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Research

Parasite stress promotes homicide and child maltreatment

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Researchers using the parasite-stress theory of human values have discovered many cross-cultural behavioural patterns that inform a range of scholarly disciplines. Here, we apply the theory to major categories of interpersonal violence, and the empirical findings are supportive. We hypothesize that the collectivism evoked by high parasite stress is a cause of adult-on-adult interpersonal violence. Across the US states, parasite stress and collectivism each positively predicts rates of men's and women's slaying of a romantic partner, as well as the rate of male-honour homicide and of the motivationally similar felony-related homicide. Of these four types of homicide, wealth inequality has an independent effect only on rates of male-honour and felony-related homicide. Parasite stress and collectivism also positively predict cross-national homicide rates. Child maltreatment by caretakers is caused, in part, by divestment in offspring of low phenotypic quality, and high parasite stress produces more such offspring than low parasite stress. Rates of each of two categories of the child maltreatment—lethal and non-lethal—across the US states are predicted positively by parasite stress, with wealth inequality and collectivism having limited effects. Parasite stress may be the strongest predictor of interpersonal violence to date.

Keywords: child abuse; collectivism; culture of honour; infanticide; infectious disease; spousal homicide

1. INTRODUCTION

This paper has three main parts. First, we give a brief overview of some aspects of the parasite-stress theory of human values and supporting evidence. Next, we propose that this theory may explain some major types of interpersonal human violence—namely, kinds of adult-on-adult homicide as well as homicide and other maltreatment of children by caretakers. Finally, we empirically test the theory's application to this violence.

2. PARASITE-STRESS THEORY OF VALUES

Established knowledge of the ecology and evolution of parasitic disease (i.e. infectious disease) provides a foundation for the parasite-stress theory of values. Infectious diseases were a major source of morbidity and mortality, and hence of natural selection, in human evolutionary history [1–5]. Human adaptations that defend against parasites comprise the biochemical, cellular and tissue-based *classical* immune system as well as the more recently discovered *behavioural* immune system. The latter includes parasite-avoidance psychology and behaviour as well as psychology and behaviour that manage infectious diseases when they occur. The behavioural immune system is composed of ancestrally adaptive feelings and values about, and behaviours towards, out-group and in-group members; caution about or

unwillingness to interact with out-group people; prejudice against people perceived as unhealthy, contaminated or unclean; philopatry (limited dispersal from the natal locale); and dislike and avoidance of out-group ideas and norms [6–18].

Infectious diseases and their hosts evolve antagonistically and perpetually. Spatial variation and localization in parasite adaptation against hosts and in host adaptation against parasites, or said differently, in host immune maladaptation against out-group-typical parasites, is a general pattern in the animal and plant infectious disease literature [19,20]. Human cases showing this include (i) the caste-specific infectious diseases and corresponding specific immunity among sympatric castes in India [21], and (ii) the village-specific immune defences against leishmania parasites in adjacent Sudanese villages [22] (also see [9]).

Because of regionally localized host immune adaptation, in an ecological setting of high disease stress, xenophobia and associated neophobia, as well as ethnocentrism and reduced dispersal, are adaptive preferences/values and behaviours for avoidance of novel parasites contained in out-groups and for the management of local infectious disease. Xenophobia—the avoidance and dislike of out-group members—discourages contact with out-groups and their likely different parasites. Ethnocentrism—in-group favouritism and embeddedness entailing nepotism towards both nuclear and extended family, as well as altruism towards unrelated in-group members—focuses prosociality among immunologically similar in-group members, and creates and fosters the supportive social networks for coping with present

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One contribution of 11 to a Theme Issue 'Disease avoidance: from animals to culture'.

infections in members of the in-group. Philopatry reduces contact with out-groups and their habitats that may contain new parasites. Neophobia reduces contact with people with non-local norms and values, and thereby the novel infectious diseases they may harbour. Thus, xenophobia, ethnocentrism, philopatry and neophobia—elements of in-group assortative sociality—are predicted to be strongly held values in regions of high parasite stress [8,15,23].

Human parasite stress is not the same across the globe nor has it been the same across time. Humans have experienced parasite gradients throughout history and continue to do so today. Parasite stress varies consistently and strongly with climate and its surrogate, latitude. Hot and wet areas or low latitudes consistently have the highest parasite stress [4,5,24–27].

Thus, the benefits and costs of in-group assortative sociality will shift along the parasite-stress gradient, such that in some areas (high parasite stress), increased levels of in-group assortative sociality will be more beneficial than in other areas (low parasite stress). As parasite stress declines, the infectious-disease contagion risks to individuals of interacting with out-groups decrease. Consequently, for individuals in areas that are relatively low in parasite stress, out-group contacts and alliances can provide greater benefits than costs. The benefits of out-group interactions include gains through intergroup trade, new and better ideas, and larger and more diversified social networks for marriage, reciprocity and other social alliances. Hence, openness towards out-groups and pursuit of out-group interactions and alliances are predicted to be strongly held values in regions of low parasite stress [8,15,23]. As mentioned, according to the parasite-stress theory, the embeddedness in in-group members that characterizes ethnocentrism functions in managing the local disease effects under high parasite stress. In contrast, under low parasite stress, social investment in in-group members—extended family and other in-group allies—is predicted to be limited [8,9].

The parasite-stress theory of values posits an adaptive (ancestrally), condition-dependent (based on local levels of parasite stress) adoption of in-group and out-group social tactics by individuals. This condition-dependent adaptation requires local variation in morbidity and mortality from parasite severity as the selective factor that acted historically to favour contingent assortative-sociality behavioural and psychological adaptations. The evolution of conditional response as an important feature of assortative sociality's design, rather than an exclusive fixity of localized, genetically distinct adaptations, is supported by knowledge about host–parasite coevolutionary races as well as local dynamics of infectious disease ecology [9].

Moreover, a diverse body of research supports the hypothesis of an evolved contingent assortative sociality in people that functions against infectious disease [9]. For example, both xenophobia and ethnocentrism within individuals increase under experimental primes of greater disease salience in the current environment [7,10]. A related study reported that research subjects who observed slides of people with disease symptoms immediately mounted a classical immune response.

