactions people had towards the scenes. Scene valence again did not moderate the key interaction, so we averaged both affect questions (i.e., want to be in the scene, feelings about the scene) across positive and negative scenes, $a = .91$. Analysis using this composite revealed no significant main effects of threat condition or germ aversion on affect, all $p$s > .25. However, we found a significant interaction between threat condition and germ aversion, $b = -.20$, $SE = .10$, 95% CI = [-.41, .00], $t(96) = -1.99$, $p = .05$, $r =$

.20 (see Figure 2). Simple slopes analysis showed that for participants cued with pathogen-threat, increased levels of germ aversion were associated with a more negative response to the scenes, *b* = -.26, *SE* = .13, 95% CI = [-.52, -.01], *t*(96) = -2.03, *p* = .05, *r* = .20. In contrast, this pattern was not present in the no-threat condition, *p* > .25. This difference in threat vs. no-threat conditions was marginally significant for those at -1SD in germ aversion, *b* = .30, *SE* = .17, 95% CI = [-.03, .63], *t*(96) = 1.83, *p* = .07, *r* = .18, but not those who scored higher (+1SD) in germ aversion, *p* > .25.

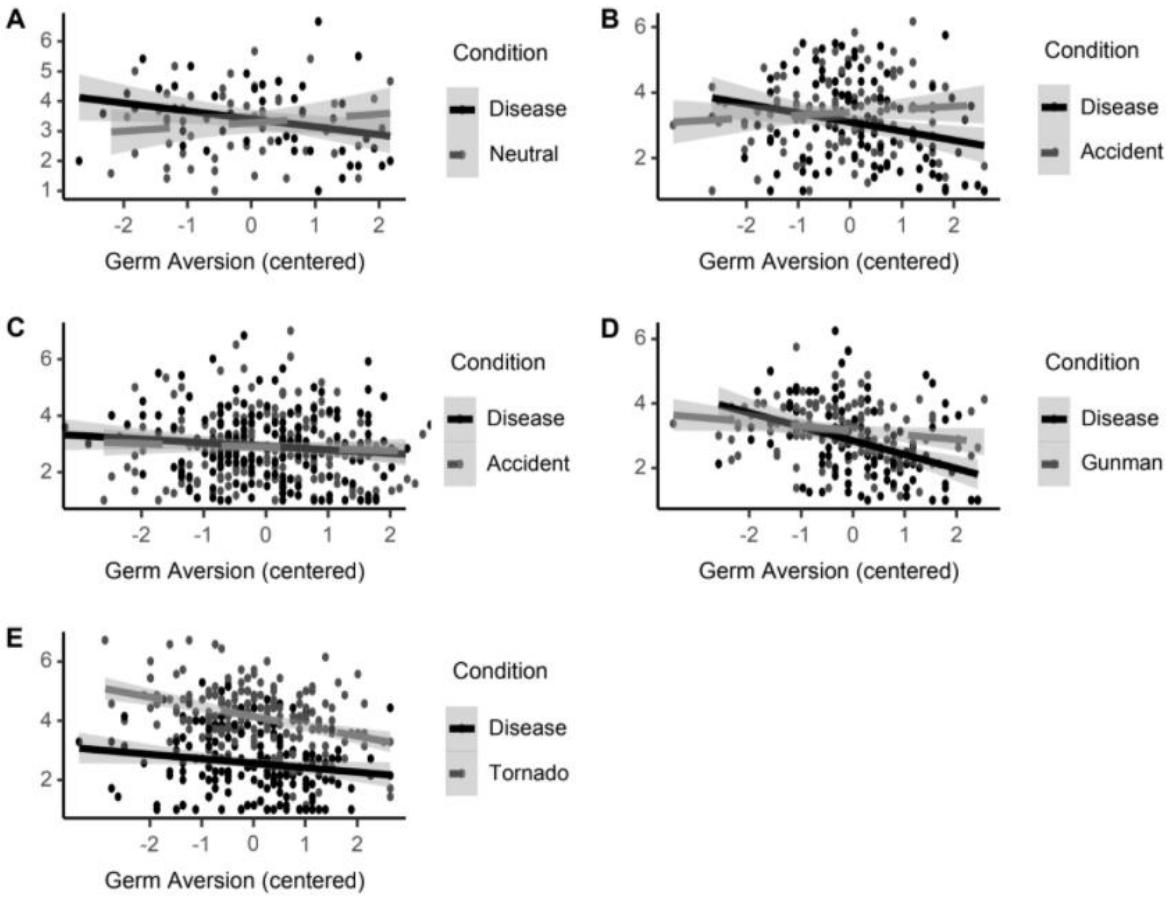



Figure 2. Affective evaluations as predicted by threat condition and germ aversion for Study 1 (Graph A), Study 2 (Graph B), Study 3 (Graph C), Study 4 (Graph D), and Study 5 (Graph E) where lower numbers indicate more negativity. Dark solid line is disease priming condition, and lighter dotted line is control (threat) condition.

## Study 2

### Method

Does any type of threat increase perceptions of crowding? Study 2 tested this by replicating Study 1 but replacing the neutral condition with a threat of personal harm. Participants were 208 people (53% females, $M_{age}$ = 36.74) recruited from MTurk. Participants either viewed a slideshow about dangerous household and vehicular accidents being on the rise

in the U.S. (Faulkner et al., 2004) or viewed a slideshow about how diseases were on the rise in the U.S. (Hill et al., 2015). Then they viewed the same scenes and were asked the same questions as in Study 1. Unlike Study 1, however, the affective evaluation questions were replaced with variations on the same theme, "How much would you want to be present in this exact situation?" (1-Not at all, 7-Very) and "How comfortable would you be in this situation?" (1-Not at all, 7-Very).

## Results

Two participants failed the manipulation check and were excluded. Again, a model with scene valence as a predictor yielded no significant interactions between scene valence and the other independent variables. Therefore, we collapsed all crowding perception *(a* = .78) as well as affect/motivation ratings (*a* = .84) into separate composites across scenes.

A linear regression analysis was conducted with threat condition (effect coded) and germ aversion (centered; *M* = 4.42, *SD* = 1.18) as well as their interaction as predictors of crowding perceptions. No significant main effect of threat condition emerged, $p > .25$. However, this analysis did reveal a significant main effect of germ aversion such that people who scored higher on germ aversion tended to perceive more crowding in the scenes, *b* = .10, *SE* = .04, 95% CI = [.02, .19], $t(202) = 2.44$, $p = .02$, $r = .17$. Notably, a significant interaction between threat condition and germ aversion emerged, *b* = .10, *SE* = .04, 95% CI = [.01, .18], $t(202) = 2.24$, $p = .03$, $r = .16$ (see Figure 1). As was found in our previous studies, people with higher levels of chronic germ aversion perceived the scenes as more crowded if they had viewed the disease slideshow (simple slope: *b* = .20, *SE* = .06, 95% CI = [.08, .32], $t(202) = 3.34$, $p = .001$, $r = .23$), but not if they viewed the accidents slideshow ($p > .25$). The difference between disease and

accident threat was greater for those high (+1SD) in germ aversion, $b$ = .14, $SE$ = .07, 95% CI = [.00, .28], $t$(202) = 1.92, $p$ = .06, $r$ = .13, than those low (-1 SD) in germ aversion, $p$ = .21.

Affect was next regressed on threat condition and germ aversion (centered) as well as their interaction. A marginal effect of threat condition emerged such that overall, people who were exposed to the disease slideshow rated the scenes as less pleasant, $b$ = -.15, $SE$ = .08, 95% CI = [-.32, .01], $t$(202) = -1.81, $p$ = .07, $r$ = .13. No main effect of germ aversion emerged ($p$ = .19). However, we again found a significant interaction between germ aversion and threat condition, $b$ = -.18, $SE$ = .07, 95% CI = [-.32, -.04], $t$(202) = -2.57, $p$ = .01, $r$ = .18 (see Figure 2). Looking at the simple slopes, when cued with disease, people who were chronically germ averse felt more negative and wanted to avoid crowded situations, $b$ = -.28, $SE$ = .10, 95% CI = [-.47, -.08], $t$(202) = -2.73, $p$ = .01, $r$ = .19. However, when cued with accidents, germ aversion did not make a difference ($p$ > .25). This difference between threat conditions was more strongly felt when germ aversion was high (+1SD), $b$ = -.37, $SE$ = .12, 95% CI = [-.60, -.13], $t$(202) = -3.09, $p$ = .002, $r$ = .21, than when germ aversion was low (-1SD), $p$ > .25.

Unlike in earlier studies, an independent samples t-test on germ aversion with prime condition as the predictor showed that germ aversion scores were influenced by the prime, $t$(204) = -2.39, $p$ = .02, $r$ = .17. Given the analytical issues this association raises, we next replicated the current study using a design intended to rule out prime effects on chronic concern.

## Study 3

### Method

In Study 3, PVD was measured one week in advance of all other study procedures (which otherwise were identical to Study 2). We ran 365 MTurk participants (52% female, $M_{age}$ = 36.22) who completed both parts of the survey (attrition rate: 18%).

## Results

We excluded 3 manipulation check failures and 4 participants who had seen the manipulation twice. We again averaged across scenes on crowding perceptions ($a$ = .91), and affective evaluations ($a$ = .92). Examining the effect of prime (effect coded), germ aversion (centered; $M$ = 4.22, $SD$ = 1.06), and their interaction on crowding perceptions, no main effect of prime emerged (p > .25), but a significant positive relationship between germ aversion and crowding perception was revealed, $b$ = .13, $SE$ = .04, 95% CI = [.05, .20], t(353) = 3.32, $p$ = .001, $r$ = .17. Unlike the prior study, the prime by germ aversion interaction was merely trending $b$ = .06, $SE$ = .04, 95% $CI$ = [-.01, .14], $t$(353) = 1.61, $p$ = .11, $r$ = .09, although the direction of the interaction mirrors what was found earlier (see Figure 1). Repeating the same regression analysis on affective reactions, we also only found a trending main effect of germ aversion, $b$ = -.10, $SE$ = .06, 95% CI= [-.21, .02], $t$(353) = -1.61, $p$ = .11, $r$ = .09, such that those who were higher in germ aversion felt more negatively about the scenes. The main effect of prime and the interaction (see Figure 2) were not significant, all $ps$ > .25.

## Study 4

### Method

Study 4 included three substantive changes from prior designs. First, we contrasted pathogen threat cues with cues relevant to a different type of interpersonal threat—physical aggression. Second, threat cues were presented as explicitly relevant to the decision context, whereas in previous studies, threat was cued in a more incidental manner. Finally, we investigated choice behavior as a consequence of shifts in affect and crowding perceptions. Participants were 236 MTurk users (54% female, $M_{age}$ = 35.46) randomly assigned to read scenarios matching one of two conditions. In the pathogen threat condition, the participant is cast

as a shopper in a mall that comes under quarantine due to reports of an Ebola outbreak. For instance, the scenario read,

> "*You learn that there is reason to believe that some people in the mall have been exposed to Ebola, an infectious disease that could be left fatal if left untreated. Officials believe exposure happened ten minutes ago in a specific area of the mall, so not everyone has been directly exposed.*"

In the aggression threat condition, the mall was undergoing lockdown due to reports of an active shooter. For instance, the scenario read,

> "*You learn that there have been sightings of a suspicious person in the mall wearing dark sunglasses and carrying several weapons. It's unclear if anyone has been hurt yet, and if so, who has been hurt. You hear that the suspicious person was last sighted ten minutes ago walking around the open areas in the mall.*"

In both stories, the participant runs into a nearby store to find a large group of people there. Participants were also told at this point that there is an empty store nearby they could move to with no adverse consequences. Participants then rated eight items that described affective reactions to being in the socially dense space (e.g., "How threatened do you feel?", "How safe do you feel about waiting in the store you are currently in?", "How much do you trust the people in the store", "How disgusted do you feel", etc.) and the three items used in the previous studies to assess perceptions of space crowdedness.

To measure choice, participants were reminded that an alternative, empty store existed that they could wait in during the scenario, and they chose whether to remain in the current, more crowded store or move to the empty store. This choice was measured using both a 6 point continuous scale (1-remain at the crowded store, 6-go to a nearby empty store) and a binomial

choice item (current store vs. empty store). Finally, we included two exclusion checks, one asking people to identify the content of the scenario and one question asking people to identify how many people were in the room they had entered immediately after hearing about the threat (response options: "Empty", "A couple", and "Many").

## Results

We excluded 14 people for failing at least one of the manipulation check questions (the reported results hold when these people are included). Given the expanded number of affect/motivation evaluation questions, we first submitted these to a principal components analysis using a promax rotation. Based on the scree plot and our theoretical predictions, we extracted one factor ($\lambda = 9.02$, all item loadings > .56) which explained 44.11% of the variance. We therefore collapsed across these items to obtain one measure of affect/motivation in the situation ($a = .81$), such that positive scores indicated more positive evaluations. As before, we collapsed the three crowding items into a composite measure ($a = .80$).

### Perceptions and Affect

Linear regression analysis of crowding perceptions revealed no main effect of the scenario manipulation (effect coded; $p = .11$), but a main effect of germ aversion (centered; $M = 4.46$, $SD = 1.13$) indicated that higher chronic levels of germ aversion were associated with higher crowding perceptions, $b = .19$, $SE = .06$, 95% CI = [.07, .30], $t(218) = 3.28$, $p = .001$, $r = .22$. As in Studies 1-2, we also found a significant interaction between germ aversion and scenario type, $b = .12$, $SE = .06$, 95% CI = [.01, .23], $t(218) = 2.06$, $p = .04$, $r = .14$, such that participants' germ aversion was predictive of crowding perceptions only when they read about the Ebola outbreak, (simple slope: $b = .31$, $SE = .08$, 95% CI = [.14, .47], $t(218) = 3.65$, $p = .003$, $r = .24$). This relationship did not emerge for those participants who read about the active

gunman ($p$ = .37) (see Figure 1). This difference in crowding perceptions between scenario manipulations was driven by those 1SD lower in germ aversion, $b$ = -.24, $SE$ = .09, 95% CI = [-.42, -.06], $t$(218) = -2.58, $p$ = .01, $r$ = .17, and not by those 1SD greater in germ aversion, $p$ > .25.

Analysis of the affect evaluation composite showed two main effects. The scenario led participants who read about an Ebola outbreak to feel more negative about their current room context than participants who read about an active shooter, $b$ = -.16, $SE$ = .07, 95% CI = [-.29, -.03], $t$(218) = -2.38, $p$ = .02, $r$ = .16. Additionally, the more germ averse people were, the more negatively they felt about the situation, $b$ = -.29, $SE$ = .06, 95% CI = [-.40, -.17], $t$(218) = -4.87, $p$ < .001, $r$ = .31. We also found a significant interaction between germ aversion and scenario type, $b$ = -.15, $SE$ = .06, 95% CI = [-.26, -.03], $t$(218) = -2.49, $p$ = .01, $r$ = .17 (see Figure 2). Teasing this interaction apart, for those high in chronic levels of germ aversion, reading about the Ebola outbreak led people to feel more negatively about being with a large group of people, $b$ = -.43, $SE$ = .09, 95% CI = [-.60, -.26], $t$(218) = -5.03, $p$ < .001, $r$ = .32; this relationship was in the same direction, though the effect was marginal for those reading about the active gunman ($b$ = -.14, $SE$ = .08, 95% CI = [-.30, .02], $t$(218) = -1.74, $p$ = .08, $r$ = .12). The difference between experimental conditions was primarily driven by those higher in germ aversion (+1SD), $b$ = -.32, $SE$ = .09, 95% CI = [-.51, -.14], $t$(218) = -3.47, $p$ = .001, $r$ = .23, while the simple slope at -1SD was not significant, $p$ > .25.

**Choice**

Examining the effects of scenario manipulation (effect coded), germ aversion (centered), and their interaction on the continuous choice measure revealed that scenario condition affected preferences, $b$ = .54, $SE$ = .10, 95% CI = [.35, .74], $t$(218) = 5.52, $p$ < .001, $r$ = .35, such that people who read the Ebola scenario preferred the empty store more ($M$ = 5.43, $SD$ = 1.24) than

people who read the gunman scenario ($M$ = 4.29, $SD$ = 5.43). There was no interaction between germ aversion and scenario condition ($p$ > .25), though a trending main effect of germ aversion did emerge ($b$ = .14, $SE$ = .09, 95% CI = [-.03, .32], $t$(218) = 1.66, $p$ = .10, $r$ = .11) such that people who were higher on germ aversion showed a slightly greater preference for the empty room.

We used logistic regression to test effects on the binomial choice item, yielding results similar to those for the continuous choice measure. The manipulation predicted choices, $b$ = .79, $SE$ = .18, 95% CI = [.45, 1.17], $z$(218) = 4.34, $\chi^2$ = 18.85, $p$ < .001, $r$ = .28. Those who read the Ebola scenario preferred the empty room (89%) more than people who read the gunman scenario (62%). There was no main effect of germ aversion and no interaction between the scenario condition and germ aversion on choice, all $p$s > .25. Thus, actual choices were influenced by experiences with pathogen threat, though unlike the affect and perception effects, this influence did not emerge as a person by situation interaction.

Finally, as in Study 2, an independent samples t-test showed that germ aversion was influenced by scenario condition, $t$(220) = -2.51, $p$ = .01, $r$ = .17. Given this result, we replicated the current study using a similar method to Study 3 in which PVD was measured separately from the rest of the study procedures.

## Study 5

### Method

To address the influence of prime on germ aversion, we ran a series of studies with PVD measured either one week before or after the main study manipulation, thereby decoupling these factors. In Study 5, PVD was measured a week in advance. Several replication studies were required because of manipulation failures and ceiling effects, as explained below. The last of this

series is reported as Study 5, and all additional studies are reported in supplemental materials. Further, all studies are included in the subsequent internal meta-analysis.

Participants were 371 Mturk workers (55% female, $M_{age}$ = 35.56) who completed both parts of the survey. We had an attrition rate of 17%. We retained the original design as Study 4, but with several changes. Because disgust is more relevant to the disease scenario, including this item in the affective evaluations composite could bias our finding in favor of this condition, and thus it was removed. In addition, the physical safety scenario about a gunman was replaced with one about a dangerous tornado because the manipulation checks for the gunman scenario did not replicate results from Study 4. Specifically, whereas in Study 4 the gunman scenario was seen as significantly more fear-inducing than the Ebola scenario, in our first replication study (see Appendix E Supplemental Study 1 for more details), this difference did not emerge. In our second replication study (see Appendix E Supplemental Study 2 for details), we attempted to address this by replacing the gunman scenario with a scenario in which the participants shelters from a tornado. The tornado scenario was pretested to elicit more fear and more concern about personal safety than the disease scenario. An excerpt of the tornado scenario read,

> "*The announcement says that officials have learned there are sightings of a dangerous weather event approaching the mall. It seems that the mall is in the path of a major tornado that has touched down a block away. It's unclear if anyone has been hurt, and if so, who has been hurt.*"

We also replaced Ebola with tuberculosis because we were concerned that the Ebola threat evoked very high levels of arousal, perhaps contributing to the ceiling effect findings. Comparing people's responses to the Ebola vs. tuberculosis scenarios, it did seem the case that tuberculosis was perceived as less worrisome. However even in Appendix E Supplemental Study

2, the ceiling effect on crowding perceptions remained, potentially obscuring any interactive effect of germ aversion and pathogen threat manipulation.

