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Aggression and violence around the world: A model of CLimate, Aggression, and Self-control in Humans (CLASH)

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Abstract: Worldwide there are substantial differences within and between countries in aggression and violence. Although there are various exceptions, a general rule is that aggression and violence increase as one moves closer to the equator, which suggests the important role of climate differences. While this pattern is robust, theoretical explanations for these large differences in aggression and violence within countries and around the world are lacking. Most extant explanations focus on the influence of average temperature as a factor that triggers aggression (The General Aggression Model), or the notion that warm temperature allows for more social interaction situations (Routine Activity Theory) in which aggression is likely to unfold. We propose a new model, CLimate, Aggression, and Self-control in Humans (CLASH), that helps us to understand differences within and between countries in aggression and violence in terms of differences in climate. Lower temperatures, and especially larger degrees of seasonal variation in climate, call for individuals and groups to adopt a slower life history strategy, a greater focus on the future (vs. present), and a stronger focus on self-control. The CLASH model further outlines that slow life strategy, future orientation, and strong self-control are important determinants of inhibiting aggression and violence. We also discuss how CLASH differs from other recently developed models that emphasize climate differences for understanding conflict. We conclude by discussing the theoretical and societal importance of climate in shaping individual and societal differences in aggression and violence.

Keywords: aggression; climate; seasonal variation; self-control; temperature; time orientation; violence

1. Introduction

> "The heat made people crazy. They woke from their damp bed sheets and went in search of a glass of water, surprised to find that when their vision cleared, they were holding instead the gun they kept hidden in the bookcase."
> – Kristin Hannah, *Summer Island: A novel* (2004)

Aggression and violence tear the fabric of society. They often pose a threat to feelings of safety and trust, undermine healthy relations among people, and bring about considerable suffering and unnecessary loss to people in many countries (Anderson 2001; Hsiang et al. 2013; Van de Vliert 2009). One of the many factors that can make people more aggressive and violent is heat, as suggested by the opening quote from Kristin Hannah's book. One major scientific puzzle derives from the observation that the prevalence of aggression and violence differs within and between countries. As a general trend, aggression and violence increase as distance to the equator decreases (e.g., Walker et al. 1990). These differences are large and widespread. For example, data from the 2013 Global Study on Homicide (United Nations Office on Drugs and Crime [UNODC] 2013) reveal that, per 100,000 people, the rates for homicide are higher for Central America (26 per

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100,000) and Middle Africa (18 per 100,000) than for Europe (5 per 100,000) and Northern America (5 per 100,000). There are, however, exceptions to this general "rule." For example, although South Africa is quite distant from the equator, it has a very high violent crime rate (30 per 100,000). Violent crime differences also occur within continents. For example, differences in violent crime rates occur along the north-south axis in Europe, with homicide rates ranging from about 4 per 100,000 in Albania, Montenegro, and Turkey to less than 1 per 100,000 in Scandinavia. For within-continent comparisons there are exceptions as well, most notably Russia, with a homicide rate of at least 5 per 100,000.

Violent crime differences also occur within countries. The Federal Bureau of Investigation (FBI) has consistently reported that, in the United States, there is more violent crime in the South than in the North (FBI 2015). Similarly, the rate of Mafia-related homicides is much higher in southern than in northern Italy (UNODC 2013). Beginning at the global level and ending at the subnational level, whether across regions, subregions, or countries, two robust trends are observed with respect to aggression and violence: (1) there are significant differences between countries (and sometimes within countries), and (2) there tends to be more aggression and violence closer to the equator than further from the equator.

This bigger picture is supported in a recent meta-analysis on climate and conflict (see Burke et al. 2015) that revealed that climate is associated with violence in 46 of 56 (82%) published studies. Moreover, temperature is associated with violence in 20 of 24 studies (83%). Burke et al. also reported that effects were stronger for temperature than for rainfall differences and for intergroup than for interpersonal conflict. This meta-analysis provides a strong – and interdisciplinary – empirical foundation for the conclusion that "large variations in climate can have large impacts on the incidence of conflict and violence across a variety of contexts" (Burke et al. 2015, p. 610).

Although there are large differences in aggression and violence within and across countries, theoretical explanations for these differences are lacking. Most explanations focus on the influence of average temperature as a factor that triggers aggression and violence (General Aggression Model), or the notion that warm temperature allows for more social interaction situations (Routine Activity Theory) in which aggression and violence are likely to unfold. We propose a new model of CLimate, Aggression, and Self-control in Humans (CLASH) that helps us to understand differences within and between countries in aggression and violence in terms of differences in climate. Specifically, we propose that higher average temperature, and especially smaller seasonal variation in temperature, calls for individuals and groups to adopt a faster life strategy, a greater focus on the present (vs. future), and a lesser focus on self-control. The CLASH model further outlines that fast life strategy, short-term orientation, and lack of self-control are important determinants of aggression and violence.

Throughout this article, we use the terms *aggression* and *violence* to describe broad classes of behavior intended to harm others. *Aggression* is defined as any behavior that is intended to harm another person who is motivated to avoid that harm, and *violence* is defined as any behavior that is intended to cause extreme physical harm (e.g., injury, death) to another person who does not want to be harmed (cf. Anderson & Bushman 2002). All violent acts are aggressive, but not all aggressive acts are violent – only acts intended to cause extreme physical harm are classified as violent. Also, our focus is not limited to acts of interpersonal aggression and violence. We also include acts of intergroup conflict, such as political violence, wars, and riots (see Burke et al. 2015).

As will be discussed, our conceptualization focuses on life strategies, time orientation, and self-control as constructs that are key to understanding aggression and violence. Each of these variables is shaped by climate (e.g., differences in average temperature, seasonal variation in temperature). Moreover, self-control in particular is assumed to be a powerful predictor of aggression and violence. Indeed, poor self-control is one of the "strongest known correlates of crime" (Pratt & Cullen 2000, p. 952), especially violent crime (Gottfredson & Hirschi 1990; Henry et al. 1996). We therefore focus on those forms of aggression and violence that are due to low self-control. Specifically, we focus on "hot," impulsive, angry behavior intended to harm another person who does not want to be harmed, called *reactive aggression* (also called hostile, affective, angry, impulsive, or retaliatory aggression [e.g., Buss 1961; Dodge & Coie 1987]). Reactive aggression is liable to occur in situations where, for example, time to think is limited, cognitive load is high, immediate retaliation is feasible, and there is "a sense of urgency" to

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respond (e.g., in response to public humiliation, in direct confrontations). Reactive aggression can be a criminal act (e.g., assault, murder) or a noncriminal act (e.g., swearing at a rude driver, screaming at one's spouse).

Before we discuss our model in greater detail, we should explicate three foci of the present theoretical analysis. First, we acknowledge that comparisons within countries are less complex than comparisons between countries. In general, there are far fewer differences within countries than between countries. Differences between countries (e.g., historical, economic, political variables) are exceptionally difficult to disentangle from climate differences (cf. Burke et al. 2015). Thus, our analysis focuses more on within-country than on between-country comparisons of climate differences. We acknowledge that between-country comparisons are important with respect to the scientific principle of efficiency (i.e., explaining a lot of variance using a relatively parsimonious model) and the societal urgencies the world faces (e.g., global change, migration issues, and international cooperation [cf. Van Lange 2013]).

Second, we focus on the Northern Hemisphere for methodological and practical reasons. A large majority of the world's population live in the Northern Hemisphere. Moreover, past research has focused on countries in the Northern Hemisphere. It is this past research that is in strong need of a new model able to account for pronounced differences between southern and northern environments (in the Northern Hemisphere) on several important dimensions: time orientation, self-control, aggression, and violence. Theoretically, the distance from the equator should work the same way in the Southern Hemisphere as in the Northern Hemisphere. Indeed, in the final analysis, we believe that it is desirable, from a scientific and societal perspective, to extend the model to both hemispheres (cf. Henrich et al. 2010).

Third, as the name conveys, CLASH focuses on humans, rather than other animals. We acknowledge that animals also adapt and respond to climatic differences (see Burghardt 2013). For example, climate differences are associated with hibernation and storage of food for some species (e.g., bears, skunks, and chipmunks), migration to other regions for some species (e.g., fish, birds, and butterflies), and movement to specific locations such as underground burrows or holes in trees in the same region for some species (e.g., mice, snakes, and frogs). Climate is also linked to seasonal "planning" of reproduction for many species that mate in the Spring (Wikelski et al. 2000). Although these patterns of adaptation can be viewed in terms of life history strategies, time orientation, and self-control, we believe it is premature to link these patterns to aggression and violence in other animals, for two reasons. First, we do not know of any empirical literature on the link between climate differences and aggression among the same animal species. It is more likely that throughout evolutionary history, animals have either adapted to the local climatological circumstances or migrated to more fitting circumstances. These topics are beyond the scope of this article. Second, as illustrated above, many species have their own unique way of adapting to annual differences in seasonal climate. This is not to imply that we regard an examination of comparative research as unimportant. Indeed, we hope that the specific tests of CLASH may be extended to humans *and* other animals in the future.

The remainder of the article is organized as follows. Section 2 presents the existing evidence and theories linking climate to aggression and violent crime. Before we describe our CLASH model, it is necessary to provide a brief overview of theories and research relevant to differences in aggression and violence, both within and between countries. This is especially important in outlining what CLASH contributes to our current understanding of violence within and across countries. Section 3 discusses theory and research relevant to two propositions that provide the foundation for CLASH. Given that climatological approaches are not common in the social and behavioral sciences, Section 4 includes a broad discussion about the ubiquity of climate for understanding human behavior in groups and societies. Because CLASH offers a novel and general framework, Section 5 considers caveats and future directions of CLASH. Section 6 concludes by outlining theoretical issues and broader scientific and societal implications of CLASH. The final section includes some concluding comments.

2. Contemporary explanations of cultural differences in violence

Inspired by the observation that countries closer to the equator are generally more violent, several theorists and researchers have attempted to determine why there is so much variation in aggression and violence around the world. One belief shared by experts and laypeople alike is that hot temperatures increase violence. The belief that higher temperatures increase violence has spurred researchers to examine the role of average heat (climate) and incidental heat (weather) in violence rates since the late 1800s (e.g., Dexter 1899; Lombroso 1899/1911; for comprehensive reviews, see Brearley 1932; Cohen 1941; Falk 1952).

Considerable research has indicated that as temperature increases, violent crime (e.g., murder, rape, assault, violent riots) also increases (Anderson 1987; 1989; Carlsmith & Anderson 1979; deFronzo 1984; Michael & Zumpe 1986), but there is no corresponding increase in nonviolent crimes. Also, as noted earlier, a variety of studies conducted in the United States have found that Southern states with warmer climates typically have higher violent crime rates than Northern states with cooler climates (e.g., Anderson & Anderson 1996; Lombroso 1988/1911; UNODC 2013). Similarly, time period studies on temperature variability have revealed higher violent crime rates in hotter years, seasons, months, and days (e.g., Anderson et al. 1997; Leffingwell 1892). In addition, field and archival studies have found a positive correlation between heat and aggression in a variety of forms (e.g., horn honking, number of major league baseball batters hit by pitched balls, prison inmate violence [Haertzen et al. 1993; Kenrick & MacFarlane 1984; Reifman et al. 1991]). Overall, correlational studies, field experiments, and archival studies of violent crimes provide evidence of the "heat effect" – higher temperatures are associated with higher levels of aggression and violence.

Given that various empirical studies have reported that as temperature increases, so do aggression and violence, the obvious question is: What is it about high temperatures that makes people generally more aggressive and violent? The two most popular theories offered to account for this positive relation between temperature and violence are

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the General Aggression Model (Anderson & Bushman 2002) from psychology and the Routine Activity Theory (Cohen & Felson 1979; Rotton & Cohn 2001) from law and criminology.

2.1. General Aggression Model

In the General Aggression Model (e.g., Anderson & Bushman 2002), two types of input variables can influence whether a person acts aggressively: personal variables (e.g., genetic predispositions, trait aggression, gender, attitudes about violence) and situational variables (e.g., alcohol, violent media, provocation, hot temperatures). The relevant situational variable here is temperature. According to the model, there are three possible routes to aggression and violence: angry feelings, aggressive thoughts, and physiological arousal. Together these three routes constitute an individual's present internal state, which encourages or discourages aggression and violence. However, these routes are not mutually exclusive or even independent. For example, someone who has aggressive ideas might also feel angry and have elevated blood pressure. High temperatures appear to operate through all three routes. For example, high temperatures make people angry, increase aggressive thoughts, and increase physiological arousal (e.g., heart rate, blood circulation, perspiration). This unexplained arousal by the heat can be mislabeled as "anger," especially in situations involving provocation and thus lead to reactive aggression (Zillmann 1979). This might help explain why a minor provoking social event, such as an accidental bump in a hot crowded bar, can lead to the trading of insults, punches, and possibly even bullets (Anderson 2001).

2.2. Routine Activity Theory

The Routine Activity Theory (Cohen & Felson 1979; Rotton & Cohn 2001) conceptualizes the effect of weather on violent crime rates in terms of the amount of social contact. As one scholar wrote, "the greater frequency of crimes against the person in summer months is probably due to the greater frequency of contact among human beings in those months rather than the effects of temperature on the propensity to criminality" (Sutherland & Cressey 1978, p. 119). The rationale underlying the Routine Activity Theory is relatively straightforward – during warmer weather, individuals are more likely to leave the safety of their homes, schools, and jobs and spend more time outside in public spaces, where interactions with others can become "heated" and aggressive (Cohn 1990). Consistent with these predictions, violent crime rate data from Minneapolis, Minnesota, and Dallas, Texas, indicate that the relation between hot temperatures and violent crime is stronger when individuals spend generally more time outdoors in the evening rather than afternoon hours and on weekends rather than weekdays (e.g., Cohn & Rotton 1997; Rotton & Cohn 2001).

2.3. Hot or not: Past theory and research

Despite the wealth of empirical studies on the heat effect, three limitations are worth mentioning. First, although the General Aggression Model (Anderson & Bushman 2002) proposes that heat-induced anger, aggressive thoughts, and physiological arousal can lead to more aggression, it is unlikely that these factors *alone* would lead to extremely violent behaviors such as homicide. Indeed, there is evidence that the effect sizes of heat-induced hostility are relatively modest, both inside and outside of the lab (e.g., Ferguson & Dyck 2012). Moreover, laboratory experiments have yielded mixed results. Some experiments indicate that extremely hot temperatures inhibit aggression, presumably because people want to escape the heat rather than fight (e.g., Baron 1972; Baron & Bell 1975; 1976). Also, some evidence suggests that aggression and violence occur less frequently in hot climates than in warm climates (e.g., Van de Vliert et al. 1999). Taken together, past research suggests that a greater scientific understanding of the mechanisms underlying the relationship between heat and aggression is needed (see Anderson & Anderson 1998).

Second, although the Routine Activity Theory proposes that the link between temperature and crime is due to individuals' congregating in public spaces with increased social interaction, this perspective has not always received empirical support (Rotton & Cohn 2000). For example, although there is a greater likelihood of violent behaviors among young people in a bar room setting, violent behaviors are unlikely to occur in this setting among groups of mixed ages and sexes (Felson 1998). This observation is consistent with what is known in the criminology literature as the "nighttime economy," which consists primarily of bars, pubs, and nightclubs, settings in which alcohol-related violence can occur (Teece & Williams 2000). For example, the correlation between hot temperature and violent crime is generally stronger during weekend evenings and nighttime hours when the temperatures are cooler and around pubs and nightclubs (e.g., Allen et al. 2003; Bushman et al. 2005; Tierney & Hobbs 2003). Another study found that robbery rates tend to increase in the evening during the fall when the sun sets earlier and tend to decrease in the spring when the sun sets later (Doleac & Sanders 2013). Moreover, congregation of a handful of individuals in public places (e.g., during festivals) can lead to identification and social cohesion (Whitehouse & Lanman 2014). All else being equal, social contact appears to be a necessary, but not a sufficient condition for the occurrence of violent crime. In addition, much violence occurs inside of the home among family members and close friends, rather than outside of the home (e.g., DeWall et al. 2016; Krahé 2017).

Third, various studies that have examined climate differences and violence around the world have included countries with high average temperatures and small seasonal variation (e.g., India, Indonesia, Kenya, and sub-Saharan Africa [see Burke et al. 2015; Simister & Van de Vliert 2005; Van de Vliert 2009]). However, many studies on the association between temperature and aggression or violence, especially field studies and laboratory experiments, have been conducted in the United States. But even within the United States, the General Aggression Model and the Routine Activity Theory cannot explain some other violence-relevant attitudes that are quite different for most states in the South versus those in the North. For example, in most Southern states, there is greater approval and support for corporal punishment, gun ownership, and capital punishment than in most Northern states (Shackelford 2005). Several scholars have argued that pro-violence attitudes in the South are characterized by

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"machismo," masculine aggression (Simister & Van de Vliert 2005), or a "Southern culture of honor," an ideology justifying the use of violence for self-defense and defense of one's "honor" or reputation for being strong, tough, brave, and manly (e.g., Cohen 1996; 1998; Cohen & Nisbett 1994; 1996; Cohen et al. 1996; 1999; Nisbett 1993; Nisbett & Cohen 1996).

Some scholars have proposed that the Southern culture of honor in the United States developed in response to the herding economy of the frontier region of the South (Nisbett & Cohen 1996). Because herding (more than farming) places an individual at risk for losing everything from theft, and because the South was a frontier region where the state had little power to prevent or punish theft of property, individuals created and enforced their own system of law and order defined by "the rule of retaliation." However, it is not clear why the Southern culture of honor still exists today, especially because the modern South is not based on a herding economy and is not lawless (Shackelford 2005). It is possible that the psychological mechanisms underlying the behavioral manifestations of the Southern culture of honor were selected as a solution to some other adaptive problem characteristic of the South (vs. North).

To summarize, although contemporary explanations of cultural differences in violence provide compelling cultural accounts of violence, they have conceptual and methodological limitations. The explanations focus more on behavioral patterns than on underlying mechanisms. The culture of honor hypothesis focuses on historical determinants in particular regions of the United States. Perhaps most importantly, the explanations do not account for the climate differences that may underlie the exceptionally large and widespread differences in violent crime within and between various countries around the world.

3. CLASH: A model of CLimate, Aggression, and Self-control in Humans

Through our CLASH model (see Fig. 1), we seek to explain differences within and between countries in terms of temperature, especially seasonal variation in temperature. Using an extension of Life History Theory and the broader literature on time orientation and self-control, we advance two propositions suggesting that temperature-related aggression and violence can be understood in terms of time orientation and self-control. Although theoretical in nature, the propositions are rooted in research conducted in various disciplines of the social and behavioral sciences, with an emphasis on social and evolutionary psychology.

Our proposals are organized around calls for the development of more interdisciplinary theories. Three broad categories of factors that influence aggression and violence levels in countries and regions are: (1) climatological, (2) evolutionary, and (3) psychological. Our goal is not to exhaustively catalogue the many factors that influence aggressive and violent behaviors. Rather, we seek to advance the theoretical understanding of the pronounced differences in aggression and violence within and between countries around the world. Unlike other explanations that focus primarily on average differences in climate (hot vs. cold climates), we focus on average temperature

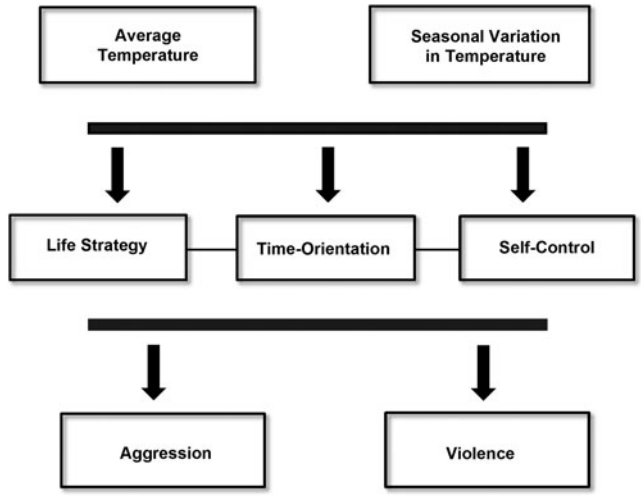

Figure 1. A model of CLimate, Aggression, and Self-control in Humans (CLASH)

and especially the broad influence of seasonal variation in climate (small or big annual differences within a location) on life strategy, time orientation, self-control, aggression, and violence. Thus, our CLASH model provides a novel perspective from which to observe why countries and regions closer to the equator tend to have higher levels of aggression and violence than do countries farther away from the equator.

The key climatological variables that influence aggression and violence are average temperature and seasonal variation in temperature. Of course, climate also entails such variables as rainfall, wind, water availability, and climate indices (e.g., El Niño Southern Oscillation Index). We focus on temperature for three reasons. First, the extant body of research has examined primarily temperature as the key climatological variable (e.g., Van de Vliert 2013a). Second, a recent meta-analysis has revealed that the association between temperature and conflict is at least four times as strong as the association between rainfall and conflict (Burke et al. 2015). Third, for most countries, there is greater predictable seasonal variation in temperature than in other climatological variables such as rainfall. Thus, although we share the view that climate differences in terms of averages and seasonal variability differ in several interesting respects, we focus on temperature rather than precipitation as the key variable.

In the next section, we discuss in detail two propositions that provide the foundation for our CLASH model. One broad assumption of CLASH is that adaptation to various climates is reflected in slow and fast life strategies, in differences in time orientation and self-control, and in differences in aggression and violence levels. *Proposition 1* states that lower temperatures and especially greater seasonal variation in temperature call for individuals and societies to adopt a slower life strategy, a greater future orientation, and greater self-control. *Proposition 2* states that lower temperatures and especially greater seasonal variation in temperature help individuals and societies evolve to be less aggressive and less violent in situations requiring future orientation and self-control. As with all scientific propositions, these propositions are subject to revision, refinement, and progress. Our primary goal in formulating CLASH is to propose a new theoretical model, and the

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propositions should help researchers develop and test specific hypotheses relevant to CLASH.

3.1. Proposition 1

One key lesson of evolutionary theory is that resources for survival and reproduction are not infinite. Hence, a basic challenge to all organisms is the successful allocation of resources needed for survival and reproduction. Natural selection favors *resource allocation strategies* that, in response to environmental conditions, enhance an organism's inclusive fitness over the life span (Ellis et al. 2009).

A prominent theory that focuses on how different resource allocation strategies arise from different exposures to environmental conditions is Life History Theory (Hill 1993; Kaplan & Gangestad 2005; MacArthur & Wilson 1967; Pianka 1970). This theory concerns the allocation of finite resources across different fitness-relevant activities. According to some theorists, two features of an environment are essential for psychological development and adaptation: harshness and unpredictability (Ellis et al. 2009; Griskevicius et al. 2011). Harshness refers to the rates of mortality and morbidity caused by largely uncontrollable factors (e.g., high rates of infectious disease [Frankenhuis et al. 2016]). Unpredictability refers to the uncertainty of future outcomes. The environmental threats of harshness and unpredictability, in combination with the resources available for coping with environmental threats, largely determine how stressful an environment is. These are features that are often reflected in higher morbidity and mortality (Adler et al. 1993; Chen et al. 2002).

Life History Theory proposes that people adapt to (un)harshness and (un)predictability by adopting either a fast (slow) life history strategy. Relative to slow life strategies, fast life history strategies are associated with reproducing at an earlier age, having more uncommitted and less stable sexual relationships, having more children, and investing less time, effort, and resources in each child. Also, relative to slow strategies, fast life strategies tend to be associated with short-term planning, greater risk taking, a focus on immediate gratification for short-term benefits, and more aggression (e.g., Ellis et al. 2009; Frankenhuis et al. 2016; Griskevicius et al. 2011; Nettle 2010; Simpson et al 2012). Thus, Life History Theory posits that people adapt to harsh and unpredictable environments by adopting faster life strategies. Because the future is unpredictable and people tend to die sooner in such environments, it is adaptive for people to enact fast life strategies because delayed payoffs may never be realized. In contrast, in environments that are unharsh and predictable, people adopt slower life strategies. Because the future is more predictable and people tend to live longer in such environments, it is adaptive for people to enact slower life strategies because delayed payoffs are likely to be realized (Ellis et al. 2009; Griskevicius et al. 2011; Simpson et al. 2012).

An abundance of research has supported this view. As noted earlier, threats of harshness and unpredictability are often reflected in higher morbidity and mortality. Lower socioeconomic status (SES) is related to nearly all forms of morbidity and mortality (Adler et al. 1993; Chen et al. 2002; Miller et al. 2011). From a life history perspective, one might expect that low-SES individuals should enact faster life strategies than high-SES individuals because they are more likely to suffer premature disability and death (Adler et al. 1993; Chen et al. 2002; Miller et al. 2011). Indeed, lower SES is associated with a number of fast life strategies, such as earlier sexual activity (e.g., Ellis et al. 2003; Kotchick et al. 2001), higher rates of adolescent pregnancy and childbearing (e.g., Ellis et al. 2003; Miller et al. 2001), greater number of offspring (Vinning 1986), and lower levels of parental investment per child (e.g., Belsky et al. 1991; Ellis et al. 1999).

Similar observations can also be made for other factors in environmental harshness and unpredictability. For example, past research has indicated that there is a greater likelihood for individuals growing up in harsh and unpredictable family environments (e.g., homes with a lot of fighting between family members) to experience faster sexual maturation, earlier age of reproduction, and higher reproductive rates (e.g., Chisholm 1999; Kim et al. 1997). Moreover, neighborhood deterioration and danger (e.g., assaults, muggings, burglaries, thefts, presence of gangs and drug addicts) are associated with earlier sexual activity and higher rates of risky sexual behaviors (e.g., Lauritsen 1994; Upchurch et al. 1999). Furthermore, as resources become increasingly scarce, females increasingly prefer mates who have access to resources, and parents increasingly invest in their offspring's reproductive value (e.g., Bugenthal & Beaulieu 2004; Durante et al. 2015; Kruger et al. 2008).

Our CLASH model extends Life History Theory. In particular, Life History Theory emphasizes unpredictability and harshness as sources of environmental stress, whereas CLASH emphasizes predictability as a source of control over environmental stress (see also Ellis et al. 2009). By control we mean the actions that can be taken to adapt optimally to predictable change, especially in preparation for predictable harsh circumstances. Although control is always low in unpredictable situations, it can be high in predictable situations. CLASH proposes that the combination of predictability and control shape a slow life strategy, a future time orientation (e.g., an orientation relevant to planning purposes), and a focus on self-control (to control short temptations and pursue long-term goals).

CLASH proposes that greater distance from the equator is associated with a slower life strategy, a stronger future orientation, and a greater focus on self-control. The key explanatory variables are average temperature and seasonal variation in temperature (see Fig. 1). In regions closer to the equator, the climate is warmer and less variable per season, and so individuals have less of a need to plan ahead to ensure survival and reproduction. That is, there is little need to focus on the future, develop a longer time perspective (Kruger et al. 2008), or exercise self-control (Baumeister et al. 2013). Moreover, societies closer to the equator are also relatively harsh and unpredictable. Hot temperatures can be an important source of stress, not only in terms of everyday life, but also as a threat to harvests in agriculture. Another source of harshness and unpredictability is pathogen stress. Indeed, the prevalence of parasitic and infectious diseases, such as malaria and the Zika virus, is considerably higher in countries closer to equator (e.g., Guernier et al. 2004), which poses a threat to survival and may activate human affect, cognition, and behavior, such as direct vigilance, stress, and escape (e.g., Fincher & Thornhill 2012; Fincher et al. 2008). Also, there is some evidence that the risk of

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natural disasters tends to increase as distance to the equator decreases (National Oceanic and Atmospheric Administration 2016).