This response was not a general reaction to danger or threat, but was specific to cues of other people with symptoms of parasitic infection [28]. In addition, Mortensen *et al.* [29] reported that subjects viewing disease-salient cues immediately exhibited greater between-person avoidance (reduced extraversion and openness to experience) as well as increased avoidant behaviour upon viewing photos of strangers. Together, the studies by Schaller *et al.* [28] and Mortensen *et al.* [29] reveal that visually perceived cues pertinent to increased risk of parasitic infection generate within individuals an immediate immune response as well as changes in personality and behavioural actions that defend against contagion. Hence, such cues conditionally activate the classical immune system as well as the behavioural immune system.

Proximate mechanisms by which individuals assess local parasite stress—and thereby ontogenetically acquire and contingently express the locally adaptive degree of defensive assortative sociality—may include immune system activation (such as the frequency of infection; [30]) and social learning of local disease risks and direct observation of parasite threat (as evidenced in studies mentioned just above). All of these mechanisms may act in combination and account for both the inter-individual and within-individual variation in values affecting in- and out-group behavioural preferences comprising assortative sociality.

In-group assortative sociality is an example, we argue, of adaptive phenotypic plasticity (i.e. of a conditional strategy with multiple contingent tactics [8,15,23]). Such plasticity in traits is favoured when phenotypic change allows the individual to modify its phenotypic expression in directions that give higher inclusive fitness than that achieved by a single phenotype. Conditional strategies in behaviour, psychology, development and physiology are very common across animal taxa [31]. Cultural behaviour in humans is a category of behavioural and psychological plasticity that evolved, at least in part, as a solution to the evolutionary historical fitness problem of local social complexity and change [32–34]. We have argued that a significant part of this complexity and change arose from local people's adjustments in in-group and out-group-oriented behaviour to deal adaptively with temporally varying parasite problems [23].

Our emphasis on adaptive contingency in the expression and adoption of assortative sociality does not imply that we predict no variation across human societies in genetic adaptation for assortative sociality. Culture–gene coevolution [35] may produce genetically differentiated cross-cultural variation in the values and behaviours of assortative sociality. For example, in areas of high parasite prevalence, the cultural practices of xenophobia, philopatry, ethnocentrism and neophobia may select for alleles affecting psychological features that promote the learning and use of these practices [8]. Our argument is that infectious disease problems are locally variable, and, hence, significant conditionality will be favoured and maintained by selection even in the presence of local genetic adaptation functioning in local adoption and use of values and behaviours. That genetically distinct adaptations for coping with an ecological problem and condition-dependent

adaptation for the same problem domain can co-occur within individuals is well established in the literature (review in [36]).

Consistent with the parasite-stress theory, Fincher *et al.* [8] and Thornhill *et al.* [23] showed that the unidimensionality of collectivism–individualism (which corresponds with the value–system dimension conservatism–liberalism) across many countries of the world is predicted strongly by infectious disease prevalence. High parasite stress corresponds with high collectivism (low individualism) and low infectious disease risk with low collectivism (high individualism). Other recent cross-national studies showed that collectivism, autocracy (low democratization), traditional gender roles and inequality (women’s subordination relative to men’s higher status), and women’s traditional sexual restrictiveness and continence are values that positively covary with one another and occur in nations with a high prevalence of infectious disease. These values are characterized by the in-group assortative sociality traits of xenophobia, ethnocentrism and neophobia, which link them functionally to the avoidance and management of parasites. Also, the antipoles of each of the values—individualism (hence, liberalism), democracy and women’s political rights, freedom and increased participation in casual sex—are a positively covarying set of values characteristic of countries with relatively low parasite stress [15,18,23].

Additional support for the parasite-stress theory comes from the empirical correspondence between parasite stress and each of the two variables ‘religiosity’ and ‘family ties’, which are features of collectivism and hence in-group assortative sociality. These two variables relate positively and robustly to parasite stress cross-nationally as well as across the states of the USA. Analyses among US states also revealed that collectivism and parasite stress are correlated positively (individualism negatively), which extended the cross-national finding of the positive covariation of collectivism and parasite stress to the more restricted geographical scale of interstate USA [9]. Moreover, across a large sample of contemporary countries, collectivism is positively correlated with philopatry measured as adults remaining throughout life in their natal region [17,37].

In sum, the parasite-stress theory of values has led to the discovery of many new relationships across several scholarly disciplines and purports to explain cross-cultural variation—both across nations and US states—in many core values and associated behaviours. Fincher & Thornhill [9] provide a full discussion of this theory and supporting evidence.

3. EXTENDING THE PARASITE-STRESS THEORY OF VALUES TO INTERPERSONAL VIOLENCE

The parasite-stress theory of values offers new perspectives on and research directions for some major topics of interpersonal violence. We treat first, previously published studies of the relationship between collectivism–individualism and non-lethal aggression against a romantic partner, after which we present our investigation of romantic-partner homicide, some other types of homicide, and non-lethal child maltreatment

by caretakers. We explain the application of the parasite-stress theory to each type of interpersonal violence as we take them up below.

(a) *Romantic partner non-lethal physical aggression and honour ideology*

Non-lethal physical aggression between romantic partners includes events such as physical abuse, battering, slapping, kicking and so on. Both men and women perpetrate acts of physical aggression against their romantic partner. Men do this much more frequently than women, and women are injured seriously much more frequently than men in these aggressive interactions [38]. The research on romantic partner non-lethal aggression by Archer [38] and other scholars summarized in his paper strongly supports that collectivism and its component value, gender inequality, are associated with higher female-partner aggressive victimization and male-partner aggressive perpetration than is seen under individualism and its associated gender equality, and that this finding is robust across both nations and the US states.