In Study 5, we again attempted to resolve the ceiling effect issue from the previous scenario studies. We reasoned that, unlike Studies 1-3 in which participants viewed photographs as part of the manipulations, no photos were used in the later scenario studies, perhaps encouraging all participants to imagine very socially dense environments, and thus creating a ceiling effect in crowding perceptions. Therefore, participants in the current study were told to imagine waiting in a store and were provided a photograph of this store that was somewhat ambiguous in social density (previously used in the pilot study and Studies 1-3). That is, the photograph showed a moderately socially dense environment but it did not reveal the full number of people or the size of the store, which should allow for subjectivity in crowding perceptions, but should also restrict participants from assuming high levels of crowdedness in the store. Lastly, in contrast to prior scenario studies, participants learned about the alternate, empty room they could choose to wait in only when receiving the choice question and not with the rest of the measures, as in earlier studies. This was done to minimize the chance of participants contrasting socially dense room against the empty room, thus exacerbating perceptions of crowdedness in the dense room.

## Results

We excluded five people who failed the manipulation check, as well as thirteen people who were able to access the survey twice, and were able to see the manipulation. Given that germ aversion was measured several days in advance, scenario condition did not predict germ aversion, $p > .25$.

### Perceptions and Affect

We again averaged across crowding perception items ($a$ = .70) and affective evaluation items ($a$ = .89). Examining the effects of scenario manipulation (effect coded), germ aversion (centered; $M$ = 4.36 , $SD$ = 1.11), and their interaction on crowding perceptions, we found a main effect of scenario condition, $b$ = .13, $SE$ = .04, 95% CI = [.05, .22], $t$(349) = 3.16, $p$ = .002, $r$ = .17, such that people who read the tuberculosis scenario perceived the room to be more crowded ($M$ = 6.47, $SD$ = 0.76) than people who read the tornado scenario ($M$ = 6.20, $SD$ = .82). There was no main effect of germ aversion, $p$ > .25, nor was the interaction significant, $p$ > .25 (see Figure 1).

We then examined the effects of scenario manipulation (effect coded), germ aversion (centered), and their interaction on affect. We again found a main effect of scenario condition, $b$ = -.79, $SE$ = .05, 95% CI = [-.89, -.68], $t$(349) = -14.82, $p$ < .001, $r$ = .62, such that people who read the tuberculosis scenario felt more negatively ($M$ = 2.57, $SD$ = 1.07) than people who read the tornado scenario ($M$ = 4.13, $SD$ = 1.00). The main effect of germ aversion was also significant, $b$ = -.24, $SE$ = .05, 95% CI = [-.33, -.14], $t$(349) = -4.97, $p$ < .001, $r$ = .26, such that people who scored highly on germ aversion were more likely to feel negatively. The interaction was only marginally significant, $b$ = .09, $SE$ = .05, 95% CI = [-.01, .18], $t$(349) = 1.83, $p$ =.07, $r$ = .10 (see Figure 2).

**Choice**

As in Study 4, the current study featured both a continuous choice item, with higher scores indicating a greater preference for the empty room, as well as a dichotomous forced choice item. For the continuous choice item, we tested the effects of scenario manipulation (effect coded), germ aversion (centered), and their interaction. Replicating the previous study, we found a main effect of scenario condition, $b$ = .71, $SE$ = .08, 95% CI = [.56, .85], $t$(349) = 9.28, $p$

< .001, $r$ = .44, such that people in the disease condition preferred the emptier room ($M$ = 5.51, $SD$ = .98) than the people in the tornado condition ($M$ = 4.09, $SD$ = 1.79). The effect of germ aversion on choice was also significant, $b$ = .16, $SE$ = .07, 95% CI = [.02, .30], $t$(349) = 2.30, $p$ = .02, $r$ = .12, such that higher levels predicted more preference for the empty room. The interaction was not significant, $p$ > .25. Similar patterns emerged for the forced choice question. Again replicating the previous study, people were more likely to choose the empty room if they were given the tuberculosis scenario, $b$ = 1.22, $SE$ = .17, 95% CI = [.91, 1.57], z(349) = 7.27, $X2$ = 52.8, $p$ < .001, $r$ = .36. Whereas only 52% of people in the tornado scenario chose to move to the empty room, almost everyone chose to move to the empty room in the tuberculosis scenario (92%). Neither the main effect germ aversion, $p$ = .14, nor the interaction were significant, $p$ = .19.

## Internal Meta-Analyses

The findings presented in this paper demonstrate relatively consistent patterns but also variation in the significance levels of certain effects, in particular the interaction of prime condition and germ aversion on crowding perceptions and affect. Therefore, we conducted an internal meta-analysis of these measures as a means of determining overall reliability and effect size. To do this, we used R's metafor package (Viechtbauer, 2010), which has been used in other recent meta-analyses (e.g., Shariff et al., 2016). We included the pilot test and studies 1-5 as well as the two additional scenario studies reported in Appendix E. Because of the variation across studies in designs and findings, we used a random effects model.

We first present the meta-analysis for crowding perception as the dependent variable, and then the meta-analysis for affect/motivation as the dependent variable. Each analysis includes tests of the main effects and interactions, and when applicable, the simple slopes for prime

conditions. Finally, we test whether the effect of the simple slope for the disease condition significantly differs from the effect for the control condition.

Examining the main effects and interaction for crowding perceptions, a Cochran's test revealed that these studies were significantly heterogeneous, all $Q(df = 7) > 14.91$, $p$s $< 0.05$, supporting the choice of a random effects model. Across the eight studies, the average effect size of the interaction between germ aversion and condition on crowding perceptions was $r = .09$, $SE = .04$, $p = .02$, 95% CI = [0.01, 0.16], indicating the presence of a reliable, if small effect (see Figure 3). Examining main effects, prime condition on its own did not predict crowding perceptions, $r = .02$, $SE = .04$, $p > .25$, 95% CI = [-0.05, 0.09]. However, germ aversion did reliably predict greater crowding perceptions, $r = .14$, $SE = .03$, $p < .0001$, 95% CI = [0.08, 0.21].

We next examined the meta-analytic effects of the simple slopes within threat condition (i.e., testing each slope against zero). To do this, we computed separate random effects meta-analyses for disease prime and control primes. Germ aversion was related to crowding perceptions in the disease prime condition, $r = .17$, $SE = .05$, $p = .001$, 95% CI = [0.07, 0.27]. The meta-analysis also revealed a weaker, though reliable relationship between germ aversion and crowding in the control conditions, $r = .05$, $SE = .02$, $p = .03$, 95% CI = [0.005, 0.09]. We compared these two estimates of effect size $r$ against each other, and indeed this test revealed that the disease primes produced significantly larger effect sizes than the control primes, $r = .12$,

*SE* = .06, *p* = .03, 95% CI = [0.01, 0.23].

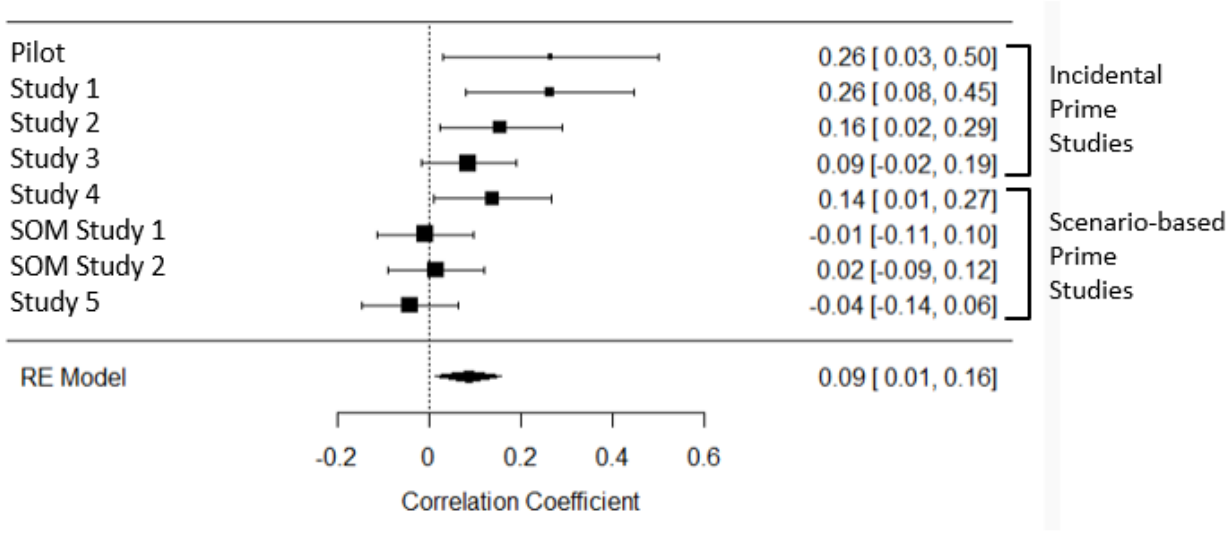



Figure 3. Meta-analytic effect of the interaction of prime and germ aversion on crowding perceptions.

As mentioned in Study 5, we suspected that there might be a moderation of this meta-analytic effect of the interaction on crowding perceptions by the type of manipulation we used. That is, whereas the Pilot and Studies 1-3 used picture-based stimuli and incidentally-framed primes, Studies 4, 5, and Appendix E Supplemental Studies 1-2 used scenario based stimuli where the participant was actually immersed in the crowded situation, as well as a prime that was more life-threatening. Our test of moderation indicated that there was a significant moderation by study manipulation, *QM*(df = 1) = 6.25, *p* = .01, such that there was a reduction in effect size for the interaction in the studies that were more scenario-based, *r* = -.07, *SE* = .03, 95% CI = [-.12, -.02], *p* = .01. This moderator accounted for 70.70% of the heterogeneity in the effect, strong evidence that the differences in manipulation type account for the different patterns we see across the studies.

We also ran a similar meta-analysis on participants' affect/motivation evaluation ratings, which were collected in seven of the studies (not included in the pilot study). We chose a random effects model for the same reasons as before, as supported by a significant Cochran's tests of heterogeneity, all $Q(df = 6) > 14.91$, all $ps < 0.02$. Based on this analysis, we found that the interactive effect of condition and germ aversion does not reliably predict affect, $r = -.07$, $SE = .04$, $p = .06$, 95% CI = [-.15, .00]. However, the average effect size of the main effect of condition was reliable and moderate, $r = -.28$, $SE = .11$, $p = .01$, 95% CI = [-0.50, -0.07]. Lastly, examining the main effect of germ aversion on affective evaluations, we found a reliable small effect, $r = -.20$, $SE = .04$, $p < .0001$, 95% CI = [-0.27, -0.13].

In sum, we find both a reliable interactive effect of prime condition and germ aversion on crowding perceptions, along with a reliable main effect of germ aversion. We also find that the relationship between germ aversion and crowding perception is significantly greater in the disease prime condition in contrast to the control prime conditions, as would be expected if people high in chronic disease concern are particularly sensitive to situational pathogen cues. Finally, with respect to affective evaluations, we find reliable main effects of condition and germ aversion. Thus, over all current studies, infectious disease threats reliably interact with individual differences in germ aversion to predict perceptions of crowding, and disease threats also predict strong negative affective evaluations of these crowds.

## Chapter Discussion

Across five studies, activation of specific threats influenced perceptions and affective evaluations of social environments. Situational cues to infectious disease threat led germ-averse people to perceive social situations as more crowded, confining, and aversive. This occurred whether pathogen cues were incidental or integrated into the social context, but did not occur in

the presence of physical accident or interpersonal violence cues. People exposed to infectious disease threat also chose to occupy an empty environment more often than a crowded one. Interestingly, both choices and perceptions were driven by affective/motivational evaluations of the situations, consistent with the idea that affect can regulate cognition (Storbeck & Clore, 2007). Internal meta-analyses supported these findings.

Why are responses to dense social environments more closely tied to infectious disease threats than other threats we examined? Unlike other threats, humans represent means through which microscopic pathogens are transmitted, making detection difficult. Our work suggests that this detection problem may lead crowds to be perceived as untrustworthy, risky, and unsafe, (i.e., items that comprised the affective evaluations composite in Study 3). In short, crowds afford unique threats to individuals from the perspective of infection risk. In contrast, more identifiable dangers (e.g., predators, aggressors) are associated with the desire to seek safety in numbers (e.g., Hamilton, 1971), making crowds more of an opportunity for individuals to conceal themselves within a larger group. This said, participants in Study 3 still generally preferred to avoid crowded areas (perhaps because the crowd consisted of strangers).

What might viewing social environments from the perspective of pathogen transmission risk offer for our broader understanding of people's day to day behaviors or even societal phenomena? The salience of outbreaks or disease cues may influence decisions made in close proximity to others, from deciding to shop at a less crowded store to avoiding relocation to a densely populated city. At a societal level, our findings may inform coping mechanisms in urban environments. Late social psychologist Stanley Milgram (1970) noted that structural components in large cities are designed to limit human contact, such as a setting of boundaries in social transactions (e.g., self-service kiosks), an increase in anonymity (e.g., unlisting of phone

numbers), a screening process to limit contact with higher status individuals, and institutions designed to reduce the burdens of population density (e.g., welfare departments). This produces a paradox of increased social isolation—despite greater potential access to social relationships in cities, city inhabitants nevertheless feel more lonely and isolated. Based on our findings, this paradox may be explained as a coping mechanism wherein the threat of pathogen transmission posed by social density is reduced. Extending such directions from earlier work, scholars have recently stressed the importance of studying the psychological effects of social ecologies (e.g., Sng et al., 2017; Oishi & Graham, 2010; Varnum & Grossman, 2016). The current research adds to this framework by highlighting how the experience of different social environments can itself be shaped by the specific threats and opportunities these environments afford.

# CHAPTER II

## Ecologies Impact Friendship Preferences

Imagine making a new friend. What qualities would you look for? Imagine meeting a person who was trustworthy and warm, but also very outgoing, messy, and a risk-taker. Then you meet someone else who is equally trustworthy and warm, but also more introverted, clean and risk-averse. Would you choose to become friends with these people? How might your environment impact your choices?

Under normal circumstances, both people could potentially be good friends. However, consider living in an environment that is high in infectious disease. In this situation, becoming friends with a person who is very outgoing, messy, and risk-taking could lead you to be exposed to harmful pathogens, whereas becoming friends with a person who is clean and avoids risks could be a safer choice. Under these circumstances, the costs associated with becoming friends with the first person might outweigh the benefits.

## Adaptive Significance of Friendship

Social relationships are an essential part of human survival (e.g., Baumeister & Leary, 1995). Friendship evolved as a means of social coordination among non-kin to help people meet fitness goals. That is, social partners mitigate costs associated with aggression and competition, and resource unpredictability (Trivers, 1971; Aktipis et al., 2016; DeScioli & Kurzban, 2009). Friends provide resources and coalitional and social support. However, although friendships afford people many opportunities, they can also come with their own set of problems. People

who freeride and cheat receive benefits without returning them (e.g., Trivers, 1971; Tooby, Cosmides, & Price, 2006), leading to fitness costs for the person providing the benefit. People therefore have evolved mechanisms designed to be able to detect and avoid cheaters (e.g., Delton et al., 2012; Neuberg & Cottrell, 2008). Given that people have limited time and resources to dedicate to their friendships, people therefore attempt to maximize benefits and minimize costs when choosing friends (Tooby & Cosmides, 1996).

Given this propensity for friends to both hurt and help our fitness goals, how do people choose social partners? As mentioned in the previous paragraph, people likely focus on behaviors and traits directly related to altruism such as honesty and trustworthiness (e.g., Neuberg & Cottrell, 2008; Delton et al., 2012; Cottrell, Neuberg, & Li, 2007). At the same time, evolutionary psychologists Tooby and Cosmides (1996) have also posited that behaviors and traits that are not directly related to altruism can still have side-effects that are beneficial for others, termed positive externalities. A person who is uniquely resourceful and skilled, and who can behave in ways that best exploit the environment is someone very useful. Indeed, some work has shown that people do look for evidence of productivity, or hunting and gathering ability, and use this evidence to judge potential friends (Eisenbruch & Roney, 2020).

In short, humans are evolved to be sensitive to the "affordance value" of a person (Neuberg & Cottrell, 2008). They not only look for traits that signal that a potential friend is a good exchange partner who is likely to repay us in the future, but also look for people who will support their goals (Fitzsimons & Shah, 2008; Sloter & Gardner, 2011), such as avoiding potential threats, or acquiring further connections or romantic partners.

## Trait Preferences in Social Contexts

Some work has investigated the role of the social context (and the subsequent goals of those contexts) on friendship preferences. People do seem to pay close attention to traits associated with cooperation such as honesty, trustworthiness, and sincerity (e.g., Chan et al., 2018; Brambilla et al., 2011; De Bruin & van Lange, 2000). These traits have shown to be highly valued across many different group and relationship contexts (e.g., work partner vs. teammate vs. close friend; Cottrell, Neuberg, & Li, 2007). At the same time, people also tailor trait preferences to different relationship contexts based on the affordances of those contexts. That is, people can recognize the potential harm of an extraverted study group member, who might distract the group from their studies, but the benefit of an extraverted sorority member, who might attract potential romantic partners or social connections to parties.

However, although this work touches on the importance of relationship context, no work has ever examined the role ecologies play in shaping friendship preferences, despite this being a very important context. Here, we examine how ecological conditions impact how people choose friendships. First, given the universal importance of cooperation and the literature suggesting the importance of interpersonal warmth (e.g., Brambilla et al., 2011), we hypothesize that people might value traits associated with cooperation—warmth and trustworthiness, across all ecological conditions. Second, we hypothesize that given the instrumentality of friends, there will emerge some traits that become more or less valuable given the threats and opportunities of a given ecology. In short, this set of studies is broadly designed to test for the universality of traits that aid cooperation, and for whether people tailor their friendship preferences to the environments in which they inhabit.

## Current Research

In our studies, we chose to explore several different ecological dimensions which have been identified to be fundamental to human fitness (Sng et a., 2018). In the Pilot study, we focus on genetic relatedness and disease threat as our dimensions of interest. In Studies 1 and 2, due to the weak effects observed in the relatedness conditions, we focus instead on disease threat and sex ratio, another fundamental ecological dimension (Sng et al., 2018).

Genetic relatedness refers to the extent to which an individual is genetically related to other individuals in his/her environment. There has been less work done on this ecological dimension in comparison to other dimensions; however, some preliminary work has shown that in environments with high genetic relatedness (indexed by percentage of cousin marriages), people report being more loyal, selfless to community, and more willing to risk their lives to defend their country (Sng, 2017). Given that places with high relatedness seem to stress social cooperation more, these findings might seemingly contradict our first hypothesis that trustworthy will emerge universally across conditions if people end up valuing these qualities more in environments marked with high genetic relatedness. However, we were also open to this possibility.