In societies more distant from the equator, people face both lower temperatures and greater seasonal variation in temperature. Both characteristics, but especially seasonal variation in temperature, should give rise to a slower life strategy, a stronger future orientation, and a stronger focus on self-control. Although there is some harshness in these societies, there is also predictability – events are largely controllable in terms of planning and "coping." In particular, individuals in these societies realize that they need to plan and prepare for the next season. For example, food supply is less plentiful and less varied during winter, posing a serious threat to health. Yet the quality and quantity of food supply can be promoted by adopting a future orientation (e.g., planning) and by exercising self-control (resisting the temptation to consume the harvest directly, a commitment to work hard to optimize the harvest for later [Ainslie 2013; Baumeister et al. 2013]). Indeed, an analysis of work-related values in 40 countries revealed that countries located farther from the equator tend to place greater value on future-oriented rewards such as perseverance and thrift (Hofstede 2001). In the next sections, we discuss empirical evidence relevant to CLASH.

3.1.1. Fast versus slow life strategy. According to CLASH, people in regions with lower temperatures and greater seasonal variation in temperature tend to adopt a slower life strategy. Distance from the equator is a good approximation for lower temperatures and greater seasonal variation in temperature. Consistent with our prediction, life expectancy is lower for countries closer to the equator than for countries farther from the equator. For example, in several African countries, Haiti, and Pakistan, life expectancy is lower than 65 years, whereas in many European countries and North America, life expectancy is higher than 80 years (World Health Organization 2013). Of course, there are some exceptions, most notably high-latitude countries near Russia (with life expectancies often lower than 70) and low-latitude countries such as Ecuador, Thailand, and Indonesia (with life expectancies of 70 or higher).

As noted earlier, one of the strongest and most objective indicators of slow versus fast life strategy is the mother's age at the birth of her first child. According to the World Factbook (Central Intelligence Agency 2014), the mother's age at first birth is less than 20 (on average) in countries closer to the equator (e.g., Gaza Strip, Liberia, Bangladesh, various middle African countries such as Kenya, Mali, Tanzania, Uganda). In contrast, mother's age at first birth is greater than 28 (on average) in countries further from the equator (e.g., Japan, Canada, and nearly all European countries). There are some exceptions to this general rule, such as Hong Kong and Singapore. Within the United States, a similar albeit less pronounced trend is observed (National Vital Statistics Reports). The five states with the lowest maternal age at first birth are located in the South: Mississippi (22.5), Arkansas (22.7), New Mexico and Louisiana (23.0), and Oklahoma (23.1). In contrast, the five states with the highest age at first birth are in the North: Massachusetts (27.8), Connecticut (age 27.2), New Jersey (27.1), New Hampshire (26.7), and New York (26.4).

Research also supports our hypothesis that a slow life history strategy is characterized by behaviors that reflect long-term planning, such as more restrictive reproductive behavior with greater parental investment in offspring. Under predictable environmental conditions, slower life history strategies would be better for enhancing an individual's inclusive fitness. Even when some harsh conditions become predictable, some control can be exerted by anticipating, preparing, and planning activities relevant to these conditions (e.g., Griskevicius et al. 2011). In these kinds of predictable and controllable environments, individuals contribute to their own embodied capital (e.g., growth and maintenance of their body and mind, accumulation of knowledge and skills [Mittal & Griskevicius 2014]). Thus, there is growing evidence that predictable environments tend to promote a slower life strategy, in terms of lower mortality and morbidity, delayed reproduction, and higher contributions to one's own embodied capital.

3.1.2. Time orientation and self-control. One key assumption in CLASH is that the harshness and predictability of the environment influence time-orientation and self-control.

In this section, we review the empirical evidence relevant to similarities and differences within and between countries in terms of both time orientation and self-control. Before doing so, we outline the differences between these two concepts and then provide a brief general review of time orientation.

Time orientation is strongly connected to concepts such as "time perspective" and "temporal discounting." It is also closely linked to self-control and related concepts such as delay of gratification and impulsivity. An orientation to the present is linked to lower levels of self-control than an orientation to the future (e.g., Baumeister et al. 1994). However, it is important to distinguish between the broad concepts of time orientation and self-control. Self-control is generally conceptualized as the ability to resist and manage "temptations" and "impulses" (see Baumeister & Tierney 2011; Joireman et al. 2008), whereas time orientation is generally conceptualized as an orientation to the present versus the future (cf. Boniwell & Zimbardo 2004; Joireman et al. 2003).

Time has objective or at least consensual features, such as "geography" and "clock time" (Boniwell & Zimbardo 2004; Snyder & Lopez 2009). Yet people experience time differently across countries around the world. For example, comparison of the United States with Brazil with respect to time reveals large differences (Levine 2006). In the United States, the conception of time emphasizes the urgency of using time efficiently, making every minute count (Levine et al. 1980). In contrast, in Brazil public clocks and personal timepieces often are intentionally set at different times (with differences up to 20 min), students often come late to class, and individuals often come late to formal appointments. Some of these differences may also be reflected in language. Countries farther from the equator emphasize the "extrinsic" value of time (e.g., "time is money"), whereas countries closer to the equator emphasize the "intrinsic" value of time. For example, in Mexico the phrase "give time to time" (*darle tiempo al tiempo*) is common; in Africa, the phrase

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"even the time takes its time" is common; and in Trinidad, the phrase "any time is Trinidad time" is common (Levine 2006). Other scholars have distinguished between clock-time cultures and event-time cultures. Clock-time cultures are more future oriented than are event-time cultures. For example, the United States and Northern European countries are clock-time cultures that rely heavily on schedules and punctuality, whereas most countries in Latin America are event-time cultures that go with the natural flow of social events (Brislin & Kim 2003; Levine 2006).

Some research has focused on "pace of life," defined in terms of rapidity or density of experiences, perceptions, and activities (Werner et al. 1985, p. 14). A slower pace of life corresponds to a present orientation, whereas a faster pace of life corresponds to a future orientation. An analysis of individuals from 31 countries found that individuals from colder countries located further from the equator had a faster pace of life than did individuals from warmer countries located nearer the equator (Levine & Norenzayan 1999). Pace of life was measured using three behaviors: (1) the average walking speed of individuals, (2) the average time needed for a routine transaction in a post office, and (3) the average accuracy of public clocks. Another study comparing Fresno, California, with Niteroi, Brazil, found that public clocks and personal time pieces were less accurate in Brazil and that Brazilians were more likely to be late for appointments, were more flexible in their definitions of *early* and *late*, were less likely to attribute being late to internal factors, were less likely to express regret over being late, and were less likely than Americans to rate punctuality as an important characteristic in a businessperson or friend (Levine et al. 1980). Niteroi, Brazil, is located much nearer the equator than Fresno, California.

Unfortunately, large cross-national studies on self-control are relatively sparse. Most studies on self-control are conducted in the United States, and if they are cross-national they often include countries from similar global regions. Also, some studies use domain-specific assessments of self-control (e.g., dieting) or antisocial behaviors that are not aggressive (e.g., truancy). One exception is a recent study that examined a self-report measure of self-control among children (Botchkavar et al. 2015). This study found higher levels of self-control in Northern European countries (e.g., Scandinavian countries, Iceland) than in Southern European countries or the United States. This finding, along with findings from cross-national studies on time orientation, provides some initial evidence for greater levels of self-control in countries farther from the equator.

3.1.3. Conclusions. Taken together, the empirical evidence supports the proposition that individuals and cultures are more likely to adopt a slower life strategy and to become more future oriented and less present oriented, as average temperatures decrease and seasonal variation in temperature increases. We should acknowledge that most studies involve comparisons among only a few countries, although a few studies have compared more than 20 countries. Moreover, various third variables may account for these differences. For example, there might be a positive association between a country's wealth or prosperity and future orientation (Milfont & Gapski 2010). It is also noteworthy that the evidence typically yields support across a variety of indicators of time orientation and that very few studies yield conflicting evidence. Unfortunately, the "ideal" study remains to be conducted. Such a study would correlate distance from the equator and average and seasonal variation in temperature with time orientation and self-control. For a comprehensive test of Proposition 1, we recommend the use of self-report measures of both time orientation and self-control, but also instruments or assessments that do not rely on self-reports, such as unobtrusive behavioral measures. Thus, although conclusive evidence has not yet been obtained, the available evidence provides a relatively coherent picture that certainly is in line with Proposition 1 of CLASH (see Fig. 1).

3.2. Proposition 2

CLASH proposes that average temperature and seasonal variation in temperature have shaped the evolution and development of different adaptations in terms of life strategy, time orientation, and self-control. In this section, we discuss research on the link between temperature and seasonal variation in temperature and aggression and violence, along with the mediating roles of life strategy, time orientation, and self-control (see Fig. 1). That is, we advance the proposition that in regions with lower temperatures and greater variation in temperature, aggressive and violent behaviors are less likely because individuals have adopted a slower life strategy, a longer time orientation, and a higher level of self-control to adapt to their environment.

There is evidence that time orientation is linked to aggression and violence. Earlier research revealed that "delinquents" are more likely to think about the short-term than the long-term consequences of their actions (Gottfredson & Hirschi 1990; Pratt & Cullen 2000). Other studies have found that experimental manipulations of "future self" reduce cheating in testing situations (Van Gelder et al. 2013; 2015). Also, several studies have investigated the role of time orientation in human cooperation, selfish behavior, and aggressive impulses. For example, people who are more prone to adopt a future orientation conserve natural resources (Kortenkamp & Moore 2006), support structural solutions to social dilemmas (Van Lange et al. 2013), and resist the urge to respond aggressively when insulted (Joireman et al. 2003).

The anticipation of future interaction is a powerful determinant of unselfish and cooperative behavior in social dilemmas (Van Lange et al. 2011). Similarly, adopting a long-time orientation in relationships inhibits selfish and retaliatory responses in close relationships (Rusbult & Van Lange 2003). A future orientation is negatively correlated with trait aggressiveness (Joireman et al. 2003; Zimbardo & Boyd 1999), hypothetical aggression in scenarios (Joireman et al. 2003), aggressive driving (Moore & Dahlen 2008; Zimbardo et al. 1997), and actual aggressive behavior, that is, willingness to administer electric shocks to another person in a laboratory experiment (Bushman et al. 2012). Thus, we conclude that a future orientation reduces selfish and aggressive behavior.

There is considerable research on the association between self-control and aggression and violence. In fact, one of the best predictors of violent criminal behavior is low self-control (see Gottfredson & Hirschi 1990). Indeed most murders committed in the United States are

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due to unchecked anger (FBI 2015). When angry feelings and violent urges become activated, self-control is what keeps them in check. Aggression often starts when self-control stops. Interestingly, experimental research has shown that self-control exercises can decrease aggression. In one experiment, for example, participants who had previously completed a measure of trait aggressiveness were randomly assigned to complete self-control exercises using their nondominant hand for everyday tasks (self-control training condition) or to answer math problems (control condition) for 2 weeks (Denson et al. 2011). After 2 weeks, participants were provoked by a confederate in the laboratory and were given the opportunity to retaliate by administering aversive noise blasts to the confederate thorough headphones. The results indicated that the self-control exercises decreased aggression, especially for individuals high in trait aggressiveness. Another experiment found that partners who practiced self-control were less aggressive toward their loved one than were partners who did not practice self-control (Finkel et al. 2009). Thus, there is strong evidence that self-control can inhibit aggression and violence.

Recent research that has examined nearly all variables included in our model (Fig. 1) – measures of life history strategy, time orientation, self-control, and aggression – found that longer life expectancy is associated with an increase in the willingness to engage in behaviors reflective of a slow life strategy, whereas shorter life expectancy is associated with an increase in the willingness to engage in behaviors reflective of a fast life strategy (Dunkel & Mathes 2011). Shorter life expectancy is also related to short-term mating and less self-control, including greater willingness to engage in aggression, sexual coercion, and violent criminal acts, whereas the opposite is observed for longer life expectancy (Dunkel & Mathes 2011; Dunkel et al. 2010a; 2010b). When facing environmental uncertainty, individuals adopt a present orientation that is reflected in a fast life strategy, which in turn leads to more risk taking in phenotypic strategies related to reproductive success, such as interpersonal aggression (Kruger et al. 2008). More generally, these findings are consistent with our larger claim that fast and slow life-history strategies are linked to time orientation and self-control, which are likely to inhibit aggressive and violent behavior. At the same time, we should note that future research should examine the mediating role of time orientation and self-control on aggression and violence.

3.3. Conclusions

Individuals developing in warmer climates, where there is little seasonal variation and the environment is harsh and unpredictable, tend to adopt faster life strategies, a stronger present orientation, and lower levels of self-control. In contrast, individuals developing in colder climates, where there is much seasonal variation and the environment is not as harsh and highly predictable, tend to adopt slower life history strategies, a stronger future orientation, and higher levels of self-control (see Fig. 1). These mechanisms are essential to the development of aggression and violence. We are not suggesting that orientation to the future and high levels of self-control serve to inhibit all forms of aggressive behavior or violence. Our CLASH model focuses on "hot," impulsive, reactive aggression and violence, for which longer time orientation and self-control are especially relevant.

4. CLASH: The ubiquity of climate (and latitude)

CLASH is not the first model to emphasize the important role of climate in affecting human thought, affect, and behavior. Indeed, climate is increasingly considered a powerful determinant of human behavior across a variety of scientific disciplines, including biological and evolutionary sciences (e.g., Epstein 1999), economics (e.g., Burke et al. 2015), and psychology (e.g., Van de Vliert 2013a). In these disciplines, several topics are now being studied (e.g., health, welfare, happiness). Likewise, the empirical relationship between higher temperatures and increased violence has been demonstrated in many settings. For example, a meta-analysis found substantial effects of temperature increases on the likelihood of interpersonal and intergroup conflict around the world (e.g., Burke et al. 2015): One standard deviation increase in temperature was associated with a 11.3% increase in intergroup conflict and a 2.1% increase in interpersonal conflict. Examples of the increase in interpersonal conflict include spikes in domestic violence in India and Australia, greater likelihood of assaults and murders in the United States and Tanzania, ethnic violence in Europe and South Asia, and civil conflicts throughout tropical countries. We conclude that differences in average temperature and differences in seasonal temperature variation both help explain cross-national differences in aggression and violence around the world.

As noted earlier, distance from the equator can be used as an approximation of higher temperatures and smaller seasonal variation in temperature. In adopting that proxy, note that the term *equator* is not only defined geographically (at 0° latitude). The meteorological equator is located north (at 6°N) and what has been termed the "biological equator" is even further north of the geographical equator (at 10°N [see Aschoff 1981, p. 481]). The biological equator is characterized by maximal ground temperatures, converging winds, and maximal cloudiness and rainfall. Although it is logical to use the biological definition of the equator (because of maximal ground temperatures), it is not entirely clear whether the biological definition is superior in terms of seasonal variation in temperature. Future research should consider all three definitions of the equator (see Douglas & Rawles 1999). Furthermore, although distance to the equator can serve as a proxy, more precise predictors would be average annual temperature and seasonal variation in temperature. These sources are readily available and would help test the predictive ability, validity, and generality of CLASH across life strategies, time orientation, and self-control, as well as aggression and violence.

From an evolutionary perspective, hot and cold climates have posed divergent problems to human survival, which have required distinct psycho-behavioral adaptations (Murray 2013; Van de Vliert 2013a; Van de Vliert & Tol 2014). The adaptive problems posed by very hot and very cold climates vary in their immediacy. In colder regions further away from the equator, the major challenge is to "heat and eat" (e.g., Van de Vliert 2009), each of which requires coordination and planning in terms of timely harvesting, production of goods, and maintenance of stock and

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supplies. In regions closer to the equator, people face different and often more immediate challenges. As noted earlier, in warmer climates, it is not only the heat itself that challenges survival, but also pathogens and predators (e.g., Epstein 1999; Fincher & Thornhill 2012; Schaller 2006; Thornhill & Fincher 2011). Pathogen stress is strongly related to distance from the equator because temperature is an important determinant of disease transmission. Closer to the equator, where there is less seasonal variability, there is no cold winter to kill the many viruses and bacteria native to these areas (Schaller & Murray 2008).

Cold winters kill not only viruses and bacteria, but also the hosts that transmit them, such as mosquitoes that transmit malaria to humans (Blanford et al. 2013). Infectious diseases, which proliferate in hotter climates, are an important cue of environmental harshness and unpredictability because they have caused more deaths in traditional equatorial cultures than predators, natural disasters, and war combined (e.g., Gurven & Kaplan 2007; Inhorn & Brown 1990). Because environments closer to the equator are characterized by harsher and more unpredictable conditions, Life History Theory predicts that the individuals living there place greater value on the present more because they have a lower life expectancy. Predation risk is another cue to environmental harshness and unpredictability prevalent in hot climates with less seasonal variation in temperature. In these warmer locations live more dangerous animals, especially venomous animals, that can lower life expectancy and motivate individuals to adopt a faster life strategy, along with a stronger present orientation and a weaker focus on self-control.

5. CLASH: Caveats and future directions

As a model, CLASH is parsimonious because it focuses on two climatological variables (average temperature and seasonal variation in temperature). It is also a general model because it generalizes across socioeconomic and political-historical variables. Of course, this is not to imply that socioeconomic and political-historical variables do not influence aggression and violence. Indeed, some socioeconomic and political-historical variables are themselves (strongly) influenced by climate, so that they become "bad controls" for cleanly examining the causes of aggression and violence (cf. "bad controls" [see Burke et al. 2015]). Nevertheless, we suggest the relevance of some key variables that might enter our CLASH model. We call them "other key variables" because it is logically impossible to assign them the exclusive status of moderating variables, as they may be influenced by climate as well. For example, it is possible that a variable (e.g., wealth) can both mediate and moderate the effect of variable x (e.g., seasonal variation in climate) on variable y (e.g., time orientation) (for a discussion, see Hayes, 2013).

5.1. What about the role of wealth?

Do all people respond and adapt in similar ways to climate differences? There is some evidence that people from lower social classes, who typically have fewer resources, are more likely to adopt a fast life history, including the desire to reproduce sooner. Consistent with Life History Theory, a key variable is whether people grew up in a resource-scarce or resource-rich environment (e.g., Griskevicius et al. 2011). It is possible for people who face great seasonal variation in temperature to adapt in ways that make them more resourceful by devoting effort to preparing for the future, individually and collectively. When seasonal variation in temperature is low, less preparation and planning are needed, which may result in less building for the future, individually and collectively. This reasoning is consistent with CLASH and suggests that over time, cultures have evolved such that economic growth and prosperity decrease as distance to the equator decreases. Also, this reasoning may help explain the existence of what has been described as the equatorial Grand Canyon, a hot belt several thousand kilometers around the equator, characterized by an exceptionally large concentration of lower-income countries (e.g., Landes 1998; Parker 2000). Thus, violence and poverty often operate in concert because they are both rooted in a fast life strategy and focus on the present and little self-control.

A complementary line of reasoning may be derived from the Climate-Economic Theory of Freedom (Van de Vliert 2009; 2013a), which emphasizes the combination of demanding climates and monetary resources. One especially relevant prediction of this theory is that monetary resources matter more in demanding climates: The rich can cope well because of their resources and even come to view demanding climates as challenging, but to the poor, demanding climates pose a genuine threat to survival. There is good evidence for this model in other social domains. A longitudinal study involving 123 countries found that generalized trust in strangers is determined by climate, primarily among the wealthier countries (Robbins 2015). Another study involving 74 countries found that adults in increasingly demanding cold or hot climates value cooperative enculturation of children if their society is richer, but value egoistic enculturation if their society is poorer (Van de Vliert et al. 2009).

These findings are in line with the Climate-Economic Theory of Freedom (for more evidence, see Kong 2013; Van de Vliert 2011b; 2013a) and underline the link of climate and wealth to self-control and aggression. On the basis of this theory it might be predicted that traits such as fast life strategy, time orientation, and self-control evolve especially among those who have plentiful resources. Those with fewer resources are not only more likely to adopt a faster life strategy, a stronger present orientation, and less self-control, but also they may face more fiercer conflicts over resources that might trigger aggression and violence.

5.2. Linear or curvilinear?

A classic issue in research on temperature and violence is whether the relationship between temperature and violence is linear or curvilinear (e.g., Baron & Bell 1975; 1976; Bushman et al. 2005; Hsiang et al. 2013). This debate is quite complex and becomes even more complex in CLASH, which focuses on both average temperature and seasonal variation in temperature. When the focus is only on temperature, there is support for a curvilinear relationship. There is considerably more aggression and violence in warm climates than in cold climates, yet there is somewhat less aggression and violence in hot climates,

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that is, climates with average annual temperatures that exceed 24°C (75.2°F), which often are located inland and very close to the equator (see Van de Vliert 2013a; Van de Vliert et al. 1999). Although comparisons between countries reveal a curvilinear relationship, comparisons within countries reveal a linear relationship. For within-country comparisons, which is our primary focus, it is important to note that many countries do not exceed the inflection point of 24°C (e.g., 60 of the 136 countries examined by Van de Vliert et al. [1999]; see also Bushman et al. [2005]). As a case in point, for comparisons within the United States, or within European countries such as Italy, or even within Europe as a continent, the parsimonious linear model is preferred over more complex, curvilinear models. Of course, for countries where the annual temperature exceeds 24°C, a different model should be advanced (see Van de Vliert et al. 1999). We recognize that CLASH is challenged in specifying how seasonal variation in temperature helps account for any deviation from linearity in the relationship between temperature and violence at the global level. Also, it is possible that the picture may be complicated by variables other than average temperature and variation in temperature, for example, differences in elevation, rainfall, distance to the ocean or sea, wind patterns, and factors linked to these geographical and climate differences, such as possibilities for agriculture, population density, and economic opportunity. For example, agriculture challenges planning and self-control, and "harbor cities" also challenge planning, self-control and organizational skill. In our view, this challenge is both theoretical and empirical and, therefore, in need of future research.

5.3. Future tests of CLASH: Many roads to Rome

5.3.1. From distance to the equator to direct tests of CLASH. The extant literature on the link between temperature and aggression has emphasized distance from the equator as an important variable. Distance from the equator is only an approximation of average temperature and seasonal variation in temperature. Both temperature and seasonal variation are determined not only by distance from the equator, but also by distance from the ocean or sea. The smaller the distance from the ocean, the less continental the climate and, therefore, the smaller the variation in seasonal temperature. Oceans make the climate milder. Continental climates are characterized by very hot summers and very cold winters and may have the strongest influence on time orientation, resulting in slower life history, stronger focus on the future and self-control, and therefore lower levels of aggression and violence. Furthermore, differences in elevation are also linked to climate. Regions at higher elevations are characterized by extremely cold temperatures. Other variables correlated with climate (e.g., seasonal precipitation) also call for planning and self-control, but are less strongly related to aggression and violence (see Burke et al. 2015). Thus, other geographical variables determine climate and may be important variables in CLASH.

In most research, it is possible to adopt a bottom-up ("data-driven") or a top-down ("theory-driven") approach. The bottom-up approach seeks to include many variables as predictors ("causes") and criterion or dependent variables ("effects"). The technique is a regression-analytic approach (or a variance-accounted-for approach [Batson et al. 2003]) that helps organize the predictor variables economically to optimize their joint ability to account for as much variance in aggression and violence as possible. This bottom-up approach allows one to view a broader picture of the world of aggression and violence and to derive precise estimates of the variance accounted for by various predictor variables (e.g., see average cold and heat demands for 232 countries [Van de Vliert 2013a]). For example, through this bottom-up approach, we know that temperature, rather than rainfall, is the more important climatological determinant of aggression and violence. This bottom-up approach is exceptionally useful in testing CLASH.

We, however, recommend that the bottom-up (data-driven) approach be complemented by a top-down (theory-driven) approach. With a top-down approach, locations are preselected on the basis of average annual temperature and seasonal variation in temperature, with other variables controlled for (e.g., wealth, religiosity). This top-down approach has some empirical costs because only some countries that can be schematically organized in a 2 × 2 framework of temperature (high vs. low) and seasonal variation (high vs. low) can be compared, while controlling for other variables. This top-down approach allows illumination of the mechanisms (i.e., the mediating power of life strategy, time orientation, and self-control) underlying the presumed effects of climate on aggression and violence. Thus, there are "many (paradigmatic) roads to Rome" and many ways to deal with "bad controls" (i.e., variables that are plausibly by themselves influenced by climate [see Burke et al. 2015; Van de Vliert 2013a]). In the final analysis, we recommend a combination of the bottom-up and top-down approaches to test key aspects of CLASH. Because most prior research has used the bottom-up approach, we emphasize the added value of the top-down approach.

5.3.2. What types of aggression and violence? As noted earlier, CLASH focuses on reactive forms of aggression and violence that are due largely to poor self-control. CLASH seems especially relevant to the various forms of aggression and violence caused by "honor" threats (Nisbett 1993; see also cultural masculinity, Van de Vliert et al. 1999). Informed by a recent meta-analysis, we also suggest that many forms of aggression and violence related to climate operate not only between individuals, but also especially between groups (Burke et al. 2015). Within psychology, there is strong evidence that aggression is easily activated between groups. Groups trust each other less than individuals, and they exhibit stronger tendencies toward mutual exploitation (e.g., Reinders Folmer et al. 2012; Wildschut et al. 2003).

This raises several intriguing topics for future research. One topic is whether regional differences, religious differences, class differences, or other "cultural" differences yield conflict. If so, the name CLASH also applies to these situations (Markus & Conner 2013). Another topic is whether distrust underlies many forms of climate-related aggression and violence. The reason is that people and especially groups may be more easily provoked if they immediately attribute a negative act to aggressive intent. Distrust breeds misunderstanding and conflict, which leads to situations that can activate climate-related aggression and violence. This line of reasoning is plausible

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because research has indicated that general trust in others is weaker in countries closer to the equator (e.g., Balliet & Van Lange 2013; Robbins 2015). Furthermore, we noted earlier that pathogen stress contributes to the harshness of countries closer to the equator (e.g, Guernier et al. 2004). However, pathogen stress is also closely associated with tendencies toward collectivism, including tendencies to think and act to protect and serve the immediate social group rather than the entire collective (e.g., ethnocentrism [Fincher et al. 2008]). A strong, prosocial orientation to one's own group often can be at conflict with other groups, especially when resources are scarce. For example, when deciding on the route of noisy planes, individuals and groups may lobby or protest in favor of their own community and seek rerouting of the planes so that they fly over communities other than their own. This line of reasoning also helps illuminate why climate is more strongly related to intergroup conflict than to interpersonal conflict.

6. Concluding remarks

Several useful theories have been proposed to explain differences in aggression and violence between those who live in warmer and colder parts of a country or the world. These include the General Aggression Model (Anderson & Bushman 2002), Routine Activity Theory (Cohen & Felson 1979), and Culture of Honor Theory (Nisbett & Cohen 1996). The purpose of CLASH is not to replace these theories, but rather to offer another possible explanation of these relatively large differences in aggression and violence between and within countries around the world. CLASH focuses on differences in average temperature and seasonal variation in temperature as two key climate variables that account for differences in aggression and violence, and it reserves key roles for fast and slow life strategies, time orientation, and self-control.

CLASH helps account for differences in aggression and violence both within and between countries, regardless of the size of those countries. It is a society-level model that uses differences in the climate (a key aspect of the "physical" environment) as a starting point and then bridges psychological processes within individuals (emphasizing life strategy, time-orientation, and self-control) with social processes and outcomes at the level of groups, cultures, and societies. Most past theories of aggression and violence tended to focus on psychological process or societal differences. Thus, we believe that CLASH provides a logical and internally consistent theoretical framework that integrates psychological processes and societal differences that have evolved and ultimately are rooted in geographical locations that underlie strong differences in climate.

Although the merit of CLASH is primarily theoretical, we close by outlining some important implications for society. Assuming CLASH is accurate, it is interesting to consider that people's thoughts and behaviors may differ based on the physical circumstances their ancestors faced and that they themselves face. The world is getting smaller and smaller. Electronic and social media (e.g., WhatsApp, Twitter, Facebook, email) connect us to people all over the world. Yet people coming from differing ancestral histories and living in different locations face challenges of self-control in a variety of ways. A businessperson from London may expect a response the next day, but the alliance in Nairobi may want to take at least an extra day. If CLASH is correct, the same pattern should hold for within-country differences between a businessperson working in Chicago and the alliance working in New Orleans, or between a businessperson working in Melbourne and the alliance in Brisbane or Cairns (with London, Chicago, and Melbourne being relatively more remote from the equator and facing greater variation in climate). Although people may have an implicit or even explicit understanding of some cultural differences in time orientation and self-control, it is likely that such differences may contribute to misperceptions and misunderstandings in cross-national communication. This is important because a perceived lack of self-control may pose a serious threat to interpersonal trust, even in ongoing relationships.