Archer [38] explained these findings as follows. Traditional sex roles and associated sex-specific behavioural expectations are normative in collectivist regions, whereas more liberalized egalitarian sexual roles are normative under individualism. Hence, in collectivist regions, women are believed to be inferior to men and are expected to be subservient to men. In such regions, women are expected to be sexually reserved, and faithful to and respectful of their male romantic partner. As the traditional sex roles are liberalized across regions, or, said differently, as one moves across nations or US states from high collectivism to high individualism, gender equality increasingly becomes normative. Concomitant with this trend towards higher individualism, women have more autonomy and are more respected by men, which reduces male-perpetrated aggression against female partners (also see [18,23] for additional empirical support of Archer’s explanation).

Archer [38] also mentions the strategic role of aggression in men’s mate guarding (also see [39]). The research he reports supports the view that the more collectivist the general cultural setting, the more men view their romantic partner as property to whom only the pair-bond male has legitimate sexual access. Research findings have documented that men’s aggression towards the partner is for sexual control of the female, which functions to increase the probability of paternity (reviewed in [40]). Furthermore, men’s aggression, both non-lethal and lethal, towards sexual rivals also functions, in part, in paternity protection [39]. The combination of male aggression towards a romantic partner and male aggression towards sexual rivals is a salient part of what has been labelled ‘male honour’ by researchers [39,41]. The research reported by Archer [38] and summarized above reveals that male honour is an ideology more characteristic of collectivist cultures than of individualist ones. This pattern, when coupled with the documented strong positive relationship between collectivism and parasite stress, implies that

high rates of physical aggression by men towards romantic partners and towards sexual competitors are more typical of regions of high than of low parasite stress.

As mentioned, women romantically paired with collectivist men are expected to honour and obey their husband—‘to stand by their man’—and to not engage in any activity that might challenge his paternity or authority. When a collectivist, romantically paired man suspects or confirms that his romantic partner has violated the feminine normative expectations for her, he may perpetrate lethal violence against her. Supporting this are findings by Vandello *et al.* [42] on the effect of male- and female-honour ideology on people’s attitudes about a woman leaving an abusive romantic relationship and the moral correctness of a husband’s physical abuse of his wife. Participants from strong honour-based cultures (Latinos, southern US Anglos and Chileans) rated as more favourable that a woman should remain in an abusive romantic relationship than did participants from cultures with low valuation of honour (the northern region of the USA and Anglo-Canadians). These researchers also reported that high-honour-culture participants were more positive than low-honour-culture participants about a husband perpetrating violence against his wife when he perceives her as flirting with another man. Although Vandello *et al.* [42] distinguished the two types of cultures in terms of honour-based ideology, and not collectivism–individualism, the cultures they studied are distinct in this way, too (see [8,9]). Strong honour cultures, i.e. highly collectivist cultures, have values that, in combination, cause and promote male-perpetrator–female-victim violence within romantic relationships. The male- and female-honour aspects of the ideology include: (i) a devaluation of females (relative to males), (ii) the female partner is sexually continent property of her male partner who is off-limits to sexual rivals and to be defended against them, (iii) the female partner should stay in the relationship regardless of her treatment by the male, and (iv) abuse of the female partner by the male for actual or suspected sexual activity outside of the romantic relationship is regarded as morally correct behaviour (see also [42]).

Now we turn to empirical investigation of homicide—lethal aggression—against a romantic partner, after which we treat some other types of homicide. We found in the scientific literature only one prior report of homicide in relation to collectivism–individualism: a brief conference abstract by Lester [43] that stated a strong, positive relationship ($r = 0.70$, $p < 0.0001$) between the overall homicide rate and collectivism across the 48 continental states of the USA. Lester’s homicide data were for 1992 (National Centre for Health Statistics) and the collectivism–individualism scores were based on the validated and widely used measure of Vandello & Cohen [44]. Our analyses (below) replicate Lester’s finding and extend it by showing that it occurs in each of multiple categories of homicide involving adult perpetrators and victims in the USA. Our analyses also relate these categories of homicide to parasite stress and thus to the parasite-stress theory of values.

(b) USA data

Vandello [45] provided homicide-rate data (per 100 000 people) across the 48 contiguous US states divided into two categories of romantic-partner homicide (male- and female-perpetrated) as well as certain other adult-on-adult homicide categories (see §3*f,g*). These data derive from reports of the US Federal Bureau of Investigation (FBI) in 1980, 1990 and 2000; two relatively collectivist states (Florida and Mississippi) did not provide data. US collectivism–individualism data are from Vandello & Cohen [44]. Parasite stress is based on rates of infectious diseases across each of the US states compiled from US Centres of Disease Control data for the years 1993–2007. Fincher & Thornhill [9] provide evidence of validation of the parasite-stress measure for the 50 US states. In this paper, we use the related measure that includes the District of Columbia (DC) because some of the analyses below include DC.

(c) Men killing female romantic partner

These homicides involved men killing wives, ex-wives, common-law wives or girlfriends, an exhaustive list of types of male–female romantic relationships in the FBI data [45]. We found that, as predicted by the parasite-stress theory, parasite stress and collectivism were correlated positively with these homicides, and strongly so: men killing a romantic partner and parasite stress, $r = 0.70$, $p < 0.0001$, $n = 48$; men killing a romantic partner and collectivism, $r = 0.53$, $p < 0.002$, $n = 48$. The parasite-stress theory proposes that collectivism, in part, mediates the relationship between these homicides and parasite stress. Consistent with this, an analysis of these homicides in relation to parasite stress with collectivism controlled resulted in a reduced effect; the zero-order r of 0.70 declines to a partial r of 0.57, $p < 0.0001$. Also, as theoretically expected, the effect size of the relationship between collectivism and these homicides declined with parasite stress controlled: partial $r = 0.20$, $p = 0.18$, not significant. Hence, collectivism appears to be a partial mediator of the relationship between the homicides and parasite stress, and the relationship between the homicides and collectivism may be mediated largely by parasite stress.