Disease threat refers to the presence of disease-causing pathogens in the environment. Pathogens have been an enduring selection pressure in our evolutionary history (Dobson & Carper, 1996; Wolfe et al., 2007) and people have developed behavioral adaptations for combatting the costs associated with infection, known as the behavioral immune system (e.g., Schaller & Park, 20011). Because engaging the physiological immune system is energetically costly, these behavioral adaptations allow people to preemptively avoid being infected in the first place. A large body of work has linked the behavioral immune system to a wide range of

behaviors, including reduced extraversion and openness (Mortensen et al., 2010), increased collectivism and conformity (Fincher et al., 2008; Murray et al., 2011), greater preference for attractive relationship partners (e.g., Gangestad & Buss, 1993), and reduced risk-taking (Prokosch et al., 2019). Some work has also posited that aggressive behavior is a behavioral immune response (Schaller, 2011). We predicted that participants would be looking for traits that capture these disease avoidant behaviors in their potential friends, in addition to some other traits that would indicate that the potential friend was directly resistant to disease (e.g., health, cleanliness) and would therefore pose less of a transmission risk.

Sex ratio refers to the ratio of men to women in an environment (e.g., Sng & Ackerman, 2020). A male-biased sex ratio refers to a sex ratio where there are more males than females and a female-biased sex ratio refers to a sex ratio where there are more females than males. When sex ratios are biased towards one sex, the sex that is more frequent faces greater competition for mates and resources. The sex that is less frequent has more freedom to choose romantic partners. This leads to a matching effect where the sex that is more frequent often adopts the sexual strategies of the scarcer sex. Females tend to be more restricted in sociosexuality than males, meaning they prefer long-term, committed relationships (Schmitt, 2005). When the ecology is male-biased and there is more competition among males, then males adopt a restricted sociosexuality in order to seem more desirable to females. The opposite is true when the ecology is female-biased; females tend to adopt a more unrestricted sociosexuality, meaning they become more open to short-term uncommitted relationships in order to seem more desirable to males (Uecker & Regnerus, 2010; Schmitt, 2005). Sex ratios also impact other behaviors. Male-biased sex ratios have been shown to be associated with greater crime (Barber, 2003); female-biased ratios are associated with females investing in career over starting a family (Durante et al., 2012).

Overall, unfavorably biased ratios are associated with greater risk-taking behavior (Ackerman et al., 2016). In terms of the role that sex ratio plays on friendship preferences, we predicted that overall, relative to disease, sex ratio would be more associated with traits useful for managing relationships and status, such as risk-taking, power, sociability, and ambition. In unfavorable ratios, people may wish to have friends who have traits that could help with attracting partners and gaining status, and who would not be a source of competition. At the same time, there could be differences between females and males in unfavorable sex ratios given the differences in the sexual strategies that females and males adopt. To simplify things, we left this open and exploratory and did not make specific predictions about differences between females and males.

## Pilot study

As previously mentioned, in the pilot study we investigated the role of either genetic relatedness or disease threat on participants' preferences for traits in their ideal friends. We predicted that participants would be looking for traits that capture disease avoidant behaviors in their potential friends, in addition to some other traits that would indicate that the potential friend was directly resistant to disease (e.g., health). We had less clear predictions about genetic relatedness, but we had some intuition that participants would be more interested in protecting their family in an environment high in genetic relatedness. For this study, we relied on the lay theories of research assistants who looked over the descriptions of the ecologies to generate the traits we used in our study.

### Method

Five hundred twenty-two participants (53% females, *Mage* = 39.19) were recruited through Amazon's Mturk to participate in the study. Participants were assigned to one of five conditions: a control condition, a low disease condition, a high disease condition, a low genetic

relatedness condition, or a high genetic relatedness condition. In the control conditions, participants were asked to think and write about their current community. In the other conditions, participants read a brief description of a community that had either no history of disease outbreaks, a history of many disease outbreaks, no family members living nearby, or many family members living nearby (see Appendices F-K for materials from all studies in this Chapter). Participants then answered some open-ended questions designed to get them to put themselves into the community (e.g., 'How would you feel living in this community?').

Next participants imagined making an ideal friend in this community. This would be an ideal friend separate from current friends. Then participants were presented with fourteen traits (i.e., physically attractive, aggressive, physically healthy, predictable, competitive, risk-taking, self-conscious, creative, sociable, trustworthy, intelligent, similar, unconventional, empathetic) and asked to rate the importance each trait for this ideal friend to have. These traits were selected based on the feedback of research assistants in the lab, who generated these traits after reading about all the communities. Participants filled out a manipulation check question to make sure they were thinking about an ideal friend, as well as several demographic questions.

## Results

Seventy-one people missed the manipulation check and were excluded from analyses. This number is a bit high but is in line with other studies we have run previously on Mturk. Given that there were many comparisons of interest and this was an exploratory study, for each trait, we ran an omnibus one-way ANOVA test and conducted pairwise analyses using Tukey contrasts (to adjust for multiple pairwise comparisons). Due to the large number of traits, we focus on key patterns and display the results in Figure 4. We first investigate whether empathetic

and trustworthy emerged as universal traits. We then report traits that were tailored to each ecology.

Conforming to our first hypothesis that warmth and trustworthiness would be universally valued, trustworthiness was rated equally important across all conditions, $p = .44$, and looking at the patterns ordinally, was ranked first in every condition (see Figure 4). A bit contrary to the first hypothesis, empathy was rated as more important in high relatedness condition compared to the low relatedness condition (ANOVA: $F(4, 446) = 2.32$, $p = .06$; pairwise comparison: $t(446) = 2.64$, $p = .064$), but its importance in the high relatedness condition was not significantly different from the control condition, or other conditions (all $ps > .43$) although the direction was the same. Empathy did not emerge as more important in the disease conditions (all $ps > .12$).

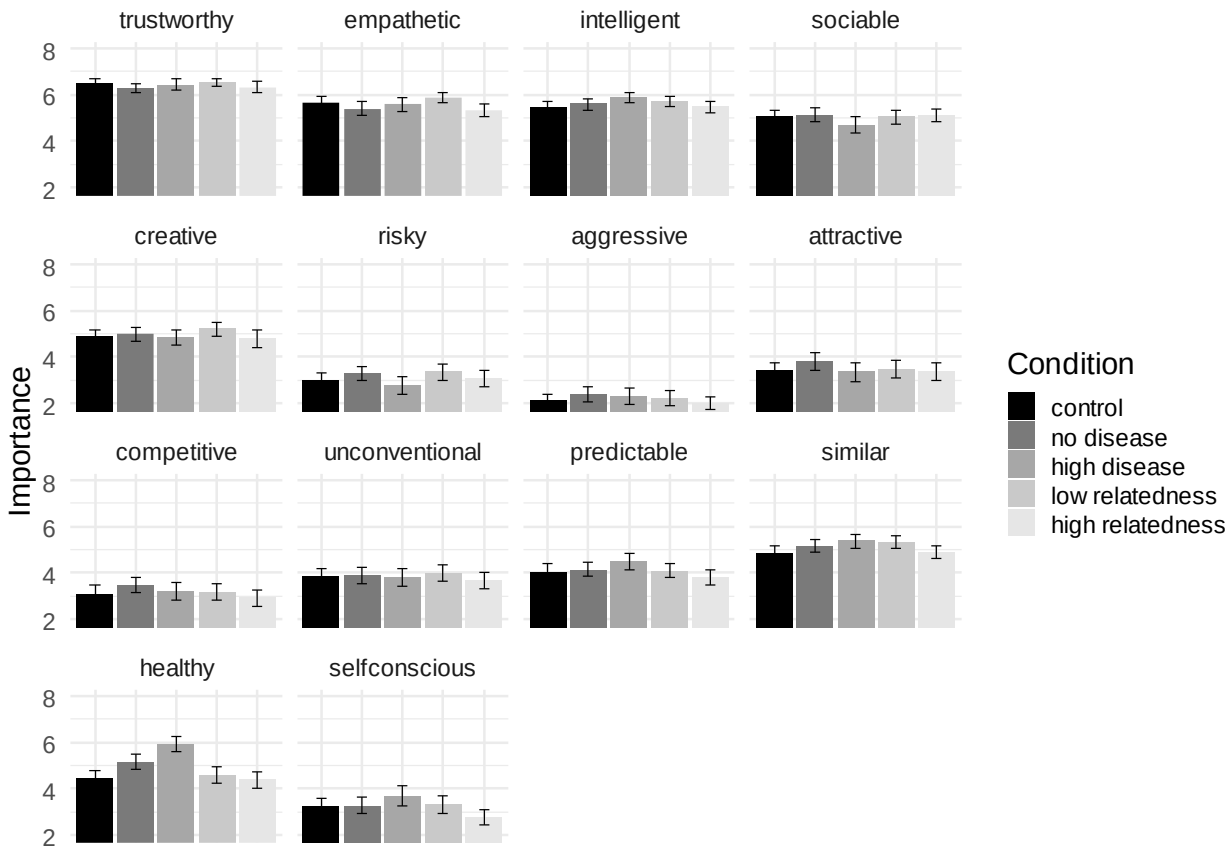



Figure 4. Bar plots of importance ratings by trait and condition with 95% CIs.

There was some evidence that people were tailoring their trait ratings to environmental condition. Several traits were rated as more important in the disease condition than in the other conditions. As expected, health was rated as much more important in the high disease condition (ANOVA: $F(4, 446) = 13.46$, $p < .001$) compared to the control ($t(446) = 5.89$, $p < .001$), low disease ($t(446) = 3.03$, $p = .02$), and relatedness conditions (high relatedness: $t(446) = 6.09$, $p < .001$; low relatedness: $t(446) = 5.40$, $p < .001$). In comparison, health did not emerge as more important for either the low relatedness or high relatedness conditions, all $p$s > .10. Interestingly, in the low disease condition, health was still rated as significantly more important than in the control condition ($t(446) = 2.97$, $p = .03$). This suggests that despite the low disease community

being described as having no risk of disease at all, the mere mentioning of disease still cued disease concern.

Self-consciousness was also rated as more important in the high disease condition (ANOVA: $F(4, 446) = 2.96$, $p = .02$) compared to the high relatedness condition ($t(446) = -3.41$), but its importance in the high disease condition was not significantly different from all other conditions (all *ps* > .52), although the direction was the same. Self-consciousness did not emerge as more important in the relatedness conditions (all *p*s > .21).

Similarity was marginally rated as more important in the high disease condition compared to the control condition (ANOVA; $F(4, 446) = 2.63$, $p = .03$; pairwise comparison: $t(446) = 2.51$, $p = .09$), but its importance in the high disease condition was not significantly different from all other conditions (all *ps* > .17), although the direction was the same. Similarity did not emerge as important in the relatedness conditions (all *p*s > .17).

Predictability was marginally rated as more important in the high disease condition compared to the high relatedness condition (ANOVA: $F(4, 446) = 2.26$, $p = .06$; pairwise comparison: $t(446) = -2.95$, $p = .03$), but its importance in the high disease condition was not significantly different from all other conditions (all *ps* > .28), although the direction was the same. Predictability did not emerge as important in the relatedness conditions (all *p*s > .44).

Lastly, intelligence was marginally rated as more important in the high disease condition compared to the control condition (ANOVA: $F(4, 446) = 2.08$, $p = .08$; pairwise comparison: $t(446) = 2.51$, $p = .09$), but its importance in the high disease condition was not significantly different from the low disease condition, or the other conditions (all *ps* > .17), although the direction was the same. This suggests again that the low disease community still cued disease

concern. Intelligence did not emerge as more important in the relatedness conditions (all *p*s > .17).

Several traits that we thought might vary by condition, did not vary by condition. For traits such as unconventional, creative, sociable, risk-taking, aggressive, attractive, and competitive, the community description did not impact ratings of importance, all *p*s > .10.

Overall, there was some evidence for our second hypothesis that trait preferences would be tailored to ecology. Patterns of responses appeared to map to the affordances of high disease environments. Pathogen prevalence has also been shown to be a predictor of tighter norms and traditionalism (e.g., Murray et al., 2011; Gelfand et al., 2011), which explains why predictability and similarity emerged as more important in the high disease condition. Health was rated as more important in the high disease condition as healthy individuals are less likely to get sick and transmit diseases. Lastly, disease threat has been shown to lead to greater self-consciousness (Ackerman et al., 2018) and self-focus, which explains why self-consciousness emerged as more important in the high disease condition. Surprisingly, many of the other traits that have been linked to disease avoidance, such as reduced sociability (e.g., Sawada et al., 2017; Mortensen et al., 2010 ), attractiveness (e.g., Gangestad & Buss, 1993), creativity (Murray, 2014), unconventionality (Murray et al., 2011), and risk-taking (Prokosch et al., 2019) were not impacted by the high disease condition, although they were trending in the predicted direction.

In terms of the affordances of relatedness conditions, empathy emerged as being marginally more important in the high relatedness condition. There may be some evidence for this in the literature. Altruistic behavior is greater in low residential mobility environments (e.g., Lun et al., 2012) and people report being more loyal to community in countries of high genetic relatedness (Sng, 2017). At the same time, predictability, similarity, and self-consciousness were

rated as less important in the high relatedness condition relative to the high disease condition, suggesting that maybe there is greater tolerance for uniqueness in friends in high relatedness environments, although there is no evidence for this in the literature.

In sum, the results of this pilot study provide some evidence that people are tailoring their friendship preferences depending on environments, but the effects are small. One concern with this study is the question of what should be the relevant comparison condition? Is the appropriate comparison for high disease condition, the low disease condition? Is the relevant comparison the relatedness conditions? Or the control condition? This issue makes interpretation of the findings difficult.

## Study 1

In Study 1, we adjusted the procedure in several ways to address some of the issues in the pilot study and better capture differences across ecological conditions. First, given the dearth of literature on genetic relatedness' impact on human psychology (Sng et al., 2018), we decided instead to focus on sex ratio, for which we had clearer predictions, given the greater focus on this ecological dimension in the behavioral ecology literature (Sng & Ackerman, 2020). Given our clear predictions about disease ecologies, we kept this condition. Second, we removed the low disease condition, because it appeared to still be cuing disease in the pilot study. We also removed the control condition because it was unclear what participants were thinking about when writing about their current community. Thus, the relevant comparison in this study for the disease condition was simply the two sex ratio conditions. Third, we switched out our short community descriptions for longer primes that have been used in prior work. Lastly, in a bottom-up approach, we allowed participants to open-endedly generate their own traits instead of

providing traits for participants to rate which could have led to demand effects or which could have biased their responses due to how the traits were being interpreted semantically.

Here, we made some predictions, but given the bottom-up design, we were open to participants listing unique traits that fell outside of our predictions. We made the prediction that warmth-based traits and trustworthiness would be listed equally likely, given their importance for social exchange. We predicted that traits associated with disease avoidance like health, low risk-taking, low sociability, and cleanliness would be listed more frequently in the disease condition relative to the sex ratio conditions. We had less strong predictions for the sex ratio conditions, but we predicted that traits associated with courtship, status, and relationship management would be more likely to be listed overall, particularly when the sex ratio was unfavorable (i.e., when the participant is female and the ecological condition is male-biased, or when the participant is male and the ecological condition is female-biased). When the sex ratio is unfavorable, people may need to work harder to manage relationships, so they may want someone who is socially connected, high in risk-taking, high status, good at attracting mates, and who can manage power dynamics, but who is not especially jealous or overly competitive. We anticipated that participant gender could still further predict differences in *how* people go about managing unfavorable sex ratios; in which case, we were open to the possibility of finding unique patterns in our exploratory analyses by gender, and did not make explicit predictions in advance.

## Method

Two hundred ninety-two participants from the University of Michigan Introduction to Psychology subject pool (64% female, Mage = 18.68, SDage = .80) took the survey. Participants were randomly assigned to read one of three articles: one about how disease was increasing in

frequency, one about the outnumbering of men to women, and one about the outnumbering of women to men. To immerse participants in the situation, they were asked to list some threats and opportunities they would experience given what was described in the article. Participants then imagined making an ideal friend and were asked to list up to five traits (a minimum of three) that they would want their friend to have given the state of the world described in the article. To help participants with this task, we also presented the threats and opportunities participants generated at the bottom of the page for participants to refer to when thinking about the traits. For each trait, participants had to explain why they wrote each trait. We did not exclude any participants—all participants passed an attention check asking them what type of person they were thinking about in the trait listing task, and all but eight participants were able to recall the topic of the article they read in the beginning.

## Results

Table 1 displays how many words were listed by gender and condition. There were less traits listed by men in our sample because there were less men in our sample. Many traits that participants listed were synonyms. For example, humorous was more likely to be listed in the sex ratio conditions, but funny, a very similar word, was equally likely to be listed across conditions. Therefore, to better view these patterns, we recruited two research assistants to review these individual traits. Using these traits, they developed a codebook (see Appendix J) for coding these traits into a set of 16 broader categories (warm, trustworthy, entertaining, sociable, calm, fair, intelligent, driven, powerful, conscientious, positive, risk-taking, similar, healthy, attractive, and clean).

| Condition | Gender | Number of traits listed |
|---|---|---|
| Disease | Female | 217 |
| Disease | Male | 90 |
| Female-biased | Female | 186 |
| Female-biased | Male | 98 |
| Male-biased | Female | 216 |
| Male-biased | Male | 109 |

Table 1. Count of number of traits listed by condition and gender.

Then, two different Research Assistants categorized each individual trait into the 16 categories. In situations where a trait counted as the opposite of a given category, it was coded as an antonym. For example, cautious was coded as an antonym of risk-taking under the category of risk-taking. In situations where the definition of the trait was ambiguous, we read the participant's reasoning for writing the trait to decide how to categorize the word. In situations where a trait could have fallen into two different categories, we counted that trait towards both categories. Fifty-eight traits did not fit into one of these 16 categories and were dropped. All categories had Cohen's *k*s ranging from .67-.89 (mean $k = .79$), with only one category (conscientiousness) not meeting the recommended *k* of .70.