The implications of cross-national communication processes are potentially far reaching, and may help illuminate challenges and problems in business transactions, in international negotiations about climate change, and even in many interactions between Northern Europeans and the refugees coming from various countries closer to the equator (e.g., Syria, Afghanistan, Somalia). Turning back to within-country variation, consider the regional differences in attitudes and communication styles even within such a (large) country as the United States (e.g., Andersen et al. 1990; Nisbett 1993). Because communicating "honor" is especially important to people living in the South of the United States, it seems advisable to adopt a respectful style of communication for business and effective negotiation with individuals from these states. Reserving judgment and giving the benefit of the doubt is probably an effective mindset, because provocation may be more quickly elicited in individuals from Southern states than in individuals from Northern states and, once elicited, more quickly translate into aggression and perhaps even violence. According to CLASH, these differences are ultimately rooted in climate differences and therefore should be relevant to understanding important differences in aggression and violence among many countries around the world.

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Dimensions of environmental risk are unique theoretical constructs

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Abstract: Life history theory serves as the foundation for the CLimate, Aggression, and Self-control in Humans (CLASH) model of aggression. However, this model embodies several misunderstandings of life history constructs and principles. The CLASH model does not recognize that environmental harshness and environmental unpredictability are unique

theoretical constructs, rendering predictions and implications from the model suspect.

Life history theory is a theoretical framework for addressing how and why organisms, including humans, allocate resources to conflicting life tasks (Del Giudice et al. 2015; Roff 2002; Sterns 1992). Life history theory is complex and rich in its predictions but is often oversimplified when applied to human psychology and behavior. Van Lange et al. (2016) also present an oversimplification of life history theory as the foundation for the CLASH model proposed to explain aggression and violence across the world. In particular, the model incorrectly specifies how environmental harshness and unpredictability affect life history strategies and behavioral outcomes. Here, we discuss three misunderstandings of life history theory expressed in the target article.

First, the CLASH model appears to conflate the constructs of environmental harshness and environmental unpredictability into a single predictor of individual variation in life history outcomes (e.g., aggression). The model correctly identifies that both environmental harshness and environmental unpredictability function to regulate life history strategies. The model incorrectly implies, however, that harshness and unpredictability are dependent constructs. Ellis et al.'s. (2009) dimensions of environmental risk – harshness and unpredictability – are independent constructs that exert *unique* influences on individual variation in life history strategies. The CLASH model of aggression specifies that environmental harshness and environmental unpredictability determine the overall stress of the environment. In turn, this overall environmental stress is predictive of aggression. Environmental harshness and environmental unpredictability can be positively associated, such that a given environment can be harsh *and* unpredictable. The CLASH model, however, does not account for, or acknowledge, that (1) dimensions of environmental risk can be inversely associated (e.g., a predictable but harsh environment), and (2) environments characterized as harsh or unpredictable are not hypothesized to be exclusively associated with fast life histories. Ellis et al. (2009) specify the conditions under which high environmental harshness and greater environmental unpredictability facilitate the adoption of either fast *or* slow life history strategies (pp. 218, 230). Whether environmental harshness or environmental unpredictability is associated with faster life history strategies is determined by age-specific rates of morbidity and mortality. Depending on whether external threats resulting from ecological factors exert greater influence on (or variation of) juvenile or adult morbidity and mortality rates, environmental harshness and unpredictability can facilitate faster or slower life histories. The CLASH model does not specify whether ecological conditions of temperature affect threats to juvenile or adult morbidity and mortality, or both. And neither does the CLASH model specify whether or how average temperature or variation in temperature differentially affect juvenile and adult morbidity and mortality.

Second, the CLASH model assumes that environmental harshness and environmental unpredictability exert similar and equal influence on specific life history outcomes over the life span. However, research has demonstrated that environmental harshness and unpredictability exert unique influence on life history outcomes at different developmental stages. For example, environmental unpredictability in childhood, but not environmental harshness, is uniquely associated with perpetration of intimate partner violence by both men and women (Barbaro & Shackelford 2016) and criminal behavior in young adulthood (Simpson et al. 2012). Other research has demonstrated that environmental harshness in adolescent years exerts unique influence on deviant behavior in adolescence, such as drug and alcohol use (Brumbach et al. 2009). Environmental harshness and environmental unpredictability may therefore uniquely predict aspects of life history strategies, including aggressive behavior, over the life span.

The CLASH model does not readily accommodate, or discuss, the possibility that the dimensions of environmental risk may exert differential influence on the outcomes of interest. Conflating environmental harshness and environmental unpredictability into a single construct of environmental stress is not warranted, and may bias the results of research guided by the CLASH model. Ellis et al. (2009) detail the properties of environmental risk dimensions and note how each dimension is associated with external threats to morbidity and mortality at various stages of development. Life history theorists, moreover, have suggested that environmental harshness and unpredictability may not exert equal influence on life history strategies (Roff 2002), such that the effects of environmental unpredictability might be smaller than the effects of environmental harshness (Del Giudice et al. 2015).

Third, the construct of environmental unpredictability is not presented accurately in the target article. The authors assert that environmental unpredictability "refers to the uncertainty of future outcomes." This definition is incorrect. Environmental unpredictability reflects the extent to which ecological factors produce variation in external morbidity and mortality threats (Ellis et al. 2009). Hypotheses derived from the CLASH model, therefore, rest on a faulty operationalization of environmental unpredictability.

The misunderstandings of life history theory embodied by the CLASH model, and the relationship between ecology and behavioral outcomes, are further evident in a primary proposition of the model. The authors suggest that greater seasonal variation in temperature should facilitate slower life history strategies, because seasonal variation necessitates that individuals "plan and prepare for the next season." However, life history theory specifies how ecology influences external threats to morbidity and mortality (e.g., increased pathogen load in the environment), which then influence the adoption of life history strategies. Because the CLASH model does not specify which external morbidity and mortality threats are affected by temperature, it is not clear how temperature is hypothesized to impact human life history strategies. For instance, temperature variation might cause greater variation in *specific* sources of external morbidity and mortality in northern environments. During colder winter months, resource availability is lower. In the hotter summer months, pathogen load and disease prevalence are greater. Greater temperature variation, then, produces greater variation in particular external threats to morbidity and mortality. It could alternatively be argued that temperature variation could lead to fast, rather than slow life history strategies.

Rather than providing an "extension" of life history theory, the CLASH model for aggression is founded on misunderstandings of life history theory. The CLASH model incorrectly specifies how environmental harshness and environmental unpredictability exert influence on life history strategies. Future applications of the CLASH model should recognize that dimensions of environmental risk are, in fact, unique theoretical constructs.

Pragmatic prospection emphasizes utility of predicting rather than mere predictability

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Abstract: Contrary to one assumption of CLASH, we suggest that colder rather than warm climates are the harsh, unpredictable ones, thus requiring greater self-control. We propose shifting emphasis from predictability to utility of prediction. Northern climates may be less predictable than tropical ones, making predictions and planning far

more important, insofar as they can prevent fatalities and promote other pragmatic benefits.

Cultures vary in many ways, including planfulness, punctuality, and violence. Van Lange et al. propose a novel, creative theory suggesting that proximity to the equator increases aggression. The mediating factors are heat (temperature), environmental predictability and harshness, life history orientation, and self-control.

We find much to admire in this (CLASH) theory, especially its emphasis on low self-control. In this brief comment, we respectfully note one problematic assertion and propose possible remedies.

The issue concerns the nature of prediction and prospective cognition. CLASH theory asserts that harsh and unpredictable climates reduce self-control. A priori, it seems one could make the opposite assumption, because self-control may be more needed for survival in harsh and unpredictable climates than in comfortably benign and predictable ones.

Harshness and unpredictability are perhaps slippery terms. Van Lange et al. assert that climates near the equator have harsher and less predictable climates than those far from it, especially in the Northern Hemisphere. We found this claim surprising and suspect many others will also. To compare the U.S. states closest to and farthest from the equator, it seems implausible to assert that Hawaii's climate is harsher and more unpredictable than Alaska's. Anecdotally, local Hawaii television stations do not bother with on-air weather reports, reportedly because the weather is so easily predictable that it seems foolish to have an expert go on camera and make essentially the same forecast every day.

The term *predictability* is perhaps slightly the wrong concept for this theory. The usual meaning of predictability refers to how accurately future events can be specified in advance. We suspect that if inhabitants (or experts) were asked to predict the high temperature on a particular day one or two months hence, their predictions would be more accurate in Hawaii than in Alaska. In that literal sense, Hawaii's climate is more predictable than Alaska's.

In contrast, a recent analysis of prospection proposed that the simple emphasis on predicting what is going to happen has misled psychological theory (Baumeister et al. 2016). Instead of predicting what is sure to occur in the future, people seek to predict points at which there are multiple possibilities and at which their own actions and responses can make a difference. This "pragmatic prospection" approach can be traced back to William James' (1890) famous assertion that thinking is for doing. In pragmatic prospection, people think about the future not because they can predict the outcomes of events, but rather because they can anticipate the choice points and performance challenges to which their responses will be decisive – because preparing for those in advance can improve one's outcomes. Thus, it is precisely because the outcomes are not known that one thinks about the future.

As one illustration, pragmatic prospection theory is at odds with the view that knowledge of one's ineluctable mortality is the paramount driving concern of all humans and the foundation of all human motivation (Pyszczynski et al. 1997; based on Becker 1973). Pragmatic prospection theory says that if thinking is for doing, there is no point in thinking about the inevitability of one's death, precisely because it is (very predictably) inevitable. In sharp contrast, people may think a great deal about an imminent, avoidable possibility of dying.

Instead of predictability, therefore, we respectfully suggest that CLASH consider incorporating something along the lines of "the utility of prediction." We suspect that Hawaii residents (and their television stations!) do not devote much effort to predicting the future weather, partly because it is so very predictable, but mainly because there is no pragmatic utility to be gained by preparing for it. In contrast, Alaskan inhabitants probably devote much more thought to upcoming weather, because they need to be prepared for wide fluctuations that include intensely cold spells. Such spells can be lethal unless one prepares for them.

If we regard Alaska rather than Hawaii as the harsh, unpredictable climate (thus reversing the assumption by Van Lange et al.), we think the pragmatic utility of prediction becomes clear. Inhabitants can reduce the danger of the upcoming winter season in Alaska by storing up warm clothes and food. Such preparations are not needed in anywhere near the same measure to get through Hawaii's "winter" (or summer) months intact.

Other evidence fits the view that the cold northern climates are the harsh ones. People seeking a pleasant respite, such as tourist vacationers and retirees, tend to move toward the equator rather than away. The slower pace of life in equatorial climates (as noted by Van Lange et al.) also suggests that life is easier and so haste is unnecessary. To be sure, extreme heat can be harsh, but as they note, aggression may decline when heat is extreme.

Might CLASH theory work even better with this slight revision? The multiple insights proposed by that theory seem quite compatible with it. Self-control and foresight are needed to prepare for eventualities, not because one knows for certain what is going to happen, but rather because one has to be ready in case something bad might happen. It takes self-control to chop wood and store food during the summer, in anticipation of winter. Hawaii's weather does not pose threats for which one can prepare. (Warm-weather deaths typically involve hurricanes and the like, which up until about a century ago were not predictable, and it was hardly feasible to live one's entire life as if a hurricane were about to happen.) Some winters are mild and others are severe, but one had best prepare for the more severe one just in case.

The accelerated life history of the equatorial cultures may be due not to unpredictability, but rather the opposite: Ease of life and predictability of future conditions may have enabled people to live for the present, rather than prepare for future challenges and threats. Indeed, the faster life history of equatorial cultures may be in part a result of their higher aggression, rather than only a cause.

Why the CLASH model is an unconvincing evolutionary theory of crime

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Abstract: The CLASH model is not convincing for two reasons. First, it ignores prior research proposing very similar ideas in a more compelling fashion. Second, it dismisses the role of genetic factors in shaping criminal propensities across population groups, opting for a facultative view of life history evolution that does not seem to square with current evidence.

Van Lange et al. suggest that two primary ecological forces, temperature and variation in temperature, contributed to variation in the life history (LH) speed of humans, which ultimately contributed to cross-national variation in criminal propensity and behavior. We agree with some of what Van Lange et al. have to say. Yet, the CLASH model is flawed because it ignores relevant literature and because it does not grapple with genetics. Most evidence

suggests that life history traits are at least partially genetically caused; we suspect that human population groups evolved different LH speeds, a plausible hypothesis Van Lange et al. ignore. We believe that it will prove difficult to explain variation in criminality without considering human population group differences and genetics. Below, we expand further on what we consider to be limitations of the target article.

J. P. Rushton was one of the first scholars, if not *the first*, to apply the concepts of LH evolution to the study of human population differences. His name is absent from the target article. Rushton (1985a; 1985b; 2000b) argued that because of variation in ecological pressures, different human population groups *evolved* different LH speeds. Specifically, population groups located close to the equator evolved faster LH traits than those further from the equator. In support of his arguments, he catalogued a host of phenotypic differences in LH traits that emerged in the population using data drawn from various population groups (Rushton 2000b). Although debate remains over parts of his work, his theory was a powerful precursor of more sophisticated LH-based attempts to explain criminality. It is therefore remarkable that Van Lange et al. completely ignore him (see Penke et al. 2007). Shortly after Rushton, Ellis (1988), and then more recently Boutwell et al. (2015), further linked LH speed to crime, yet these names too are absent from the target article. Failure to cite relevant work is not just an oversight, however. The larger consequence is a theory that is likely incorrect in key respects.

The CLASH model asserts that populations located nearer to the equator have faster LH speeds than those located farther from the equator. Yet, theirs is a very facultative explanation, one in which calibration of LH speeds appears to take place within an individual's lifetime as his or her body responds flexibly to ecological forces. A straightforward prediction of this model is that LH speeds should depend almost exclusively on where an individual is raised. Imagine an extreme version of this. According to the CLASH model, if a woman from an ancestral group that evolved near the equator moved to northern Michigan and had a child, her child's LH speed should, ceteris paribus, resemble the LH speeds of those who were raised in Michigan. The reverse should also be true. Evidence, however, strongly contradicts this. Human population groups that evolved closer to the equator for longer periods (in our ancestral past) have faster LH speeds than other groups even if they currently dwell far from the equator (Barnes et al. 2016; Rushton 2000b). It gets worse than this for the CLASH model. One can restrict one's focus to an individual state (even counties within states) and find variations in LH speeds and criminal propensities (Beaver & Wright 2011). These data are incongruous with the CLASH model. Furthermore, Figueredo et al. (2004; see also Penke et al. 2007) have noted that LH speeds are at least moderately heritable. Therefore, although the environment may play some role in modifying LH traits, genetic endowment also seems to play a strong role, and LH traits are not nearly so malleable as the CLASH model appears to suggest.

A more biologically defensible hypothesis – one, in fact, already proposed by Rushton (1985a) – would predict that variation in LH speeds across population groups exists in part because of biological adaption across those groups. After migrating from Africa, human groups lived in relative isolation from one another for thousands of years, each group facing different ecological pressures. One may object that evolution could not have fashioned differences between human population groups in such a short (in evolutionary terms) time. This does not appear true (Cochran & Harpending 2009), as recent evidence continues to mount suggesting that natural selection can operate more quickly than once assumed, making changes even in the course of a few thousand years (Beauchamp 2016). There is no reason, and Van Lange et al. do not provide one, to dismiss Rushton's hypothesis that human population groups evolved different LH speeds in response to different selective pressures. One of the pressures might have been temperature, but Van Lange et al. are silent on the issue of whether they think that temperature differences acted to change the frequency of trait-relevant genes across different population groups. This is a proposition worth testing, of course. Either way, the CLASH model needs to take more seriously the likelihood that genetic variation between population groups also explains (at least partly) variation in LH speed and, thus, in criminality. Currently, the CLASH model is like a theory that explains variation in the color of bear fur by climatological variables, ignoring genetics and group variation. It isn't *entirely* wrong – bear fur is, after all, a response to features of the environment. It is just not very helpful because it ignores the most important variables (genetics, evolutionary history, etc.).

Van Lange et al. have propounded a theory that, from our perspective, appears to represent a minor step forward in our understanding of the variation of criminal propensities. Yet, the unique hypotheses they offered are almost certainly overstated or likely incorrect (e.g., the more facultative hypotheses of LH speed). The rest of their theory is a restatement of other analyses that are more fruitful and compelling than is this incarnation of an LH approach to crime. Our suspicion, however, is that this theory's shortcomings will have the positive effect of drawing attention to those more plausible, powerful, and parsimonious analyses.

Using foresight to prioritise the present

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Abstract: Planning for the future may encourage apparently "impulsive" behaviour when the future is anticipated to be bleak. Thus, a seeming failure of self-control in reactive violence could be caused not by a disinclination to plan ahead, but by virtue of this ability. Furthermore, we point to empirical and theoretical shortcomings in the authors' case, such as a failure to distinguish proximate and ultimate explanations.

In their target article, Van Lange et al. argue that cooler temperatures and greater seasonal variation encourage future planning and self-control in countries further from the equator, leading to reduced reactive violence. Van Lange et al. draw together research from evolutionary, social, and cognitive psychology in pursuit of an integrative model. However, we do not find their model compelling. Firstly, we point out an alternative role for explicit mental planning. Secondly, we note that the authors are not clear what kind of explanation they advance and, thus, what predictions the model makes. Finally, we note some apparent inconsistencies and empirical holes in their argument.

Although people vary in their tendency to make future-oriented decisions (Kirby et al. 1999; Zimbardo et al. 1997), the capacity to travel mentally in time is a universal human ability among healthy adults, with undeniable adaptive advantages (Suddendorf & Corballis 2007). The ability to imagine future situations and organise current actions accordingly has been called *episodic foresight* (Suddendorf & Moore 2011). People frequently rely on episodic foresight when making various kinds of decisions (e.g., Gilbert & Wilson 2007), including, as Van Lange et al. acknowledge, social ones (e.g., Boyer 2008). Van Lange et al. note that "The anticipation of future interaction is a powerful determinant of

unselfish and cooperative behavior in social dilemmas" (sect. 3.2, para. 3). Indeed, as economists and psychologists have realised, the anticipated costs of antisocial behaviours can reduce a propensity for so-called "short-sighted" or "impulsive" social transgressions, like stealing and aggression that may accrue immediate benefits, for instance, in terms of material wealth or status (Boyer 2008; Frank 1988).

Thus, one of the reasons humans avoid reactive violence is that the delayed interpersonal costs of doing so can be foreseen. However, we think the role of mental time travel into the future does not end here. It may have the opposite effect when people imagine futures that are volatile, uncertain, or harsh. In those circumstances, delayed relational and coalitional costs of immediate violence may be downplayed because they are foreseen as less likely to materialise, or less dramatic against the harsh backdrop of one's expected future (see Bolland 2003; Brezina et al. 2009). For this reason, a seeming "failure" of self-control in reactive violence may sometimes be caused not by a disinclination to plan ahead, as Van Lange et al. imply, but by very virtue of this ability. In other words, prudent foresight, in certain circumstances, should lead to a general prioritisation of the present (Bulley et al. 2016; see also Daly & Wilson 2005).

A second concern is that it is not clear what reasons the authors propose for the apparent links between average temperature/seasonal variation and life history, time perspective, self-control, and aggression. Are the purported relationships driven by explicit mental reasoning (as discussed previously), individual learning, cultural evolution, an evolved genetic predisposition or calibration mechanism, or some combination of these factors? At times Van Lange et al. point to individual reasoning and foresight, for instance, when they write that individuals "*realize* that they need to plan and prepare for the next season" (sect. 3.1, para. 8). At other times, they appeal to evolutionary adaptation or developmental plasticity: "Average temperature and seasonal variation in temperature have shaped the *evolution and development of differential adaptation* in terms of life strategy, time orientation, and self-control" (sect. 3.2, para. 1). And yet elsewhere, they seem to appeal to cultural evolution: "lower temperatures and especially greater seasonal variation in temperature *helps* individuals and *societies evolve* to be less aggressive" (sect. 3, para. 4; all emphases added).

Aside from inappropriately framing evolutionary processes in terms of goal directedness (e.g., that the environment "helps" people to evolve in a certain way), such statements fail to carefully delineate proximate (mechanistic/developmental) and ultimate (phylogenetic/functional) explanations, a practice that is critical when making evolutionary arguments (Mayr 1961; Tinbergen 1963). Given the potentially socially divisive nature of some possible interpretations of Van Lange et al.'s propositions, it seems particularly important to be clear about what kind of explanation the authors advance and, hence, what testable predictions follow (e.g., if their proposed explanation is at the phylogenetic level, it could be tested with genetic or twin studies).

The authors also apply their argument inconsistently. They do not adequately explain why seasonal temperature variation should encourage planning more than other important predictable environmental stressors. For example, many hot countries north of the equator are subject to seasonably variable, but reasonably predictable, precipitation (Brown & Lall 2006), leading to significant water stress (Oki & Kanae 2006), a fact that Van Lange et al. acknowledge. Nonetheless, they choose not to focus on the effects of variability in rainfall, reasoning that (1) the effects of temperature have been more thoroughly examined in the literature, (2) the associations between temperature and conflict appear to be stronger than those between rainfall and conflict, and (3) for most countries, temperature varies more predictably than rainfall. Whilst these might be good reasons to *focus on* the effects of temperature variability, they are not good reasons to *ignore* other climatic variables, which, by applying the authors' logic, should be important. In avoiding discussion of the effects of rainfall, as well as other variables, Van Lange et al. fail to answer a key question: Why shouldn't the predictable stressors of hot climates also engender planning and self-control as per the predictable stressors of cooler climates?

There is a risk that ambiguous reasoning, aired in an esteemed journal such as this, will play into the hands of old racist prejudices about evolved inferiority of certain peoples. So we want to end this commentary with a warning that, in addition to the theoretical shortcomings already discussed, there are large empirical holes in the authors' case. For example, the target article avoids adequate consideration of the historical contexts of the regions in question (e.g., the profound consequences of slavery and colonisation for equatorial countries [see Diamond 1999]). They also sidestep potential counterexamples from near the equator (e.g., the peaceful nature of places such as Singapore [The World Bank 2013]), from history (e.g., the simultaneous planning successes and extreme violence of ancient Mesoamerican societies [see Harner 1977]), and from prehistory (e.g., that the extended time perspective characteristic of our species arguably began to evolve in African savannah–dwelling hominins [see McBrearty & Brooks 2000; Suddendorf & Corballis 2007]).

NOTE

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Inconsistent with the data: Support for the CLASH model depends on the wrong kind of latitude

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Abstract: We argue that the CLASH model makes a number of questionable assumptions about the harshness and unpredictability of low-latitude environments, calling into question the life history strategy approach used, and that it is inconsistent with more nuanced global patterns of violence. We suggest an alternative account for less violence at high latitudes, based on a greater need for cooperation.

Van Lange et al. suggest that environmental harshness and unpredictability, associated with low-latitude equatorial environments, lead to faster life history strategies, of which increased violence and aggression is one consequence. In general, we agree that factors that correlate with latitudinal climatic variation might influence relative frequencies of fast and slow life history strategies and that this could plausibly lead to different rates of aggression and violence in different regions across the world. The CLASH model, however, depends on questionable characterizations of what constitutes harsh, unpredictable environments and shaky assumptions about Life History Theory, and is inconsistent with patterns of violent crime rates in many regions of the world.

The authors make a very specific argument about environmental predictability and harshness: they equate high temperatures and low seasonal variation in temperature with high levels of harshness and unpredictability. Conversely, high seasonal

variation, including the harsh winters that occur as one approaches the poles, are described as predictable, hence less harsh. Although environmental challenges apart from temperature and its annual fluctuations will undoubtedly contribute to harshness, Van Lange et al. argue that temperature is the environmental variable with the most explanatory power regarding violence and aggression, so for the moment we will limit our criticisms to that. It seems somewhat counterintuitive to us to assert that low seasonal variations in temperature automatically produce an unpredictable environment, which would render planning for the future an unprofitable activity. Harsh northern winters, on the other hand, may well provide selection pressure for future planning – not because the environment is mild and so a long, future-focused, life history strategy generally is adaptive – but simply because, if you don't plan and stockpile, you die. It seems more valid to argue that the harshness of extreme temperature fluctuations necessitates the capacity to plan, rather than to argue that the supposed harshness and unpredictability of annually consistent temperatures preclude planning. Indeed, strong seasonality has been recently associated with rises in violent crime because groups use warm periods to loot in preparation for the coming harsh periods (Landis 2014).

As the authors argue, one factor that does contribute to environmental harshness in the tropics is pathogen prevalence; this is the main "harsh" environmental factor associated with equatorial regions. The relationship between pathogens and latitude, however, is not straightforward. Disease is more prevalent at low latitude only where it is wet. Deserts and other arid environments have relatively low disease prevalence (Stromberg 1997), and in many other respects, equatorial regions (particularly wet ones) are less harsh, with plentiful, year-round resources.

In addition to theoretical difficulties, the CLASH model is enunciated with reference to only a subset of the available empirical evidence. The evidence reviewed is derived only from the Northern Hemisphere, because most people live in this hemisphere and it has therefore been the focus of most research. Van Lange et al. omit some awkward data points even from the Northern Hemisphere (Alaska has one of the highest rates of violent crime in the United States, and Russia is considered an outlier), and the Southern Hemisphere provides very obvious exceptions to the latitudinal pattern of violence: Australia and New Zealand have low levels of violence, whereas South Africa (which is at a similar latitude) has much higher levels (with African countries between South Africa and the equatorial countries much lower). Melanesian and Polynesian islands have relatively high levels of some kinds of violence, whereas more equatorial Southeast Asia has low levels of violence.

In an analogous kind of global analysis, patterns of women's preferences for masculinity in men's faces were attributed to patterns of disease prevalence (DeBruine et al. 2010), with women in areas of higher disease prevalence adopting a faster life history strategy and a preference for cues to good genes. A subsequent reanalysis of the data, however, showed that the pattern was more parsimoniously explained by the level of economic inequality present in each country (measured by the Gini coefficient), leading to increased levels of competition in equatorial countries (Brooks et al. 2010). Given the pattern of high-latitude countries in the Northern Hemisphere being characterised by relatively high wealth and low wealth inequality, it may be that the fast life history strategies associated with equatorial, high-violence countries, may also be attributed to this increased competition over resources.

Although there is a broad global pattern of lower levels of violence in places of higher latitude (with some important exceptions), this is not obviously a consequence of such climates proximally selecting for slow life history strategies, as the model requires. One alternative ultimate-level explanation is that surviving harsh, resource-poor winters requires high levels of cooperation, and this is what has led to lower levels of interpersonal violence in such regions, as interpersonal violence interferes with cooperative enterprises.

Such adaptation might result from cultural practices, selection on dispositional characteristics, or both. And high-latitude societies have exported both their practices and institutions. Some former European colonies have low violence, possibly because democratic governance took hold in those places, irrespective of their latitude. Former colonies where economic and political institutions are extractive rather than inclusive are among the least prosperous, successful, and peaceful places today (Acemoglu & Robinson 2012).

In conclusion, although we agree that the increased violence in equatorial countries may be partially attributable to fast life history strategies, we question whether the "harsh" environment proposed as the cause of this life history variation is plausibly disease prevalence. We also suggest that other factors, not included in the model, might better account for the generally lower levels of violence at high latitudes, as well as for the complex mosaic of violence patterns across the globe.