(d) Women killing male romantic partner

This type of homicide is the least common type recorded by Vandello [45]. Daly & Wilson [39] evaluated the circumstances leading up to the homicidal behaviour of women against their male partner. Typically, these cases involve a long history of male non-lethal violence against the female. Although the female in these homicides tolerate the violence for long periods of time, one day they avenge this act. That the long-term, non-lethal aggression of the mate leading up to the female-perpetrated homicide is characteristic of collectivist cultures is supported also by the research reported in Archer [38] and Vandello *et al.* [42] (discussed in §3*a*). Consistent with the parasite-stress theory, female-perpetrated homicide against a romantic partner is related positively and strongly to parasite stress and positively and moderately to collectivism across the US states: for parasite stress, $r = 0.73$, $p < 0.0001$, $n = 48$ states; for collectivism, $r = 0.46$, $p < 0.008$, $n = 48$. Controlling

collectivism in analysis of the relationship between these homicides and parasite stress reduces the effect; the partial r is 0.64, $p < 0.0001$. The relationship between collectivism and these homicides with parasite stress controlled is near zero (partial $r = 0.07$, $p = 0.64$).

(e) *Potential confounders*

The scientific homicide literature emphasizes the role of inequality of income and overall wealth, as measured by the Gini index, as a cause of homicidal behaviour. Gini is widely recognized as a robust economic indicator of dire circumstances, personal hardship and mortality salience in a region—the higher the Gini, the greater the wealth disparity. A robust positive relationship between homicide and the Gini index, based on inequality at the household or family level, has been documented cross-nationally, as well as across US cities and states, Canadian provinces and Chicago neighbourhoods. Income inequality is a stronger predictor of homicide than average or median income and various other variables that have been analysed previously (see the studies reviewed in Daly *et al.* [46]). The theoretical focus on income disparity is warranted, as it is based on sexual selection theory. Accordingly, wealth disparity, not absolute or average resource level, is expected to motivate men to violently, including lethally, compete for resources and mates [39,46].

Income inequality, however, is not a variable that is independent of parasite stress and associated collectivism—individualism. First, across the 50 US states and the District of Columbia, parasite stress and Gini (see below) are strongly positively correlated: $r = 0.76$, $p < 0.0001$, $n = 51$. The positive relationship across the 50 US states between collectivism and Gini is also substantial: $r = 0.45$, $p = 0.0001$, $n = 50$. Second, we have proposed and empirically supported the following. Income inequality is caused by and varies with the value dimension collectivism—individualism and hence with parasite stress. As collectivism increases or, said differently, individualism decreases, income inequality increases correspondingly. Collectivists value human inequality, viewing in-group people as superior and more deserving than out-group people, which, when combined with the collectivist value of authoritarianism, promotes and morally validates economic and social inequality across the populace. In contrast, individualists value human equality and support a more equitable resource and opportunity distribution across the populace [23] (see also [47]).

Although the parasite-stress theory implies that resource inequality is caused importantly by parasite stress and associated collectivism, given the central role that prior homicide researchers have placed on the Gini index, we controlled it (household Gini [48]) in additional analyses of the two types of homicide analysed above. A multiple regression with the rate of male-perpetrated homicide of a partner predicted by parasite stress and Gini showed only parasite stress had a significant effect: $R^2 = 0.49$, $F = 21.75$, $p < 0.0001$, $n = 48$; parasite stress standard $\beta = 0.72$, $p < 0.0001$, Gini standard $\beta = -0.04$, $p = 0.73$, not significant,

variance inflation factor (VIF) = 1.26. A multiple regression with male-perpetrated homicide of a partner predicted by collectivism and Gini showed only collectivism had a significant effect: $R^2 = 0.29$, $F = 9.03$, $p = 0.0005$, $n = 48$; collectivism standard $\beta = 0.49$, $p = 0.0008$, Gini standard $\beta = 0.11$, $p = 0.41$, not significant, VIF = 1.14. Similar patterns were found with female-perpetrated homicide of a partner, with parasite stress and collectivism each predicting the rate of homicide, but not Gini. For parasite stress and Gini in relation to the female-perpetrated homicide: $R^2 = 0.53$, $F = 25.39$, $p < 0.0001$, $n = 48$; parasite stress standard $\beta = 0.72$, $p < 0.0001$, Gini standard $\beta = 0.01$, $p = 0.94$, not significant, VIF = 1.26. For collectivism and Gini in relation to the female-perpetrated homicide: $R^2 = 0.25$, $F = 7.46$, $p = 0.0016$; collectivism standard $\beta = 0.39$, $p = 0.007$, Gini standard $\beta = 0.20$, $p = 0.16$, not significant, VIF = 1.14. Hence, parasite stress and collectivism significantly explain variation in each of the two types of romantic-partner homicide independent of Gini. Gini itself seems not to influence the two homicide rates independent of parasite stress and collectivism.

Vandello [45] hypothesized that the ratio of adult males to females across US states may cause variation in homicide rates by affecting the degree that men compete for women. His analyses of sex ratio in relation to homicide, however, yielded no convincing evidence for sex ratio as a significant predictor of variation in homicide rates at the conventional level of recognizing statistical significance ($p \leq 0.05$). Given Vandello's insignificant findings, sex ratio is not treated as a potential confounder in this paper. He concluded that some of the relationships he did find, although not statistically significant, might achieve significance in large samples; his sample size was restricted by the fact that there were only 48 states for which he had homicide and sex ratio data. Even with the restricted sample size, however, both collectivism and parasite stress predict homicide at highly significant levels.

Scholars have proposed that warm or humid weather conditions cause human aggression (e.g. [49,50]). We have criticized this claim on evolutionary theoretical grounds: the high cost of aggression leads to the expectation that aggressive acts will be engaged in primarily when individuals perceive benefits can be gained and not merely when they are uncomfortable from ambient conditions (see [51]). The positive association between aggression and temperature is undisputed. We propose, however, that this relationship occurs because each of the variables covaries with parasite stress. Hence, in this paper, we do not examine climatic factors as potential confounds.