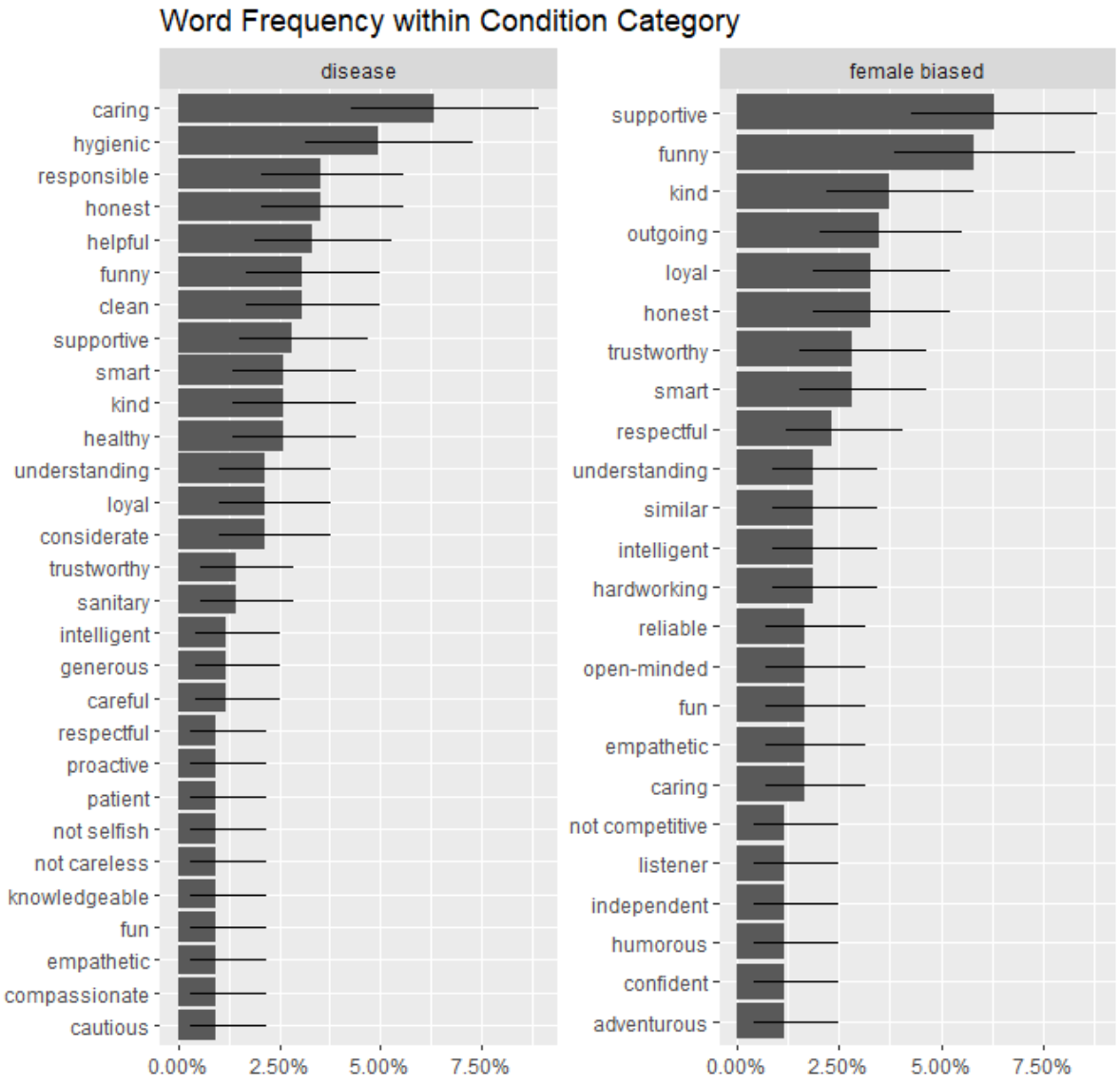
To analyze our data, we created correspondence tables for each of the words, then computed a Fisher's exact test to compare two groups at a time (similar to the analytical method used in Study 1 of Michalak & Ackerman, 2020). When examining the raw traits, due to the greater number of traits, we selected the top 25 traits.

**Examining disease effects**

**Is there a difference in friend preference between disease and sex ratio ecologies?**

Examining the raw traits and making a comparison between disease and aggregated sex ratio conditions, participants in the disease condition were more likely to list traits that would aid in disease avoidance: caring, hygienic, responsible, helpful, clean, healthy, considerate, sanitary,

careful, and not careless (see Figure 5). In contrast, participants in the sex ratio conditions were more likely to list traits that would be useful in overcoming obstacles and forging both additional connections and romantic relationships: supportive, outgoing, caring, confident, reliable, hardworking, and listener. Across conditions, our key universals honest, kind, understanding, trustworthy, compassionate, and empathetic were equally likely to be listed.



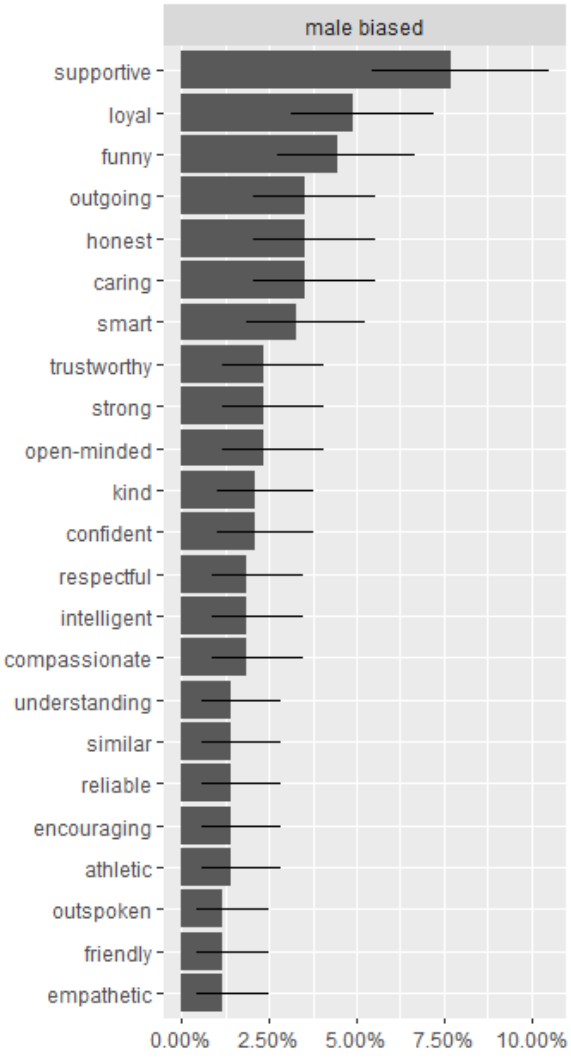



Figure 5. Word frequency for the top raw traits for each condition. Bars represent 95% CIs.

Examining the research assistant coded broad trait categories, participants in the disease condition were more likely to list traits that fell into the broad categories of cleanliness, health, conscientiousness, and less risk-taking (see Figure 6 and Table 2). This is aligned with our intuition that people who are clean, healthy, conscientiousness, and low in risk-taking would make good friends in a disease ecology, as they would be less likely to carry diseases or be in a position where they could become infected or infect others. In contrast, participants in the sex ratio conditions were more likely to list traits that fell into broad categories of trustworthiness, entertainment, sociability, fairness, power, drive, increased risk-taking, and similarity to the

participant, traits that appear to be more useful for managing and acquiring alliances, status, and romantic relationships. Across conditions, warmth was equally valued, but as mentioned, trustworthiness emerged as more likely in the sex ratio conditions, a point we will return to later. Participants also were equally likely to list traits that fell under intelligence, calmness, and positivity.

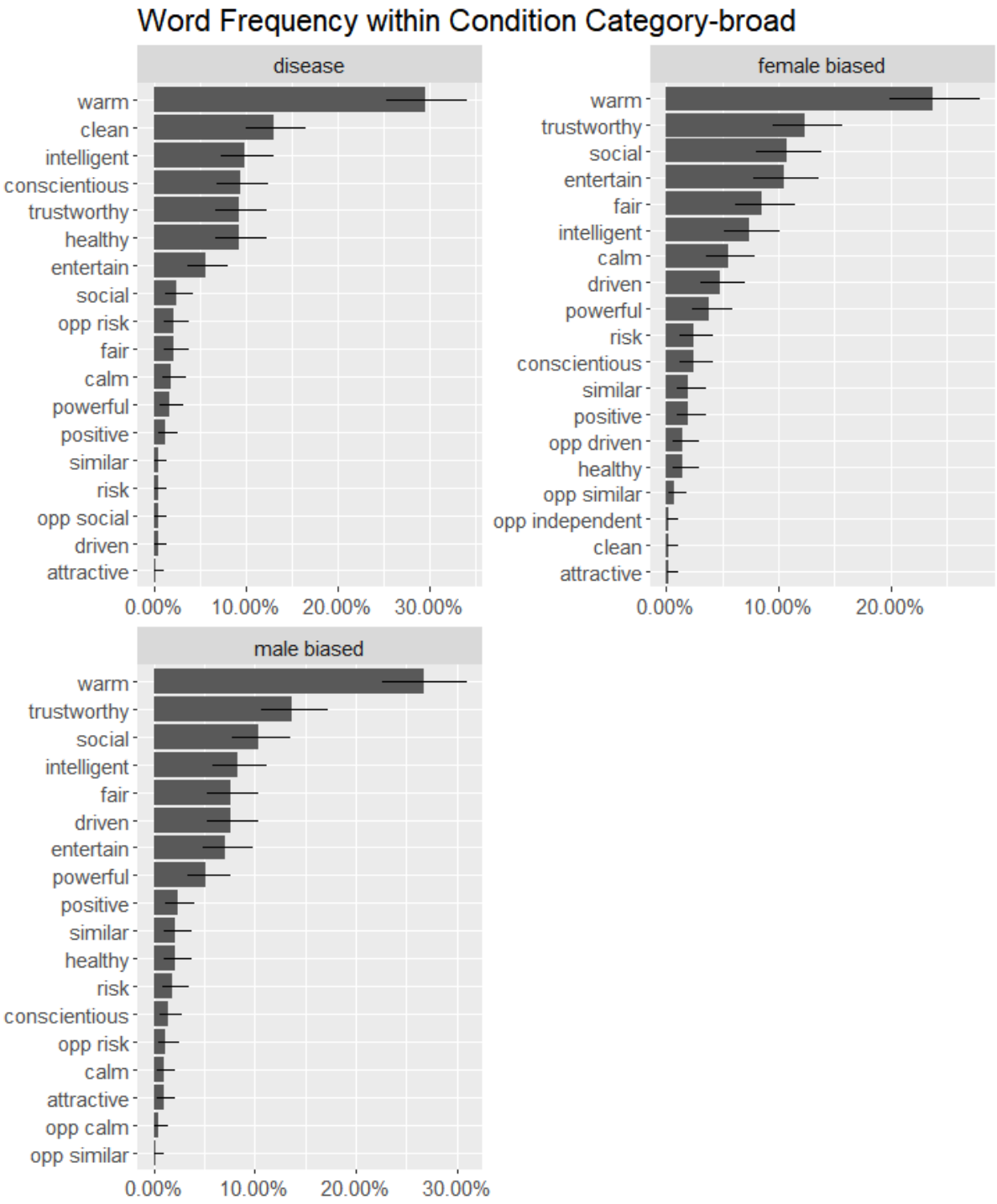



Figure 6. Word frequency for the top research assistant coded trait categories for each condition. Bars represent 95% CIs.

| Word | Disease | Sex Ratio | OR | CI lower | CI upper | h | p |
|---|---|---|---|---|---|---|---|
| warm | 0.3 | 0.25 | 0.80 | 0.61 | 1.05 | 0.11 | 0.10 |
| clean | 0.13 | 0 | 126.82 | 21.66 | 4974.14 | 0.74 | <.001** |
| intelligent | 0.1 | 0.08 | 0.77 | 0.50 | 1.19 | 0.07 | 0.24 |
| trustworthy | 0.09 | 0.13 | 1.47 | 0.99 | 2.24 | -0.13 | 0.05* |
| conscientious | 0.09 | 0.02 | 5.41 | 2.91 | 10.51 | 0.33 | <.001** |
| healthy | 0.09 | 0.02 | 5.61 | 2.97 | 11.13 | 0.33 | <.001** |
| entertain | 0.06 | 0.09 | 1.62 | 0.99 | 2.76 | -0.11 | 0.06$^{+}$ |
| social | 0.02 | 0.11 | 4.73 | 2.42 | 10.32 | -0.39 | <.001** |
| fair | 0.02 | 0.08 | 3.92 | 1.92 | 9.02 | -0.29 | <.001** |
| powerful | 0.02 | 0.04 | 2.72 | 1.19 | 7.29 | -0.12 | 0.01** |
| calm | 0.02 | 0.03 | 1.67 | 0.73 | 4.28 | -0.06 | 0.27 |
| less risk | 0.02 | 0.01 | 3.75 | 1.12 | 14.33 | 0.08 | 0.02* |
| positive | 0.01 | 0.02 | 1.77 | 0.63 | 6.15 | -0.08 | 0.37 |
| driven | 0 | 0.06 | 13.43 | 3.50 | 114.48 | -0.49 | <.001** |
| risk | 0 | 0.02 | 4.46 | 1.06 | 39.76 | -0.28 | 0.03* |
| similar | 0 | 0.02 | 4.21 | 0.99 | 37.74 | -0.28 | 0.05* |

Table 2. Disease vs. aggregated sex ratio conditions (no gender split) for the top most listed trait categories for each condition. ** indicates a $p$ <= .01 significance, * indicates a $p$ <= .05 significance, $^{+}$ indicates a $p$ <=.10 significance on Fisher's exact tests. Trait categories that are colored blue mean they were more likely to be listed by participants in the disease condition and traits categories colored orange mean they were more likely to be listed by participants in the sex ratio conditions.

**Examining sex ratio effects**

**Is there a difference between favorable and unfavorable sex ratios?** To examine this, we collapsed across favorable (i.e., women in the male-biased condition, men in the female-biased condition) and unfavorable (i.e., men in the male-biased condition, women in the female-biased condition). Examining the raw traits, participants in a favorable sex ratio were marginally more likely to list confident and strong. Some of these traits might be for balancing a power dynamic, e.g., in a male-biased sex ratio, females do have more choice, but they also experience a power imbalance where men might hold all the power in a workplace. In this case, confidence and strength might be important. Participants in an unfavorable sex ratio were marginally more likely to list athletic and humorous, traits associated with cooperative courtship potentially.

Examining the research assistant-generated broad categories, both participants from favorable and unfavorable ratios were equally likely to list traits that fell into the categories of warmth and trustworthiness (see Figure 7 and Table 3). Participants in a favorable sex ratio were marginally more likely to list traits that fell under sociality. This is harder to interpret but could reflect the desire to make more connections when there is more choice for romantic partners (e.g., cooperative courtship). Participants in an unfavorable sex ratio were significantly more likely to list traits that fell under calmness and less drive, which is consistent with what we saw with the raw traits; participants in these more competitive environments wanted friends who were less competitive.

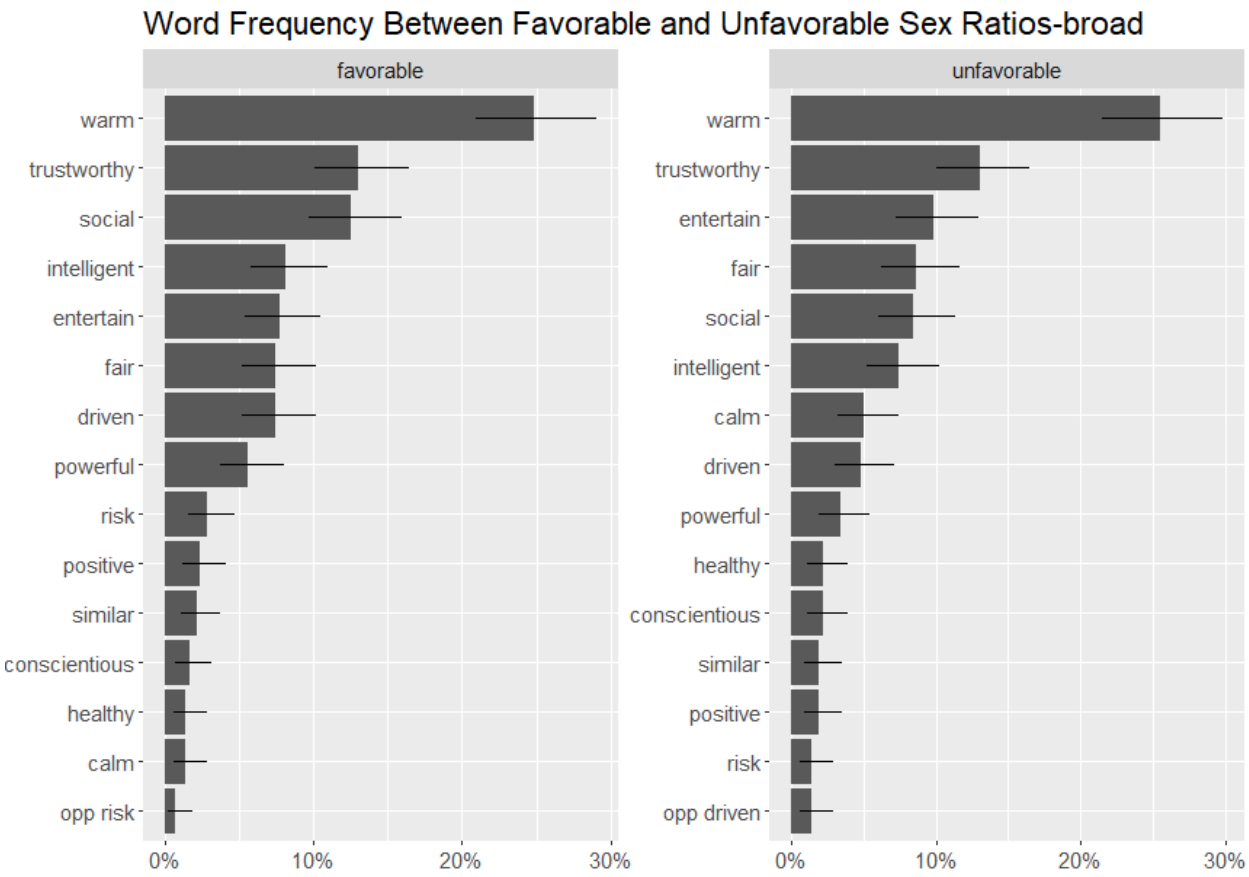



Figure 7. Word frequency for the top research assistant trait coded categories for each sex ratio condition collapsed into favorable vs. unfavorable. Bars represent 95% CIs.

| Word | Favorable | Unfavorable | OR | CI lower | CI upper | h | p |
|---|---|---|---|---|---|---|---|
| warm | 0.25 | 0.26 | 0.97 | 0.70 | 1.33 | -0.02 | 0.87 |
| trustworthy | 0.13 | 0.13 | 1.00 | 0.66 | 1.53 | 0.00 | 1.00 |
| social | 0.13 | 0.08 | 1.56 | 0.97 | 2.52 | 0.16 | 0.06+ |
| intelligent | 0.08 | 0.07 | 1.10 | 0.64 | 1.88 | 0.04 | 0.80 |
| entertain | 0.08 | 0.1 | 1.32 | 0.79 | 2.20 | -0.07 | 0.27 |
| driven | 0.07 | 0.05 | 1.59 | 0.86 | 2.98 | 0.08 | 0.12 |
| fair | 0.07 | 0.09 | 1.18 | 0.70 | 2.01 | -0.07 | 0.53 |
| powerful | 0.06 | 0.03 | 1.69 | 0.83 | 3.59 | 0.15 | 0.14 |
| risk | 0.03 | 0.01 | 1.96 | 0.67 | 6.41 | 0.15 | 0.23 |
| positive | 0.02 | 0.02 | 1.21 | 0.43 | 3.57 | 0.00 | 0.81 |
| similar | 0.02 | 0.02 | 1.09 | 0.37 | 3.27 | 0.00 | 1.00 |
| conscientious | 0.02 | 0.02 | 1.34 | 0.44 | 4.27 | 0.00 | 0.62 |
| calm | 0.01 | 0.05 | 3.76 | 1.45 | 11.51 | -0.25 | <.001** |
| healthy | 0.01 | 0.02 | 1.57 | 0.49 | 5.40 | -0.08 | 0.44 |
| opp risk | 0.01 | 0 | 1.45 | 0.17 | 17.44 | 0.20 | 1.00 |
| opp driven | 0 | 0.01 | Inf | 1.23 | Inf | -0.20 | 0.01** |

Table 3. Favorable vs. unfavorable sex ratio conditions for the top most listed trait categories for each condition. ** indicates a $p$ <= .01 significance, * indicates a $p$ <= .05 significance, $^{+}$ indicates a $p$ <=.10 significance on Fisher's exact tests. Trait categories that are colored blue mean they were more likely to be listed by participants in the favorable sex ratio condition and traits categories colored orange mean they were more likely to be listed by participants in the unfavorable sex ratio condition.