Reply to Van Lange et al.: Proximate and ultimate distinctions must be made to the CLASH model

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Abstract: Transcending reviewed proximate theories, Van Lange et al.'s CLASH model attempts to ultimately explain the poleward declension of aggression and violence. Seasonal cold is causal, but, we contend, principally as an ecologically relevant evolutionary pressure. We further argue that futurity and restraint are life history variables, and that Life History Theory evolutionarily explains the biogeography of aggression and violence as strategic adaptation.

Van Lange et al. present the CLASH model wherein average temperature and seasonal fluctuation influence self-control and future orientation, which in turn explains aggression and violence as they vary within and between countries. The authors contrast their CLASH model, derived from evolutionary-ecological theories, such as Life History (LH) Theory, with proximate models that focus on immediate environmental effects. We agree with the authors on the need to progress toward an ultimate explanation, derived from climate and LH variation. Nevertheless, we believe that the distinction made by the authors between *ultimate* and *proximate* explanations (Scott-Phillips et al. 2011) can be more precise. Our commentary thus focuses on disaggregating the two by asking for more clarification through the following questions: (1) How do self-control and future orientation relate to LH Theory? (2) Does biogeographical variation in climate and seasonality influence self-control and future orientation facultatively, developmentally, or evolutionarily? (3) How does the CLASH model's explanation of biogeographical variation relate to previous literature that clearly links biogeographical variation to evolved racial variation?

Proximate/ultimate distinctions come from specifying whether future orientation and self-control are subordinate expressions of LH or independently evolved and predictive variables.

Pursuant to this, some approach measurement using single measures of biological or psychological traits relative to a constrained definition of LH strategy (Copping et al. 2014), whereas others approach measurement using integrated complexes of behavioral, cognitive, and psychosocial traits relative to a broad definition of LH strategy (Figueredo et al. 2015a; 2015b). Although life history is in any case a suite of strategically related traits (Stearns 1992), the broad conceptualization of Life History Theory clearly encompasses both future orientation and self-control (Figueredo et al. 2015a; 2015b). The LH variables of encephalization, intelligence, and most specifically executive control relate centrally to both future orientation and self-control, as pace of life, anxiety, and risk assumption do so peripherally. On this basis, we ask Van Lange et al. to define their approach to LH Theory, specifically commenting on whether self-control and future orientation are understood to be conceptually and empirically distinct as explicitly illustrated in their Figure 1, or simply emphasized because they are exceptionally important LH predictors of aggression and violence. As subscribers of the broad psychometric approach (Figueredo et al. 2005), we find it arbitrarily isolating and possibly erroneous to separate future orientation and self-control because suites of psychological traits, not just these two constructs, should be under the same ecological and climatologic selective pressures (Hertler 2015; 2016). To the extent that self-control and future orientation are understood as LH variables responsive to varying ratios of intrinsic and extrinsic mortality, proximate/ultimate relationships measured by the CLASH model become clearer, but with the effect of undermining the novelty of its contribution.

Clarifying the CLASH model's assumptions concerning proximate/ultimate causation also entails specifying the degree to which climatic effects on aggression and violence are evolutionary, developmental, or facultative. In other words, do average temperature and seasonality influence the decisions of adults, alter the development of children, or shape the evolution of populations? Terminology (*adopt*, *enact*, *make*), phrases ("willingness to engage in behaviors reflective of a slow life strategy"), citations of seasonal changes, and indiscriminate references to homogeneous old-world countries and heterogeneous new-world countries suggest Van Lange et al. favor facultative responses to climate, even when directly speaking of life history. In the most explicit statement to the contrary, Van Lange et al. state that "traits such as fast life [history] strategy, time orientation, and self-control evolved or developed" (sect. 5.1, para. 3). Though there is research indicative of facultative change (Dunkel et al. 2013), developmental (Mittal et al. 2015) and evolutionary (Rushton 1985a) explanations of LH strategy predominate, and can be applied dynamically when explaining biogeographical LH variation: Developmental models of LH Theory have discussed the salience of parent-child relationships and household dynamics in the development of reproductive and social strategies. Over developmental time, the family and household dynamics should either be a reflection of or a buffer against the outside environment (Belsky et al. 1991). This means individual variation should exist for these traits. However, if the same conditions persist and affect the household dynamics similarly, over phylogenetic time we should expect to see a convergence of traits across ancestors and subsequent generations, as is in fact the case judging from high heritability of life history (Figueredo & Rushton 2009), future orientation (Anokhin et al. 2015), self-control (Niv et al. 2012), and also aggression and violence (Kendler et al. 2015; Rushton et al. 1986).

CLASH would be refined by referencing additional biogeographical theories that make explicit proximate/ultimate causal inferences. Moynihan (1993) found a correlation of $r = 0.52$ between U.S. state capitals' proximity to the Canadian border and eighth grade math scores, which led to his sardonic policy proposal of moving states closer to the Canadian border. As it stands, CLASH would result in similar proposals for violence reduction. In contrast, "cold winter theories" have posited that ancestral environments produced distinct evolutionary pressures, affecting behavioral and cognitive traits (Lynn 1991). Planning, future orientation, reduced aggression and violence, conscientiousness, general intelligence, and related slow LH traits are clearly described as *evolved responses*, requisite for survival and reproduction in northerly latitudes (Lynn 1991; Rushton 1985a; Hertler 2015; see Woodley 2011 on why intelligence may not directly correlate with LH strategy).

CLASH benefited from the inclusion of LH Theory, but minimized its importance. Not only are future orientation and self-control LH variables, but so are the aggression and violence they purportedly explain. From thence stemmed confusion of ultimate and proximate. With this reorientation, we clarify our position: *Climatic variation ultimately causes evolved biogeographical LH variation, which proximally explains a complex of biological and behavioral LH traits, among which are future orientation, self-control, violence, and aggression*. Van Lange et al.'s CLASH model, with its important emphasis on biogeography, its careful review of literature, and its insightful emphasis on seasonality, is nonetheless an important spur, which may renew the biogeographical study of LH and all its component parts.

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A climate of confusion

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Abstract: I identify two confusions and omissions in the target article. Confusion arises from failure to distinguish between a genetically transmitted adaptation and a conditional response to the environment, and from the elision of individual and societal adaptations. Despite points of similarity, there is no mention of Rushton's controversial theory of the climatic basis of race differences in violent crime. Sex differences are also ignored.

Despite the authors' acknowledgement that they are not the first to link psychology with climate and that their proposal is rooted in evolutionary psychology, there is no reference to the work of J. P. Rushton. From 1985 until his death in 2012, he wrote extensively on race and crime, arguing for an evolved life history adaptation based on temperature and climate variability as proposed in the target article. Consider, for example, the following statement:

> Climate differences also influenced mental abilities. In Africa, food and warmth were available year round. To survive the cold winters, the populations migrating northwards had to become more inventive…. Making special tools, fires, clothing and shelters called for higher intelligence. Moving 'Out of Africa' meant moving into a K-type life-history strategy. That meant higher IQ, larger brains, slower growth, and lower hormone levels. It also meant lower levels of sexuality, *aggression, and impulsive behavior*. More family stability, advanced planning, *self-control*, *rule-following*, and longevity were needed. (Rushton 2000a, p. 41)

Given the volume of Rushton's work and the publicity that it spawned, this omission is astonishing. Whatever the merits, Rushton presented data on a far larger number of theoretically derived variables, including sexual behaviour, reproductive timing, litter size, growth rate, hormone levels, IQ, and brain volume (e.g., Rushton 1985a).

Although Rushton was unambiguous (and politically controversial) in proposing a genetic basis for climate-related evolved

differences, the same cannot be said for Van Lange et al., who maintain an uncomfortable fence-straddling position on the issue. The majority of researchers in human life history treat fast/slow trajectories as conditional or facultative adjustments predicated on early life experiences (e.g., the intensity of local resource competition is proximally transmitted to the child through family breakdown and/or father absence). A testable hypothesis would be that harsh and unpredictable climates near the equator are associated with family dysfunction and breakdown. However, Van Lange et al. depart from this model in suggesting that temperature and seasonal variation affect temperament directly (see their Fig. 1). Yet the authors offer no account of the age at which regionally variable climatic cues are detected by the individual and how this awareness is translated into a temperamental adjustment.

Although they make a case for the "adaptiveness" of a faster life tempo in hotter climates, a glaring omission is how the psychological magic actually happens. The individual as the unit of analysis is too often occluded by nation or region. At other points in their argument, they seem to suggest a genetic basis for the adaptation ("From an evolutionary perspective, hot and cold climates have posed divergent problems to human survival, which have required distinct psycho-behavioral adaptations" [sect. 4, para. 3]). In yet other passages, the authors resolutely cling to ambiguity. Consider the following two statements: "…people's thoughts and behaviors may differ, based on the physical circumstances their ancestors faced *and* they themselves face" and "people coming from differing ancestral histories *and* living in different locations face challenges of self-control" (sect. 6, para. 3, emphasis added). By encompassing both ancestral and contemporary conditions, they create a convenient ambiguity.

Equally unclear is whether climate adaptations are proposed to occur at the individual or societal (cultural) level. In their key propositions, the two are elided, for example, "Lower temperatures, and especially larger degrees of seasonal variation in climate, call for individuals and groups to adopt a slower life history strategy, a greater focus on the future (vs. present), and a stronger focus on self-control" (abstract). This has two unfortunate consequences. First, their argument runs perilously close to the ecological fallacy by switching between units of analysis. For example, in a section purporting to address time orientation, we learn that culturally "people experience time differently across countries around the world" (sect. 3.1.2, para. 4). But the key dependent variables – acts of aggression and violence – are committed by individuals, not by cultures. Minimally, we need evidence that individuals living near the equator discount the future more steeply and are more aggressive. Despite claims that cross-cultural data on self-control are sparse (they cite only one study), the impulsiveness, self-discipline, and deliberation facets of the Big Five have been measured in 26 cultures (Costa et al. 2001). Second, the authors need to clarify the relationship between "individual" and "societal" evolution. For example, do societal constructions of time derive from individual temperaments (culture as the individual "writ large")? Or can culture itself select for evolved individual differences in time orientation (people who experience time as moving "faster" leave more offspring)? Or do cultural ideas about time ("memes") have an evolutionary life of their own based on contemporary popularity? Without answers, the article fails to live up to its promise of bridging "psychological processes within individuals … with social processes and outcomes at the level of groups, cultures, and societies" (sect. 6, para. 2).

Ultimately, the aim of the article is to provide an evolutionarily informed account of regional differences in aggression. But there is too much concern with region and too little with aggression. The authors fail to make a case for the functionality of heightened aggression under harsh ecological conditions. Indeed, they seem to undermine any such argument by restricting their proposal to reactive aggression rather than the instrumental aggression that would be relevant to resource competition. Is reactive aggression simply a spandrel dragged along by its association with poor self-control and short time horizons? The proposal also fails to address the well-established sex difference that is at the heart of an evolutionary approach to aggression (Campbell 2013; 2015). Worldwide, women commit less than 20% of violent offences and less than 4% of homicides. What is the correlation between men's and women's violent crime over climatic regions? If they are positively related, why are women less strongly affected by climate than men? More fundamentally, the authors fail to explicate evolutionary arguments as to the source of the sex difference or the psychological infrastructure that supports it. This is unlikely to be sex differences in either self-control or future orientation, which show small effect sizes in meta-analysis (Cross et al. 2011). An adequate theory of aggression should intrinsically encompass the sex difference rather than add on half the world's population as an afterthought.

The importance of being explicit

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Abstract: Van Lange et al. propose that climate affects violence via its effects on life history. That much is reasonable (and not novel), but their theory lacks causal specificity. Their foundational claim of an association between heat and violence is not well documented, and several findings that the authors themselves cite seem inconsistent with their model, rather than supportive.

In the target article, Van Lange et al. maintain that latitude is a strong predictor of variations in human aggression and violence and that this fact reflects adaptive "life history" variability in response to differences in climate. This is not a novel argument. The logic is essentially identical to that of Rushton (1995), who proposed that people whose recent evolutionary history occurred in Africa pursue relatively "fast" life histories, whereas populations that dispersed into Europe and Asia evolved "slower" life histories. Both Rushton and Van Lange et al. hypothesize that these contrasts reflect adaptation to the "harshness" and "unpredictability" of environments at different latitudes and their associated mortality risks. The primary difference is that Rushton attributed life history variability to differential past selection on different "races," whereas Van Lange et al. allow that the variability might reflect differences in past selection pressures, in facultative responses of a universal human nature to present cues, or both.

Aspects of this theory have an *a priori* plausibility. If unpredictable mortality caused by pathogens is higher in the tropics than in northern climes, for example, that alone might select for differences in age at first reproduction and other components of a fast life history (Møller 1997). But Van Lange et al.'s claim that climate becomes more "predictable" and less "harsh" as we move away from the equator is less plausible, and they present no supportive evidence. As in many treatments of human life history variability, the concept of environmental harshness in the target article lacks the sort of rigorous definition that would permit quantification. Do the equatorial latitudes in which we evolved really constitute a harsher environment for *Homo sapiens* than the extreme latitudes of Eurasia? How so, exactly? And as for predictability, does the extent to which today's temperature is predictive of tomorrow's – or is predictive of the

temperature on the same date a year hence – increase with distance from the equator? That seems to be what is being proposed, but as with "harshness," the authors provide no quantified comparisons of "predictability." Instead, they simply assert that the strong seasonal *variation* in temperature at extreme latitudes is itself a sort of predictability that equatorial climates lack!

Van Lange et al.'s model also suffers from insufficient specificity. Temperature is portrayed as affecting life history, time orientation, and self-control, but how? By their own argument, the latter two are consequences of life history, not parallel constructs at the same level of analysis. The authors allude to various ways in which a relationship between climate and life history might be mediated, but do not clearly articulate the need to test among them. The theoretical chasm that presently separates the climatic inputs from the psychological outputs cries out for more explicit hypotheses about causal links, which could then be tested by structural equation modeling or path analysis. Even the premise that violence may be functional is treated obliquely: Section 3.1 hints that violent aggression is an adaptive component of a fast life history, but in ensuing sections it sounds more like a maladaptive by-product of poor self-control, leaving readers wondering whether the authors accept that aggression and violence are adaptations that are facultatively deployed (Daly 2016; Krupp et al. 2013).

Even the foundational claim that heat and violence go hand in hand is questionable. The target article's opening paragraph provides a cherry-picked contrast of "Albania, Montenegro, and Turkey" versus "Scandinavia" to illustrate how "differences in violent crime rates occur along the North-South Axis in Europe." The trouble with this is not simply that Russia has Europe's highest homicide rate and coldest average temperature, nor even that excluding the former Soviet republics and Warsaw Pact countries moves Finland into first place. The bigger problem is that, using the same Global Study on Homicide cited by the authors (United Nations Office on Drugs and Crime 2013) and mean temperatures from 1961 to 1990 (Wikipedia 2016a), the correlation between homicide and temperature is *negative* across the 37 European countries with populations greater than one million ($r = -0.43$, 95% confidence interval: −0.66, −0.12).

The only systematic, persuasive evidence of a heat/violence association that the authors cite is in Burke et al. (2015). Unfortunately, that study finds a much larger effect of climate on intergroup than on interpersonal aggression (see also Bell & Keys, in press), a result that Van Lange et al. struggle to force into their model. Are individuals with poor self-control, short time horizons, and a quarrelsome bent really better able than those with the opposite temperament to form effective coalitions in warfare (Wright et al. 1999)? This example is symptomatic of a tendency to cite results that are problematic for the authors' model as somehow supportive. They note, for example, that temperature apparently affects violent, but not nonviolent, crime; but why should poor self-control and short time horizons elevate murder rates and *not* elevate impulsive property crime or illicit drug use? And then there is the claim (sect. 3.1.2) that people with "present" time-orientations – people who are *short on time* – are the very ones who act as if they have all of the time in the world, while those with "slower" life histories move faster!

The authors maintain that their model's value is "primarily theoretical" (sect. 6, para. 3). But until their theory is grounded in explicit definitions of environmental harshness and predictability, and specifies crucial explanatory links between the climatic inputs on the one hand and the psychological outputs on the other, we do not believe that it can be helpful. Also, even with a more explicit causal model, we would still need experimental studies (*contra* the authors' claim in sect. 3.1.3), as well as correlational ones, to make causal sense of a complex and confusing set of cross-national patterns and associations.

CLASH's life history foundations

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Abstract: We recommend extending CLASH by incorporating two evolutionary accounts of the shift toward fast life histories under harsh, unpredictable conditions. These accounts, if integrated with CLASH, make different predictions about the distributions of aggression and violence within and between societies. We discuss these predictions and propose ways of testing them.

CLASH proposes that warm and less variable climates are harsh and unpredictable, and that these conditions shift individuals toward faster life histories involving a here-and-now orientation, which sparks aggression and violence. These relationships can result from a variety of adaptive processes, including development, contextual plasticity, and social learning. Here, we focus on development. Specifically, we expand CLASH by considering two distinct, but mutually compatible, evolutionary accounts of the shift toward fast life histories: external and internal predictive adaptive responses (PARs) (Nettle et al. 2013; Rickard et al. 2014).

The external PAR account proposes that fast life histories evolved in response to factors in the external environment (e.g., warm, variable climates) that *forecasted future environmental conditions* that reduce life expectancy (e.g., famine) (Belsky et al. 1991). The internal PAR account, in contrast, proposes that fast life histories evolved in response to factors that directly reduced life expectancy (e.g., nutritional deprivation) by *accelerating somatic aging* (e.g., impairing cell repair), irrespective of future environmental conditions (Nettle et al. 2013; Rickard et al. 2014).

Mathematical modeling indicates that external and internal PARs evolve under different conditions (Nettle et al. 2013; Rickard et al. 2014). External PARs require that environmental conditions are stable over individuals' lifetimes (e.g., if there is drought today, there will likely be drought next year). Internal PARs do not require such stability, but rather require individuals' somatic conditions to be stable over their lifetimes (e.g., if my body is in a poor state today, it will be likely in a poor state next year). In an environment that is completely unpredictable, external PARs cannot evolve; however, internal PARs can, if earlier somatic states are correlated with later somatic states. Such somatic autocorrelation is well known to exist in humans (Blackburn et al. 2015).

The internal and external PAR accounts often make the same predictions about the effects of environment on life history and hence, if integrated with CLASH, about the distributions of aggression and violence. For example, if warm and variable climates are harsh and unpredictable (as CLASH proposes), both accounts predict that such climates produce fast life histories, albeit for different reasons. The external PAR account posits this because it supposes that earlier environmental adversity predicts later environmental adversity. The internal account posits it because it supposes that earlier adversity accelerates somatic aging, irrespective of future environmental conditions.

Despite partial overlap in predictions, the internal and external PAR accounts make different predictions about individuals or populations of the same chronological age in two cases: (1) when they have the same somatic age, but have been exposed to different environmental conditions, and (2) when they have

been exposed to the same environmental conditions, but vary in their somatic age. Here, we focus on the second case.

Individuals or populations that have been exposed to the same environmental conditions (e.g., drought) may vary in their somatic quality (e.g., tissue damage) for many different reasons, including genetic mutations, developmental noise, and chance events (e.g., idiosyncratic exposure to disease). The internal PAR account predicts that individuals or populations that have incurred higher levels of somatic damage (e.g., telomere attrition) will develop faster life histories than those within the same environment that have incurred lower levels of damage. This prediction does not follow from the external PAR account, as all people in this environment will be equally likely to suffer from death and disability caused by future external conditions.

Consistent with the internal PAR account, British data indicate that girls who experienced chronic disease in childhood develop faster life histories, as indicated by earlier timing of first reproduction, even though chronic disease was not correlated with other measures of environmental stress (e.g., father absence, parental socioeconomic status) (Waynforth 2012). Similarly, Danish data indicate that low birth weight (a marker for somatic quality) predicts lower levels of trust in adulthood, even after controlling for multiple indicators of childhood family environment (e.g., mother's education and income). A possible explanation is that low birth weight predicts small size and physical vulnerability later in life, increasing the risk of being socially exploited (Petersen & Aarøe 2015).

The internal PAR account predicts that individuals who have incurred higher levels of somatic damage are more here-and-now oriented. Interestingly, in European starlings, individuals with greater developmental telomere attrition show higher impulsivity in their foraging decisions (Bateson et al. 2015). According to CLASH, a stronger here-and-now orientation increases aggression and violence. A caveat here is that adults who are physically small (e.g., because of low birth weight or disease in childhood) are less likely to be successful when engaging in aggression and violence (Sell et al. 2009). Therefore, tests of the internal PAR account should control for current somatic factors (e.g., body size) that affect the likelihood of winning fights.

Generally, the internal PAR account predicts that somatic age mediates the link between exposures to harsh, unpredictable environments and faster life histories. Testing this mediation would require measures of somatic aging (e.g., telomere attrition, oxidative stress), environmental stress (e.g., socioeconomic status), and aggression and violence of the same individuals. The external PAR account predicts that higher environmental stress predicts greater aggression and violence. The internal PAR account predicts this relationship as well (as environmental stress causes somatic damage), and additionally predicts that (1) higher somatic age (for a given chronological age) is associated with greater aggression and violence, and (2) the relationship between environmental stress and aggression and violence is reduced when somatic age is included as a mediating variable.

Of course, the internal and external PAR accounts are not mutually exclusive. It is possible that individuals predict both their future environment and their future somatic states and tailor their life histories accordingly. However, as these two accounts are distinct and make different predictions about life history in certain circumstances, CLASH could benefit from incorporating both.

The CLASH model lacks evolutionary and archeological support

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Abstract: Data from archaeology and paleoanthropology directly challenge the validity of the basic assumptions of the CLASH model. By not incorporating a "deep time" perspective, the hypothesis lacks the evolutionary baseline the authors seek to infer in validating the model.

There are a number of significant methodological and theoretical errors in the article by Van Lange and colleagues. We take one specific element as the focus of our response here: they fail to include historical, archaeological, and paleoanthropological data in their model. By not incorporating a "deep time" perspective, the hypothesis lacks the evolutionary baseline the authors seek to infer in validating the model. Data from human history directly challenge the validity of the basic assumption of the CLASH model that higher average temperature with smaller seasonal variation creates an evolutionary process biasing populations toward increased aggression.

If Van Lange et al. are correct about the relationships among aggression/violence, climate, and life history, we should find the majority of conflicts occurring in equatorial regions during prehistoric and historic times. This is not the case, as historical (e.g., Vikings, Mongols), recent (e.g., World War 1, World War 2), and archeological data attest (e.g., Ferguson 2013). Such data illuminate a significant problem for the model. The authors fail to consider historical and cultural legacies and deep-time data relevant to the exhibition of aggression. Moreover, we wonder how the CLASH model, and its focus on countries as units of analysis, accounts for migration in recent and historical contexts, as genetic evidence points to substantial migration across latitudes throughout human history (Cavalli-Sforza et al. 1996; Coop et al. 2009; Templeton 1999). How many generations, under CLASH, would a group need to live in a lower latitude to evolve this new disposition? Likewise, would a person who grew up in the southern latitudes and then migrated to the north be more aggressive than a native-born northerner?

Indeed, we are surprised that for a paper making such grandiose claims, so few data are offered in support their assertions. They rely on citing compilation works or making assumptions such as "societies closer to the equator are also relatively harsh and unpredictable" (sect. 3.1, para. 7), without defining which societies these are or how parameters like unpredictability are measured. For a model that seeks to explain major behavioral components through causal links, we would hope to see more empirical support. For example, while they note that they only look at the Northern Hemisphere, they suggest that the model will hold for the Southern Hemisphere as well. But is this true? Figure 1 illustrates the homicide rate by country per year (between 2012 and 2014) per 100,000 inhabitants (data from the World Bank) by the latitude of the country (taken as the midpoint of the country). As can be seen, the data support the model in the northern hemisphere, with $r^2 = 0.108$. However, in the Southern Hemisphere the relationship does not hold ($r^2 = 0.007$). This suggests to us that other factors are in play.

Variation in temperature may provide a perspective on environmental impact, but it does not take into account more accurate reflections of local ecologies such as rainy seasons, droughts, and other climatic events that could increase variability and its interplay with historical, political, and economic contexts. For example, the authors rely extensively on the meta-analyses of Burke et al. (2015), whose data sets strongly indicate that economic impacts of climatic variation are critical in leading to conflicts and that such conflicts are tied to the relative importance of local agricultural production. Temperature out of context is meaningless.

For the CLASH model to reflect an actual outcome of natural selection processes, there must be a demonstrated connection between the ecological variables of interest (in their case temperature) and specific effects on fitness values of the populations of interest. Their limited attempt to connect with Life History

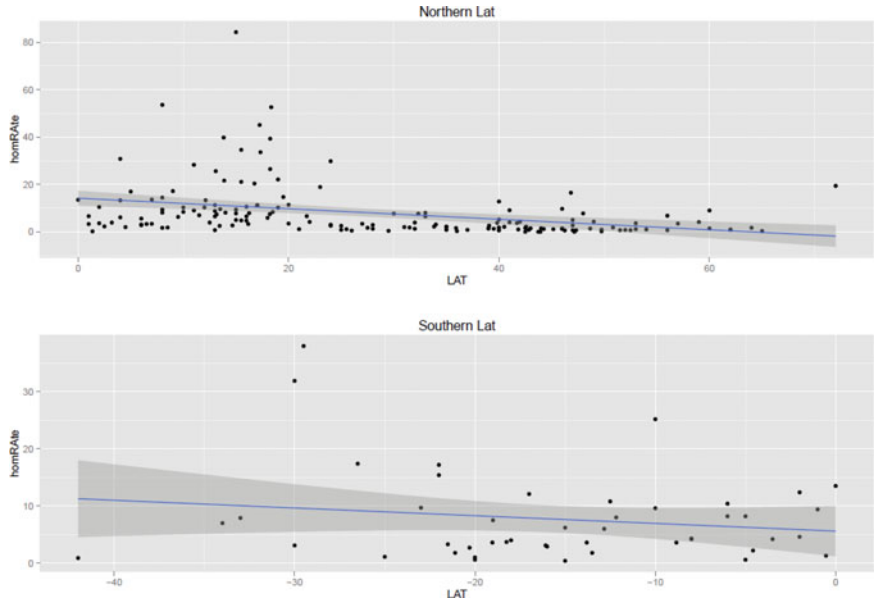

Figure 1. (Fuentes et al.). Homicide rate with respect to latitude for each country.

Theory is not sufficient. By purposefully removing key historical and ecological variables and attempting to reduce the complex suites of behaviors in aggression and conflict to simplistic few-variant causal factors (average temperature and seasonal variation in temperature), the relevance of such gross model predictions is called into question.

There is substantial paleoanthropological research into the question of how climate affects humans and our ancestors. Adaptation to increasing climactic variability/unpredictability appears to be a core process for early *Homo* (Anton et al. 2014), suggesting that our species as a whole is pre-adapted to climate variability. Geographers and paleoclimatologists argue that economic transformations and conflicts are associated with temperature declines (Büntgen et al. 2013), whereas periods of prosperity are linked to wet and warm summers (Büntgen et al. 2011). Moreover, the advent of agricultural communities at the beginning of the Holocene reduced the amount of resource unpredictability, but increased the opportunities and frequencies of conflict over resources (Ferguson 2013, Bowles & Choi 2013), complicating the assertions of the proposed model.

To be fair, Van Lange et al. do offer a section on "caveats" recognizing the potential for socioeconomic and political-historical factors to play a role. But their treatment of these possibilities is superficial and relies on statements such as "over time, cultures have evolved such that economic growth and prosperity decrease as distance to the equator decreases" (sect. 5.1, para. 1). Archeologically and historically speaking this is false, as the Mayan, Incan, Egyptian, Majapahit, and many other major civilizations demonstrate. If the authors mean for the CLASH model to reflect only the past two to three centuries, then they cannot seriously propose that it reflects evolutionary processes. Many of the countries in equatorial regions today are postcolonial nations and, thus, have historical ties to other nations and economic processes that create and/or amplify a wide range of structural inequalities. These regions are often underdeveloped with respect to economic and health infrastructures, making it likely that historical contingencies (Furtado 1964), rather than climate, are particularly important causal factors in lower life expectancy, higher homicide rates, and more aggression. Until these confounding variables can be addressed, we remain skeptical of the CLASH model.