(f) *Male-honour homicide*

We now examine the application of the parasite-stress theory of values to argument-related homicide—also called male-honour homicide—across US states. In this relatively common type of homicide, both perpetrator and victim are male. Typically, protagonists are acquainted, unrelated young adults [39]. The context here is a brawl owing to the influence of alcohol or

narcotics, a lovers' triangle, an argument about money or property or other arguments [45]. The issues boil down to argument that violently escalates between men when their status is disrespected or their sexual exclusivity to a woman is threatened. The contest is about male face and reputation within the local community—in a nutshell, the contest centres around local male honour [39].

The hypothesis we tested, derived from the parasite-stress theory of values, was: male-honour homicide is caused by high parasite stress and its associated collectivist values. Collectivist values place a premium on family and other in-group's reputation and honour. Second, collectivists are embedded in the in-group and do not understand self as separate from in-group harmony and well-being; that is, collectivists have an interdependent self concept, whereas individualists have an independent or autonomous self concept [47]. Relatedly, collectivists, compared with individualists, have low emotional and intellectual autonomy [47]. It follows, then, that when a collectivist is disrespected, simultaneously and necessarily that collectivist's family and other in-group members are disrespected. We argue that this is why collectivist men are provoked when 'dissed' (vernacular for disrespected), and then may become lethally violent. We suggest, too, that the collectivist values of parochialism and philopatry generate the typical context for these homicides of local competition between acquainted men.

The strong relationship between this male-honour ideology and male–male homicide has been documented by many scholars (see reviews in Nisbett & Cohen [41] and Vandello *et al.* [52]; see also [39]), but most extensively by Nisbett & Cohen [41] in their book *Culture of honor: the psychology of violence in the South*. In this book, Nisbett & Cohen documented that there is a culture of male honour in the USA's south and that it causes male–male homicide. They reviewed other scholars' similar claims and associated evidence, and provided copious new evidence of the region's culture of male honour. Daly & Wilson [53] accepted this, but criticized Nisbett & Cohen's [41] proposal that male-honour homicide is transmitted across generations by non-material means—that is, by an inertia inherent in culture itself. Instead, Daly & Wilson [53] proposed that male-honour homicide and the associated culture of male honour are transmitted and maintained in the USA south by the material cause (ecological/proximate cause) of wealth inequality (Gini) and associated sexual competition among men. We agree, but add the proximate causes of parasite stress and associated collectivism. In our perspective, high parasite stress evokes collectivism, and collectivism includes the values of social and economic inequality and authoritarianism, which generate wealth disparity across the population of a collectivist culture [23]. Wealth disparity intensifies inter-male competition for resources and mates, and when associated with collectivist values, this male–male sexual competition is especially prone to lethal contests. Furthermore, high parasite stress may amplify the local effects of sexual selection (both male–male sexual competition and mate choice) by its revelation of phenotypic and genetic variance among males [25,54].

Gini, however, is predicted to have an effect on male-honour homicide that is independent of the effect of parasite stress.

Our findings support this perspective. There is a strong, positive relationship between male-honour homicide rates and parasite stress: $r = 0.74$, $p < 0.0001$, $n = 48$ states. Also, there is a strong, positive correlation between male-honour homicide and collectivism: $r = 0.58$, $p < 0.0001$, $n = 48$. The relationship between these homicides and parasite stress declined somewhat when collectivism was controlled: partial $r = 0.64$, $p < 0.0001$. That between the homicides and collectivism declined substantially and became only marginally significant when parasite stress was controlled: partial $r = 0.28$, $p < 0.06$.

A multiple regression with male-honour homicide predicted by parasite stress and Gini showed parasite stress had a stronger effect, but both predictor variables were significant: $R^2 = 0.62$, $F = 36.71$, $p < 0.0001$, $n = 48$; parasite stress standard $\beta = 0.59$, $p < 0.0001$, Gini standard $\beta = 0.32$, $p = 0.004$, VIF = 1.26. A multiple regression with male-honour homicide predicted by collectivism and Gini revealed that the two predictors had equal effects: $R^2 = 0.50$, $F = 22.77$, $p < 0.0001$, $n = 48$; collectivism standard $\beta = 0.43$, $p = 0.0004$, Gini standard $\beta = 0.43$, $p = 0.0004$, VIF = 1.14.

(g) *Felony-related homicide*

The US FBI distinguishes a category of homicide called felony-related homicide, which predominantly involves the murder of a man by another man during robbery, burglary, vehicle theft, or which is associated with narcotic drug law violations or other felonies or suspected felonies [45]. In general, these homicides are not distinct in provocation and motivation from male-honour killings. Felony murders frequently involve a similar scenario to that of male-honour homicides: insult or disrespect leads to an escalation of conflict and the motivation of the parties to defend their honour (see [39,53]). Thus, rates of felony-related homicides should exhibit patterns like those found above for male-honour homicides; this was the case. Felony-related homicides: with parasite stress, $r = 0.65$, $p < 0.0001$, $n = 48$ states; with collectivism, $r = 0.53$, $p < 0.0001$, $n = 48$ states. The relationship between these homicides and parasite stress declined when collectivism was controlled: partial $r = 0.49$, $p = 0.0005$. That between the homicides and collectivism declined considerably and became insignificant when parasite stress was controlled: partial $r = 0.24$, $p = 0.10$.

Parasite stress and Gini each significantly explained felony-related homicide, but parasite stress had a stronger effect: $R^2 = 0.49$, $F = 21.90$, $p < 0.0001$; parasite stress standard $\beta = 0.51$, $p < 0.0001$, Gini standard $\beta = 0.30$, $p = 0.01$, VIF = 1.26. Collectivism and Gini are about equal predictors of felony-related homicide: $R^2 = 0.42$, $F = 16.03$, $p < 0.0001$; collectivism standard $\beta = 0.38$, $p = 0.003$, Gini standard $\beta = 0.40$, $p = 0.002$, VIF = 1.14.