**Understanding gender profiles within sex ratio conditions**

**Do sex ratio effects depend on gender?** Another way of examining the sex ratio conditions is to split the results by gender within each condition. This would help us to potentially detect if there are any differences by gender. That is, males and females may differ in how they respond to favorable and unfavorable sex ratios. We also suspected there could be hidden affordances associated with the specific gender imbalances that we were losing if we collapse across favorable and unfavorable sex ratios. For example, male-biased ecologies have been shown to be associated with greater crime (Barber, 2003). Previewing our analytic strategy, we examine females in male-biased and female-biased conditions, and males in male-biased and female-biased conditions. We start with the raw traits participants listed and move to the broad categories that research assistants coded.

We examined the sex ratio conditions split by gender, starting with the raw traits participants had listed. Examining the traits listed in the male-biased condition (favorable for women), women were more likely than men to list supportive, confident, and strong (marginal), traits that appear to be for social support and for combating potential status and physical threats from men. Examining the traits listed in the female-biased condition (unfavorable for women), women were marginally more likely than men to list supportive, empathetic, independent, and not competitive. Perhaps female participants were sensitive to the fact that the environment was unfavorable and therefore competitive, and therefore listed traits associated with less competitiveness.

Examining the research assistant-coded broad trait categories (see Figure 8), women in the male-biased condition (favorable) were more likely than men to list traits that fell under warmth, drive, and power. Again, these traits are associated with acquiring status and social ties. Women in the female-biased condition (unfavorable) were more likely than men to list traits that fell under warmth, and marginally likely to list traits that fell under reduced drive (likely to do with a desire for less competitiveness), traits for social support and managing conflict.

We then examined the raw traits men generated. Men in the female-biased condition (favorable to men) were more likely than women to list responsible and marginally likely to list respectful, similar, humble, not sexist, and sporty. These traits were difficult to interpret, but overall appear to still be associated with courtship and managing friendships and status. Men in the male-biased condition (unfavorable to men) were more likely than women to list respectful, athletic, and not arrogant, traits which could be useful for cooperative courtship.

Examining the research assistant-coded trait categories, men in the female-biased condition were more likely than women to list traits that fell under sociability, and marginally

were likely to list traits that fell under similarity, and fairness. These traits appear to be for courtship and fostering connections. In terms of fairness, men might have been anticipating that women would hold more power and would want a friend who would help with managing that gender power imbalance. Men in the male-biased condition were more likely to list traits that fell under fairness, similarity (marginal), and health (likely to do with a desire for athleticism). Fairness would help with the competitive nature of an unfavorable sex ratio, and health could be a trait that aids in courtship.

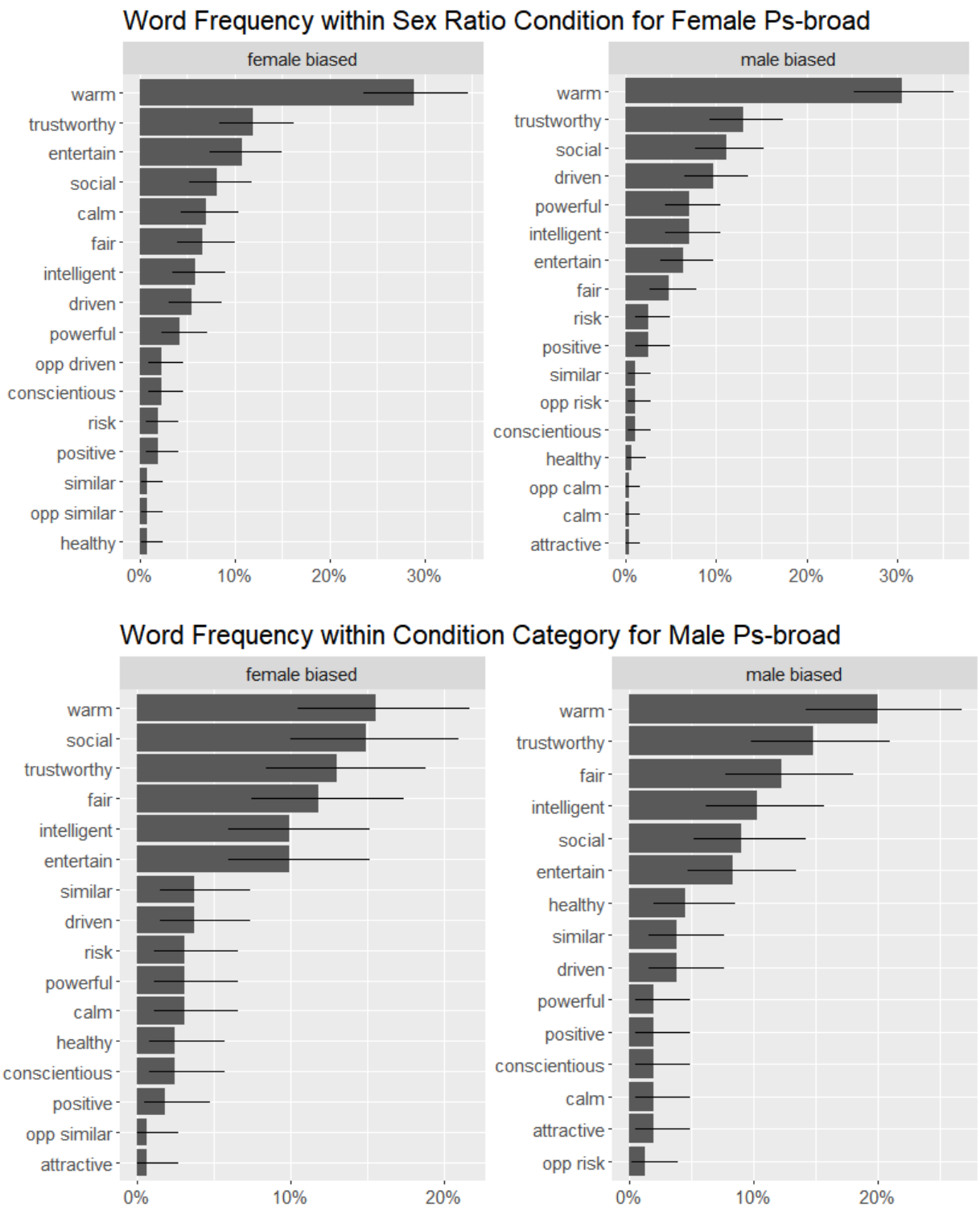



Figure 8. Word frequency for the top research assistant coded trait categories by condition and gender. Bars indicate 95% CIs.

**Testing patterns for females and males across sex ratio conditions**

It makes sense to examine gender patterns across the sex ratio conditions. That is, we should compare women across the two sex ratio conditions, and we should compare males across the two sex ratio conditions to see whether participants really are tailoring their friendship preferences to the respective sex ratios.

Women in the female-biased condition were more likely to list traits that fell under the broad trait categories of calm, and less driven, and marginally were more likely to list traits under the category of entertainment. Calmness and reduced drive reflect traits that could aid in diffusing the competitiveness of an unfavorable sex ratio. Women in the male-biased condition were marginally more likely to list traits that fell under the driven category than women in the female-biased condition. Men did not show significant differences in trait categories across sex ratio conditions. This lack of difference between the men in the sex ratio conditions could suggest that men perhaps are less likely to be sensitive to sex ratio information. At the same time, there were less men in our study, and we may be underpowered to detect these differences.

In summary, regardless of conditions and gender, it seemed that participants were equally likely to list traits associated with warmth. Interestingly, trustworthiness was less likely to be listed in the disease condition compared to the sex ratio condition. This might have been because there were a limited number of traits participants could list (only 5 maximum) and other more relevant traits for managing disease come to mind. Alternatively, trustworthiness could be a trait that is more important in managing relationships between the sexes.

There emerged a clear difference between the disease and sex ratio conditions, such that people who received the disease article were more likely to list traits associated with disease avoidance, such as cleanliness, health, conscientiousness, and less risk-taking.

Turning to the sex ratio conditions, favorable sex ratios were marginally associated with more traits that fell under the social category, potentially indicating a preference for friends who would provide greater opportunities to make social connections. Unfavorable sex ratios were associated with more calm and less drive, indicating a preference for friends who would not cause emotional turbulence and who would not be competitive. Examining the specific gender patterns in the sex ratio conditions, in the female-biased condition, women were more likely to list traits associated with wanting more calmness and less drive in a friend. One interpretation of this is that women in a female-biased environment desire someone who would not compete with them for resources and romantic partners. Overall, males seemed less sensitive to sex ratio information, and there were no traits that emerged as more likely to be listed in the male-biased condition for males, but this could have been because they were underrepresented in our sample. Lastly, one limitation to this study is the large number of statistical tests that needed to be done in order to compare word frequencies between these groups, which we aimed to reduce in the next study.

## Study 2

In Study 2, we employed a two round limited budget paradigm (e.g., Cottrell et al., 2007; Li et al., 2002). This paradigm is designed to distinguish between necessities and luxuries. In the first round, participants invest their initial allocated friend dollars on necessities, or those traits that they feel are fundamental and essential, whereas in the second round, participants are given an additional allocation and allowed to invest in luxuries, or those traits that they feel are valuable but non-essential. This contrasts with our pilot study design, which allowed participants to rate every single trait on the list as important for an ideal friend to have if they chose to, which could have explained the small effect sizes we found in that study.

Second, the current study allowed us to conceptually replicate Study 1. For the traits in the current study, we used the broad categories generated in Study 1. We chose trustworthiness and warmth as key traits, given our first hypothesis that these traits are important to social exchange and would still emerge strongly regardless of condition. Based on the results from Study 1, we included cleanliness, health, conscientiousness, and risk-taking as key traits that would be associated with disease. We anticipated people would be more likely to allocate to the first three, and less likely to allocate to risk-taking in the disease condition. We included calmness, drive, power, and risk-taking as key traits associated with sex ratio. This was because in Study 1, in the unfavorable sex ratio condition, people were less likely to want drive, and more likely to want calmness in a friend. We included power and risk-taking because we hypothesized in the sex ratio condition, people would be more concerned with status and acquiring mates.

## Method

Five hundred fifty-four participants from Prolific Academic (45% female, 51% male, 4% other; *Mage* = 32.57) took the survey in total. As in the previous study, participants first read an article about the rise of disease in America, a population increase in men over women, or an increase in the number of women over men. Then, participants completed the within-subjects two round limited budget paradigm (e.g., Cottrell et al., 2007; Li et al., 2002). In the first round, participants were given a budget of 20 dollars to spend on nine traits (trustworthiness, warmth, conscientiousness, cleanliness, health, openness to risk, calmness, drive, and power).

Each trait was defined for the participant based on the coding scheme that was developed in Study 1. Participants were given similar instructions to the pilot study; they were told to imagine they were creating an ideal same-sex friend given the state of the world described in the article, and that they had $20 total to spend. Each dollar represented an increase of ten percentile

in that trait; each trait maxed out at 10 dollars. For example, if a person spent $1 on one trait and $7 on another trait, the friend would be in $10^{th}$ percentile on the first trait and $70^{th}$ percentile on the second trait.

In the second round, participants were given an additional budget of 20 dollars. The allocations across the two rounds were cumulative, meaning that the original investments from the first round were kept, and participants could add to those investments or choose new traits to invest in for the second round. We included a couple manipulation checks asking participants to recall and summarize the article they read at the beginning of the study and asking participants to recall what type of person they were designing in the budget allocation task. Finally, we asked participants to answer three vocabulary questions that were designed to filter out bad quality data.

## Results

After all exclusions, we were left with 483 participants. We ran an initial linear mixed model with trait, round, and Condition and their interactions as fixed effects and a random intercept for participant. This revealed that there was zero variance contributed by participant; therefore, the random effect of participant was not included. Instead, we ran a three factor ANOVA using the same fixed effects. There was no significant 3-way interaction, $p$ =. 44. There was a significant interaction between trait and condition, $F(16, 8280)=3.28$, $p$ <.001, and a significant interaction between trait and round, $F(8, 8280) = 24.23$, $p$ <.001. This suggests that there exists some significant difference between conditions within some of the traits and that there exists some significant difference in allocation between rounds. However, a lack of three-way interaction suggests that this allocation between rounds does not depend on condition. This implies that condition did not differentially impact the rate of allocation to “necessities” or

"luxuries". Given this, we decided to just collapse across rounds and probe the two-way interaction between trait and condition (see Figure 9). To do this, we ran a linear regression; our key planned contrast for conditions compared disease vs. sex ratio conditions (.5, -.25, -.25), and we also included the contrast comparing sex ratio conditions (0, -.5, .5) to keep the contrasts orthogonal.

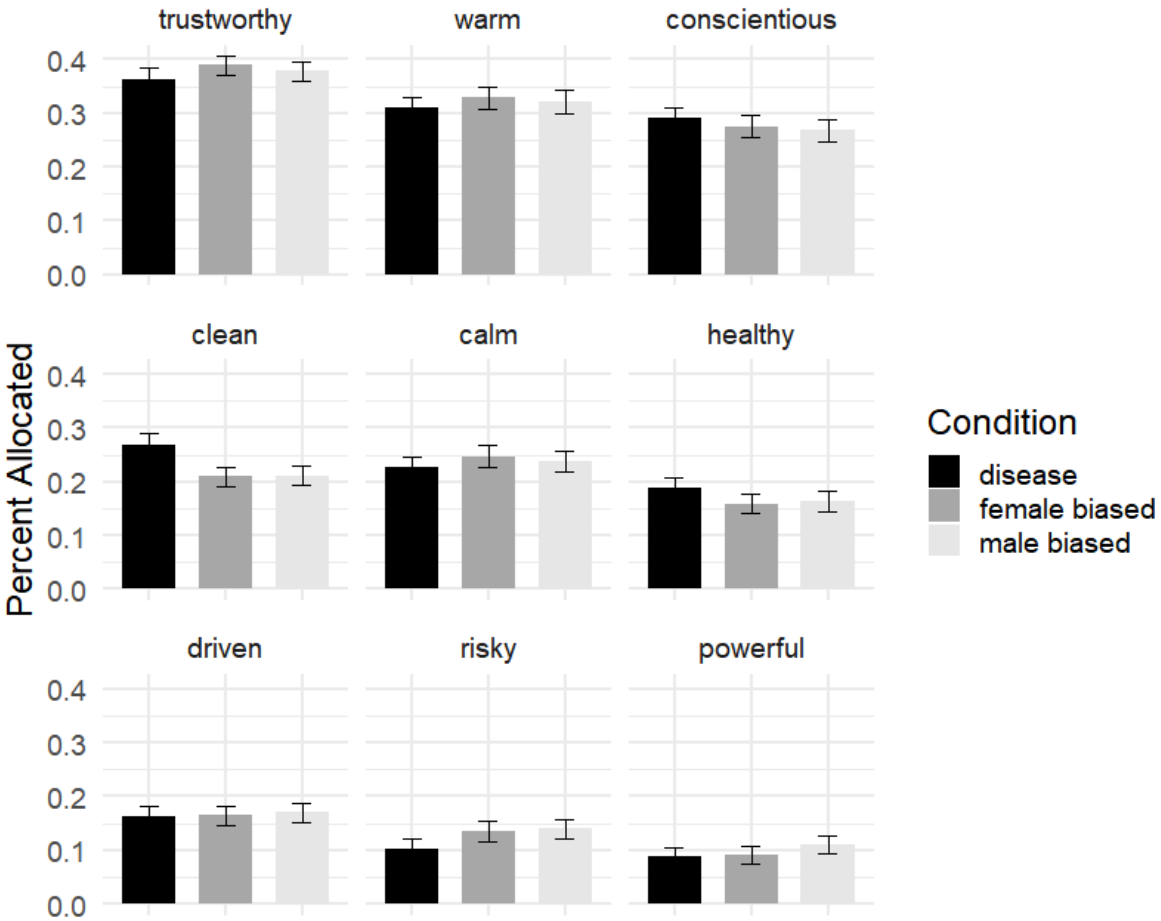



Figure 9. Bar plot of percent of budget allocated across rounds, by trait and condition. Bars represent 95% CIs.

**Examining disease effects**

**Did participants tailor their allocations to disease condition?** Regardless of disease or sex ratio condition, people invested in warmth equally. Participants in the disease condition invested less in trustworthiness compared to the two sex ratio conditions, $t(480) = -2.13$, $p = .03$,

*95% CI* = [-.06, -.002], similar to the finding in Study 1. Participants in the disease condition invested more in health compared to the two sex ratio conditions $t(480) = 2.42$, $p = .02$, *95% CI* = [.01, .07]. Participants in the disease condition also invested more in cleanliness compared to the two sex ratio conditions, $t(480) = 4.87$, $p < .001$, *95% CI* = [.05, .11]. Participants in the disease condition also invested less in risk-taking compared to the two sex ratio conditions, $t(480) = -2.91$, $p = .003$, *95% CI* = [-.07, -.01]. Participants, however, did not invest more in conscientiousness in the disease condition, $p = .12$. Except for conscientiousness, these patterns match what was found in Study 1 and our predictions. In terms of the traits we hypothesized to emerge as greater linked to the sex ratio conditions: drive, power, and calmness did not differ across disease and sex ratio conditions, all *ps* >.12; however, part of our prediction hinges on a gender by sex ratio interaction, so we return to this in the next section.

Overall, comparing disease with the sex ratio conditions, results confirmed and disconfirmed some of our hypotheses. Warmth indeed was viewed as equally worthy of investment regardless of condition. Contrary to the first hypothesis, there was a marginal difference in investment in trustworthiness, where participants in the disease condition invested less in trustworthiness relative to participants in the sex ratio conditions. Given that participants had a limited budget, likely this was because in the disease condition, there seem to have been other traits like cleanliness in which participants were more interested in investing.

There was some evidence for the tailoring of traits to condition, particularly in the disease condition, participants invested more in cleanliness and health, and invested less in risk-taking; both of these decisions minimize the chances a prospective friend would be at risk for spreading disease. Contrary to the second set of hypotheses, conscientiousness was not a trait that participants in the disease condition invested in more relative to participants in the sex ratio

conditions. This may be because conscientiousness is more of a general trait and less directly related to disease avoidance and participants preferred to directly invest in cleanliness and health. In line with our hypotheses, participants invested more in risk-taking in the sex ratio condition. Contrary to these hypotheses, participants did not invest more in drive, power, and calmness in the sex ratio conditions; however, these may differ by gender, to which we turn to next.