In sum, if a model seeks to be evolutionary, as the CLASH model does, data and theory that offer both temporal depth and evolutionarily relevant contexts cannot be ignored.

Does distance from the equator predict self-control? Lessons from the Human Penguin Project

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Abstract: We comment on the proposition "that lower temperatures and especially greater seasonal variation in temperature call for individuals and societies to adopt … a greater degree of self-control" (Van Lange et al.,

sect. 3, para. 4) for which we cannot find empirical support in a large data set with data-driven analyses. After providing greater nuance in our theoretical review, we suggest that Van Lange et al. revisit their model with an eye toward the social determinants of self-control.

Van Lange et al. formulated a theoretical model in which they proposed climate as a predictor of self-control (and aggressive behavior). We comment on the proposition "that lower temperatures and especially greater seasonal variation in temperature call for individuals and societies to adopt … a greater degree of self-control" (sect. 3, para. 4), which, they argue, is due to a slower life history strategy. In developing their theoretical position, the authors propose distance from the equator as a predictor of self-control. They advocated a "data-driven" approach, allowing one "to derive precise estimates of the variance accounted for by various predictor variables" (sect. 5.3.1, para. 2). In our Human Penguin Project (HPP; available at: https://osf.io/2rm5b/), we collected latitude, self-control, and a variety of important social predictors from 12 countries with varying distances from the equator. These variables allowed us to test the proposed relationship between distance from the equator and self-control. The social predictors included variables such as social network quality and size and variables that are crucial for Life History Theory, like people's attachment styles (Del Giudice 2008). Together, we provide the very first test of the authors' proposed model through data-driven analyses (a method called *supervised machine learning;* for more technical discussions, see Breiman [2001]; IJzerman et al. [2016]; Yarkoni & Westfall [2016]) as proposed by the authors, and in a more traditional null hypothesis significance testing confirmatory manner (a mediation analysis).

We analyzed data from 1507 participants from 12 countries on three different continents, with countries at varying levels of distance from the equator. The underlying analytical details (including a detailed explanation of supervised machine learning) are reported online (https://osf.io/gtj38/). Our method is very powerful and robust, as it validates the model internally as it tests the strength of the model and the size of the error. We found distance from the equator to be a significant predictor of self-control (Tangney et al. 2004), but barely so: It was the 14th predictor in our list and comparable in prediction power to whether participants spoke Serbian or not (the 13th predictor).[2] As we could compare the strength of different predictors, our analyses revealed that the power to predict self-control was much greater for such variables as attachment anxiety, proneness to feeling nostalgia (a complex social emotion), social network size, level of complex social integration, and participants' attachments to their homes. Plotting these variables, controlling for the remainder of the model, further confirmed the stronger relationship of social determinants over distance from the equator (https://osf.io/vzwbe/).

Was distance from the equator then a reliable predictor of climate? We think so: Equator distance correlated strongly with the minimum temperature of that day ($r = 0.90$, $N = 1463$). We further explored whether attachment anxiety would mediate the relationship between equator distance and self-control; attachment anxiety (a strong predictor of self-control) could be indicative of differing life history strategies (Del Giudice 2008). There was no such relationship, as distance from the equator failed to be related to attachment anxiety ($t = 0.02$, $p = .99$), with a nonsignificant mediation onto self-control (95% confidence interval [CI]: 0.0007 to 0.0007). To be sure, we also tested for attachment avoidance, which also was not predicted by equator distance ($t = 0.02$, $p = .85$, 95% CI: 0.0003 to 0.0004). We thus find little evidence that distance from the equator matters for predicting self-control and life history strategies, and our analyses support the idea that the social environment is much more important in predicting self-control.

How could this be so? The authors reviewed evidence that seemed supportive of their relationship between climate and self-control. However, our reading of the literature suggests more nuance. Warmer water temperatures are indeed associated with faster growth, earlier death, and higher risk acceptance for some animals (all indicative of a faster life history trajectory [Holt & Jørgensen 2014]). But in contrast, warm-blooded mesopelagic fish (which live in an extremely *cold* environment) *also* exhibit a precocious maturation comparable to that of other animals in *warmer* environments (Miya & Nemoto 1986). And life history strategies cannot be easily extended from animals to humans. Humans are more unusual in that both slow and fast life history strategies can involve effortful control and impulsivity (Del Giudice 2015). Furthermore, warmer temperatures are not just related to aggression; a wealth of evidence in humans indicates that higher temperatures can also relate to *prosocial* behavior (cf. IJzerman et al. 2015a).

Furthermore, the authors neglected the fact that self-control via internalized norms is not linked to time horizon, but to a feeling of *obligation*. It is thus strongly influenced by the relevance of goals (Lindenberg 2013). For example, Dutch males scoring higher on honor concerns respond more aggressively when insulted, but less aggressively when not insulted (IJzerman et al. 2007). A recent study also indicated that the relationship between armed conflict and heat waves or droughts is due to the fact that heat waves or droughts exacerbate existing ethnic strife (Schleussner et al. 2016). Goal relevance, rather than a lack of self-control, strengthens aggressive responding in these cases.

In short, a broader consideration of the literature speaks against most of the propositions of their theoretical model. Most critically our data, which were suited for testing many of their claims, do not provide empirical support, likely because their theoretical model is *underfitted,* with the link between climate and self-control being underspecified. It is thus not surprising that the HPP provided evidence against their model, which we take as a strong suggestion for the authors to revisit their proposed link between climate and self-control.

In reformulating their model, we further advise that they give greater weight to established theories on the complex relationships between self-control, life-histories, culture, social organization, and violence, such as the literature mentioned previously, as well as literature on the development of culture (Diamond 1999) and the antecedents of violence (Fiske & Rai 2015). These theories support our results that the social environment rather than climate predicts self-control, and we suspect it is this social environment that mostly predicts aggressive behaviors. Cultures are not *individuals writ large;* they invariantly are complex and cannot be reduced to a simple main-effect model.

NOTES

1. Hans IJzerman is the lead author of this article and Siegwart Lindenberg the last. All other authors are listed alphabetically. Address correspondence to Hans IJzerman.

2. Notably, when testing *solely* for the correlation between distance from the equator and self-control, we find a significant correlation ($r = 0.12$, $N = 1484$). However, our machine learning approach did not detect a similar pattern, and we think the correlation is spurious and overfitted (Yarkoni & Westfall 2016).

Where the psychological adaptations hit the ecological road

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Abstract: We argue that the target authors focus too much on adaptive behavioral *responses* and not enough on actual psychological *adaptations*. We suggest the Dark Triad traits may represent facultative, psychological adaptations sensitive to seasonal variance and food shortages. We document that shorter distances from the equator are linked to higher national narcissism levels, whereas longer distances are associated with higher national-level machiavellianism. Dark Triad traits may serve as critical survival mechanisms when prioritizing oneself over and/or at the cost of others.

Van Lange et al. provide a compelling new way of understanding the often cited yet poorly understood relationship between heat and violence at the societal level. Unlike most social psychological models, the authors adopt an evolutionary framework – Life History Theory – that suggests manifestations of violence, aggression, and limited self-control are adaptive responses to the environmental contingencies of sharp seasons *and* temperature. For instance, in climates like those found in Canada, there is a greater need for cooperation and long-term planning given extreme seasonality. As such, they argue one should expect (and empirically it appears to be the case) that Canadian populations are characterized by *slow* life history traits such as limited aggression and high levels of future planning.

We argue here, however, that Van Lange et al.'s evidence of mere behavioral manifestations of life history traits fails to adequately test their evolutionary hypothesis because it does not focus on the actual underlying adaptations themselves. Their approach conflates adaptive behavioral *responses* with actual psychological *adaptations*. From an evolutionary perspective, behaviors such as violence and cooperation are likely linked to differences in local ecology (Schmitt 2015), but do so by interacting with internal, psychological adaptations that, we would suggest, are the constellations of hormonal, cognitive, neurological, and motivational dispositions that most researchers call personality traits (Jonason & Ferrell 2016). Selection has acted on these traits – not the specific behavioral outputs of the traits – as facultative adaptations, and it is these specially designed dispositions that interact with local ecologies in ways that ultimately produce the patterns of behavior that appear to support the authors' hypotheses.

One set of potential facultative, psychological adaptations that have been successfully studied using a life history framework are the Dark Triad personality traits (Jonason et al. 2012): machiavellianism, narcissism, and psychopathy (Paulhus & Williams 2002). The Dark Triad traits are characterized by vanity and self-centeredness (i.e., narcissism), manipulation and cynicism (i.e., machiavellianism), and callous social attitudes and amorality (i.e., psychopathy). These traits predict variance in community, online, and college student samples that reflect both (1) life history behavioral indicators and (2) the psychological adaptations that are precursors to both aggression and cooperation as highlighted by Van Lange et al. For example, these traits are correlated with lower-order aspects of personality that serve to facilitate both cooperation and aggression, such as limited self-control (Jonason & Tost 2010) and empathy (Wai & Tiliopoulos 2012). Psychopathy and narcissism are particularly correlated with various forms of aggression (Jonason & Webster 2010) and heightened competitiveness (Jonason et al. 2015b). Conversely, machiavellianism is distinguished by its long-term, tactical, strategic, and pragmatic nature (Jonason & Webster 2012), which may serve individuals who live in environments where resources are variable and future planning is essential. In addition, the importance placed on physical attractiveness in narcissism might be an adaptive response to higher pathogen loads in warmer climates (i.e., near the equator). Overall, based on this we expect that distance from the equator will be negatively correlated with narcissism and psychopathy (potentially) and positively correlated with machiavellianism.

Thus, we suggest Dark Triad personality traits represent facultative, psychological adaptations that are sensitive to seasonal variance and food shortages. Over evolutionary time, climatological patterns and resource irregularity would be fairly recurrent. Those people who were differentially characterized by these traits across varying environments may have been selected because the traits facilitated context-specific, or in this case climate-specific, survival. It may be useful, and perhaps adds to and improves the authors' assertions, to test ostensible dispositional adaptations – Dark Triad traits – for environmentally contingent links to survival, as opposed to the behaviors that

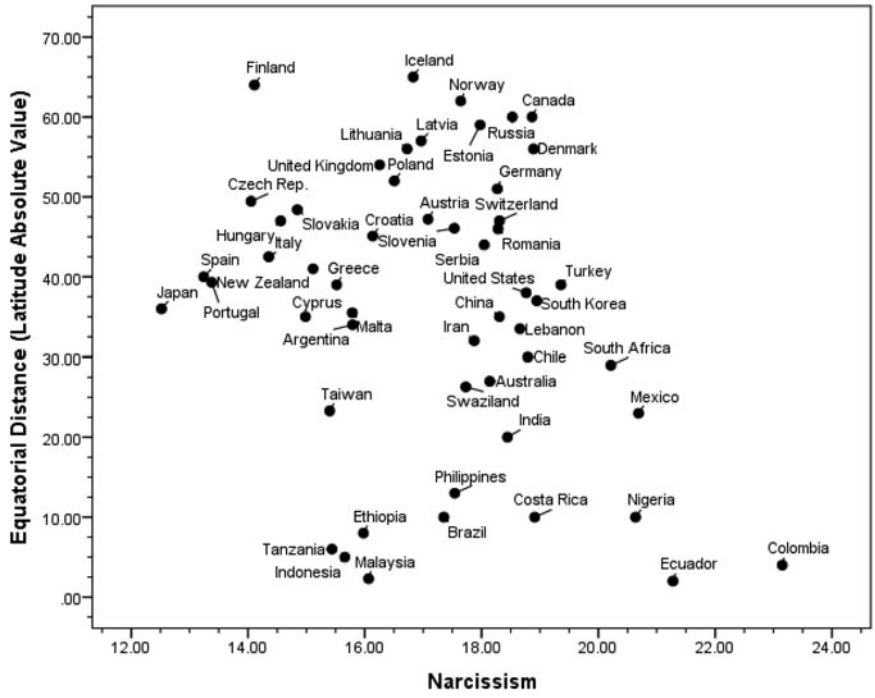

Figure 1. (Jonason & Schmitt). National narcissism levels related to distance from the equator across 53 nations from the International Sexuality Description Project 2 (Schmitt 2015).

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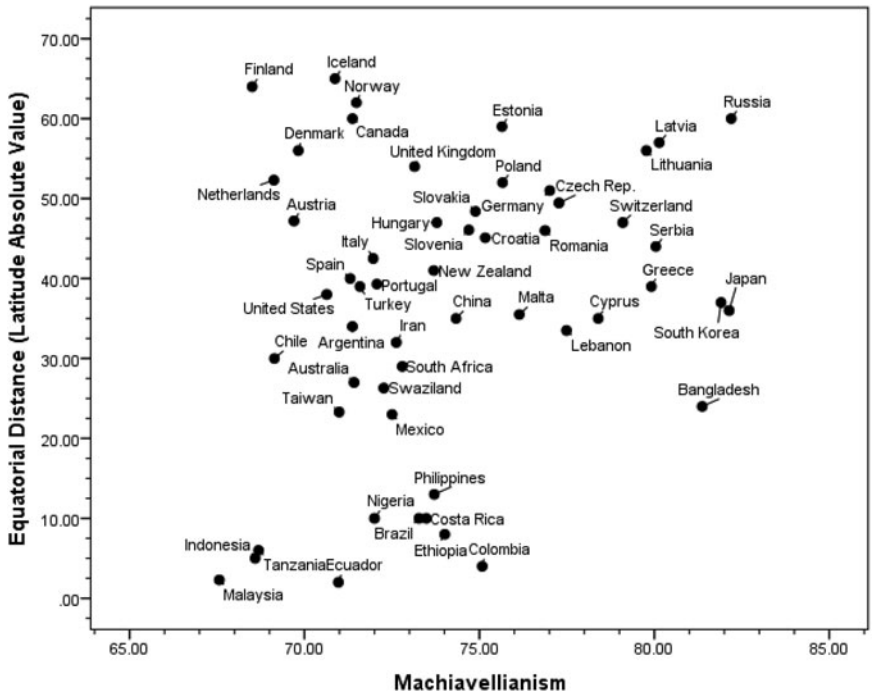

Figure 2. (Jonason & Schmitt). National machiavellianism levels related to distance from the equator across 54 nations from the International Sexuality Description Project 2 (Schmitt 2015).

are manifested from recurrent adaptive person × ecology interactions.

To add to and improve on the authors' argument, and the data brought to bear on the CLASH model, we highlight here findings from the International Sexuality Description Project 2 (see Schmitt 2015). ISDP-2 was a collaboration of more than 100 psychologists around the world in which surveys were administered to 36,314 people across more than 50 nations. As part of ISDP-2, participants were administered measures of narcissism (e.g., NPI [Raskin & Terry 1988]), machiavellianism (e.g., MACH-20 [Christie & Geis 1970]), and psychopathy (e.g., SRPIII [Paulhus et al. 2009]). (More details about ISDP-2 methods and samples are available on request.)

At the national level, the shorter the distance from the equator, the higher were the national narcissism levels ($r(51) = -0.25$, $p < .05$) (Fig. 1). In contrast, machiavellianism become more evident the greater the distance from the equator ($r(52) = 0.24$, $p < .05$) (Fig. 2). Psychopathy was not sensitive to variation in distance from the equator ($r = 0.01$). The results in the target article, therefore, might be a function of these Dark Triad adaptations for survival under varying levels of climatological threat. That is, the Dark Triad traits – particularly high narcissism and low machiavellianism – may serve as survival mechanisms when the organism is under threat, the time when prioritizing oneself is most important. Prioritizing oneself over and/or at the cost of others is at the core of these traits.

These findings represent a climate-specific, adaptationist view of Dark Triad traits, which is in contrast to most work that has focused on sexual selection arguments of the Dark Triad (Jonason et al. 2009). Our assertions here might conflict with the pathological view of antisocial traits (Hare 1985). Such psychological survival adaptations may be pseudopathologies (Jonason et al. 2015a) that confer benefits to the person at the cost of the group (Crawford & Anderson 1989).

In conclusion, we agree with the thrust of the CLASH hypothesis, but feel the authors have not presented the best tests of their climate-linked hypotheses. We have presented evidence here that we feel better tests their assertions by examining ostensible psychological preconditions and adaptations for survival. We encourage future work to not conflate manifestations of psychological adaptations with the adaptations themselves because, after all, it is called evolutionary *psychology* for a reason.

Warm coffee, sunny days, and prosocial behavior

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Abstract: This commentary discusses the research finding that warmer temperatures are associated with more prosocial outcomes. It calls for future research and theory on climate-related variables and social behavior to allow for both positive *and* negative emotional and behavioral responses to warmer temperatures.

In the target article, Van Lange et al. go beyond the documentation of interesting temperature-aggression effects and try to explain such findings with their theoretical model. However, there are some critical points for further consideration. First, the CLASH model focuses only on "hot" (i.e., reactive) aggression and does not try to explain "cold" aggression, the kind of calculated, planful aggression that takes a degree of self-control and future orientation to execute. A parsimonious model of the role of climate-related variables in aggression and violence should explain both types of aggression. Would "cooler" aggressive behaviors be more likely to occur in cooler climates and/or those with more seasonal variation in temperature? How does their model address such types of aggression?

Second, and worthy of further elaboration, the CLASH model does not account for the research finding that warmer temperatures (and the concept of warmth more generally) are also associated with increased prosocial behaviors and that both hot *and* cold temperatures have been found to reduce self-control (Gailliot 2014). These results, at first glance, seem to contradict the

CLASH model; however, it may be possible for the authors to revise it to encompass this broader set of findings.

There are significantly more publications examining how temperature and climate-related factors are associated with aggressive outcomes, rather than prosocial outcomes (see target article). However, one can also make a case for the role of temperature in promoting prosocial outcomes. Future researchers should add to this literature and revise their theoretical models to include a fuller picture of climatological effects that include prosocial outcomes.

Starting in the realm of everyday language use and metaphor, people commonly talk about their "warm feelings" toward loved ones or shunning by way of giving the "cold shoulder." Images of warmth and coldness are thus central to discussions of relationship closeness and connection, similar to the importance of images of heat when discussing anger and aggression (e.g., "red hot" anger or "fiery temper"). Social psychologists have long been aware that the concepts of psychological warmth (vs. coldness) are of central importance to people's judgments about others (Asch 1946; Fiske et al. 2007; Kelley 1950). Indeed, scholars have suggested that noticing others' potential warmth could provide a survival advantage by helping to identify trustworthy partners (Fiske et al. 2007). Attachment theorists link physical warmth to early experiences of parental bonding and care (e.g., Bowlby 1969). These lines of research all place the concept of warmth (whether psychological or physical) as fundamental to bonding and social regulation. Metaphorical links between physical and psychological warmth have substantive implications for behavior (for a discussion see Bargh & Shalev [2012]).

Indeed, not only has some laboratory research found that high temperatures can actually *inhibit* aggressive behavior (e.g., Baron 1972), but also other studies have found that they *promote* prosocial behaviors. Warmer temperatures can enhance relational mindsets (IJzerman & Semin 2009) and affiliative motivation (Fay & Maner 2012), but also making people see others as interpersonally warmer and closer to the self. For example, participants who were holding a warm object (such as a hot coffee), compared with those holding a cold object, felt closer to a loved one (IJzerman & Semin 2009) and judged others as being friendlier (Williams & Bargh 2008). Warmer temperatures can also affect prosocial behaviors, making people more likely to give a gift (Williams & Bargh 2008) or share money with others (Kang et al. 2010; Storey & Workman 2013). The effects of warm temperature on prosocial behavior seem to be especially pronounced for those who have a secure attachment style (IJzerman et al. 2015b).

Of course, laboratory experiments on the effects of temperature on prosocial outcomes may not translate to the role of broader climatological variables. Thus, field studies on how weather variations are associated with behaviors are also informative. Although these studies do indicate a role for temperature in promoting prosocial behaviors, they find that other climatological factors are also important (Cunningham 1979; Guéguen & Lamy 2013; Lagacé-Séguin & d'Entremont 2005). For example, studies find that sunshine is associated with increased positive moods, more helping behaviors, and less aggression (Cunningham 1979; Guéguen & Lamy 2013; Lagacé-Séguin & d'Entremont 2005), with one study finding that the effects of sunshine are stronger than temperature itself (Cunningham 1979). In addition, studies have pointed to the role of humidity, rather than temperature itself, in predicting increased aggression and decreased prosocial behavior in children (Ciucci et al. 2011; Lagacé-Séguin & d'Entremont 2005), suggesting that Van Lange et al. also need to disentangle temperature from humidity effects.

To date there have been limited cross-national studies examining how climate-related variables are associated with prosocial outcomes. Using data from the World Values Survey, one study found that people from cultures with demanding hot or cold climates (represented as deviations from a comfortable 22°C), especially those from the richest cultures, held more cooperative values (Van de Vliert et al. 2009). People from poorer cultures with demanding climates held more egoistic values (Van de Vliert et al. 2009). Another study by the same authors finds similarly complex relationships between climate, wealth, and prosocial behavior (Van de Vliert et al. 2004). Although these studies did not report main effects of average annual climatological variables such as temperature and sunshine, they suggest another lens of analysis for Van Lange et al.

There is some evidence that increases in temperature can lead to both increased aggression, as the target article suggests, and increased prosocial outcomes, although this is based on a smaller literature. Thus, a theory on climate and social behavior must allow for both positive *and* negative emotional and behavioral responses to warmer temperatures. There may be evidence for a more general argument, namely, that warmer temperatures influence *emotional reactivity* in general – both positivity and negativity. Future theories and research studies must address why some people react with more hostility and aggression in warmer temperatures, whereas others react more prosocially with similar situational triggers. Moreover, this future work should go beyond temperature itself and consider the psychological and behavioral implications of other climate-related variables.

More than just climate: Income inequality and sex ratio are better predictors of cross-cultural variations in aggression

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Abstract: Van Lange et al. argue that variations in climate explain cross-societal variations in violence. We suggest that any approach seeking to understand cross-cultural variation in human behavior via an ecological framework must consider a wider array of ecological variables, and we find that income inequality and sex ratio are better predictors than climate of cross-societal variations in violence.

Van Lange et al. present a model wherein ecological variations (climate) predict cross-societal variation in aggression. We agree with Van Lange et al. that an ecological framework can provide ultimate explanations for such variation in aggression, as well as a wide variety of other human behaviors. However, any approach seeking to understand cross-cultural variation in human behavior via an ecological framework would do well to consider a wider array of theoretically relevant ecological variables (e.g., Grossmann & Varnum 2015; Varnum & Grossmann 2016a; 2016b).

To illustrate our point, we draw on established work in behavioral ecology, evolutionary biology, and animal behavior to identify two ecological features that might play a role equal to if not larger than that of climate in explaining cross-cultural variation in the frequency of two types of aggression (e.g., Clutton-Brock & Parker 1995; Daly & Wilson 2001; Emlen & Oring 1977; Fisher 1930; Griskevicius et al. 2012). Here we focus on *income inequality* (a marker of the distribution of resources in an ecology) and *adult sex ratio* (the adult male-to-female ratio in an ecology) as predictors of homicide (typically male-male violence) and rape (typically male-female violence).

Income inequality has been touted as arguably the best predictor of variability in violence across nations, with greater inequality linked to greater (typically male-perpetrated) violence (e.g., Daly & Wilson 2001; Kenrick & Gomez Jacinto 2013; Ouimet 2012; Wilson & Daly 1997). Because males experience greater fitness

Table 1. (Krems & Varnum) *Income inequality, adult sex ratio, climatic demands, intentional homicide rates, and rape rates: Correlations*

Variable	1	2	3	4	5
1. Income inequality	—				
2. Adult sex ratio	0.009 (n=95)	—			
3. Climatic demands	−0.548*** (n=95)	−0.025 (n=189)	—		
4. Homicide rate	0.476*** (n=87)	−0.096 (n=144)	−0.233** (n=143)	—	
5. Rape rate	0.401** (n=39)	0.208† (n=58)	−0.149 (n=58)	0.174 (n=54)	—

†$p < .12$, *$p < .05$, **$p \leq .01$, ***$p \leq .001$.

variance, they engage in more risky, frequent, and intense intrasexual competition (e.g., violence) for status and related mating opportunities. Income inequality is thought to exacerbate male mating competition, and thus male violence, by increasing the perceived benefits of high-risk competition, perhaps especially when lower-risk routes to status are unavailable and/or yield unsubstantial gains (e.g., Daly & Wilson 2001).

Compared with income inequality, the link between biased sex ratios and violence is equivocal; previous research has found variously that male-biased sex ratios are associated with more, less, or no differences in violence (e.g., see Schacht & Mulder 2015). There may be a stronger case, however, for linking male-biased sex ratios to higher rates of sexual violence against women. Previous work has argued that more males means more male mating competition, increasing the likelihood that some males resort to rape to obtain mating opportunities and/or to intimate partner violence to prevent the loss of existing relationships (e.g., D'Alessio & Stolzenberg 2010; Messner & Blau 1987; Thornhill & Palmer 2000; Trent & South 2012).

We gathered archival data on 2009–2010 income inequality (World Bank 2015), 2010 adult sex ratios (ratio of males to female, aged 15–64 [Central Intelligence Agency 2016a]), and climate (total climatic demands [Van de Vliert 2013a]). Zero-order correlations are presented in Table 1. We tested the relative contribution of these ecological factors to cross-societal variations in rates of intentional homicide (World Bank 2016b) and rape (United Nations Office on Drugs and Crime 2011) in 2010, using multiple regression analyses in which all three predictors were simultaneously entered and only countries with data on all three predictors and the dependent variable were included. Data for rates of intentional homicide and all three predictors were available for 87 countries, and data for rates of rape and all three predictors were available for 39 countries (all data available at https://dataverse.harvard.edu/dataverse/Krems_Varnum_2016_BBS_Commentary).

Multiple regression analysis revealed that the strongest predictor of homicide rates was income inequality, $\beta = 0.402$, $p = .001$. Male-biased sex ratios, $\beta = -.176$, $p = .070$, were marginally associated with homicide rates, but climatic demands were not, $\beta = -0.139$, ns.[1] Income inequality was also the strongest predictor of rape rates, $\beta = 0.571$, $p = .003$. Male-biased sex ratios were also a significant predictor of rape rates, $\beta = 0.363$, $p = .018$, but climatic demands were not, $\beta = 0.219$, ns.

Drawing on the cross-disciplinary ecology literatures, we identified two ecological features with established theoretical and empirical links to violence. These features were comparatively better predictors of cross-societal variation in homicide and rape rates than was climate. Although these findings are consistent with the idea that we can use ecology to understand cross-societal variations in aggression, they also illustrate the importance of considering multiple ecological dimensions in such models.

NOTE

1. In additional analysis of the homicide data we used Cook's D to identify data from any nations that might be exerting undue influence. Using the conventional cutoff point of $4/n$, we identified potential outliers – Maldives, Honduras, Jamaica, El Salvador, Lesotho – and ran an additional regression model excluding them. Income inequality remained a significant predictor of intentional homicide rates, $\beta = 0.743$, $p < .001$. Adult sex ratio, $\beta = -0.117$, ns, and climate, $\beta = 0.076$, ns, were not significant predictors in this model. We also used Cook's D to identify outliers in the rape data – Botswana, Sweden, Jamaica, Columbia – and ran an additional regression model excluding them. Income inequality, $\beta = 0.493$, $p = .026$, and adult sex ratio, $\beta = 0.375$, $p = .032$, remained significant predictors of rape rates. Climate remained nonsignificant, $\beta = 0.082$, ns.

The role of adolescence in geographic variation in violent aggression

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Abstract: In explaining variation in violent aggression across populations, the age structures of those populations must be considered. Adolescents between the ages of 15 and 25 are disproportionately responsible for violent aggression in every society, and increases in violence tend to follow population "youth bulges." Large numbers of adolescents in equatorial regions may account for observed relationships between geography and violence.