4. MALE LIFESPAN

In addition to the Gini index, in the homicide scientific literature, there is an emphasis on reduced male life

expectancy as a proximate cause of male-honour homicide perpetration [55]. This stems from life-history theory [56,57]. Accordingly, when men face short lives, they strategically adopt and engage in more impulsive actions and risk-taking, including violence, than when their lifespan is extended. It is important to recognize, however, that male life expectancy is, in large part, a product of infectious disease morbidity and mortality. Medical and sanitation improvements were the major cause of dramatically reduced mortality and increased longevity across many regions of the world over the past 150 years [58]. Moreover, the relationship between our measure of parasite stress and male life expectancy across the USA was -0.77 ($n = 51$, including the District of Columbia), and a similarly robust pattern has been reported cross-nationally: the variable ‘combined parasite-stress’ (see Fincher & Thornhill [9] for a description and validation) by male life expectancy [59], $r = -0.78$, $p < 0.0001$, $n = 190$ countries (for additional analyses, see Thornhill *et al.* [23]). Hence, parasite stress may be an ultimate and a proximate cause of certain life-history decisions of men.

For completeness, we examined the relationship across US states between male-honour homicide and parasite stress with male life expectancy controlled. The zero-order relationship reported above ($r = 0.74$) was considerably reduced but remained statistically significant: partial $r = 0.50$, $p = 0.0003$.

(a) *Cross-national homicide*

We have focused on homicide data across the US states because the rates of homicide types are separated. To our knowledge, the separation of these types of murders is not available for international rates of homicide. The US data are also more likely to be reliable and accurate estimates than international homicide data [45]. We hypothesize that under-reporting of homicides is correlated positively with the degree of collectivism across countries. First, highly collectivist governments sometimes achieve a despotic and totalitarian rule by governmental elites [23], which, by definition, gives those in authority licence to kill political enemies with impunity; one can safely assume that autocratic governments do not keep accurate records of this homicide. Second, relative to individualist cultures, the people in power in collectivist countries show low interest and monetary investment in public goods and services (see [23]); thus there likely is limited record-keeping that benefits the well-being of or informs the public at large. If our hypothesis about reporting of homicide is correct, then report-bias is systematic across countries in a way that counters our prediction that there will be a positive relationship between homicide rate and parasite stress or collectivism (and negative relationships with individualism). We cannot discount that there is not a similar systematic bias, but to a much lesser degree, across the states of the USA. However, even with error in the data, systematic or random, there are robust relationships between the homicide types and parasite stress and collectivism–individualism across the US states.

With these caveats about the international homicide data in mind, we obtained national homicide rates (per 100 000 people) from Public Health Sources of the United Nations Office on Drugs and Crime (<http://www.unodc.org/unodc/en/data-and-analysis/homicide.html>). These data are rates of ‘the intentional killing of a person by another’ for the latest available year (see website). Unknown is how countries may differ in reporting of different types of homicide. Presumably, the United Nations data cover to varying degrees all the homicide types we have analysed above, as well as homicides resulting from child maltreatment that we treat below. The United Nations homicide variable was analysed in relation to the variable combined parasite-stress. The relationship was strong: $r = 0.54$, $p < 0.0001$, $n = 179$ countries. A multiple regression with this homicide variable by parasite stress and Gini [59] revealed a sizeable effect of parasite stress, but a smaller effect of Gini: $R^2 = 0.36$, $F = 34.47$, $p < 0.0001$, $n = 126$; parasite stress standard $\beta = 0.43$, $p < 0.0001$, Gini standard $\beta = 0.24$, $p = 0.05$, VIF = 1.57. The relationship between homicide and individualism across countries was moderate in magnitude: $r = -0.40$, $p = 0.001$, $n = 64$. This analysis used the measure of individualism provided by Hofstede (see [8]). A multiple regression with individualism and Gini as predictors of the international homicide rate indicated a robust effect of Gini, but an insignificant effect of individualism: $R^2 = 0.35$, $F = 15.67$, $p < 0.0001$, $n = 61$ countries; individualism standard $\beta = -0.13$, $p = 0.34$, not significant, Gini standard $\beta = 0.51$, $p = 0.0003$, VIF = 1.53.

In sum, the findings of parasite stress and of collectivism in relation to homicide across US states are repeated at the cross-national scale. Homicide rates increase with both parasite stress and collectivism. Unlike the US states analyses, the national analysis indicates that collectivism is not a significant predictor of homicide independent of Gini.

Additional evidence that the parasite-stress theory is relevant to cross-national variation in homicide comes from the classic study of homicide by Archer & Gartner [60], which provided the first data for homicide rates across many countries. Their data covered the period of 1900–early 1970s. They emphasized that their data suffered from variation in the definition, reporting and labelling of homicides. We used their category for ‘homicide’ for the last year reported after World War II under the assumption that the latest reports would be most accurate. The reports used ranged from the 1950s to early 1970s depending on the country. Homicide and combined parasite stress showed a strong, positive correlation: $r = 0.53$, $p = 0.004$, $n = 27$. The covariation of Hofstede’s individualism and homicide was negative and moderate in effect size, but not statistically significant given the small sample of countries: $r = -0.37$, $p = 0.11$, $n = 20$.

(b) *Child maltreatment and parasite stress*

Three prominent, proximate causes of child maltreatment—child neglect, abuse and murder, typically by parents but also by other caretakers—have received empirical support: (i) low levels of available resources to invest in dependent offspring, (ii) a step-parent in

the household in which a child is reared, and (iii) relatively low phenotypic quality of offspring as a result of compromised health or physical or mental disability [39]. In regard to (iii), it has been established that unhealthy children and children with disabilities are at much greater risk of maltreatment than are healthy children (e.g. US Department of Health and Human Services, see <http://www.childwelfare.gov>; also [39]).

Like other parental animals, human parents exhibit discriminative parental solicitude, and Daly & Wilson [39] call this selective investment. Parents are designed by evolutionary selection to invest primarily when the investment would have resulted in their reproductive success in human ancestral populations. When conditions are dire, parents divest and thereby save their investment for later times when ecological conditions for offspring are improved. Step-parents lack the genetic overlap with their step-children that genetic parents have; hence step-parents are less investing in step-children than genetic parents are in their genetic children. Offspring of low phenotypic quality would have had low reproductive value in evolutionary ancestral settings and hence receive parental divestment [39].