**Examining sex ratio effects**

**Is there a difference between favorable and unfavorable sex ratios?** To examine this, we collapsed across favorable (i.e., women in the male-biased condition, men in the female-biased condition) and unfavorable (i.e., men in the male-biased condition, women in the female-biased condition). Here we were looking to replicate our findings from Study 1: in unfavorable ratios, we should see greater investment in calm and less investment in drive.

We ran the same omnibus ANOVA but only selected the favorable and unfavorable sex ratio conditions. There was no significant interaction between trait and sex ratio favorability, $p$ = .15. There was a marginally significant interaction between trait, round, and sex ratio favorability, $p$ = .06.

To unpack this interaction, we split analyses by trait and round, and ran linear regression models with sex ratio favorability as a predictor. In round 1, examining the traits we expected would not differ, warmth and trustworthiness, we found that there was a marginal effect such that participants in the unfavorable sex ratio condition invested slightly more in warmth than those in the favorable condition, $b$ = .02, $t$ = .01, $t(301) = 1.94$, $p$ = .05, *95% CI* = [-.00, .05] (see Figure 10); there was no effect of sex ratio favorability on trustworthiness, $p$ = .89. This departs from Study 1, where we did not find any differences between conditions in how likely people

were to list traits that fell into the warmth category.

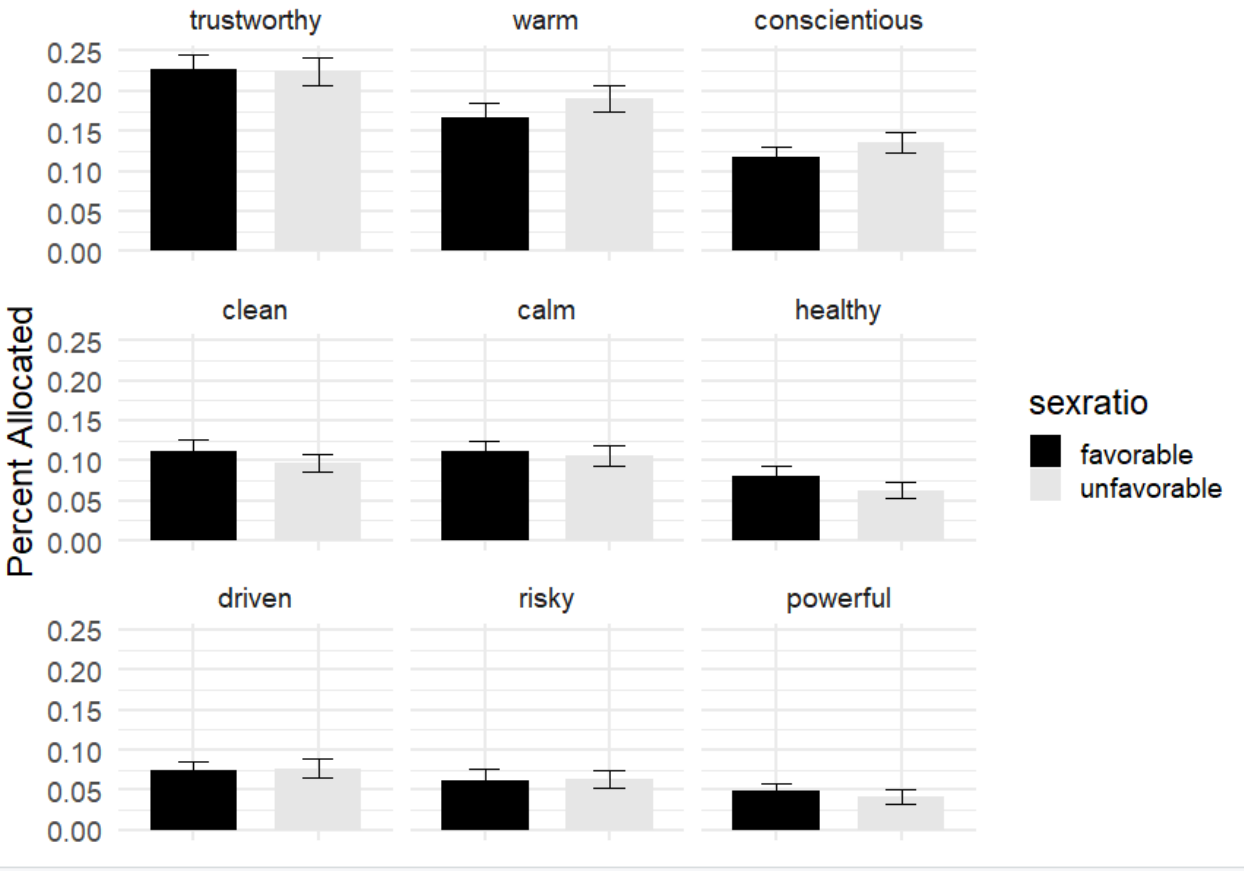



Figure 10. Bar plot of percent of budget allocated in round 1, by trait and sex ratio favorability. Bars represent 95% CIs.

In terms of the traits we expected would differ between favorable and unfavorable sex ratios, calmness and drive, we found no significant differences, all *ps* > .59. Instead, we found some other differences we did not expect. People in the favorable sex ratio condition invested more in health (*b* = -.02, *SE* = .01, *t* = -2.02, *p* = .04, *95% CI* = [-.03, -.00]), and people in the unfavorable sex ratio invested marginally more in conscientiousness (*b* = .02, *SE* = .01, *t*(301) = 1.88, *p* = .06, *95% CI* = [-.00, .04]). Neither of these were predicted effects.

Examining round 2, there were no differences between conditions for all traits, all *p*s > .23, except cleanliness, such that people in the unfavorable sex ratio condition invested more in

cleanliness, $b$ = .02, $SE$ = .01, $t(301)$ = 2.35, $p$ = .02, *95% CI* = [.003, .04]. Overall, these patterns did not match our predictions and we did not further interpret these findings.

**Understanding gender profiles within sex ratio conditions**

**Were there any gender differences in the sex ratio conditions?** In order to understand the allocations in the sex ratio conditions, we needed to examine effects by participant gender. Again, we did this in case there were some gender-specific friendship preferences. Here, we were looking to replicate our findings from Study 1: in the female-biased sex ratio, women seemed less likely to want drive, and more likely to want calmness in a friend compared to women in the male-biased sex ratio.

We ran the same omnibus ANOVA test but only selected the sex ratio conditions and included participant gender as an interactive variable. There was no significant interaction between trait, sex ratio condition, and gender, $p$ = .17. There was a marginally significant interaction between trait, round, sex ratio condition, and gender, $p$ = .06. To unpack this interaction, we split analyses by trait and round, and we ran linear models with gender, sex ratio condition, and their interaction as predictors, focusing on the interactive effect between gender and sex ratio condition. Specific contrasts were tested using Tukey contrasts given the multiple comparisons.

Overall for warmth, there was a marginal interaction between participant gender and sex ratio condition, such that women invested more in warmth than men, but this difference was particularly great in the female-biased condition (interaction: $b$ = .04, $SE$ = .02, $t$ = 1.93, $p$ = .054, *95% CI* = [.00, .09]; see Figure 11), suggesting perhaps that women seek more warmth as a buffer against female competition, although we did not predict this. Trustworthiness did not

exhibit any interactive effect, neither did our traits of interest: drive, power, and risk-taking, all *ps* > .12. Cleanliness did not exhibit any interactive effect, which we expected, $p = .13$.

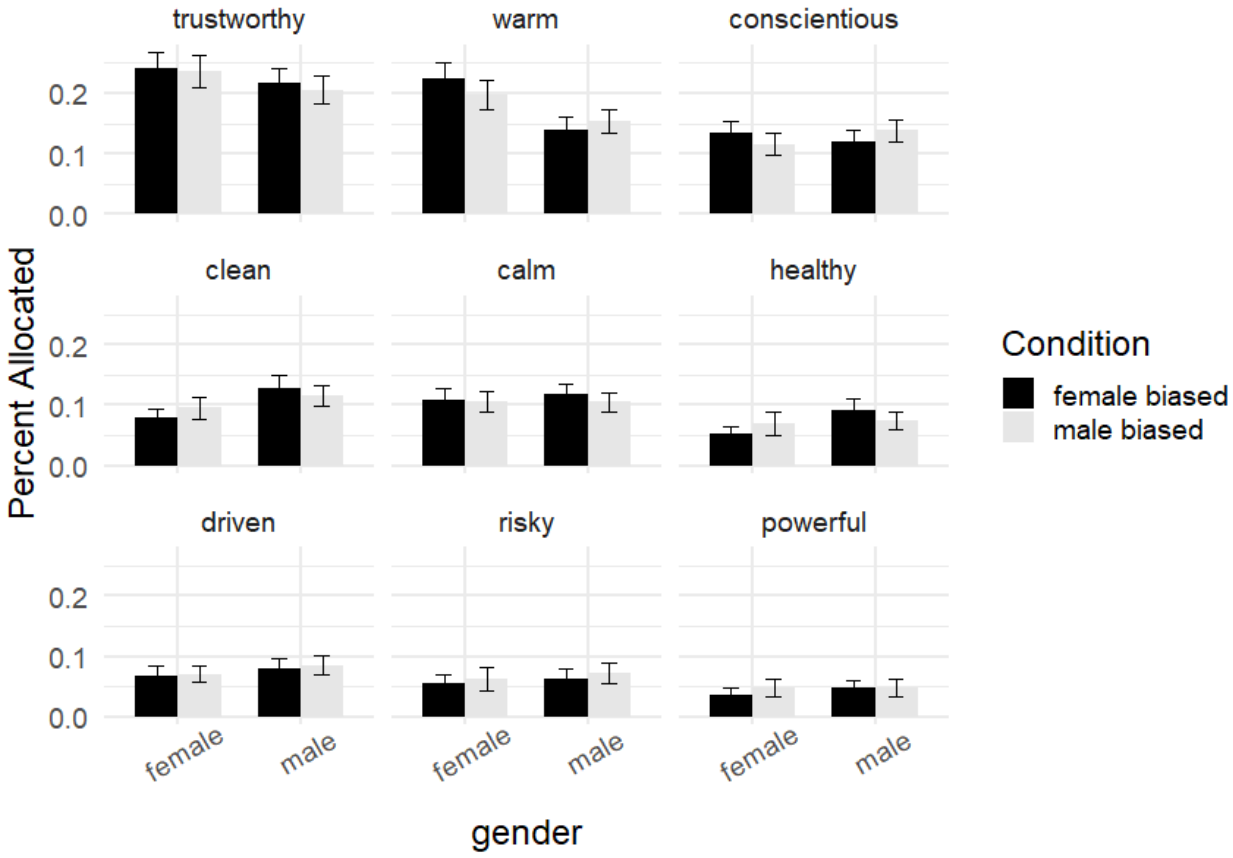



Figure 11. Bar plot of percent of budget allocated in round 1, by trait, gender, and sex ratio condition. Within each trait facet, the left cluster of bars refer to female participants, the right cluster of bars refer to male participants. Female-biased condition is in black, while male-biased condition is in light gray. Bars represent 95% CIs.

We did not predict some of the patterns. Women and men who were in unfavorable sex ratios invested marginally more in conscientiousness , $b = .04$, $SE = .02$, $t = 1.89$, $p = .06$, *95% CI* = [.00, .07]. Men overall invested more in health than women, but this difference was particularly great in the female-biased condition, $b = -.03$, $SE = .02$, $t = -1.99$, $p = .05$, *95% CI* = [-.07, .00].

For all the traits, just as we did in Study 1, we examined specific contrasts. We first compared the trait investments from women in the female-biased condition to those from women in the male-biased condition. We then compared the trait investments from men in the male-biased condition to those from men in the female-biased condition. There were no significant difference for either comparison, all *ps* >.29. This suggests that these interactions between participant gender and sex ratio condition were driven primarily by the difference between the preferences of women and men, suggesting in some conditions, women and men are more or less convergent. However, whether women or men are convergent is less relevant to our question of interest, which is more about within-gender differences.

By round two of the limited budget paradigm, the patterns in the first round had disappeared; the only trait that displayed any interactive effects was cleanliness, which was invested in more by both women and men who were in the unfavorable sex ratio condition, $b$ = .04, $SE$ = .02, $t$ = 2.35, $p$ = .02, *95% CI* = [.01, .08], all other *ps* > .23. Again, when we examined specific contrasts comparing the trait investments of the women in the male-biased condition to those trait allocations of the women in the female-biased condition and comparing those made by men in the male-biased condition to those made by men in the male-biased condition, there were no significant differences, all *ps* >.32. Generally, these results did not replicate the findings from Study 1 and ran contrary to our specific predictions.

**In sum**, the first hypothesis that warmth emerge as a high investment trait regardless of condition was supported. Replicating Study 1 but in contrary to our original first hypothesis, participants invested in trustworthiness slightly less in the disease condition; this might have been because there were several other traits that were directly relevant to disease management and given the constrained budget, participants had no choice but to reduce their allocation

towards trustworthiness. At the same time, examining the allocations ordinally, in all three conditions, trustworthiness still emerged as the top trait.

Some trait investments were tailored to condition, partially supporting the second hypothesis. Matching our findings in the previous studies, participants invested more in cleanliness, health, and invested less in risk-taking in the disease condition. Surprisingly, and contrary to prediction, conscientiousness, drive, power, and calmness did not differ between conditions. Originally, we had anticipated that conscientiousness would be more valued in the disease condition, while drive, power, and calmness would be more valued in the sex ratio conditions, but we found no evidence of this.

Overall, participants tailored their trait allocations to the disease condition, but had a did not seem to tailor their allocations  to the sex ratio conditions. We did find some effects of sex ratio favorability, and some participant gender by sex ratio interactions, but these were not predicted patterns and therefore were harder to interpret. Our difficulty might stem from the fact that the sample in Prolific is an older sample relative to the student sample in Study 1 and the sex ratio manipulation was tailored to young adults. For instance, the articles used to manipulate sex ratio provide several examples of sex ratio imbalance in a college and high school. Another possibility is because the study was conducted during the height of the coronavirus pandemic, it was perhaps much easier for people to imagine the situation described in the disease condition, but harder to think about the sex ratio situation. Alternatively, this could have also meant participants were already chronically primed with disease, which explains why the investment in health and cleanliness in the sex ratio conditions is non-zero. Moreover, even though the traits used in this paradigm were derived using a bottom-up approach, we still provided them to participants. As such, there still was the potential for demand effects. A final possibility is that,

given the complexity and nuance of the English language, we should not expect to be able to distill the diversity in the descriptions from Study 1 into these broad categories; some meaning is lost in this process.

## Chapter Discussion

Did some traits emerge as universals? Across three studies, we find evidence that warmth and trustworthiness, fundamental traits for social exchange, emerge as very strongly valued traits. When comparing them to other traits, participants rated these as highly important, were willing to spontaneously generate them, and invest more in these traits, regardless of condition and participant gender. Still, there were some small differences in the role of trustworthiness. For participants in the disease condition, trustworthiness played a lesser role than in the sex ratio conditions. This could have been because we explicitly drew a lot of attention towards the ecology during the task and there were more relevant traits for disease avoidance, such as cleanliness and health, that were more salient than trustworthiness. But, if this is true, then this could be an interesting finding—in some environments, other traits may indeed be more important for friendship than even trustworthiness. Would that mean that these traits are less 'externalities', or "side-effects" of friendship, and more central to the relationship than we previously thought? However, trustworthiness was always very highly valued—often ranked first among all other traits, suggesting it is still very important relative to other traits, but not always as equally important across environments.

Did some traits seem to be tailored to ecological condition? We find some evidence that this is true. Across several studies, participants were consistently more likely to value health, cleanliness, and less likely to value risk-taking for a friend in the disease condition, traits clearly

associated with disease avoidance. There was less evidence of tailoring in the other ecological conditions we chose—genetic relatedness and sex ratio.

Why might people want to tailor their friendship preferences to ecological condition? In the introduction to this chapter, we suggested that not only are people interested in whether a person is an honest, cooperative social partner, they are interested in the positive side-effects, or positive externalities, of friendship. They are interested in finding someone who will support their goals and not put them at risk. In this way, they seek to find a person who is adept at navigating and exploiting their environment, and who will help fulfill the same goals.

Why might we have not seen much tailoring in the genetic relatedness and sex ratio conditions? The threats and opportunities that friendships afford may be quite clear in the disease threat ecology—they put people at risk of disease transmission, but they may also provide support and care. However, the threats and opportunities that friendships afford in the other two ecologies are less clear, which might also explain why there has been so much empirical work investigating the impact of disease on sociality (e.g., Schaller, 2011), but less on the impact of these other ecological dimensions. Sex ratio effects could depend on other demographics, like relationship status, age, or sexual orientation. Genetic relatedness effects could interact with the participant's experiences with or feelings towards their family members. If this is true, then our effects might be more complex than we were able to capture in our experimental designs, or people may have had a harder time completing our task and might have defaulted to imaging a typical friend. Our studies also assume people have conscious access to their friendship preferences, but this may only be the case for ecologies where the costs and benefits of friendship are clear, such as in the disease threat ecology. Lastly, the lack of tailoring in the sex ratio conditions in Study 2 could have been due to experimenter error in terms of the prime not

being written to suit an older participant population or could have been due to data collection taking place during the coronavirus pandemic.

One criticism of our findings is that participants in our study could have merely been thinking of what an average person is like in these ecologies and then using their prototype of an average person to fill out their friendship preferences. There is some reason to doubt this explanation, at least for some of the traits. In our pilot study, we also included an additional task where participants had to rate how common each trait was in the community. Participants in the pilot study in the high disease condition rated health, predictability, similarity as important and risk-taking as unimportant in an ideal friend. However, they actually rated health, predictability, and similarity as more *atypical*, and risk-taking as more *typical* in the high disease condition relative to the other ecological conditions. This suggests that participants are not just thinking about what an average person would be like when making their trait valuations. In fact, there may be a benefit for people to anticipate that the average person is less than ideal, such that the threshold for friendship is kept high.

One large contributor to actual friendship that we did not address in our studies is propinquity, or closeness in distance (e.g., Liberman & Shaw, 2019; Preciado et al., 2012). In real life, we are limited in our friendships to the people we see the most often. In real life, the ideal person may not be available for friendship. Still, it may benefit us to study what people's standards are for friendship without the constraints of distance to understand the functional purpose of friends. Our work may also contribute towards explaining friendship satisfaction. If people do end up starting friendships with whoever is closest or most available, mismatches between the traits a friend has and the traits that afford the most benefits in a given ecology could explain low relationship satisfaction. And if there is a wide range of options in a person's

vicinity, our findings may contribute to understanding why they chose one person over someone else. With apps like Bumble, and with online friendships, people can bridge distance, space and availability, but evolved preferences should remain.

What might these findings offer for understanding cross-cultural differences in friendship? At a societal level, our findings may contribute to understanding friendships across cultures. In one of the earliest cross-cultural studies of friendship, Adams and Plaut (2003) identified many differences in the friendship structures between Americans and Ghanaians. Relative to Americans, Ghanaians had smaller friendship circles, and were more suspicious and distrustful of their friends. Could some of these differences be explained by ecological differences, where harsh environments lead people to have greater standards when it comes to friendships?