Violent aggression is overwhelmingly a problem of adolescence. Around the world, adolescents commit proportionally more violent aggression than any other age group. Violent crime rates peak around age 20, and youths between the ages of 15 and 25 (with age 25 marking the approximate end of adolescent brain development [Blakemore 2008; Giedd 2004]) engage in anywhere from 2 to 10 times more violence than adults or younger children (Moffitt 1993; Snyder 2012).

This difference can be attributed to a range of cultural, social, and neurodevelopmental factors, including – of particular relevance to the CLASH model – poor self-control (Cohen et al. 2016; Moffitt 1993). Poor self-control in adolescence reflects in part the rapid development and heightened activity of reward-sensitive regions of the brain in this age group, even while executive regions responsible for balancing risk and reward, and weighing short- and long-term rewards, remain underdeveloped. These dynamics increase the risk not only of aggression, but also of

related outcomes like substance use, accidental injury, and unintentional drowning (Steinberg 2013). All of these phenomena are particularly pronounced in adolescent males (Scheidt et al. 1995), in whom patterns of brain development are somewhat delayed relative to those of females (Lenroot & Giedd 2006), and who are also much more likely to engage in violent aggression (Snyder 2012).

The authors have made a strong case that rates of violent aggression rise with geographic proximity to the equator, which is used as a proxy for climate. But the model may require amending to incorporate the mediating or moderating role that the proportion of adolescents across regions may play in geographic variation in violent aggression.

As it happens, more equatorial countries also contain large – sometimes much larger – proportions of adolescents. Almost without exception, those nations with median ages less than the global median age of 29 are equatorial nations of Africa, Asia, and Central and South America. The youngest countries in the world include equatorially proximate African nations like Uganda, Niger, and Mali. By contrast, the oldest countries include Japan, Germany, Monaco, and other European and Asian countries closer to the poles (Central Intelligence Agency 2016b).

So-called "youth bulges" in countries proximal to the equator could explain increased violence in these countries without reference to life history theories or climate. It has been observed that the proportion of individuals within a society who are between the ages of 15 and 24 is predictive of the prevalence of various forms of violence in that society, including homicide, domestic armed conflict, terrorism, and rioting (Bricker & Foley 2013; Mesquida & Wiener 1999; Urdal 2006). In the United States, a significant proportion of changes in violent crime over time can be explained by fluctuations in the proportion of adolescents (Phillips 2006). Globally, the relationship between violence and the proportion of a country's population composed of adolescents has also been found across several investigations (Cincotta & Leahy 2011; Pampel & Gartner 1995; Urdal 2006).

Van Lange and colleagues might argue that countries like Guatemala, Belize, and Honduras are among the most violent countries in the world because of their equatorial climates, which result in the population of these regions adopting relatively fast life history strategies, characterized by "short-term planning, greater risk taking, a focus on immediate gratification for short-term benefits, and more aggression" (sect. 3.1, para 3). But one could just as easily argue that the reason these quintessentially adolescent traits are pervasive in these countries is that their populations are disproportionately composed of adolescents. These are among the world's youngest countries, and are the three youngest nations in the Americas. Nearly a quarter of the population of Guatemala, for example, is between the ages of 15 and 24 (Central Intelligence Agency 2016b).

It is possible, then, that the patterns the authors have observed do not reflect climate-induced variation in life history strategies, but are instead an artifact of geographic fluctuations in the proportion of youths, owing to reasons that are unrelated to climate. Alternately, it is possible that fluctuations in the proportion of youths could be incorporated into the CLASH model. Youth bulges are thought to emerge during the stage of a nation's development when infant mortality has been successfully reduced, yet fertility rates remain relatively high (Bricker & Foley 2013), but no generally accepted explanation exists for why youth bulges currently cluster around the equator.

Any attempt to incorporate the relationship between youth and violence into the CLASH model should reflect the fact that the relationship between youth bulges and violent aggression may not be a simple one. Variables like access to education and jobs are critical influences on the behavior of youths within a society (Bricker & Foley 2013). Likewise, the effect of youth bulges on violent aggression may be mitigated by protective cultural factors like collectivism, which can transform large youth populations into civic opportunities (Pampel & Gartner 1995). Understanding the role of adolescence in societal variation in aggression therefore requires considering not only how many adolescents a society contains, but also how those adolescents are faring: Are they civically engaged? Educated? Impoverished? Optimistic about their future prospects (Bricker & Foley 2013; Hart et al. 2004; Pampel & Gartner 1995)?

The essential fact remains that a model of cultural variation in violent aggression that does not consider the role of adolescence remains an incomplete model.

Climate is not a good candidate to account for variations in aggression and violence across space and time

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Abstract: We agree with Van Lange et al. that climate is likely to affect individuals' social behavior in many ways. However, we suspect that its impact on physiology and psychology is so remote that its predictive power disintegrates almost completely through the causal chain underlying aggression and violence.

Using data about current and past patterns of aggression and human sociality, we show that the causal role of climate vanishes once one switches from a worldwide perspective to a more local one, and that it becomes quasi-irrelevant once a historical dimension is considered. Evolutionary models in biology provide explanations of variations in traits that are generalizable across both space and time. We believe that this criterion of relevance is, however, not met by CLASH.

We start our demonstration by testing whether climate predicts interpersonal violence during a restricted period within geographic Europe (Fig. 1A,B), an area that is similar in size and culture to the United States. Except for Russia, all major European countries with available climatic and homicide data for the 2008–2012 period were included (35 countries, sources: World Bank (The World Bank Group 2016a; United Nations Office on Drugs and Crimes [UNODC] 2016). Following methodological recommendations from studies that inspired the target article (Burke et al. 2015; Hsiang et al. 2013), we ran a series of correlations between interpersonal violence (measured by the homicide rate [Burke et al. 2015]) and either yearly average temperature or seasonal variations in temperature (i.e., the difference between the average temperature for the three summer months and the three winter months). We included only countries where CLASH was applicable (average year temperature under 24°C). Contrary to CLASH's predictions, both year-by-year and period-wise analyses revealed that interpersonal violence did not vary with temperature (all r values < .12, all $t(34)$ values < 0.67, all p values > .25) (Fig. 1A) and, more surprisingly, increased with seasonality (all r values > .39, all $t(34)$ values > 2.49, all p values < .018) (Fig. 1B).

We then tested whether climatic variables predicted homicide rates in elapsed time periods (Fig. 1C,D) using historical records from two geographically distant countries of the temperate zone: Japan (1924–2004 [Statistics Bureau, Ministry of

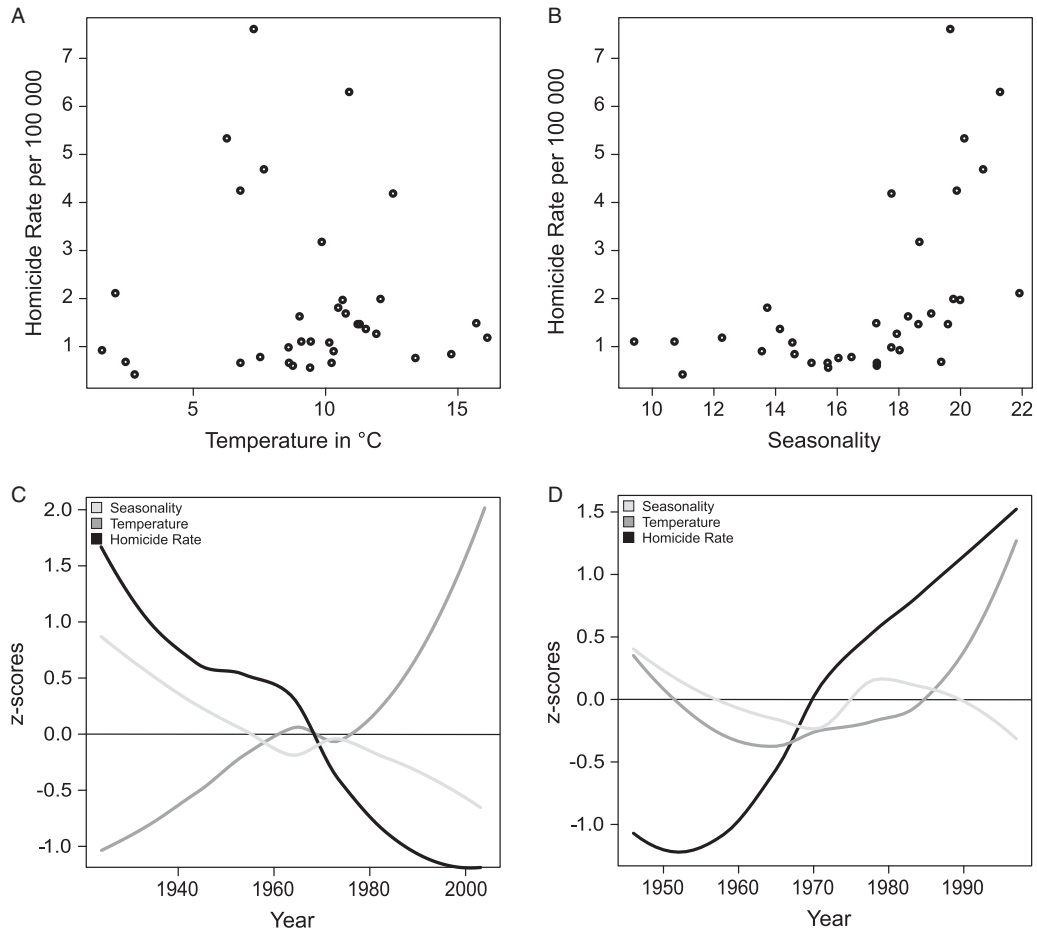

Figure 1 (Mell et al.). (A,B) Homicide rates averaged for the 2008–2012 period for countries (N=35) constituting geographic Europe, as a function of (A) temperature and (B) seasonality. (C,D) Year-by-year evolution of homicide rate, temperature, and seasonal variation for (C) Japan and (D) Great Britain.

Internal Affairs and Communications 2016a; 2016b; The World Bank Group 2016a]) and Great Britain (1951–1999 [Richards 1999; The World Bank Group 2016a]). For representational purposes, all three variables were expressed in units of standard deviations of their respective means over the whole period (*z*-score transformed). Figure 1C and D represent the trend for each variable across the time record, with ranges and standard deviations differing between Great Britain (homicide rate per 100,000: 0.58–2.06, SD = 0.42; temperature: 7.55°C–9.52°C, SD = 0.47; seasonality: 7.54°C–14.01°C, SD = 1.28) and Japan (homicide rate per 100,000: 0.97–4.14, SD = 0.98; temperature: 10.11°C–12.71°C, SD = 0.56; seasonality: 17.5°C–22.95°C, SD = 1.09). The impact of temperature and seasonal variations on homicide rates was the strict opposite of CLASH's predictions for Japan (average temperature: $r = -.52$, $t(79) = -5.43$, $p < .001$; seasonality: $r = .22$, $t(79) = 1.99$, $p = .049$) (Fig. 1C), whereas no effect was observed for Great Britain (both r values < .18, both $t(45)$ values < 1.26, both p values > .215) (Fig. 1D). Figure 1D illustrates the importance of considering historical data to avoid spurious correlations when trying to find determinants of trait variations: during the 1990s, homicide rate and temperature positively covaried in Great Britain, but it is seen by going back further in time that the rise in homicides preceded the temperature increase and that the relationship was actually reversed in the 1950s.

One could argue that testing countries with relatively homogeneous temperate climates is inappropriate because small climatic variance might not include the critical threshold at which more dramatic levels of violence occur. If true, then deviations from the mean could be pure noise. However, we believe that this is not the case. Figure 2 indeed illustrates the difference in murder rates measured for the year 2013 (Federal Bureau of Investigation [FBI] 2013) in all 50 states of the United States and in the five boroughs of New York City (Pediacities NYC) and shows that variations observed at a very local scale (city) can be of similar magnitude as variations observed at a very global scale (continent). We doubt that it is reasonable to posit that climate differences act as a major predictor, at the expense of other explanatory variables such as, for example, differences in income.

In addition to these empirical arguments, we raise a more fundamental concern: CLASH cannot satisfyingly account for major transitions in the evolution of human sociality such as, for instance, the replacement of asocial religions by prosocial ones. Recent work indeed demonstrates that the best explanatory factor of this phenomenon is an increase in affluence (energy capture per capita, urbanization rate, population growth), a variable highly predictive of individuals' level of resources (Baumard et al. 2015). This is in line with the life history framework, which predicts that individuals enjoying higher levels of resources engage in slower life strategies that are characterized by high investments in long-term goals, including cooperative goals. The early emergence of belief systems promoting prosociality can thus be better understood as the consequence of historical changes in the distribution of resources (Baumard & Chevallier 2015), rather than climate. It becomes especially striking when one considers that prosocial religions appeared in different

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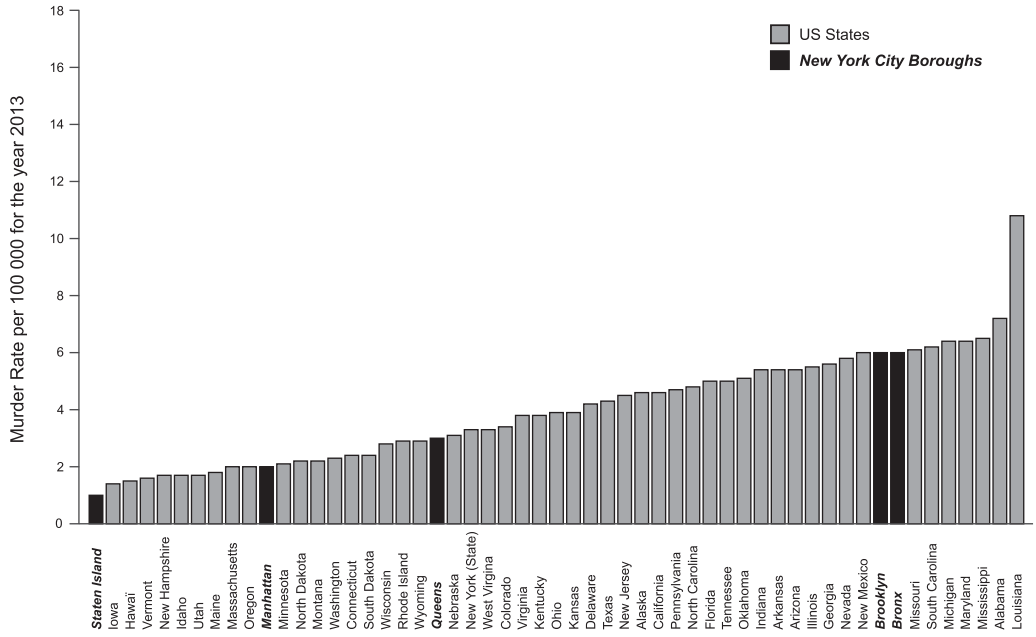

Figure 2 (Mell et al.). Murder rates measured for the year 2013 in all 50 states of the United States and in the five boroughs of New York City.

civilizations located in arid, semi-arid, and tropical zones of the world (Eastern Mediterranean, Mesopotamia, Northern India) long before they emerged in more temperate areas.

In sum, between-individual differences in life strategies – whose acceleration *eventually* leads to greater violence – are more likely to depend on ecological dimensions whose fluctuations matter more than climate for survival and reproduction in complex social worlds. All things being equal, climate differences ought to be part of the general explanation, but we doubt that they should constitute the core feature of evolutionary models of aggressive and violent behaviors.

The paradoxical effect of climate on time perspective considering resource accumulation

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Abstract: Considering purely climate, southern countries are less harsh and more predictable than northern countries. From a historical perspective, freezing winters resulting in fewer available resources contribute to the development of strong future orientation. The paradox is that future orientation contributes to accumulation of resources in the long run, making individuals' immediate living conditions less harsh, leading to slower life strategies.

Predictability and climate can be seen from different points of view. On the basis of Life History Theory (e.g., Hill 1993; Kaplan & Gangestad 2005), it is claimed that fast life strategies (related to reproducing earlier, having higher mortality and morbidity rates, having higher levels of violence) are adopted when life events are unpredictable and harsh (Ellis et al. 2009; Griskevicius et al. 2011), and slow life strategies (the opposite) are adopted when life is more predictable and less harsh. Van Lange et al. connect this to climate and claim that in warmer areas close to the equator, life is more unpredictable and harsher (from the perspective of climate as a result of viruses and natural disasters). Contrary to this argument, if one focuses on climate and its seasonal variation close to the equator, the climate is less extreme and there is less seasonal variation. From the perspective of climate arises the question: What can be more predictable and less harsh than constant warmth with little variation? Contrary to the authors' claim, it is plausible that areas close to the equator are more predictable, and considering purely climate, seasonal changes in areas farther from the equator can result in harsh life conditions such as freezing winters, unexpected summer droughts, and floods.

From a historical perspective, in those regions where the weather was comfortably warm all year, crops could be harvested twice a year and food and shelter were available all year. However, in the past, a second harvest in the winter was not possible in northern regions and it was more difficult to find shelter, which made living conditions harsher and less predictable. In short, they had fewer exposed resources during a certain part of the year. These conditions could have motivated northerners to become more future oriented, that is, to think about the forthcoming winter and its possible negative consequences and, thus, to accumulate and save resources (Ashkanasy et al. 2004). These northerners were forced to accumulate resources to cover the periods when resources were scarce. For them, future orientation was the key to survival (Zimbardo & Boyd 2008). Throughout history, this accumulating behavior driven by future orientation allowed northern societies to reach a higher level of economic development, whereas in southern regions, where resources were available all year long, societies were less focused on the future.

As accumulation of resources reached a point when there were more than enough resources for one harsh winter, the perceived availability of resources changed. If the pantry is full all year, the

perceived scarcity of resources changes fundamentally in a positive direction despite the variation in climate (e.g., unpredictable droughts, floods, or freezing winters). Societies that accumulated resources were more able to provide these to individuals than societies that were less pressured to accumulate. Thus, the northerners gained more control over the environment to make the living conditions more predictable and less harsh. This future-oriented accumulative attitude for controlling the harshness of winter finally made the immediate environment of the northerners more predictable than was necessary for the southerners. With a relatively constant warm climate without variation, southerners developed a present hedonistic time perspective that enabled them to enjoy each day more fully, which, in turn, led to pleasure-seeking behavior instead of accumulating behavior.

Resource accumulation is the basis of wealth. Northerners were forced to accumulate resources as a consequence of hard winters, which in turn led to gradual economic development. This economic growth created improved living conditions that in turn led to more predictable and less harsh living conditions. On the other hand, southerners were not forced to think of the future because their winters were mild or nonexistent and thus they did not have to learn how to accumulate resources. Here lies a paradox: Exposure to available resources (as a result of the climate) could create social psychological situations that could stimulate the foundation of resource accumulation and, in turn, provide better and more predictable living conditions in northern countries with less fortunate climates. To our best knowledge, data directly underpinning this hypothesis are scarce. However, it is in line with Morselli's (2013) argument that future orientation – in contrast to present or past orientation – can be considered as a way of coping with uncertain environmental factors.

In sum, we claim that climate, as an important contextual factor, has a direct impact on time perspective (Chen & Vazsonyi 2011), whereas fast and slow life strategies are consequences of the economic conditions created by presence of a future orientation or lack of a future orientation. It is clear that more northern nations, or those geographical areas within any nation, above the equator, have higher gross national products.

In conclusion, we claim that paradoxically the harsher and more unpredictable life conditions led to the development of a future time perspective, which – through resource accumulation in the long run – resulted in better economic conditions (with less threat and more predictability) that finally resulted in a slower life strategy. That meant being aware that their future needs were relatively secured, they could enjoy daily life more fully.

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Russian data refute the CLASH model

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Abstract: We examined the CLASH model using the data on climate and violence from the Russian Federation. The Russian Federation is a huge country with dramatic climatic differences between regions. Our results are absolutely inconsistent with the model. We consider there are a range of climates in which the human organism functions optimally. Deviations from the range cause impulsiveness and aggression.

In the target article, Van Lange et al. attempt to explain the relationship between aggression, violence, and climate differences. They assume that there exists a positive association between average annual temperature and violence. According to Van Lange et al., this is a universal law. To prove this association, they suggest that to adapt to lower temperatures and greater seasonal variation in climate, people adopt a slower life history strategy and a stronger focus on self-control. These psychological characteristics inhibit aggression and diminish violence.

It is necessary to note that Van Lange et al. derive a positive association between average temperature and violence mainly from the differences between countries. However, these differences can easily be explained by social, cultural, and historical variables. To demonstrate that the same mechanism operates within countries they consider the United States and Italy; however, such a small sample may be hardly representative, and the differences within these countries also can be explained by social and historical factors. As there is a certain shortage of data on the differences within countries, we decided to examine the CLASH model using the data on the differences within one country, the Russian Federation.

The Russian Federation is a huge country that consists of 85 regions (federal subjects) with very large climatic differences. The most southern regions are situated at the latitude of Rome and Madrid, but the country also includes Yakutia, which is the coldest place in the Northern Hemisphere. Moreover, many regions have a large seasonal variation in climate, when the difference between the average temperatures in January and July is 40°C–50°C. The population of 83 regions exceeds 100,000. This means that all statistics can be considered representative. Moreover, the population of the Russian Federation is relatively homogenous; ethnic Russians constitute 81%of the population, and Russians predominate in most of the regions (Wikipedia 2016c). This means that the cultural and social differences between regions should be relatively narrow.

We found the average annual temperature and seasonal variation in climate for each region in Wikipedia. When these data were missing for a region,we used the average temperature and seasonal variation for the capital of that region.

The violent crime rate for each region was calculated as follows: Violent crime rate = (murder+assault) per 100,000 in 2014. According to the CLASH model, life expectancy can be considered as an intermediate variable between climate and aggression. Because the vast majority of violent crimes are committed by males, in our analysis we used the regional male life expectancy in 2014. This factor varies up to 20 years for different regions of the Russian Federation. Van Lange et al. discuss the relationship between wealth and the CLASH model, and we decided to add the regional average income in 2014 to the analysis. The wealthiest region exceeded the poorest one as much as 4.7. All of these statistics are from Oxenoit et al. (2015).

To evaluate the relations between the variables we applied multiple regression analysis, where violent crime rate was a dependent variable and average annual temperature, seasonal variation, average income, and male life expectancy were independent variables. The results of the analysis are presented in Table 1.

These results are entirely inconsistent with CLASH. The basic assumption of Van Lange et al. is a positive association between violence and average annual temperature. Our association, however, is negative (Fig. 1). The CLASH model expects a negative relation between seasonal variation in climate and violence, but this relation is positive within the Russian Federation.The significance of life expectancy means that violence is connected to life expectancy regardless of annual average temperature. The fact that the regression coefficient between average temperature and average income is not significant may indicate that economic and social factors do not contribute to this dependence within the Russian Federation.

Our approach to the relationship between climate and aggression is as follows. First, it is absolutely incorrect to compare

Table 1. (Prudkov & Rodina) *Regression analysis*

$R = .78295029$, $R^2 = .61301115$, Adjusted $R^2 = .59316557$, $F(4,78) = 30.889$, $p < .00000$

Independent variable	Beta	p level
Average annual temperature	−0.373456	0.006522
Seasonal variation	0.179164	0.050557
Average income	−0.023360	0.804021
Male life expectancy	−0.372241	0.000516

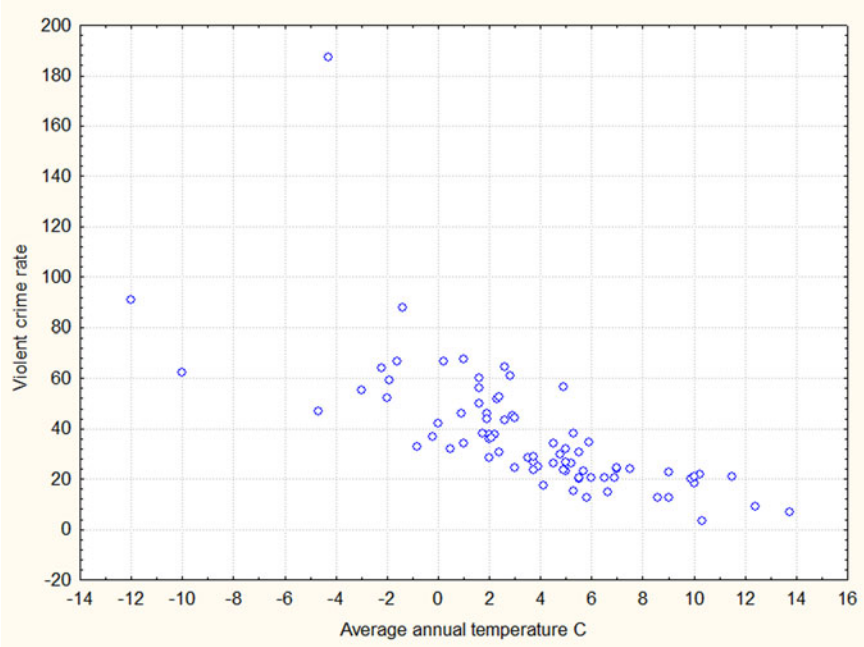

Figure 1. (Prudkov & Rodina). Average annual temperature versus violent crime rate.

various countries solely on the basis of climatic or psychological variables without taking into consideration cultural, economic, and historical factors. This method inevitably results in wrong conclusions. For example, the number of motor vehicles per 1000 people is 747 in Iceland and 591 in Norway. In contrast, this indicator is 6 in Burundi and 3 in Liberia (Wikipedia 2016b). No one would derive from these facts that heat inhibits the desire to own a car. Van Lange et al. mention that the rate of violent crimes is low in Europe, but they probably forgot that the two world wars started in Europe, not in Latin America. In other words, we do not think that the differences between countries confirm CLASH. Moreover, the data within the Russian Federation, a country with very large climatic differences and a relatively homogenous population, are inconsistent with CLASH. As a result, we conclude the CLASH model is wrong.

Second, humans have evolved under particular climatic conditions that are probably optimal for the functioning of the human organism. Living in an inappropriate (overly hot or overly cold) climate becomes a stressor, which can stimulate impulsivity, irritation, and frustration. These psychological variables may inhibit self-control, thus activating aggression (Anderson et al. 2000). However, the role of climatic variables is limited compared with the roles of social, economic, and cultural factors. These factors fundamentally influence violence and possibly alter the effect of climatic variables. For example, the low violence rate in Scandinavia may partially be explained by a rather high personal income that allows its residents to travel frequently to warmer climates.

Postcolonial geography confounds latitudinal trends in observed aggression and violence

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Abstract: To support their hypothesis, the authors point to an inverse correlation between latitude and the incidence of civil conflict and crime. This observation cannot be accepted as evidence for the hypothesis, because of a weighty confounding variable: the historical geography of colonialism and its effects on the fragility of nations.

"Although there are various exceptions," the authors claim, "a general rule is that aggression and violence increase as one moves closer to the equator, which suggests the important role of climate differences" (Abstract). As the authors acknowledge, there are problems in using cross-cultural (or cross-sectional) data on climate, violence, and civil conflict because "[d]ifferences between countries (e.g., historical, economic, political variables) are exceptionally difficult to disentangle from climate differences" (sect. 1, para. 5; see also Burke et al. [2015, p. 580]). In this case, however, one variable, the historical geography of colonialism and its effects on the distribution of fragile, postcolonial states in the 20th century, has such a weighty confounding effect that

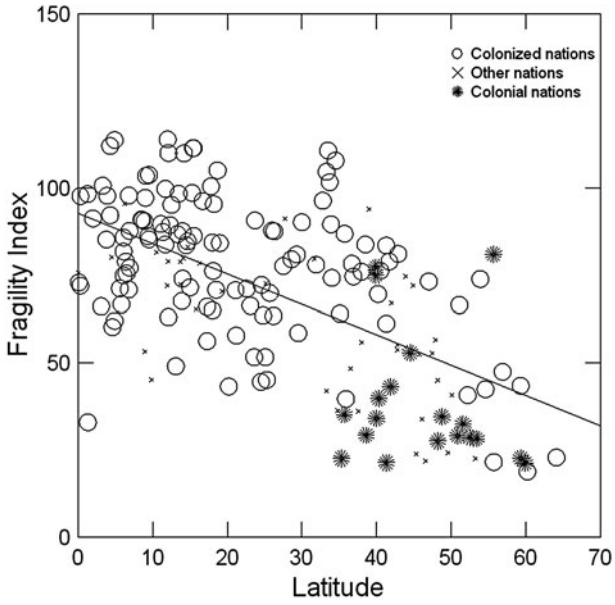

Figure 1. (Roscoe). Colonial status and 2016 fragility of 178 nations by capital city latitude. A high fragility index denotes high fragility.

latitudinal data on rates of conflict and violence cannot be accepted as evidence for the authors' argument.

