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Evidence from hunter-gatherer and subsistence agricultural populations for the universality of contagion sensitivity

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ABSTRACT

The phenomenon of *magical contagion* – the unobserved passage of properties between entities that come into physical contact – was described by anthropologists over a century ago, yet questions remain about its origin, function, and universality. Contagion sensitivity, along with the emotion of disgust, has been proposed to be part of a biologically-evolved system designed to reduce exposure to pathogens by increasing the avoidance of "contaminated" objects. Yet this phenomenon has not been studied using systematic psychological comparison outside of industrialized populations. Here we document contagion sensitivity in two culturally, geographically, and economically distinct populations with little exposure to Western biomedicine and formal education: the Hadza hunter-gatherers of Tanzania and Tannese subsistence-agriculturalists of Vanuatu. In both populations, a majority of individuals rejected familiar and palatable foods when contaminating items touched the food but were subsequently removed. The Tannese children in our study showed a similar response, consistent with previous research with Western children. Our data support the proposal that contagion sensitivity is universal in human populations.

1. Introduction

The belief that physical contact between two entities often entails the passage of properties between them, even after contact has been severed, was labeled as the *law of contact* or *magical contagion* by anthropologists >100 years ago (Frazer, 1922/1890; Freeland, 1980; Mauss, 1972/1902; Tyler, 1974/1871). Magical contagion was thought to be a ubiquitous and fundamental feature of magical practices and rituals in traditional societies and folklore.[1] A common instantiation of this principle relates to food and disgust: a favored or acceptable food is often rejected after it has, even briefly, contacted a certain class of offensive objects. A widely held view is that both the contamination sensitivity surrounding offensive items and its associated disgust response are part of a biologically-evolved system designed to reduce the transmission of pathogens and disease (e.g., Oaten, Stevenson, & Case, 2009; Curtis, Aunger, & Rabie, 2004; Curtis & Biran, 2001; Tybur, Lieberman, Kurzban, & DeScioli, 2013). Indeed, contagion is regularly associated with the emotion of disgust and a defining feature of disgust-eliciting objects is their contaminating properties (Rozin & Fallon, 1987). Though systematic cross-cultural data are lacking, studies with U.S. adults in the late 1980's suggest that contagion is widespread in Western, educated adults (Rozin, Millman, & Nemeroff, 1986; Rozin, Nemeroff, Wane, & Sherrod, 1989). Here we examine the presence of contagion beliefs in two culturally, geographically and economically diverse and remote populations with relatively little experience with Western biomedicine and formal education: the Hadza hunter-gatherers of Tanzania and the Tannese subsistence agriculturalists of Vanuatu.

In the current study, we examined contagion in the domain of pathogen avoidance (e.g., rotten or contaminated food and bodily fluids) and poison avoidance (e.g., toxic plants and inedible objects). The properties of contagion are consistent with cues that correlated with pathogen presence in ancestral environments (Tybur et al., 2013). Disgust may have evolved to regulate the avoidance of substances harboring pathogens (Rozin, Haidt, & McCauley, 2008; Tybur, Lieberman, & Griskevicius, 2009) and may have been co-opted to regulate behavior in other domains related to reproduction and social transgressions (Rozin, Haidt,

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[1] Tyler, Frazer and Mauss provide treatises on the mental foundations of religion, mythical thought and magic. The laws of magic, including the law of contact, were formed by Tyler and later developed by Frazer and Mauss. All provide the example of magical punishment, whereby a person can be acted upon by others through the use of an object in which she had once been in contact, including their clothing hair and nails. Frazer further described examples of magical contact that can occur between friends and other relations, such that the behavior of one affects the behavior of another. Likewise, he documents examples of sympathetic eating such that an individual is said to acquire the traits of the animal or person she consumes. None of the authors systematically cataloged examples of magical contagion. Nevertheless, we provide a summary of their examples, but note that most examples are of backward contagion which does not fit the pathogen model (Table S1).

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& McCauley, 1993; Schaich Borg, Lieberman, & Kiehl, 2008; Tybur et al., 2009).

According to Rozin and Nemeroff (1990), the properties of contagion are as follows: First, the contaminant must physically contact the target entity. Second, contagion is dose insensitive; even brief contact with the contaminated object is sufficient to produce a strong negative response and this does not increase much with higher doses. Third, rejection of the contacted target is permanent so long as the person in question remembers the past contact - thus the description of contagion as "once in contact, always in contact" (Mauss, 1972/1902). Fourth, contagion is manifested much more generally, and in higher magnitude, if the source entity is hazardous, hence the frequent use of the word contamination to describe contagion. Fifth, contagion beliefs can account for both the transmission of specific attributes from the source to the target (e.g., "you are what you eat", Nemeroff & Rozin, 1989), but also a general negative valence. Finally, the contagion process may best be described as a transfer of some kind of *essence* from the source to the target (Raman & Gelman, 2004).

Because viruses and bacteria tend to be invisible, cognitive (contagion sensitivity) and affective (disgust) processes may have evolved to prevent individuals from making contact with hazardous items (Tybur et al., 2013). Specifically, contagion beliefs may be shaped by a specialized learning mechanism designed to modify the disgust response adaptively depending on local environment and culture (Curtis, de Barra, & Aunger, 2011). That is, the disgust system is specially designed to interact with local conditions such that the items that induce disgust and contaminate will vary between groups in ways that are beneficial for preventing the spread of disease within those groups. That said, some disgust cues (e.g. bodily fluids, rotten foods, toxic plants) are expected to be culturally invariant because of their adverse effects in *all* environments. The emotion of disgust, with its distinctive facial expression (Brown, 1991; Ekman & Friesen, 1971) and characteristic feelings of revulsion (Angyal, 1941; Rozin & Fallon, 1987), is likely universal (e.g. Curtis & Biran, 2001), however, it is currently unknown whether contagion beliefs involving disgust-eliciting items are also universal.