Of the three above causes of child maltreatment, we propose that the effect of offspring phenotypic quality is related most directly to parasite stress. First, the higher the parasite stress cross-nationally, the higher the child mortality [61] and presumably the greater the proportion of offspring born with low phenotypic quality. Second, pregnant and postpartum women infected with parasites will be in poorer condition than unparasitized mothers, which will limit the ability of the unhealthy mothers to produce high-quality offspring. The suggested maternal-condition effect is seen in the strong, positive relationship between parasite stress and the proportion of low birthweight births to total births across the US states and the District of Columbia (2007, <http://www.statehealthfacts.org>): $r = 0.69$, $p < 0.0001$. Moreover, in a multiple regression, parasite stress has a stronger influence on the percentage of low birth-weight infants than does Gini: $R^2 = 0.54$, $F = 28.40$, $p < 0.0001$; parasite stress standard $\beta = 0.45$, $p = 0.0016$, Gini standard $\beta = 0.35$, $p = 0.013$, VIF = 1.90. It follows from the two factors mentioned that the higher the parasite stress, the more offspring born with low phenotypic quality and associated reduced health and reproductive value. Hence, parasite stress is hypothesized to be a cause of child maltreatment by parents.

One well-established pattern consistent with this hypothesis is that both non-lethal and lethal maltreatment by caretakers are focused on very young children, with rates declining strongly across increasing age categories (see various data sources in Daly & Wilson [39]; also the US National Child Abuse and Neglect Data System (NCANDS), <http://www.childwelfare.gov/systemwide/statistics/can.cfm>). The discriminative-parental-solicitude psychological adaptation of parents is expected to be designed by evolutionary selection to detect low phenotypic quality early in the lives of offspring and divest then to reduce the costs of continuing parental care. Also, as offspring increase in age up to puberty and adolescence, their reproductive value increases, which cause parents to

perceive them as more worthy recipients of parental investment [39].

Furthermore, if our hypothesis applies to child maltreatment by parents, parasite stress will predict positively both homicide and non-lethal abuse and neglect of children by parents. Data available for the USA allow a test of this. The US government data on child maltreatment are replete with errors and inconsistencies (e.g. [62]; also see URLs cited below). States differ in how cases of the maltreatment are counted and in other procedures for its assessment and recording. Also, states differ in definitions of the maltreatment (see <http://www.childwelfare.gov/pubs/factsheets/fatality.cfm>). There is some indication, however, that the data on child maltreatment by caretakers have improved through the years. As of 2008, many states employed an improved standardized system of compiling information about child maltreatment cases (see <http://www.childwelfare.gov/pubs/factsheet/s/fatality.cfm>). Hence, we used data for 2008 (the most recent year of reporting) from the NCANDS [63]. According to NCANDS, most of these data derive from US child welfare agencies. They are submitted voluntarily by the states and the District of Columbia to NCANDS. In 2008, in the USA, 772 000 children were reported victims of abuse and neglect. About 80 per cent of child maltreatment perpetrators were parents, and another 7 per cent were other relatives of the victim. Of perpetrators who were parents, 90 per cent were the assumed genetic parent(s) of the child. In 2008, 1740 children died from the maltreatment, a rate of 2.33/100 000 children. About 80 per cent of child-fatality victims were younger than 4 years old; 45 per cent were younger than 1 year.

First, we treat the patterns of rates of child death per 100 000 children owing to abuse and neglect across the US states that reported data, including the District of Columbia. The relationship between parasite stress and child murders was strongly positive, $r = 0.67$, $p < 0.0001$, $n = 48$. Gini is a measure of widespread economic and personal stress in a state, and hence relates to the causal variable in child maltreatment of a limitation of resources available to caretakers to invest in their offspring—the higher the Gini, the higher the proportion of parents with resource limitation. Gini in relation to child fatalities was $r = 0.58$, $p < 0.0001$, $n = 48$. A multiple regression with the child fatalities predicted by parasite stress and Gini yielded a strong effect of parasite stress, but an insignificant effect of Gini: $R^2 = 0.46$, $F = 19.46$, $p < 0.0001$, $n = 48$; parasite stress standard $\beta = 0.53$, $p = 0.002$, Gini standard $\beta = 0.20$, $p = 0.21$, VIF = 2.04. Parasite stress was a stronger predictor than Gini of rates of child fatalities resulting from caretaker abuse and neglect. Gini alone had little predictive power to explain interstate variation in the child murder rate beyond its covariation with parasite stress.

Rates of non-lethal caretaker's abuse and neglect of their children also is related positively and significantly to parasite stress, but less strongly than the pattern for child murders by caretakers. Data for the non-lethal category derive from the 2008 reports to NCANDS from 49 states plus the District of Columbia. The relationship was $r = 0.28$, $p = 0.05$, $n = 50$. In this

case, however, there was no statistically significant effect of parasite stress independent of Gini: non-lethal abuse and neglect by parasite stress with Gini controlled, partial $r = 0.10$, $p = 0.50$.

In sum, parasite stress was a strong, positive predictor of child-murder-by-caretaker rates across the states of the USA. This effect was robust to the effects of certain economic conditions. Parasite stress was also a significant positive predictor of non-lethal abuse and neglect by caretakers, but this effect was smaller and seemed to be mediated, in part, through the inter-relationship of parasite stress and economic factors.