Another interesting possibility is that not only might people in ecologies characterized by harshness or high pathogen prevalence be choosier about friendships, they may also have stricter strategies for managing friends. For example, in a high pathogen environment, a person may only interact with a messy friend in certain situations, such as away from their home or in an outdoor setting. People may also impose stricter social norms for friendship transactions, where favors are expected to be returned or social support given more readily. This also touches upon an important distinction between exchange and communal relationships, where some relationships are strictly transactional and favors are meant to be repaid, whereas others are looser and repayment is not expected (Clark & Mills, 1993). Just as relationship context (e.g., daughter vs. stranger) impacts how communal a relationship is, environmental conditions could also impact whether a friendship is more exchange or communal. In harsh conditions where friendships pose greater costs, a friendship may become more exchange-based.

Lastly, existing societal differences in relationship structures, such as relational mobility, or the ease at which an individual can start and end interpersonal relationships, likely factor into the costs of starting friendships and might even interact with our findings here (Thomson et al., 2018). The US is relatively high in relational mobility, and accordingly our participants may have been laxer in their friendship criteria if they felt they could easily terminate these relationships. Further work could examine real world ecologies and the impact these have on friend choices.

The current research adds to the growing work on the role of ecology in shaping psychology (e.g., Sng et al., 2017; Oishi & Graham, 2010; Varnum & Grossman, 2016), extending it to the burgeoning study of the adaptive significance of friendship. People do value friends who are stable forms of social exchange. However, people judge a friendship as beneficial or costly depending on the affordances of the environment in which they inhabit. A friend might be a good social exchange partner, but still a poor choice if they are not healthy or hygienic.

# Chapter III

## Conclusion

Across two lines of work, I demonstrated that ecological conditions impact people's social decisions. This was especially the case when I had participants imagine an ecology that was high in infectious disease. In Chapter one, I demonstrated that dense social environments afford unique risks to individuals—they facilitate disease transmission. Under infectious disease threat, people perceived dense social environments as more crowded and aversive and reported wanting to leave or avoid these social environments. These patterns were much weaker when I used other types of self-protection threats, suggesting that people's aversion to crowds are specific to disease avoidance. This work expands the literature on environmental psychology by providing a functional explanation for why people might feel averse to crowding.

In Chapter two, I investigated the traits people value in friends depending on their environment. Similar to previous work, across environments, I found people greatly valued warmth and trustworthiness, traits associated with effective social exchange. I also found some evidence that people calibrate their friendship trait preferences in a way that maximizes their affordance value given their environment. Under infectious disease threat, people were more likely to request a friend be clean, healthy, and low in risk-taking, traits that reduce a person's risk for catching and transmitting diseases. However, I was unable to find consistent results for sex ratio in friendship trait preferences. Although in a study where we asked participants to

spontaneously generate preferred traits, I did find that in the sex ratio conditions, participants were more likely to mention risk-taking, calmness, and drive than participants in the disease condition. This work adds to a burgeoning literature on the function of friends. While friends are direct sources of resource exchange, they also possess positive externalities that can help us in our goal-pursuit.

The work I presented here provides new perspectives on social decision-making, but these have opened more interesting questions. In Chapter one, I drew the conclusion that crowding responses were more unique to disease threat, but more and more threats of self-protection are now associated with large groups of people. For example, the white supremacist attack in Charlottesville occurred amid a large crowd of people, where a terrorist was able to run over many protestors on a public street. In the future, might we see people increasingly associate crowds with threats of self-protection through cultural learning?

How might we be able to apply our work in Chapter one to real world situations? The coronavirus outbreak has allowed us to see the lengths we will go to in order to reduce social density and disease transmission. Stores have installed barriers between customers, have placed markers designating distancing guidelines, and have reduced customer capacity. Workplaces and doctors' offices have moved online, and states have adopted alternative voting methods like no excuse absentee and early voting.

In Chapter two, I drew the conclusion that people tailor their friend trait preferences to the current environment. How might these friendship selections play out in the real world? In the real world, we are also not able to receive friend profiles that tell us what traits a potential friend possesses. Instead, we rely on cues such as the choices people make, or their facial and body appearances. If people are looking for a friend who is a low risk-taker, they should not look for

this person at a bar or casino. In future work, I might use more ecologically valid designs, and explore more the actual cues people use to make friendship choices. Another interesting question is if people know that certain environment-relevant qualities are associated with a greater chance of being chosen as a friend, would they also try harder to display these qualities in order to impress potential friends? Would this then select for perceivers who excel at detecting true displays of these qualities in specific environments?

In conclusion, these two lines of work shed light on the role of ecological conditions on sociality. In Chapter one, I demonstrate that people's decisions to enter or avoid social situations are influenced by disease threat. In Chapter two, I demonstrate that, when people are determined to engage in friendship, the specific qualities people search for in friends are also influenced by disease threat. Overall, this work demonstrates that people are sensitive to the threats and opportunities present in different environments and use these to judge the affordance value of others. To manage these affordances, people engage in social avoidance (when they choose to avoid a large crowd of people), or they engage in careful vetting (when they make sure that potential friends possess traits that match the ecology). Thirteen studies therefore converge on the idea that people are strategic in their social behavior.

# APPENDICES

# APPENDIX A

## Example Primes used in Chapter 1

### Example of Incidental Primes

Neutral Prime

Imagine you are in your house, in the room where you study. You have decided to organize your workspace because the semester has just begun and you want to be organized. You have already bought your books for classes and you have a syllabus and some initial paperwork for each class. You are taking 5 classes: Botany, Math, Psychology, History and English.

For Math, you will be handing in a lot of assignments on notebook paper and you decide that those would be most easily ordered and maintained in a three-ring binder. You take the syllabus and assignment-list for that class and three-hole punch them and put them at the front of the folder. Then you place four dividers in the folder and label them as Test 1, Test 2, Test 3 and Test 4 so that you can put material that will be covered on each test in those sections.

Then you take the four folders you recently bought and choose a separate color for each remaining class and put your syllabus and any other handouts you have received in those folders. You choose green for Botany because plants are green. You choose blue for Psychology because people see psychologists when they're feeling blue. For English, you choose yellow because your teacher wore an obnoxious yellow dress the first day and now the color just seems to be associated with the class. And finally, you make the white folder History because that's the only one left.

You have learned from previous semesters that if you create too many folders, you never seem to remember to grab the right one before you leave for school in the morning. So this year, you decide to get a five-subject notebook for taking notes. That way, you won't have to think about which notebook to take to class. If you receive a handout, you can just put it into the appropriate folder when you get home.

Now that you have everything for your classes, you decide to put it all on your bookshelf. You clear the top shelf of all of the books and put your class books on first, ordering them by size. Next to those you put your three-ring binder and then your notebook and four folders. You contemplate what the best strategy is for organizing all of your other books on the shelves below. First, you think you might do it by author within each genre so that the books are easy to find. But then you realize you will probably be too busy with school this semester to do any fun reading, and you decide to just organize it by the size of the books so that it looks nice. Also, you're able to get it done much faster that way.

All you have left now is your desk. Only your top drawer is really out of order. But all you have to do is grab up all of your loose pens, pencils, paper clips, rubber bands, staples, tacks and binder clips, and separate them into their own compartments in the tray in your drawer.

Your workspace looks pretty good now, but you still need to clean the rest of your room. Your classes are not too demanding on your time yet, so you decide to take a break for a little while and get back to it later tonight.

### Disease Prime

You're not enjoying your biology course. During one week you had to operate on a pig preserved in a foul-smelling formaldehyde solution. The next week's assignment is volunteer work in the geriatric ward of the local hospital. You recall visiting your great-grandmother in the hospital, and remember how the sight of all those elderly patients made you feel a bit queasy.
Arriving at the hospital, you immediately confront the same unpleasant stench you experienced years before. The attendant introduces you to a very elderly woman shuffling along in a walker. Her wrinkled hand reaches out to shake yours, and you notice she has very little muscle tone. You can't help staring at the liver spots on her hand, and the i.v. taped to the vein in her forearm.

Your first task is to spoon-feed an old man whose aging body is obviously wasting away. He needs help because his arthritic hands are no longer strong enough to grasp the spoon. As you raise the first spoonful to his mouth, you feel a bit repulsed as the spoon rubs against one of his few remaining yellowed teeth. His poor muscle tone causes him to drool, and after every few spoonfuls, you need to wipe his chin. After one spoonful, he sneezes and your hand is covered with a fine spray of soup and saliva. The attendant must have noticed the look of disgust you were trying to suppress, and suggests you take a break. You run out to the hospital cafeteria, happy to leave the smells and sights of the ward behind.

Although your stomach is still a bit queasy, you are starving because you missed breakfast that morning. The food selection is limited, but you settle on a hamburger and a bowl of tapioca pudding. When you bite into the hamburger, however, the smell of the ward still lingers in your nose, so you push it aside after forcing down one mouthful. The tapioca pudding is blandly lukewarm and soupy, and when you spill some on your finger you are reminded of the old man sneezing onto that same hand. Your appetite completely disappears when you notice a human hair mixed in with your pudding.

When you return to the ward, things only get worse. You are asked to change the bandages on an elderly patient with a distended swelling on the upper thigh. As you remove the bandage, you are shocked to see a large open sore. You involuntarily pull your head back from the putrid stench and sight of pus. You are overwhelmed with nausea as you taste the half-digested hamburger returning into your mouth.

## Example of Scenario Primes

### Self-protection

It's the weekend and you decide to go shopping at the mall. The mall is not too large, but still quite popular, and has a decent variety of different stores. You go in not looking for anything in particular, so you decide to walk around to some of the stores. You enter one of them just to check it out.

After a while going through the stores, you feel hungry, so you walk from your store to get something to eat for lunch at the food court. There seem to be a large number of people in the food court today; you see a lot of long food lines.

Unexpectedly, you hear a broadcast over the loudspeaker of the mall: **An URGENT announcement.**

The announcement says that officials have learned there are **sightings of a dangerous weather event approaching the mall. It seems that the mall is in the path of a major tornado that has touched down a block away.** It's unclear if anyone has been hurt, and if so, who has been hurt. The announcement also says to avoid open areas in order to reduce the chance of being harmed.

Police have placed the mall on lock-down and are encouraging people to take shelter in one of the stores nearby. In the meantime, they will decide how best to handle the situation safely. You are not near any of the exits to even attempt to leave, so you think that sheltering is a good idea.

**Looking through one of the food court skylights, you see the sky turn an ominous dark gray-green color. Suddenly, the skylight shatters, blowing glass everywhere.** In a panic, everyone nearby starts running, trying to get out of the open. You notice that some people are breathing faster, shaking, and wide-eyed.

Without much thought, you quickly run into one of the small nearby stores hoping to find shelter. On the next page, you'll see a photo of the store you ran into. Please take some time to look at the photo and then answer the questions.

# Disease

It's the weekend and you decide to go shopping at the mall. The mall is not too large, but still quite popular, and has a decent variety of different stores. You go in not looking for anything in particular, so you decide to walk around to some of the stores. You enter one of them just to check it out.

After a while going through the stores, you feel hungry, so you walk from your store to get something to eat for lunch at the food court. There seem to be a large number of people in the food court today; you see a lot of long food lines.

Unexpectedly, you hear a broadcast over the loudspeaker of the mall: **An URGENT announcement.**

The announcement says officials have learned that **some people in the mall were previously exposed to tuberculosis, a dangerous infectious disease that is potentially fatal if left untreated.** The infected people could spread this disease to others as tuberculosis is highly contagious. It's unclear if anyone else has been infected yet, though, as the symptoms are not always visible. The announcement also says to avoid open areas in order to reduce the chance of being harmed.

The Centers for Disease Control have placed the mall on quarantine and are encouraging people to take shelter in one of the stores nearby. In the meantime, they will decide how best to handle the situation safely. You are not near any of the exits to even attempt to leave, so you think that sheltering is a good idea.

**Looking around, you see people who appear run down or queasy. Suddenly, a nearby person moans, bends over, and vomits on the ground.** In a panic, everyone nearby starts running, trying to get out of the open. You notice that some people are breathing faster, shaking, and wide-eyed.

Without much thought, you quickly run into one of the small nearby stores hoping to find shelter. On the next page, you'll see a photo of the store you ran into. Please take some time to look at the photo and then answer the questions.

## APPENDIX B

Examples of Crowded Scenes used in Chapter 1

Subway

Store (also used in the Scenario Priming studies)

Pool

Bar

Club

# APPENDIX C

## Measures used in Chapter 1

### Crowding perceptions

Touch How likely are the people to bump into or brush against each other?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very likely7 (7)

Crowd How crowded do you think this situation is?

- ❍ Empty1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very crowded7 (7)

Conf How would you feel in this situation?

- ❍ Unconfined1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Confined7 (7)

## Affective Evaluations (Incidental Studies)

Feel How do you feel when you look at this picture?

- ❍ Negative1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Positive7 (7)

Want How much would you want to be present in this situation?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very much7 (7)

## Affective Evaluations (Scenario Studies)

uncertain How uncertain do you feel?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

safe How safe do you feel about waiting in the store you are currently in?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

risky How risky do you think it is to continue waiting in the store you are currently in?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

threat_store How threatened do you feel?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

threat_ppl How threatening are the other people in the store?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

safe_ppl How safe are the other people in the store?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

distrust_ppl How much do you trust the other people in the store?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ A lot7 (7)

disgust How disgusted do you feel?

- ❍ Not at all1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ Very7 (7)

## Choice Question (Scenario Studies only)

choice1 In answering the next questions, remember that there would be little difficulty in switching stores.How much would you like to change stores and go to the empty one?

- ❍ Remain at the current store1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ Go to a nearby empty store6 (6)

choice2 If you had to make a definite choice, which would you choose?

- ❍ Remain at the current store. (1)
- ❍ Move to the empty store. (2)

## APPENDIX D

### Perceived Vulnerability to Disease Scale (from Duncan et al., 2009)

PVD1 It really bothers me when people sneeze without covering their mouths.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD2 If an illness is "going around," I will get it.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD3 I am comfortable sharing a water bottle with a friend.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD4 I don't like to write with a pencil someone else has obviously chewed on.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD5 My past experiences make me believe I am not likely to get sick even when my friends are sick.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD6 I have a history of susceptiblilty to infectious illnesses.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD7 I prefer to wash my hands pretty soon after shaking someone else's hand.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD8 In general, I am very susceptible to colds, flu, and other infectious diseases.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD9 I dislike wearing used clothes because you don't know what the past person who wore it was like.

- 1 - Strongly disagree (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 - Strongly agree (7)

PVD10 I am more likely than the people around me to catch an infectious disease.

- 1 - Strongly disagree (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 - Strongly agree (7)

PVD11 My hands do not feel dirty after touching money.

- 1 - Strongly disagree (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 - Strongly agree (7)

PVD12 I am unlikely to catch a cold, flu, or other illness, even if it is going around.

- 1 - Strongly disagree (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 - Strongly agree (7)

PVD13 It does not make me anxious to be around sick people.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD14 My immune system protects me from most illnesses that other people get.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

PVD15 I avoid using public telephones because of the risk that I may catch something from the previous user.

- ❍ 1 - Strongly disagree (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 - Strongly agree (7)

Subscale 1 (Perceived Infectability): Items 2, 5, 6, 8, 10, 12, 14

Subscale 2 (Germ Aversion): Items 1, 3, 4, 7, 9, 11, 13, 15

# APPENDIX E

## Supplemental studies for Chapter 1

### Pilot field study

### Method

We ran an exploratory pilot test during a norovirus outbreak on a large Midwestern campus. The university contacts the student body by email about such outbreaks, making it likely that all participants were cued with this infectious disease threat. We could therefore examine how an active outbreak would impact people's perceptions. In this first test, we measured the confinement and crowdedness of these places. We anticipated that the outbreak would act as a situational disease cue but be differentially effective depending on people's chronic concerns about germs. We therefore also measured germ aversion. Because the outbreak was short-lived, we ran the study by having research assistants ask 64 students (18 females, 4 declined to answer; $M_{age}$ = 20.71) in the student union to voluntarily complete a short paper survey. To ensure that pathogen threat was salient for all participants, we first asked people whether they had heard about the outbreak. Participants then rated how confining they felt seven places on campus were (e.g., their largest class, the student union). All places included locations that undergraduates frequent daily and where other people gather. Finally, they completed the germ aversion subscale (Duncan, et al., 2009).

### Results

We collapsed across the crowding and confinement ratings for each campus location to form one general measure of crowding perceptions ($a$ = .85). We found a significant correlation between this measure and germ aversion, $r$ = .43, $p$ < .001, which suggested that chronic germ

aversion was associated with the perception that everyday spaces are more crowded, at least in the context of a salient pathogen threat.

## Supplemental Study 1

### Method

Supplemental Study 1 followed the same methodology as Study 4 in the paper except for one change. Given that in Study 4, we found that the scenario we used was shifting germ aversion, we decided to run a study where germ aversion was measured one week after the rest of the study. Specifically, at Time 1, we had participants read the scenario, and then answer the crowding, affective evaluations, and choice questions. At Time 2, participants completed the PVD scale. Participants were 349 mturk workers (53% female, *Mage* = 38.21, *SD* = 11.67) who completed both parts (attrition rate: 22%).

### Crowding and Affect

We excluded seven people who failed manipulation checks and one person who was able to complete the survey twice. We again created composites of the crowding items ($a$ = .70) and affective evaluations ($a$ = .82). We ran a linear regression with scenario condition (effect coded), germ aversion (centered; $M$ = 4.41, $SD$ = 1.14) and their interaction as predictors of crowding perception. The only significant predictor was germ aversion, such that those people who were higher in germ aversion rated the store as more crowded, $b$ =.09, $SE$ = .04, 95% CI = [.01, .18], $t(338) = 2.30$, $p < .001$, $r$ = .12. Scenario condition and the interaction between germ aversion and the scenario condition were both not significant predictors, all $ps > .25$.

We ran another linear regression with the same predictors of affect evaluations. This time, scenario condition predicted people's feelings about the store, such that people who got the Ebola story felt more threatened and at risk ($M_{Ebola}$ = 2.44, $SD_{Ebola}$ = .90; $M_{gunman}$ = 3.41, $SD_{gunman}$ = .94), $b$ = -.48, $SE$ = .05, 95% CI = [-.57, -.38], $t(338) = -9.91$, $p < .001$, $r$ = .47. Germ aversion also significantly predicted feelings about the situation, such that people who were higher in germ aversion felt worse about being in the room, $b$ = -.20, $SE$ = .04, 95% CI = [-.29, -.12],

$t(338) = -4.85$, $p < .001$, $r = .26$. The interaction between these was not a significant predictor, $p = .14$.

In sum, germ aversion both positively predicted people's perceptions of how crowded the store was, as well as negatively predicted people's affective evaluations of being in the situation. Scenario condition did predict people's affective evaluations, such that the disease scenario made people feel much worse about being in the socially dense room.