A number of observations support the hypothesis that the original function of disgust and contagion was pathogen avoidance (Curtis, 2013; Rozin et al., 1993; Rozin, Haidt, & McCauley, 2016; Tybur et al., 2013). First, the transmission of infectious disease is a ubiquitous problem and natural selection has produced an array of taxa with various pathogen-avoidance mechanisms. For instance, mangabey (*Cerocebus albigena*) movement patterns respond, in part, to the risk of parasitic infection from contaminating fecal matter of conspecifics (Freeland, 1980). Second, physical contact with an infected entity can, and often does, transmit pathogens from the source to the target (Rozin et al., 1986; Rozin & Fallon, 1987). Third, a wide range of data supports the link between the emotion of disgust and items that spread disease (Oaten et al., 2009).

Contagion beliefs exhibit design features indicative of adaptations including reliability, precision, efficiency, complexity, and logic (see Williams, 1966). Disgust-eliciting items reliably contaminate items once physical contact is made, regardless of the item it is contaminating, and does so, with precision. A pen and a spoon would both become contaminated after making contact with fecal matter, but these effects would not generalize to other uncontacted spoons and pens. Contagion beliefs also efficiently solve the problem of pathogen exposure since contagion leads to revulsion and rejection of potentially hazardous, pathogen-laden items. The fact that exposure to contaminants are largely dose-insensitive, such that brief contact will have contaminating effects, suggests that the system is well-calibrated for avoiding harmful micro or ultra-microscopic bacteria and viruses. Finally, this constellation of features displays a degree of complexity that makes arguments that it arose by chance unlikely. It is hard to imagine another specific and recurring problem that contagion beliefs so fittingly solve.

The strong inference that a feature of human behavior is evolved, in the absence of an historical record, also depends on assembling a range of convergent evidence. The most persuasive evidence is presence in other primates and/or presence at birth. That said, adaptations do not need to be present at birth, rather, they need to develop reliably and at a time during development when the trait would be needed (Cosmides & Tooby, 1997). Pathogen and poison contagion awareness develops robustly in early and middle childhood in Western industrialized populations (Legare, Wellman, & Gelman, 2009). And while there are clear developmental trends toward greater awareness and understanding with age (Au & Romo, 1999; Au, Sidle, & Rollins, 1993; Fallon, Rozin, & Pliner, 1984; Hejmadi, Rozin, & Siegal, 2004; Rozin, Fallon, & Augustoni-Ziskind, 1985), 3- and 4-year-olds have shown initial contamination understanding in a few studies (Kalish, 1996, 1999; Siegal & Share, 1990). Other research suggests that a rudimentary awareness of plant toxicity may be present in infancy (Wertz & Wynn, 2014a, 2014b).

Other questions about the adaptationist account of pathogen and poison contagion remain unresolved. Many elicitors of disgust are not actually harmful or contagious. A notable example is moral disgust.[2] Again, explanations for other forms of disgust do not preclude pathogen-avoidance accounts. In fact, it has been argued that disgust in these other domains was co-opted from its original purpose (pathogen-avoidance) to serve different functions (i.e. Rozin et al., 1993, 2008; Tybur et al., 2013). One even wonders whether magical practices relying on contagion/contact, were also co-opted from this original purpose?[3] Another problem is that many contagion responses are resistant to acts like sterilization which eliminate the contagion (Nemeroff & Rozin, 1994; Rozin et al., 1986). Since many of the safety practices that are used to destroy, remove, or deactivate pathogens (e.g. pressure, chemicals, radiation) are recent technological inventions in human history, this is not a serious problem for the evolutionary account. Genetic evolution is a slow process and adaptive lag is anticipated given the speed at which technology has changed the environment in which humans operate.

Contagion beliefs about pathogens and poison are shaped by cultural input and experience (Curtis, Danquah, & Aunger, 2009). Global public health research has demonstrated that extensive education is often required to increase compliance with sanitary behavior (Biran et al., 2014; Freeman et al., 2014). Contagion beliefs are heavily influenced by learning about the presence of pathogens and toxins and how they are transmitted. The germ theory of disease rose to attention in late 19th century France and is now globally accepted, with numerous public-health interventions and awareness campaigns happening worldwide (Biran et al., 2014; Freeman et al., 2014).

Strong evidence to support the idea that pathogen and poison contagion beliefs are part of an evolved species-typical architecture would be to demonstrate its universality. Testing evolutionary hypotheses that predict universality is best accomplished by sampling diverse populations isolated from the influence of Western biomedicine and formal education (Apicella & Barrett, 2016). Whereas there is some evidence for the presence of a disgust face in slash and burn farmers (i.e., the Fore of New Guinea) (Ekman, 1992), contagion beliefs about pathogens have primarily been studied in industrialized populations (e.g., Hejmadi et al., 2004; Rozin et al., 1986).

The objective of the current studies was to test for pathogen and poison contagion sensitivity in two small-scale societies that differ markedly from both each other and Western populations. We predicted that across populations, adults would demonstrate reluctance to consume edible and desirous substances upon contact with disgust-eliciting, pathogenic, and poisonous objects. We also examined whether contagion beliefs were sensitive to contact with items posing a greater risk of harm by testing contaminant versus control items. We predicted

[2] To the extent that behaviors spread through social networks (i.e., Centola, 2010; Christakis & Fowler, 2013) immoral behavior may, in fact, be "contagious".

[3] Note that some examples of magical contagion are of backward contagion, which does not correspond well to the pathogen model.