As Figure 1 reveals, most colonized nations that achieved their independence between 1900 and the present (*circle icons*) are located in the warmer, lower latitudes between 0° and about 35°. In contrast, the nations that colonized them (*star icons*) occupy the higher, cooler latitudes, between 35° and 60° ($p < .0001$).

Because postcolonial nations are structurally more fractured than colonizing nations, and their governmental institutions less equipped to control crime or preempt civil conflict, it follows that aggression and violence will increase as one moves closer to the equator. Prior to imperial control, postcolonial nations existed as autonomous indigenous polities, most of them periodically or permanently at war with their neighbors. Colonization, however, abruptly grouped these communities together as a single polity – a "colony" – within borders arbitrarily defined by accidents of geography and history (Roscoe 2013; 2014; see also Kaplan 2008). With the collapse of empires in the last century, these artificially aggregated communities were then pronounced autonomous "nation-states" by fiat, and expected rapidly and without rancor to lay aside the enmities that had divided them just a few decades to a century or so previously.

In most cases, the colonial period was too brief to erase these divisions. In contrast to the more "organic" unity enjoyed by the nations that colonized them, postcolonial states comprise a set of political communities each of which still envisions itself to varying degrees as separate in identity and independent of the others. In many postcolonial nations, the task of managing these political fault lines was complicated by the egalitarian political orientation of their component communities, which interfaced poorly with the hierarchical, Euro-American governance structures they inherited (Strathern 1993, p. 719). To add to the difficulties of unification, the communities originally corralled into a postcolonial nation seldom spoke a single language. Depending on definitions, for instance, the number of languages in Papua New Guinea is at least 600; the Democratic Republic of the Congo has at least 215.

Given an inverse latitudinal gradient between the occurrence of stable colonizer nations and weak postcolonial ones, we should therefore expect a similar gradient in national fragility, a relationship empirically confirmed by the Fragile States Index (Fund for Peace 2016) (Fig. 1, regression line; r = −0.605). Because postcolonial nations are structurally more fractured than colonizing nations, and their governmental institutions less equipped to control crime or preempt civil conflict, it follows that aggression and violence will increase as one moves closer to the equator.

It may be, as the authors claim, that temperature affects human aggression and violence, but to use latitudinal data to justify a hypothesis that inhabitants of warmer climates are more present than future oriented and less focused on self-control than those in colder climates ignores the historical role of the latter in generating weak systems of sociopolitical control in the former. Worse, it runs the danger of unjustly stereotyping the populations of postcolonial nations.

The CLASH model in broader life history context

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Abstract: In this commentary, we address two questions: (1) Is the drive in many young men to gain status and amass resources, which frequently entails direct competition with members of outgroups, one of the key variables underlying the CLASH model? (2) Why is there so much variation in reactive aggression/violence between people living in the *same* environment?

It is encouraging to see life history thinking being incorporated into a broad, societal-level model explaining how differences in average and variation in local temperature are related to specific psychological and social processes, which in turn affect reactive aggression and violence. The aggression/violence area has needed, and will benefit from, an infusion of more evolutionary thinking.

In this commentary we address two questions: (1) From a life history perspective, is the drive in many young men to gain status and amass resources, which often may involve direct competition with outgroups, one of the key factors underlying the CLASH model? (2) Why is there so much variation in reactive aggression/violence between people living *in the same* environment if local temperature and seasonal variation are such fundamental predictors of aggression/violence?

Question 1. In the target article, the authors cite an important finding that receives insufficient theoretical attention. In a recent meta-analysis, Burke et al. (2015) reported that a one standard deviation increase in local temperature predicts an 11.3% increase in intergroup conflict, but only a 2.1% increase in interpersonal conflict. Moreover, these effects are confined primarily to visible, "reactive" forms of aggression/violence rather than other types of offenses or conflicts.

This significant difference provides a telltale sign that the deeper evolutionary reason for some of the effects anticipated by the CLASH model may center on how certain people – especially young, aspiring males with few resources and limited options – may try to increase their reproductive fitness at the expense of members of outgroups with whom they are competing in high average temperature/low variability temperature environments. In these environments, social status is important and resources are scarce and difficult to obtain and maintain, so finding a way to achieve higher social status and secure resources is paramount. One way to elevate one's status and rank in the ingroup, especially if one is a young male of mating age who

lacks status and resources, is to engage in risky, opportunistic actions that would improve one's position within the ingroup relative to competing outgroups. Such actions may, at times, involve intimidation, aggression, or violence directed at outgroup members during scrambles for status or limited resources (Wilson & Daly 1997). Young males who engage in such behaviors that yield successful outcomes should become leaders of their ingroups, which typically would translate into greater reproductive fitness during our ancestral past (Puts et al. 2016). This should be particularly true in pathogen-ridden environments, in which leaders engaged in very difficult or highly taxing behaviors perceived by others – especially by potential mates – as being "honest signals" (Zahavi 1975) of their health, stamina, and durability (Gangestad & Simpson 2000). Because women in evolutionary history did not need to gain status or accrue resources before reproducing, this pattern should be specific to males.

This account provides a good explanation for the aggressive/violent actions of young, resourceless males, but not for females. The vast majority of reactive aggression/violence, however, is perpetrated by young men who lack status and resources and have limited options to achieve them (Daly & Wilson 1988). Deeper and clearer evolutionary thinking could be infused into the CLASH model if Burke et al.'s intergroup conflict versus interpersonal conflict findings are integrated with sexual selection principles that address gender differences (see Trivers 1972).

This focus on the "fast" side of the temperature→reactive aggression/violence equation does not diminish the theoretical importance of the "slow" side. From a life history perspective, large seasonal swings in temperature should require better planning for the future, greater impulse control, and more sustained efforts to be cooperative, not only with ingroup members, but also with outgroups with which trust and reciprocal exchanges can be developed. All of these tendencies should have increased reproductive fitness in both sexes in these arduous environments. Thus, different evolutionary forces may have shaped the temperature→reactive aggression/violence link: one driven primarily by young males seeking to gain status and resources in pathogen-prevalent, intergroup-competitive, and high temperature/low temperature variability environments, and another driven by males and females who had to survive and successfully reproduce in equally challenging "heat and eat" environments.

Question 2. At the societal level, reactive aggression/violence is clearly more prevalent in hotter environments with smaller seasonal changes in temperature. Nevertheless, there is a great deal of variation in reactive aggression/violence between people who live in the *same* environment. Some people display reactive aggression/violence relatively frequently, whereas others never do. The CLASH model does not explain these individual-level effects, but other life history models do.

As discussed in the target article, different programs of research inspired by Ellis et al.'s (2009) distinction between harsh and unpredictable environments have revealed that individuals exposed to more harshness (e.g., lower-socioeconomic-status environments) and/or greater unpredictability (e.g., more chaotic home environments) early in life are more likely to engage in short-term planning, take more and larger risks, prefer immediate gratification over delayed rewards, and be more aggressive (e.g., Frankenhuis et al. 2016; Griskevicius et al. 2011; 2013; Nettle 2010; Simpson et al. 2012). Much of this research is consistent with Belsky et al.'s (1991) Evolutionary Model of Social Development. According to this model, the primary evolutionary function of early social experience is to prepare children for the social and physical environments they are likely to inhabit during their lifetime. Males and females exposed to high levels of harshness and/or unpredictability should receive less sensitive/more rejecting parenting, which generates insecure attachment working models. Insecure models, in turn, should speed up physical maturation, resulting in earlier sexual activity, short-term/unstable romantic pair bonds, and less parental investment (a fast orientation). Those exposed to lower levels of stress early in life should enact a slow orientation, which culminates in later sex, long-term/stable pair bonds, and greater parental investment. Mounting evidence supports this model (Simpson & Belsky 2016; Szepsenwol et al. 2015).

To obtain a more complete and nuanced understanding of why temperature is related to reactive aggression/violence, societal-level models such as CLASH should be melded with individual-level life history models.

An alternative interpretation of climate data: Intelligence

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Abstract: The CLASH model proposed in the target article is plausible but less than parsimonious. I suggest that statistical analysis probably would find slower life history strategy, greater focus on the future, and greater self-control to be highly correlated and perhaps unifactorial, because they are all manifestations of a single underlying variable, namely, intelligence. I suggest how intelligence as a state variable plausibly could explain the differences observed by the authors.

Van Lange et al. propose a plausible model of climatic and particularly temperature effects on behavior that they call CLASH: CLimate, Aggression, and Self-Control in Humans. According to the model, the greater propensity to aggression and violence of people near the equator is the result of a (1) slower life-history strategy, (2) greater focus on and orientation toward the future, and (3) greater self-control. The model seems plausible given the data presented. There are a few puzzles in the model, at least for me, such as the limitation of the model to the Northern Hemisphere (why would the Southern Hemisphere be different?) and the apparent near discounting of cultural variables, for which a strong case has been made by Nisbett and Cohen (1996), among others. But the greatest puzzle in the model is its rather strange conjoining of three variables that are presented as distinct, but that, I suspect, would be highly correlated and likely unifactorial were data collected to test their statistical properties. To focus more on the future and especially the distant future, one needs greater self-control (e.g., Mischel, 2015). And a slower life history strategy really is, in large part, a focus on the future because one perceives oneself as having the intelligence to navigate life so that one has a relatively remote future on which to focus.

The question then arises as to whether a more parsimonious interpretation of the data might be possible – an interpretation that views the probably high intercorrelations of these variables (were data actually to be collected) as reflecting some kind of single underlying factor. I would like to suggest what this factor might be, namely, intelligence, which can be viewed narrowly in terms of traditional factors (Carroll 1993) or broadly in terms of successful intelligence, encompassing creative, analytical, practical, and wisdom-based aspects (Sternberg 2003b).

There already is evidence that, on average, people from cooler climates show higher analytical intelligence than people from hotter climates (Lynn & Vanhanen 2002). One possible explanation, among many, derives from the distinction between intelligence as a trait and intelligence as a state (Sternberg 2014).

It is well known that a number of factors can affect people's performance on assessments of intelligence (Anastasi & Urbina 1997). The effects of these factors are not limited to formal intelligence or related tests, but can be found in everyday life as well. For example, people welcome air conditioning, not only because it makes them more comfortable, but also because the temperatures

it produces enable them to work more effectively (Sepaenen et al. 2006), in the same way that freedom from unwanted distractions does. Indeed, extreme heat is an unwanted distraction from one's work. Extreme heat, like extreme noise or extreme lack of ventilation, can adversely affect cognitive and other performance. These are among the many variables that contribute to the distinction between one's intellectual competence and one's intellectual performance (see Davidson & Sternberg 1985; Sternberg 2015). Intelligence as a state – as a level of performance distinct from and potentially lower than one's intelligence as a trait (competence) – could be responsible for the differences that Van Lange et al. have observed.

Intelligence may be a more parsimonious interpretation of the data, but is it plausible that it would predict the kinds of behavior Van Lange et al. have reviewed, such as aggressive and violent behavior? There are persuasive data that IQ, an aspect of intelligence, does predict such variables. More intelligent people plan more for the future, have better self-control, and have a slower life history, in part because their higher intelligence allows them to live longer (Deary & Whalley 2008; Gottfredson & Deary 2004). They are less likely to be incarcerated or, in general, to put themselves in a position where they will die from violence, caused either by themselves or by others. Indeed, in studies of styles of conflict resolution, my collaborators and I found that the style most associated with higher intelligence was "step-down," or trying peacefully to defuse conflicts (Sternberg & Dobson 1987; Sternberg & Soriano 1984).

In sum, the variables posited by CLASH may be three related manifestations of intelligence rather than three distinct constructs. In the end, the only way to determine the correct explanation would have to be empirical. And by the way, regardless of the explanation – Van Lange et al.'s, mine, or someone else's – climate change bodes ill for the rational behavior in the future of our citizens and their leaders.

Aggression, predictability of the environment, and self-regulation: Reconciliation with animal research

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Abstract: Apparently inconsistent with the CLASH model, animal research relates predictable environments to rigid routine behaviors and aggression. However, our work on evolutionary and neural adaptations to (un)predictable environments may be able to reconcile the CLASH model with the animal research, but also suggests complexities beyond the dichotomous approach of CLASH.

Van Lange et al. propose the CLASH model, in which a slow life strategy, characterized by future-oriented self-control, inhibits aggression in environments that have lower temperatures and larger seasonal variation in climate. Their model is based on Life History Theory (e.g., Figueredo et al. 2006), which proposes that people adapt to environmental (un)harshness and (un)predictability by adopting either fast or slow life history strategies. CLASH focuses on humans, rather than other animals, perhaps because research on animals seems inconsistent with the CLASH model.

Contrary to Van Lange et al., research on individual differences in animals relates aggressiveness to predictable environments. It has been proposed that aggressive animals have the evolutionary advantage of being better able to compete with others for known resources in predictable and familiar environments. As such, aggressive animals easily develop routines, that is, a rather intrinsically driven rigid type of behavior, and show reduced impulse control in operant conditioning paradigms. Nonaggressive animals, on the other hand, react more strongly to environmental stimuli, that is, they show larger cue dependency. For that reason, Koolhaas et al. (1999) suggested the terms *proactive coping*, which they associated with higher levels of aggression, and *reactive coping*, associated with increased restraint and lower aggression.

Proactive and reactive coping styles represent fundamental biological characteristics that can be observed in many species. The optimal proportion of each trait in a population changes with the predictability and stability of the environment (Koolhaas et al. 1999). The two traits evolved because reactive control of behavior is adaptive in unpredictable or changing environments, whereas proactive control is adaptive in predictable and stable environments (Tops et al. 2014). Although proactive individuals lack flexibility, they tend to increase the predictability and stability of their environment through social dominance and by being in control. However, the exclusive association of aggression with proactive coping is nuanced by literature suggesting that proactive and reactive coping have been associated with differential types of aggression, namely proactive aggression which is 'cold-blooded' and supports goal-directed behavior, and reactive aggression which is associated with 'hot-tempered' emotional responses to threat (Kempes et al. 2005). However, we suggest that both types of aggression are lowered by future-oriented control in humans.

The association between proactive control and aggression described in the animal literature only applies to simpler adaptations to predictable environments that benefit from rigid routines (Del Giudice 2015; Tops 2014). For more sophisticated, future-oriented control in predictable environments, lowered impulsivity and reduced overt aggressive behavior seems to be beneficial. The fact that most species do not engage in the kind of long-term planning typical of human adults may explain the apparent consistency of the animal literature, in which predictability is almost invariably associated with traits that indicate primacy of proactive control, including aggression. We proposed that evolution produced at least two more coping styles in humans (Tops 2014). Because both those coping styles exploit the advantages of predictable environments and are associated with low aggression, their existence in humans reconciles CLASH with the animal literature on proactive coping styles.

First, we argued that human evolution favored the emergence of a more self-regulatory type of personality (Tops 2014; Tops et al. 2016; Van der Linden et al. 2015), in which the aggressive control of the proactive trait is supplemented by a conscientious variant. This personality type exploits the advantages of collaboration and of moral and authority rule structures in order to protect obtained (in-group) resources from aggression and other threats. More specifically, predictability enables long-term investments and slow life history strategies (reduced impulsivity and aggression) if those investments can be protected against aggressive competition. Notably, the 'cold winter theory' claims that cold climates were a driving force in the evolution of predictive control by increasing selection of self-regulation, social constraints and future-orientation (Lynn 1987). However, similar to proactive personality, the conscientious, self-regulatory personality type is still associated with rigidity (Ferguson et al. 2014). For example, conscientiousness has been associated with higher probability of obsessive-compulsive disorder (Del Giudice 2014; Tops 2014).

Second, we argued that in humans not only the conscientious coping style evolved, but also a coping style that makes use of more flexible predictive control. Although proactive animals seem to a certain degree able to exploit environmental predictability, humans appear to be able to go beyond such rigid predictive

(i.e., proactive) control by using more flexible predictive control. Through increased encephalization, prolonged learning, and development of language, humans evolved flexible predictive control that could be applied in a wider variety of circumstances such as increased exchange with outgroups (Tops 2014).

As we discussed, the distinction between proactive control on the one hand and, on the other hand, the conscientious, self-regulatory personality (Van der Linden et al. 2016) and flexible predictive control, may explain why predictable environments are associated with impulsivity and aggression in animals, but with future-orientation in humans. By discriminating adaptations to predictable environments that are associated with either high or low aggression, we add some nuance to a simple predictable/slow strategy/low aggression – unpredictable/fast strategy/high aggression dichotomy. Resource availability, another key dimension of the environment that affects the development of life history strategies, shows similar complexities. Although low environmental resources tend to be associated with fast life strategies, energetic stress may cause the developing individual to shift toward a slower life history strategy. This translates into development of a more energy-sparing phenotype, including slower growth, delayed sexual maturation, and low fecundity (Ellis et al. 2009). The role of temperature in life history strategies is probably similarly complicated. Temperature is related to environmental resources and higher temperature is itself an environmental resource (Davis & Levitan 2005; IJzerman et al. 2015a). Moreover, temperature has also been hypothesized in various ways to be implicated in increased encephalization (Naya et al. 2016), a development that seems crucial in flexible predictive control. The association with resources and encephalization suggests that higher temperature may be involved in mechanisms that increase aggression as well as in mechanisms that are aimed to control overt aggressive behavior.

Hell on earth? Equatorial peaks of heat, poverty, and aggression

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Abstract: Van Lange et al.'s global CLASH model overemphasizes climatic origins and underemphasizes economic origins of aggression. Our 167-country analysis of latitudinal gradients of heat, poverty, and aggression finds that heat-induced aggression is mediated by poverty and that heat tempers rather than fuels poverty-induced aggression. More importantly, the CLASH model hints at latitudinal, equatorial, and hemispheric upgradings of climato-economic modeling of human behavior.

Latitude determines the amplitudes of winter cold versus summer heat, cooler nights versus warmer days, and the consequent temporal variation of thermoregulation in endothermic species. Within this thermal maze, Van Lange et al. have creatively mapped out a conceptual path marked by latitude and leading from smaller seasonal variation in temperature – much warmer winters with somewhat hotter summers – to greater human aggression. A shining virtue of the CLASH model is the emphasis Van Lange et al. place on the equator as a biogeographic divide (e.g., sect. 1, para. 8). By implication, the equator comes to stand out as a boundary link between distinct hemispheric labs for studying human adaptation to latitude-related conditions including heat and poverty.

On the shadow side, theories like the CLASH model can be criticized for preaching climatic determinism and dwarfing the gigantic impact of poverty on hostile conflict and violent behavior (Van de Vliert et al. 2013b). Actually, aggression against people and ecosystems is most prevalent in poor populations threatened by demanding cold or hot climates and least prevalent in rich populations challenged by equivalently demanding cold or hot climates (Van de Vliert 2011a; 2016). Although the current earth system offers endothermic species more variation in cold demands than in heat demands, the current world economy offers humankind more wealth in colder regions and more poverty in hotter regions (cf. sect. 5.1), with the likely contemporary consequence of greater aggression at lower latitudes.

Addressing this clash between the CLASH model and climato-economic modeling, we concentrate on Van Lange et al.'s geographic criterion, *distance from the equator*, which hints at research opportunities for replication across hemispheres and making use of equatorial turning points in latitudinal gradients. We first highlight the descriptive and illustrative qualities of the opposite directions of the latitudinal gradients of heat stability, economic poverty, and societal aggression on the northern and southern sides of the equatorial divide. Then we report that the effect of the latitudinal gradient of heat stability on the latitudinal gradient of societal aggression is mediated by the latitudinal gradient of economic poverty, and that heat tempers rather than fuels poverty-induced aggression.

We use a country's midrange distance from the equator purely as a north-south coordinate for description. The centerpiece of the CLASH model, the seasonal variation in temperature, is measured here as the sum of a country's average cold downward deviation and average hot upward deviation from 22^{0}C (~72°F; see Van de Vliert [2013b, pp. 505–07]), and is then multiplied by −1 to represent heat stability. Poverty is the average of a country's log-transformed income per capita in 2000, 2002, and 2004 (United Nations Development Programme [UNDP] 2002; 2004; 2006) multiplied by −1. Aggression is the average of three standardized national measures: the 2010 index of domestic conflict and violence (http://www.visionofhumanity.org/#/page/indexes/global-peace-index/2010), press repression from 2005 to 2008 (Van de Vliert 2011a), and business costs of crime and violence in 2006 and 2007 (World Economic Forum 2007) (Cronbach's α reliability is 0.704).

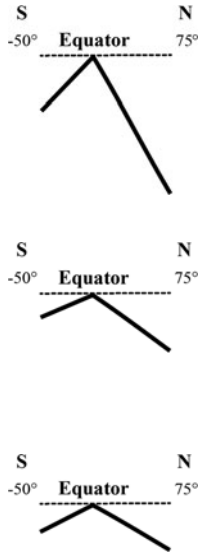
Table 1 indicates that latitude (X) is an adequate descriptor of heat stability, economic poverty, and societal aggression ($\hat{Y}$), and that the opposite directions of the latitudinal gradients in the Northern and Southern Hemispheres create intersecting peaks near the equator. It is unlikely that this consistent pattern of steeper northern gradients, flatter southern gradients, and near-equatorial turning points occurs randomly, also because heat stability (r = 0.339) and economic poverty (r = 0.651) are positively related to societal aggression (p's < .001).

Unconditional process analysis with 1000 bootstrap samples for constructing bias-corrected confidence intervals (Hayes 2013, model 4) reveals that the impact of heat stability on societal aggression is not a direct effect (lower limit confidence interval [LLCI] = −0.018, upper limit confidence interval [ULCI] = 0.190), but is completely mediated by economic poverty (LLCI = 0.111, ULCI = 0.283; total R^2 = 0.433). Faster life strategy – represented by the fertility rate 2000–2005 (source: UNDP 2006) – does not have an extra mediation effect (LLCI = −0.203, ULCI = 0.002; ΔR^2 = 0.014, total R^2 = 0.447). This mediation by poverty rather than fertility suggests a climato-economic revision of the CLASH model.

Conditional process analysis (Hayes 2013, model 74) cumulatively uncovers that the sizable effect of poverty on aggression is slightly modified by heat (LLCI = −0.284, ULCI = −0.078; ΔR^2 = 0.041, total R^2 = 0.474). Higher levels of poverty are associated with decreasingly higher levels of aggression at higher levels of heat (LLCI = 0.163, ULCI = 0.452 at the 10th percentile of heat; LLCI = 0.106, ULCI = 0.272 at the 50th percentile of heat; LLCI = 0.056, ULCI = 0.199 at the 90th percentile of heat). The

Table 1. (Van de Vliert & Daan) *The equatorial peaks of heat, poverty, and aggression.*

Heat stability	
$\hat{Y} = (-0.727X) + (-0.018X^2)$[a]	$R^2 = 0.715^{***}$
Northern gradient[b]	$r_{134} = -0.877^{***}$, $\hat{Y}=1.825X$
Southern gradient	$r_{33} = 0.729^{***}$, $\hat{Y}=1.066X$
Equatorial peak[c]	0^0 36′ S
Economic poverty	
$\hat{Y} = (-0.238X) + (-0.007X^2)$	$R^2 = 0.321^{***}$
Northern gradient	$r_{129} = -0.591^{***}$, $\hat{Y} = 0.733X$
Southern gradient	$r_{38} = 0.392^{**}$, $\hat{Y} = 0.426X$
Equatorial peak	2^0 35′ N
Societal aggression	
$\hat{Y} = (-0.146X) + (-0.005X^2)$	$R^2 = 0.285^{***}$
Northern gradient	$r_{124} = -0.520^{***}$, $\hat{Y} = 0.609X$
Southern gradient	$r_{43} = 0.465^{**}$, $\hat{Y} = 0.525X$
Equatorial peak	4^0 59′ N



[a]$\hat{Y}$ = dependent variable (heat, poverty, aggression). X = centered midrange latitude.
[b]Northern gradients are geometrically represented as right downward slopes, southern gradients as left upward slopes.
[c]The peaks are located at $X_m + (-b_1 / 2b_2)$, with X_m = mean midrange latitude (19^0 35′ N).
$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

interaction of hellish heat and abject poverty thus appears to temper aggression, which remains nevertheless high relative to the levels of aggression in richer regions. This climato-economic interaction also amends the CLASH model.

Van Lange et al. focus on the Northern Hemisphere but nevertheless think it necessary "to extend the model to both hemispheres" (sect. 1, para. 8). Along this line, we reran the last analysis on the 124 Northern Hemisphere countries (above 4^0 59′ N), and used the resulting regression equation for the prediction of societal aggression in the 43 Southern Hemisphere countries (below 4^0 59′ N). The positive relationship between predicted aggression and measured aggression ($r = 0.443$, $p < .01$) supports both the generalizability of our findings across hemispheres and the importance of the equator as a biogeographic divide.

Summarizing by metaphor, we view the CLASH model as a rickety lighthouse radiating flashes of insight. The most brilliant flashes of insight concern people's differing degrees of future orientation and self-control along the north-south axis of locations of residence. These biogeographic beams of light may navigate scientists toward latitudinal, equatorial, and hemispheric upgradings of climato-economic modeling of human behavior.

The role of climate in human aggression and violence: Towards a broader conception

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Abstract: The psychological processes that predict aggressive behaviour are also typically associated with violent self-harm (e.g., poor self-control). Yet, although human violence (towards others) appears to increase with proximity to the equator, suicide rates tend to decrease. In the light of this empirical puzzle, I argue that Van Lange et al.'s CLASH model would benefit from a broader conceptualization of human aggression.

In attempting to explain societal differences in the occurrence of human violence and aggression around the world, the CLASH model proposed by Van Lange et al. integrates the role of the physical environment with a number of important psychological processes, such as time orientation and self-control. Although I applaud the interactionist approach of the CLASH model in advancing our understanding of variation in human violence and aggression both between and within countries, I argue that the relatively narrow definition of "aggression" adopted by the authors hinders theory development in two important ways. First, it restricts the conceptual depth and breadth of the CLASH model. Second, it obscures a more complex empirical relationship between the role of physical geography and worldwide patterns of human violence and aggression. In particular, the authors state that "throughout this article, we use the terms aggression and violence to describe broad classes of behaviour intended to harm others" (sect. 1, para. 5). What is peculiar is that this definition is entirely unidirectional in the sense that it does not include, or allow for, violent behaviours intended to harm *one's self*.

In this commentary, I argue that the lack of consideration of violent behaviour geared towards one's self (rather than others) is consequential for two primary reasons: (1) the psychological processes associated with violent self-harm are conceptually consistent with the CLASH model in a number of important and interesting ways, yet (2) they also present a challenging empirical puzzle, raising critical questions about the causal role of climate in human aggression.