**Choice**

We also ran a linear regression analysis on the continuous choice DV, with germ aversion, scenario condition, and their interaction as predictors. Here, we only found a main effect of scenario condition, such that those people who were in the Ebola condition were more likely to prefer the empty room ($M_{Ebola} = 5.70$, $SD_{Ebola} = .73$; $M_{gunman} = 4.24$, $SD_{gunman} = 1.83$), $b = .72$, $SE = .07$, 95% CI = [.58, .87], $t(338) = 9.73$, $p < .001$, $r = .47$, all other $ps > .25$. We ran a logistic regression with the forced choice DV with the same predictors and found similar patterns, such that, people in the Ebola condition were more likely to choose to move to the empty room, $b = 1.32$, $SE = .21$, 95% $CI = [.94, 1.77]$, $z(338) = 6.28$, $X2 = 39.4$, $p < .001$, $r = .32$, all other $ps > .25$. Sixty three percent of people in the gunman scenario chose to move to the empty room, whereas 96% chose the empty room in the Ebola scenario.

**Supplemental Study 2**

**Method**

Participants were 361 mturk workers (52% female, $M_{age} = 36.54$, $SD = 11.32$) who completed both parts (attrition rate: 20%). We made several changes from Supplemental Study 1. First, at Time 1 we measured germ aversion, then at Time 2, the participant came back to complete the rest of the survey. We did this because we realized that the original order was not the order requested in our first review round, and also because this would more likely guarantee that the manipulation did not impact germ aversion. Second, we replaced the gunman scenario with a tornado scenario. We did this in order to try and increase participant fear, because in Supplemental Study 1, it did not appear that the gunman scenario had as much impact as it did in Study 4. Indeed, we pretested the tornado scenario and gunman scenario and found that the tornado scenario was stronger. Third, we replaced the specific disease in the scenario with

tuberculosis because we were concerned that Ebola was too intense of a cue and perhaps intensity was driving the ceiling effects from earlier studies.

**Crowding and Affect**

We excluded eight people who failed the manipulation check and two people who completed the survey twice. We again created composites of the crowding items ($a$ = .76) and affective evaluations ($a$ = .85). We ran a linear regression with scenario condition (effect coded), germ aversion (centered; $M$ = 4.41, $SD$ = 1.14) and their interaction as predictors of crowding perception. Here, no predictors were significant, all $ps$ > .25, and there was still a strong ceiling effect. We ran a linear regression with the same predictors on affective evaluations. Here we found a significant main effect of scenario condition, such that relative to people who read the tornado scenario, reading the tuberculosis scenario made people feel more negative in the dense social situation ($M_{tb}$ = 2.65, $SD_{tb}$ = 1.02; $M_{tornado}$ = 4.10, $SD_{tornado}$ = .92), $b$ = -.73, $SE$ = .05, 95% CI = [-.83, -.63], $t$(347) = -14.61, $p$ < .001, $r$ = .62. In addition, germ aversion predicted affective evaluations of the situation, such that people who were higher in germ aversion felt worse in the crowded store, $b$ = -.21, $SE$ = .04, 95% CI = [-.30, -.13], $t$(347) = -4.81, $p$ < .001, $r$ = .25. There was no interaction between the predictors, $p$ > .25.

**Choice**

We ran a linear regression on the continuous choice item, with germ aversion, scenario condition, and their interaction as predictors. Replicating previous studies, there was only a main effect of scenario condition, such that people in the tuberculosis scenario preferred the empty room more so than the people in the tornado scenario ($M_{tb}$ = 5.47, $SD_{tb}$ = 1.05; $M_{tornado}$ = 3.85, $SD_{tornado}$ = 1.67), $b$ = .81, $SE$ = .07, 95% CI = [.66, .96], $t$(347) = 10.85, $p$ < .001, $r$ = .50, all other $ps$ > .25. We ran a logistic regression on the forced item, with the same predictors. Here again people in the tuberculosis condition were more likely to choose to move to the empty room, $b$ = 1.35, $SE$ = .17, 95% $CI$ = [1.03, 1.72], z(347) = 7.74, $X2$ = 59.90, $p$ <.001, $r$ = .38, all other $ps$ > .25. Fifty percent of people in the tornado condition chose to move to the empty room. In comparison, 94% of people in the tuberculosis condition chose to move, a very clear preference.

## APPENDIX F

## Ecology Primes used in Chapter 2

## Pilot Study

### Control

In this study, we ask you to think about the current environment that you are living in.

### Low Disease

Think of a community where there has been almost no history of infectious disease outbreaks. Getting sick is something that does not happen frequently because you are rarely exposed to disease-causing germs. When someone in the community does get sick, the likelihood of it spreading is low, the sickness is often minor, and very avoidable for other community members. The community is really quite healthy. Day to day, you don't have to worry about catching any cold or flu, or other serious illnesses from other people. While walking in public places, you have absolutely no concern of being coughed on, sneezed on, or touched by a sick person. Only 1% of people in this community will develop an infectious disease at some point in their life here.

### High Disease

Think of a community where there has been a long history of many infectious disease outbreaks. Getting sick is something that happens frequently because you are often exposed to disease-causing germs. When someone does get sick, the likelihood of it spreading is high, the sickness is often more serious, and very difficult to avoid for other community members. The community is really quite disease-prone. Day to day, you have to worry about catching the cold or flu, or other serious illnesses from other people. While walking around public places, you are in constant fear of being coughed on, sneezed on, or touched by a sick person. Over 99% of people in this community will develop an infectious disease at some point in their life here.

### Low Genetic Relatedness

Think about a community where very few of your family members live nearby. Almost everyone around you has no family relation to you. Running into members of your family is a rare thing that happens perhaps once a year. You cannot be certain that if you needed to reach a family member, they would be easily and quickly reached by everyday means of transportation (walking, driving, biking, etc.).

### High Genetic Relatedness

Think about a community where a lot of your family members live nearby. Almost everyone around you has some kind of family relation to you. Running into members of your family is a common thing that happens almost every day. You can be certain that if you needed to reach a family member, they would be easily and quickly reached by everyday means of transportation (walking, driving, biking, etc.).

**Studies 1-2**

**Disease**

The New York Times

**U.S. Report Predicts Severe Increase of Infectious Diseases**

By MORGAN K. JAMESTON, Senior Writer

Rates of infectious disease are reported to skyrocket this next year, according to new epidemiological research. Whether it's in class, at work, out shopping or eating, people today should expect to see more people coughing and sneezing.

The U.S. Centers for Disease Control recently released statistics of current patterns of infectious disease across various regions of the country. The trends show that influenza alone could infect as much as half of the U.S. population, causing as many as 30,000 to 90,000 deaths. "It's astounding," says Susan Rice, undersecretary at the CDC. "Hospitals across the country are expected to be overflowing with patients suffering from influenza complications."

The trend is especially evident at college campuses where there are greater rates of transmission. Across the universities of the Big Ten, for example, many dorms have experienced outbreaks of diseases like norovirus, flu, and hepatitis A. "We've had to train students and residence hall advisers on how to respond to some of these situations," notes Taylor Bryan, a residential coordinator at Indiana University. "For instance, students were all issued bottles of hand sanitizer and trained on how to avoid getting sick."

Epidemiologists note that this trend will continue into the near future. "Looking at the incidence rates of the most common infectious diseases in the U.S.," observes Ryan Connick, a professor at the University of Maryland, "it's pretty clear that we have reached a time point where more and more lethal strains are emerging at higher rates."

The White House's Council of Advisors on Science and Technology issued a statement, citing "a serious situation for the people of the United States." The CDC report calls for the government to intensify efforts to track infections and hospitalizations, and advocate common sense measures to prepare for the season.

Researchers across the country note that the patterns for this year closely resembles some previous years'. In 1957, the rate of death from flu alone was 70,000 people. In 1968, it was 30,000. Each year, rates of infection do change, but the CDC warns that many of the ways people interact in the present day only makes it easier for disease to spread. For now, people should expect that they will be at a greater risk for catching virulent strains of flu and other infectious diseases.

**Male-biased**

The New York Times

**Fewer Women For Every Man**

By MORGAN K. JAMESTON, Senior Writer

There was once a time when the average young adult could look around their city or town and expect to see a generally even number of men and women. Those times are changing rapidly, however, according to new sociological research. Whether it's in class, at work, out shopping or eating, people today should expect to see fewer women for every guy.

The U.S. Department of Health and Human Services recently released statistics of current demographic patterns across various regions of the country. The trends show that significantly more than half of people 18-29 are men. "It's astounding," says Susan Rice, undersecretary at HHS. "Many regions of the country are overflowing with men."

The trend is especially evident at college campuses. Across the universities of the Big Ten, for example, many co-ed dorms have more men than women. "We've had to turn some of our girls bathrooms into boys bathrooms," notes Taylor Bryan, a residential coordinator at Indiana University. "Whenever I walk around the dorms now, I always see some girl surrounded by a group of guys."

Interestingly, most people do not appear to notice the skew unless it is made explicit to them. At a Phoenix-area mall, for example, several passersby were asked to observe people around them for five minutes. Chris Jenkins, a shopper, quickly noticed the trend. "Everywhere I looked, there were groups of men," said Jenkins. "I was intrigued that there were so many guys and so few women. I guess I need to get used to this."

Demographers note that this trend will continue into the near future. “Looking at high schools right now,” observes Ryan Connick, a professor at the University of Maryland, “it’s pretty clear that more men will be applying to college and entering the workforce in the next few years.” Connick notes that this trend is a result of the number of males and females born in a given year. “We had a series of years a while back when more men were born. There is nothing wrong with this, but it will have an impact on people’s lives.”

The high numbers of men are likely to influence both the professional and the recreational lives of men and women. But it’s important to realize that this trend, termed the U.S. sex ratio, is a lasting generational phenomenon. As the current generation of young adults gets older, there will continue to be more men than women of similar ages. “Even now, this sex ratio is evident within many jobs,” points out Connick. “In the future, I wouldn’t be surprised if people end up working in an office full of men and maybe one or two women.”

Researchers across the country note that the sex ratio has looked different in the past, and will likely look different again in the future. For now, however, people should expect to be surrounded by an abundance of men.

**Female-biased**

The New York Times

**Fewer Men For Every Woman**

By MORGAN K. JAMESTON, Senior Writer

There was once a time when the average young adult could look around their city or town and expect to see a generally even number of men and women. Those times are changing rapidly, however, according to new sociological research. Whether it’s in class, at work, out shopping or eating, people today should expect to see fewer men for every woman.

The U.S. Department of Health and Human Services recently released statistics of current demographic patterns across various regions of the country. The trends show that significantly more than half of people 18-29 are women. “It’s astounding,” says Susan Rice, undersecretary at HHS. “Many regions of the country are overflowing with women.”

The trend is especially evident at college campuses. Across the universities of the Big Ten, for example, many co-ed dorms have more women than men. “We’ve had to turn some of our boys bathrooms into girls bathrooms,” notes Taylor Bryan, a residential coordinator at Indiana University. “Whenever I walk around the dorms now, I always see some guy surrounded by a

group of girls."

Interestingly, most people do not appear to notice the skew unless it is made explicit to them. At a Phoenix-area mall, for example, several passersby were asked to observe people around them for five minutes. Chris Jenkins, a shopper, quickly noticed the trend. "Everywhere I looked, there were groups of women," said Jenkins. "I was intrigued that there were so many girls and so few men. I guess I need to get used to this."

Demographers note that this trend will continue into the near future. "Looking at high schools right now," observes Ryan Connick, a professor at the University of Maryland, "it's pretty clear that more women will be applying to college and entering the workforce in the next few years." Connick notes that this trend is a result of the number of males and females born in a given year. "We had a series of years a while back when more women were born. There is nothing wrong with this, but it will have an impact on people's lives."

The high numbers of women are likely to influence both the professional and the recreational lives of men and women. But it's important to realize that this trend, termed the U.S. sex ratio, is a lasting generational phenomenon. As the current generation of young adults gets older, there will continue to be more women than men of similar ages. "Even now, this sex ratio is evident within many jobs," points out Connick. "In the future, I wouldn't be surprised if people end up working in an office full of women and maybe one or two men."

Researchers across the country note that the sex ratio has looked different in the past, and will likely look different again in the future. For now, however, people should expect to be surrounded by an abundance of women.

## APPENDIX G

### Trait Ratings Task from Chapter 2, Pilot Study

Think about making **an ideal friend in this community** that is **[insert ecological condition]**. Again, when imagining this ideal friend, think of them as being separate from your current friends.

What comes to mind? What would be the ideal qualities of this person?

**Please rate the importance of the following traits in an ideal friend you would make in this community.**

| | Not at all important 1 | 2 | 3 | 4 | 5 | 6 | Very important 7 |
|---|---|---|---|---|---|---|---|
| competitive | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| intelligent | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| unconventional | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| aggressive | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| creative | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| risk-taking | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| sociable | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| self-conscious | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| predictable | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| similar to you | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| empathetic | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| trustworthy | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| physically healthy | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| physically attractive | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## APPENDIX H

### Trait Generation Task from Chapter 2, Study 1

**These instructions correspond to the task you will complete on the next page. We will ask you to summarize these instructions below. Please listen to the research assistant who will read these carefully. Read over the instructions yourself. Summarize them below.**

Now imagine that you were wanting to make a same-sex friend, given the state of the world described in the article. You don't want to become friends with just any person, but the **ideal friend in a world like this** – the kind of friend that you MOST want to make. What would this person be like?

Importantly, this person should be the ideal friend regardless of any other friends you currently have. Also, this should **NOT** be a person you are interested in romantically (just as a friend).

In each of the following blanks, **please list one trait or characteristic this ideal friend would have that would be valuable, given the environment described in the article.** Then, please tell us why you think this trait is important to have (in the "because" section). In the because section, please answer using as much text as you need, and avoid one-word answers. You are not required to list 5 traits, but try and list as many as you can.

You can also list traits you do **not** want your friend to have—in this case, write the word “not” before the trait (e.g., The ideal friend would be..."not XX").

Remember, the traits you list should represent your ideal friend given the type of world you just read about. To help you fill out this section, you might think back to the things you listed on the previous page, which we have re-printed at the bottom of the page here for you to refer to again.

| | |
|---|---|
| The ideal friend would be | |
| because... | |

# APPENDIX I

## Limited Budget Paradigm from Chapter 2, Study 2

Now imagine that you were wanting to make a **same-sex friend, given the state of the world described in the article.** You don't want to become friends with just *any* person, but the ideal friend in a world like this – the kind of friend that you MOST want to make. What would this person be like?

Importantly, this person should be the ideal friend regardless of any other friends you currently have. Also, this should NOT be a person you are interested in romantically (just as a friend).

**Please design your ideal friend, that is, who you would most want to be friends with in this state of the world.** Select a percentile level for each characteristic. The relevant population for comparison is all members of your sex.

Imagine you have $20 total **to spend**. Each dollar corresponds with a 10th percentile increase on the trait on which it is spent. For example, if you spent $1 on Trait 1 and $7 on Trait 2, you would be in the 10th percentile for Trait 1 (i.e., 90% of your same-sex peers would be better than your friend for Trait 1) and you would be in the 70th percentile for Trait 2 (i.e., 30% of your same-sex peers would be better than your friend for Trait 2).

| Trait | Percentile | Dollar Spent |
|---|---|---|
| Trait 1 | 10% | $1 |
| Trait 2 | 70% | $7 |

**You must spend exactly $20 in this task. Please type in the number of dollars you would like to spend on each trait.** For each trait, the maximum you can spend is $10 corresponding to 100% percentile.

| | |
|---|---|
| **Openness to taking risks**: a quality that describes someone who is adventurous, brave, and a risk-taker | 0 |
| **Conscientiousness**: a quality that describes someone who is responsible, careful, and proactive | 0 |
| **Cleanliness**: a quality that describes someone who is hygienic, clean, and sanitary | 0 |
| **Trustworthiness**: a quality describing someone who is loyal, honest, trustworthy, and reliable | 0 |
| **Physical health**: a quality that describes someone who is healthy, in shape, and active | 0 |
| **Power**: a quality that describes someone who has leadership qualities, and who is confident and assertive | 0 |
| **Warmth**: a quality that describes someone who is supportive, caring, kind, and understanding | 0 |
| **Drive**:a quality that describes someone who is hardworking, strong, motivated, and ambitious | 0 |
| **Calmness**: a quality that describes someone who is relaxed, not competitive, calm, and easygoing | 0 |
| Total | 0 |

Now you have an additional $20 **total to spend**. As before, each dollar corresponds with an additional 10th percentile increase on the trait on which it is spent.

Next to each trait, we remind you how many additional dollars are available to spend (since you can only spend up to $10 on each trait between these two rounds). If you put a value above the maximum value you can spend, we have disabled the Next button so you cannot proceed until this is correct.

We remind you that your task is to "build an ideal same-sex friend" that you would like to have, given the state of the world described in the article.

**You must spend exactly $20 in this task. Please type in the number of dollars you would like to spend on each trait, keeping in mind the maximum value you can spend per trait which is presented next to the trait.**

## APPENDIX J

### Codebook for the Trait Categories from Study 1 in Chapter 2

1. **Trustworthiness**
    a. Definition: traits that demonstrate one's authenticity
    b. Example: Honest, truthful
    c. Codes: 0 = doesn't fit, 1 = fits, 2 = antonym
2. **Entertaining**
    a. Enjoyable to be around or funny.
    b. Humorous, fun
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
3. **Intelligent**
    a. Is high functioning cognitively
    b. Smart, intelligent
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
4. **Has social skills/Extraverted**
    a. Someone who is easy to speak to
    b. Communicative, extravert
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
5. **Warmhearted**
    a. Traits that describe someone who puts others before themselves
    b. Supportive, selfless
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
6. **Positive**
    a. Someone who is zealous or is cheerful
    b. Happy, positive
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
7. **Conscientiousness**
    a. Someone who is responsible and professional, and does things in a timely, organized manner.
    b. Mature, prepared
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
8. **Adventurous/Risk-taking**
    a. Traits that describe someone who is not afraid of a challenge or is willing to attempt potentially dangerous activities or both
    b. Brave, courageous
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
9. **Clean**
    a. Traits that describe someone's hygiene or sanitation habits
    b. Tidy, bathed
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
10. **Non-discriminatory/Fair**

    a. Someone who is accepting of others and not discriminatory in any way (not racist or sexist for example)
    b. Feminist, not racist
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
11. **Similar**
    a. Being similar to someone or engaging in similar behaviors
    b. Similar
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
12. **Healthy**
    a. Being in good health and having characteristics that would improve or maintain good health
    b. Strong, young
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
13. **Independent (category was dropped due to low usage)**
    a. Able to do things on their own and be on their own
    b. Independent, self-sufficient
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
14. **Calm**
    a. Laid-back and/or little emotional response
    b. Chill, calm
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
15. **Attractive**
    a. Physically attractive
    b. Handsome, pretty
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
16. **Powerful**
    a. Someone who leads others or serves as a model for others
    b. Being powerful or having characteristics related to power/success
    c. Empowered, Wealthy
    d. 0 = doesn't fit, 1 = fits, 2 = antonym
17. **Driven**
    a. Determined to work hard, focused on goals, or having characteristics that help achieve goals
    b. Determined, motivated, competitive, persistent
    c. 0 = doesn't fit, 1 = fits, 2 = antonym
18. **Misfit**
    a. A list of traits that are not considered to fit within any of the above categories
    b. Code: 1 = this should be coded as a misfit

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