(c) *Child maltreatment and collectivism*

The relationship between collectivism–individualism and child maltreatment is probably conceptually complex. From one perspective, it might be argued that collectivism will covary positively with child maltreatment (and with individualism, negatively). Cultures of honour—collectivist ones—condone, endorse and value violence as a mechanism to control the behaviour of social intimates as well as enemies. In this paper, we have documented this from published studies on non-lethal aggression in romantic relationships across countries and the states of the USA and our analyses of adult-on-adult homicides across states and nations. Under collectivism, the strategic use of violence is potentially socially encompassing. Cultures of honour also may use violence to socialize, control and manipulate children. This is suggested by the USA south's relatively high value placed on the use of corporal punishment, both by parents at home and by schools, to control and punish children [41]. Compared with other regions of the USA, the south places more value on the expectation that children will follow the traditional, normative rules of behaviour. From another perspective, however, one might predict that child maltreatment will be related negatively to collectivism if collectivist norms and associated behaviours are effective in controlling children such that excessively abusive and neglectful tactics are relatively unnecessary. A third perspective is that the value system of collectivism–individualism is not related to child maltreatment; in this case, child maltreatment is caused by parasite stress, economic factors, step-parent divestment in step-children and other causes.

The third perspective is the only one of the three supported by the evidence. Across the 47 states for which data exist for both collectivism and child death resulting from abuse and neglect (2008), the relationship between these two variables is $r = 0.14$, $p = 0.35$, not significant. For the same year across the 49 states with data for both collectivism and non-lethal child abuse and neglect (NCANDS), the relationship was $r = 0.05$, $p = 0.72$, not significant.

Various other factors contribute to the conceptual complexity of a possible relationship between collectivism–individualism and child maltreatment. The effect of collectivism–individualism on child maltreatment may be dependent on the children's ages. Older children, perhaps especially those of pubertal ages, are more likely to oppose parental rules of conduct and thereby engage in activity that would

provoke maltreatment by caretakers. Thus, it is in this older age group that maltreatment may be associated positively with collectivism (and negatively with individualism). Moreover, collectivists have more durable marriages (a lower divorce rate) than individualists [47], which should reduce step-parent households and thus child maltreatment caused by step-parent divestment.

5. OVERALL SUMMARY OF FINDINGS

The parasite-stress theory of values appears to account for considerable amounts of the variation in the most prevalent forms of human interpersonal violence across the states of the USA. As predicted from the theory, across the US states, each of the two variables, parasite stress and collectivism, correlated positively and consistently with male- and female-perpetrated murder of a romantic partner, male-honour homicide and felony-related homicide. Collectivism, in part, may mediate the relationship between each of these types of homicide and parasite stress. Parasite stress appears to mediate the relationship between each of the types of homicide and collectivism. Gini (wealth inequality and related dire circumstances) seemed to have a significant role, independent of its interaction with parasite stress and collectivism, in increasing rates of male-honour and felony-related homicides, but not in increasing rates of romantic-partner homicides. Parasite stress and collectivism also positively predict international rates of overall homicide. Each of two types of child maltreatment by caretakers (primarily parents), child murder and non-lethal abuse and neglect, across the US states is predicted positively by parasite stress. Gini had little, if any, predictive power for rates of child murder by caretakers independent of its covariation with parasite stress. Non-lethal abuse and neglect of children by caretakers are not predicted by parasite stress independent of Gini. Neither of the two types of child maltreatment is predicted by collectivism.

Parasite stress appears to be the most empirically verified variable accounting for many types of interpersonal violence. The research presented in this paper contributes to a unification of understanding of the causes of major types of interpersonal violence and anchors them in infectious diseases and, with respect to adult-on-adult homicide, in the values these diseases generate. By no means is the application of the parasite-stress theory limited only to interpersonal violence. It also appears to help elucidate the other major category of violence, inter-group violence or warfare [51,64].

6. OTHER TESTS AND FUTURE DIRECTIONS

The parasite-stress theory's application to interpersonal violence could be tested in ways other than the cross-states and cross-national comparative methodology we have used. An experimental approach of manipulating parasite stress, say in the USA, could be used also to test the hypothesis that parasite stress causes interpersonal violence. Such a test could be modelled after the research documenting the successful eradication

programme against hookworm parasites in the USA south [64]. The basic experimental design was based on the application of health improvements against hookworms in some regions of a state, but not in adjacent regions of the same state. This was then replicated over many regions of multiple states to obtain a sample of manipulated versus comparison (control) regions [65]. Another experimental design used to measure the effects of hookworm reduction was to compare regions of high initial infectious disease with adjacent regions of low initial infectious disease in terms of outcomes subsequent to health intervention across all the regions [66].

A similar experimental approach could be used to test for the effect of the reduction of the impact of infectious diseases on homicide. Adding comprehensive, free, easily accessible and sustained healthcare and monitoring for people in states with a high homicide rate (such as Alabama or South Carolina; [45]) would provide data of scientific value for the test. There is convincing evidence that public-health expenditures that target infectious diseases actually reduce greatly the severity of the diseases in general (i.e. reduce the number of cases of the diseases) [27]. The parasite-stress theory of values predicts that homicide rates would begin to decline after one generation (about 20 years) and continue to decline in successive generations. Evidence suggests that healthcare improvements in the 1920s to mid 1940s in the USA that targeted infectious diseases (e.g. child vaccination programmes, chlorinated and fluoridated water, antibiotic availability, vector control and sanitation infrastructure and legislation) changed the values of people in one to two generations: people showed increased liberalization in their values [23]. The predicted reduction in collectivism (with a corresponding increase in individualism) following the experimental health improvements is expected to cause reductions in rates of all types of homicides related to collectivist ideology. Child maltreatment rates are predicted also to decline with the health interventions.

Additional research is needed to separate the two evolutionary hypotheses for why people murder conspecifics. Duntley & Buss [67] have proposed that humans have adaptation that is functionally designed specifically for murder. Others have proposed that, ultimately, murder is explicable entirely as a maladaptive by-product of adaptations that function for aggressive, non-lethal outcomes [39]. Our results cannot distinguish between the two hypotheses, but may provide new avenues for future research directed at resolving this issue.

R.T. dedicates this paper to the fond memories of Margo I. Wilson (1942–2009), a pioneer in the study of interpersonal conflict and violence. We thank Trevor Case and another reviewer for helpful comments on the manuscript. Anne Rice's assistance in preparing this paper is greatly appreciated.

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