The human ability to express and experience violent and aggressive thoughts and behaviours is a global phenomenon that need not be restricted exclusively to harming others, as there is near-

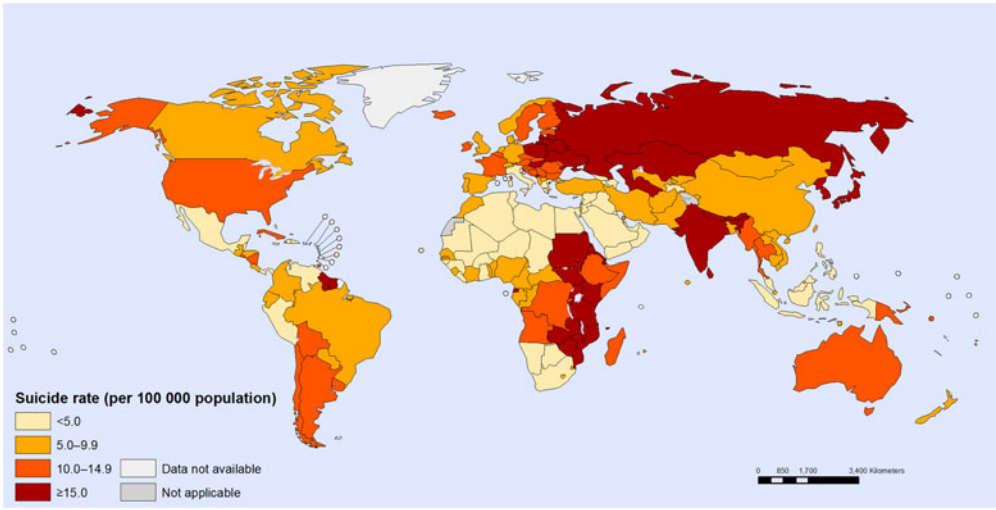

Figure 1. (van der Linden). Age-standardised suicide rates per 100,000 in 2012 around the world. *Note:* From World Health Organization (2014).

universal evidence of violent self-harm throughout recorded human history (DeCatanzaro 1980). Suicides are a notable and increasing cause of human mortality. Indeed, suicide is the 15th leading cause of human deaths worldwide and the 2nd leading cause of death among 15- to 29-year-olds specifically (World Health Organization 2014). In fact, global suicide rates have risen over the last decades, particularly among males (Bertolote & Fleischmann 2002).

Van Lange et al. implicate two key psychological processes in understanding aggression and violence: time -orientation (future vs. present) and self-control (high vs. low). Specifically, the authors focus on the type of poor self-control that results in "hot," impulsive, and angry reactive behaviour. Importantly, however, these psychological mechanisms are not only at play in explaining aggression and hostility towards others, but also in explaining violent self-harm. Indeed, low self-control, high anger, aggression, and impulsivity have all been reported to substantially contribute to suicide risk (Gvion & Apter 2011; Hawton et al. 2012; Horesh et al. 1997). Moreover, van Lange et al. cite evidence that, compared with a long "future" time orientation (i.e., a "slow life strategy"), a present (short-term) focus is often associated with higher aggression and violence. In a similar vein, the (in)ability to imagine a positive future is a major factor in depression and suicide risk, and suicidal patients often display reduced future-directed thinking and are significantly more present oriented (Greaves 1971; MacLeod & Byrne 1996). In short, expanding the conceptual definition of violence and aggression to include self-harm would add to the generalizability of the CLASH model, as the same psychological mechanisms that underlie violent harm towards others are associated with violent self-harm.

Importantly, the empirical evidence paints a more complicated and nuanced picture. Contrary to van Lange et al.'s review of the evidence that warmer temperatures and closer proximity to the equator are often associated with higher levels of aggression and violence, the geographical relationship between violent self-harm (suicide) and distance to the equator reveals substantially more spatial heterogeneity. To illustrate, the map in Figure 1. shows the most recent age-standardised suicide rates around the world, with the highest suicide rates occurring in countries with lower average temperatures and those more distant from the equator (e.g., Northern Europe, North America, Russia, India, Alaska, Australia etc.). In fact, although year to year variation exists, some of the *lowest* suicide rates are found in countries on or close to the equator, and standardised differences over many decades indicate a general trend that the further one moves away from the equator, the higher the suicide rate (Davis & Lowell 2002).

Although van Lange et al. recognise that the between-country evidence is more complex and less consistent, even the within-country evidence for self-harm is less clear-cut. For example, more suicides typically occur in the North of the United States than the South (Lester 1986). This is not to say that heat does not play a role in suicide risk; on the contrary, although complex, decades of research from around the world have documented the link between climate variables, such as increased temperature and (less) seasonal variation, and the risk of violent suicide (Deisenhammer et al. 2003; Maes et al. 1993). For example, even in traditionally darker and colder areas or so-called "suicide capitals of the world," such as Alaska and Greenland, suicides tend to peak in late spring and during the summer (Björkstén et al. 2009).

So where does that leave us? On the one hand, there is good evidence for the finding that heat, present-time orientations, and low self-control all contribute to violence and aggression *in general* (i.e., to one's self as well as to others). On the other hand, it is clear that warmer temperatures and less seasonal variation do not *cause* suicides. Similarly, being closer to the equator is neither a necessary nor sufficient condition to cause harm to either one's self or others. In conclusion, this is a cautionary tale about causality. Geography and climate may very well exacerbate human aggression and violence in general, but the relationship remains complex and varied. The CLASH model would benefit from broadening its definition of aggression and violence, including a more nuanced assessment of the evidence in the light of this empirical puzzle.

Sociocultural discourse in science: Flawed assumptions and bias in the CLASH model

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Abstract: In this commentary, we contest Van Lange and colleagues' central claim that "countries closer to the equator are generally more violent." We point to the lack of credible empirical evidence for this assertion and suggest that the CLASH model uses the language of science to lend false credibility to a problematic sociocultural discourse.

Van Lange et al. propose that the CLASH model will facilitate understanding of "differences within and between countries in aggression and violence in terms of differences in climate" (Abstract). Although the authors cite several studies to support their contention that differences in aggression over time and within region are associated with temperature, their argument that "countries closer to the equator are generally more violent" (sect. 2, para. 1) lacks empirical support. This misrepresentation of the literature on temperature and aggression, paired with the authors' exclusion of historical context in theory building, betrays what Harrison (1995, p. 50) has identified as "essentialist and universalized 'biomoral' assumptions concerning the natural history of human variation." We contend that in this presentation, Van Lange et al. fail to adequately disentangle empirical findings from culturally constructed assumptions. The result is a model that is eerily reminiscent of 18th-century European imperialist ethos (Cohen 2003):

> You will find in the climates of the north, peoples with few vices, many virtues, sincerity and truthfulness. Approach the south, you will think you are leaving morality itself, the passions become more vivacious and multiply crimes… The heat can be so excessive that the body is totally without force. The resignation passes to the spirit and leads people to be without curiosity, nor the desire for noble enterprise (Montesquieu 1748/1989, pp. 233–234).

In this commentary we identify unsubstantiated claims in the article and express our concern that the CLASH model uses the language of science to lend false credibility to problematic and damaging sociocultural discourse.

First, the article lacks evidence of a relationship between latitude and a cultural propensity for aggression. To support the claim that an aggression-climate pattern holds such that countries closer to the equator are more violent, Van Lange et al. cite a brief summary of a 1989 crime survey published by the Australian Institute of Criminology examining crime rates in Australia, the United States, Canada, and other countries in northern or western Europe (Walker et al. 1990). They then provide an unsystematic selection of violent crime statistics for broad groupings of countries (e.g., "Central America," "Middle Africa") selected from the 2013 Global Study on Homicide, glossing over relevant counterexamples that suggest a more complex relationship between climate and conflict. The authors also extensively cite a recent meta-analysis by Burke et al. (2015). Yet Burke et al. (2015) limit their analyses to within-population (e.g., within the same country, municipality, province, state, site, or district), and they explicitly question the validity of comparisons between groups that do not share culture and history: "It seems implausible that the conditions needed for causal inference are met in this setting" (p. 580). Thus, there appears to be little empirical support for Van Lange et al.'s central claim that "countries closer to the equator are generally more violent."

Similarly, although the authors' linking of Life History Theory and climate is an interesting idea that may overlap with some contemporary economic theories regarding climate and economic development (Easterly & Levine 2003; Sachs 2001), they provide little empirical support for the inclusion of impulsivity or time orientation in the model. No research is cited to directly support the assertion that cultures closer to the equator are more broadly "impulsive" than more northern cultures. With respect to time orientation, the authors fail to acknowledge the body of research linking time urgency (i.e., "clock time") with hostility and aggression (e.g., Glass et al. 1974; Karlberg et al. 1998).

Finally, the authors' inconsistent definitions of aggression result in an ambiguous construct that conflates reactive and proactive aggression. Even if we accept the premise that "countries and regions closer to the equator tend to have higher levels of aggression," Van Lange et al. are imprecise and inconsistent in defining the type of "aggression" explained by the model. For example, they state that their "focus is not limited to acts of interpersonal aggression and violence. We also include acts … such as political violence, wars, and riots" (sect. 1, para. 5). This broad inclusion of war and political violence within the purview of "reactive aggression" is inconsistent with the way this construct was defined by Dodge and Coie (1987), the authors that were cited. Further, some of the greatest violence witnessed within the last centuries has been initiated and perpetrated in a planned and systematic (i.e., "proactive") fashion by societies situated quite far from the equator (e.g., Nazi Germany's systematic process of occupying countries and implementing genocide; the Stalinist Soviet Union's Great Purge and forced labor camps). Based on the evidence presented, Van Lange et al.'s proposed model does not appear to have direct relevance to war and/or political violence. If the authors wish to argue for this point, then a careful historical analysis of the relationship between war and latitude would be needed.

Ultimately, the CLASH model as presented here does not sufficiently acknowledge the influence of historical, cultural, and contextual variables that might also be significant contributors to aggression and violence. Although the authors claim that the model is "organized around calls for the development of more interdisciplinary theories" (sect. 3, para. 2), they fail to appropriately acknowledge the ways in which sociopolitical factors such as income inequality, political instability, and scarcity or resources greatly influence aggression, irrespective of latitude (Krug et al. 2002). Many countries closer to the equator have a history of colonization and exploitation by northern countries, which some scholars contend has led to poverty, lack of basic necessities, and limited educational resources (Ghandi 1998). Furthermore, given the strong history of using psychology and brain science to support eugenicist movements in Europe and the United States (Fienberg & Resnick 1997), we argue that scientists in these fields have a duty to monitor our work for remnants of this legacy. We suggest that researchers maintain a cautious skepticism of this and other models that purport to explain population-level behavioral differences, particularly when the constructs under consideration, such as aggression, are fraught with moral overtones.

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NOTES

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Bullying when it's hot? The CLASH model and climatic influences on bullying

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Abstract: A novel predictor of bullying may be underlying regional weather conditions (i.e., climate). Bullying data support the CLASH model of aggression by suggesting that climate may moderate the forms and severity of bullying, as well as predict its prevalence across countries. Furthermore, bullying data also suggest that the CLASH model may apply to forms of aggression beyond reactive aggression.

Van Lange et al. propose an interesting new model to help explain global patterns of aggression with their CLASH model. Given the global nature of CLASH's predictions, it may be useful to apply it to a global form of aggression: bullying. Bullying can be defined as an "aggressive goal-directed behavior that harms another individual within the context of a power imbalance" (Volk et al. 2014). Globally, between 100 and 600 million adolescents are estimated to be involved in bullying as perpetrator or victim (Volk et al. 2006). Bullying therefore appears to be a ubiquitous behavior that causes significant harm on a global scale (Wolke & Lereya 2015).

One of the stronger arguments for the ubiquity of bullying is that it is an evolved behavior that can be found in all cultures, times, and places where sufficient data exist (Volk et al. 2012). To support this argument, in part, I have used two ethnographies as extreme examples: "Never in Anger" (Briggs 1970; Inuit in the Canadian Arctic) and "The Harmless People" (Thomas 1989; ! Kung in the Kalahari desert). Both explicitly describe their groups as peaceful and non-aggressive, yet bullying can still be observed within these groups. However, the bullying reported in these "peaceful" cultures is generally less risky, indirect, or social bullying (e.g., spreading rumors, excluding others), as compared with the more overt and violent bullying (e.g., punching, kicking, direct verbal insults) observed in other hunter-gatherer groups who live in less extreme environments (e.g., Yanomamo [Chagnon 1983; Chagnon personal communication 2013]; Ik [Turnbull 1972]). These qualitative data support a curvilinear CLASH model for average temperatures whereby the climatic stressors found in extreme environments moderate bullying toward less overt and severe forms.

To further explore the link between the CLASH model and bullying, I analyzed data from the largest cross-cultural study on bullying (Craig et al. 2009). Across 40 European and North American countries, for both boys ($r_s = 0.34$, $p < .05$) and girls ($r_s = 0.34$, $p < .05$), there was a significant positive correlation between the prevalence of bullying and proximity to the equator (as ranked by 10° latitude bands). To my knowledge, this is the first time that anyone has examined whether bullying is related to geographic latitude/climate factors, and reveals an important source of variation that has so far been overlooked by bullying researchers. It also offers potential further quantitative support for the CLASH model. I say "potential support" because it is important to note Van Lange et al.'s cautions about using CLASH for comparison of between-country prevalence rates, but the relatively robust effect sizes suggest a novel step in explaining the variance associated with the prevalence of bullying, and an interesting new line of inquiry for bullying research.

However, a link between bullying and climate also somewhat contrasts with the CLASH model. Bullying is a largely proactive form of aggression (Volk et al. 2014), whereas the CLASH model aims at explaining largely reactive forms of aggression caused by poor self-control. I therefore wonder whether CLASH-associated Life History Theory (LHT) solely explains reactive aggression or whether it better explains impulsive aggression that might include reactive and/or overt forms aggression. Multivariate models equating LHT with personality traits suggest that a fast LHT (as proposed by CLASH) is more strongly associated with lower Extraversion and Conscientiousness rather than tendencies to engage in proactive aggression (Honesty-Humility), or especially to react aggressively to provocation (Agreeableness [Strouts et al. 2016]). I therefore propose that CLASH may be tapping into a dimension of antisocial carelessness that leads to an increase in overt, as well as possibly reactive, forms of aggression. This lack of conscientious control suggests that the link between CLASH and reactive aggression may be due to confounding variables (low Extraversion and Conscientiousness) instead of an increased tendency to be reactive toward provocation (low Agreeableness). In support of this, the higher levels of overt physical bullying found in warmer climates (e.g., Chagnon 1983) may be best predicted by low levels of Conscientiousness, not Agreeableness (Farrell et al. 2014). I therefore suggest that further tests of the CLASH model incorporate an emphasis on different forms of aggression beyond reactive aggression. As a form of general aggression, bullying may offer an excellent format for testing CLASH's ability to predict proactive, reactive, covert, and overt forms of aggression along with their personality correlates (Farrell et al. 2014). The CLASH model thus receives some support from bullying research while provoking further research questions from that literature. Given the importance of the outcomes of bullying (Wolke & Lereya 2015), Van Lange et al. add new lines of inquiry that are a welcome addition to growing efforts aimed at reducing or preventing bullying.

Stuck in the heat or stuck in the hierarchy? Power relations explain regional variations in violence

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Abstract: We contend that an ecological account of violence and aggression requires consideration of societal and cultural settings. Focusing on hierarchical relations, we argue countries with higher (vs. lower) power distance are, on average, located closer to the equator, have more challenging climates (e.g., higher temperature; lower temperature variation), and have a greater prevalence of violence and aggression (e.g., higher homicide rates).

The CLASH model seeks to explain regional variations in violence and aggression by focusing on how individuals cope with environmental stressors irrespective of the wider social context. This approach overlooks the fact that environmental challenges affect

Table 1. (Weick) *Associations of power distance with climate and violence (homicide rates) in different geographic regions*

	Correlations with power distance (country level)								
	Americas			Europe			Worldwide		
	τ	n	p	τ	n	p	τ	n	p
Distance from equator	−.412	18	.018	−.404	30	.002	−.330	84	<.001
Annual temperature[a]	.328	20	.044	.282	33	.022	.337	96	<.001
Temperature variation[b]	−.286	20	.079	.213	33	.082	−.126	96	.072
Homicide rate	.317	20	.051	.310	34	.012	.193	101	.005

τ = Kendall's Tau-b correlation coefficient; n=number of countries.
Data sources: power distance (Hofstede, n.d.); distance from equator (Laitin et al. 2012); annual temperature and temperature variation (World Bank 2011); homicide rates (United Nations Office on Drugs and Crime 2013).
[a]Arithmetic mean and [b]standard deviation of average monthly temperatures spanning 1961–1999.

individuals' relations with others and the very fabric of society, creating variations in culture (e.g., Barkow et al. 1995).

In the present commentary we focus on the role of societal structures that originate from the distribution of power and resources (material and social), which, we argue, contribute to regional variations in violence and aggression. In unequal and hierarchical societies, the less privileged are inclined to adopt a shorter life strategy (e.g., Griskevicius et al. 2011; Moon & Chen 2014), are more oriented towards the present moment (e.g., Magee & Smith 2013; Weick & Guinote 2010), and are more impulsive (e.g., Wood 1998). Thus, contrary to Van Lange et al.'s assertion that "[cultural] explanations focus more on behavioural patterns than on underlying mechanisms" (sect. 2.3, para. 5), there are well-defined routes through which societal and cultural variables can affect violence and aggression. We agree with the authors that "life strategy" (LS), "time orientation" (TO), and "self-control" (SC) can contribute to regional variations in violence and aggression, but we question whether the physical environment (including temperature and temperature variation) contributes to differences in LS, TO, and SC independently of cultural and societal settings.

A consideration of societal and cultural variables enables us to move beyond intra-individual variables (LS, TO, and SC) to consider variables operating at the inter-individual and group levels. In hierarchical societies, factors such as expectations of deference from those of lower rank (e.g., Tyler et al. 2000) and the need to demonstrate one's worth (e.g., Mendoza-Denton et al. 2002) are chief concerns that can exacerbate conflicts. An imbalance in power can also trigger retaliatory aggression in chronically powerless individuals when the opportunity arises (Strelan et al. 2014). All of these factors operate in the context of cultural norms that can further fuel abuse, in particular downward abuse, in hierarchical settings (cf. Pearson et al. 2000). This, combined with the fact that the importance of the social context increases to the extent that people live in harsher and more unequal circumstances (e.g., Bianchi & Vohs 2016; Walasek & Brown 2015), leads us to believe that the focus on intra-individual variables (LS, TO, and SC) paints an incomplete picture.

Our claim that societal and cultural variables are important for understanding variations in levels of violence and aggression is bolstered by the observation that countries with some of the highest homicide rates – including Honduras, Venezuela, Guatemala, Mexico, and Panama – are not only characterised by high temperatures and low seasonal variations, but also are in the upper quartile of Hofstede's power distance index, which captures the extent to which hierarchies are embedded in society and inequalities are accepted as there to stay (Hofstede 1980). Conversely, some of the lowest homicide rates can be observed in countries such as Iceland, Switzerland, Sweden, and Denmark —countries with low temperatures and high seasonal variation that are also characterised by low power distance. Bergeron and Schneider (2005) established an association between power distance and cross-national differences in aggression, but their analysis did not include homicides and other extreme violence, nor did it examine climatological variables. In the present commentary, we sought to fill this gap, also examining for the first time the link between power distance and climate. As shown in Table 1, we found that power distance is associated with higher homicide rates across countries. Crucially, power distance increases with greater proximity to the equator, high average annual temperature, and lower seasonal temperature variation (the latter does not hold for Europe). These data bolster our proposition that social structures and the distribution of power can contribute to geographic and climatological variations in violence.

We posit that the association between power distance and violence is mediated by individual-level variables such as LS, TO, and SC, as well as inter-personal and group-level variables such as expectations of deference and concerns about one's social worth. However, power distance may also act as a moderator, operating in concert with other societal and cultural variables to weaken or strengthen the relationship between variables such as LS, TO, SC, and different manifestations of violence and aggression. Future research should explore the precise routes through which power distance contributes to regional variations in violence and aggression.

In sum, we applaud the authors for putting ecology at the forefront of research on violence and aggression. Their approach ties in with a growing body of research (see Oishi [2014] for a review) showing that economic (e.g., farming/herding see Uskul & Over [2014]), political (e.g., voice/accountability, see Helliwell & Huang [2008]), environmental (e.g., green spaces, see Kaplan & Berman [2010]), and demographic (e.g., sex ratio, see Pollet & Nettle [2008]) variables affect behaviour. However, an ecological approach to human behaviour is inherently intertwined with societal and cultural factors, which, in our view, need to be considered when seeking to explain regional and climatological variations in violence and aggression.

Culture matters for life history trade-offs

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Abstract: Van Lange et al. add important life history perspectives to understanding violence. However, direct links between climate and violence are unlikely because cultural institutions modify human responses. Examples are given from the Bushmen of the Kalahari and Enga of Papua New Guinea. The correlations identified may occur because many countries closer to the equator are caught in the gap between the demise of traditional cultural institutions and the rise of modern forms of governance.

Life History Theory has proven to be a powerful theoretical framework for understanding the trade-offs that humans face in the allocation of finite resources at developmental and evolutionary levels that shaped the characteristic course of the human life span with prolonged childhood and long life span after menopause ((Brumbach et al. 2009; Hawkes et al. 2003; Hill & Hurtado 1996; Kaplan & Gangestad 2005; Kramer 2005). Van Lange et al. add important perspectives to understanding violence in that the behavioral correlates of faster life histories in the CLASH model have the potential to generate aggression.

What the CLASH model overlooks in its parsimony is that adaptations to the threats posed by the key variables in the model – average temperature and seasonal variation – are mitigated by cultural institutions that increase predictability, reduce risks, and promote stability in human societies. There is no direct causal link between temperature, seasonal variation, and human behavior, because cultural institutions modify human responses to climactic conditions (Henrich 2015b). As Pinker (2011) has shown, it is the development of cultural institutions over the last centuries that has greatly reduced violence.

I will draw on two examples to illustrate how cultural institutions structure fast or slow life strategies, time orientation, and self-control. The first comes from the Ju/'hoansi Bushmen of the Kalahari who live at 19.5°S. Temperatures are high for all but four months each year, environment is harsh, and resources highly variable in both time and space. The foraging way of life and unpredictable environment preclude storage of surplus for lean times. Cultural adaptations include networks formed by gift exchange partnerships that extend within a 200-km radius (Wiessner 1982). These involve relationships of mutual support and access to alternate residences that mitigate the risks that might favor a fast life history.

Exchange partnerships are based on marriage ties, as the Ju/'hoansi say: "Marriage is far too important to be left to the young." Until recently, marriages were arranged before or around puberty to minimize aggressive male competition and build desired social ties, a practice widely found in hunter-gatherer societies. After the birth of the first child, divorce rates were low and extramarital affairs infrequent, for fear of damaging crucial social ties (Howell 2000; Lee 1979). Birth spacing was wide, allowing for substantial investment in children. Because peaceful relations were essential to mobility, Ju/'hoansi deplored violence of any kind and emphasized self-restraint. Most disputes were solved by talk or dispersal until tempers cooled (Wiessner 1982). Moreover, what appears to be present orientation and lack of efficiency in time use is misleading. The Ju/'hoan foraging economy does not allow for storage of food or wealth; people store in social ties. A great deal of leisure time was spent cultivating and maintaining such relationships in pursuit of life-long social security (Wiessner 1982). As in many traditional societies, "relationships structure time" time is taken to get essential relationships right. In Western societies, where people insure and advance themselves through storage or savings, time is money, and the converse is true. Time spent on social relationships may be rationed such that "time structures relationships."

The Enga of highland Papua New Guinea, who live at 5.5°S in a temperate climate, provide another example. Resources are abundant and predictable, with minimal seasonal variation, allowing for substantial surplus production and aggressive status competition. Cultural institutions structure the trade-offs in Enga life. Until the past few decades, exogamous marriages were arranged to build social networks outside the clan; promiscuity was severely sanctioned. Separate men's and women's houses, crafted for politics, also allowed for female choice over reproduction, wide birth spacing, and high investment in children. Bouts of interclan warfare were frequent, though contained through institutions for peacemaking. Although violence was socially sanctioned in certain contexts, young men were strictly disciplined and controlled by elders through a series of initiations, as they were in many New Guinea cultures (Wiessner & Tumu 1998). Needs from birth to death were met by the clan, while wealth from outside the clan was obtained through female ties. Future orientation was expressed by investing in these long-term social relationships. Life history was slow.

Similar examples of the mitigation of risks related to climate and society through cultural institutions abound in anthropology, raising questions about the value of any model that directly links average temperature and seasonal variation in temperature to violence. The dissolution of many cultural institutions with colonization, missions, and involvement in the global economy has had a major impact on the trade-offs that individuals face in allocation of resources over the life span. For example, for the Enga the discontinuation of male initiations and the introduction of high-powered weapons has reversed the male age power hierarchy, resulting in reduced self-control and higher rates of rates of murder, rape, and other forms of crime, despite recent reduction in tribal fighting (Wiessner & Pupu 2012). Marriage traditions have broken down, fathers are often absent, women seek men with money, and sex is negotiated at an early age through mobile phones. These factors lead to a faster life history for some.

The turmoil in Enga resembles that occurring in many societies today. It is due partially to the gap created by the dissolution of traditional institutions without replacement by fully functioning democratic institutions, court systems, and culturally appropriate education. The association between climate and violence in the CLASH model may in part be the product of the history of the breakdown of indigenous cultural institutions and the degree of replacement by modern systems of governance. With notable exceptions, countries further from the equator, such as those in Europe, are further ahead in this process than countries closer to the equator, such as those in Central America and Middle Africa.

Authors' Response

The Logic of Climate and Culture: Evolutionary and Psychological Aspects of CLASH

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Abstract: A total of 80 authors working in a variety of scientific disciplines commented on the theoretical model of CLimate, Aggression, and Self-control in Humans (CLASH). The

commentaries cover a wide range of issues, including the logic and assumptions of CLASH, the evidence in support of CLASH, and other possible causes of aggression and violence (e.g., wealth, income inequality, political circumstances, historic circumstances, pathogen stress). Some commentaries also provide data relevant to CLASH. Here we clarify the logic and assumptions of CLASH and discusses its extensions and boundary conditions. We also offer suggestions for future research. Regardless of whether none, some, or all of CLASH is found to be true, we hope it will stimulate future research on the link between climate and human behavior. Climate is one of the most presing issues of our time.

R1. Introduction

Our target article advances a theoretical model of CLimate, Aggression, and Self-control in Humans (CLASH). CLASH is based on the broad scientific assumption that climate is an important determinant of culture and human behavior. Although most of the critical empirical tests have yet to be conducted, CLASH was inspired by several general findings that are well documented in the scientific literature. First, there are pervasive differences in aggression and violence within and between countries around the world. Second, differences in aggression and violence are generally not randomly distributed across the planet — they are strongly related to both geographical latitude and temperature: the warmer the climate, the higher the levels of aggression and violence, especially intergroup conflict (see Burke et al. 2015). Third, in regions with warmer climates, people seem to adopt faster life strategies (e.g., women become mothers sooner and have more children). Fourth, in regions with warmer climates, time matters less; there is a stronger emphasis on the present and a weaker emphasis on the future. Fifth, self-control, which is strongly related to future orientation, may be associated with climate in a similar fashion. Sixth, self-control is one of the strongest predictors of aggression (e.g., Baumeister & Tierney 2011; DeWall et al. 2011) and violence (e.g., Pratt & Cullen 2000), especially violent crime (Gottfredson & Hirschi 1990; Henry et al. 1996). Seventh, there is some evidence that future orientation can reduce aggression (Joireman et al. 2003) and violent crime (Van Gelder et al. 2013; Van Gelder et al. 2015). These seven general findings can help solve what might be labeled as "the aggressive behavior-culture puzzle: the ABC puzzle." We believe that the tools used to solve this important puzzle should be empirical, logical, *and* theoretical (see Van Lange 2013).

There are two general themes in the commentaries: (1) climate should be viewed in the light of social-economic or political-historic variables (e.g., wealth, income inequality, governance), and (2) aggression and violence should be viewed in the light of proximal and ultimate mechanisms. In response to the first theme, we discuss the logical properties of climate, concluding with a brief outline of the relative stability of climate (see Section R2), and provide a discussion of the evidence for CLASH (Section R4) and extensions of CLASH (Section R5). In response to the second theme, we discuss our perspective on cultural evolution, which serves as a conceptual backbone of CLASH (see Section R3). The commentaries discussed boundary conditions (Section R6) and other issues (Section R7) relevant to CLASH. We conclude with some avenues for future research (Section R8) to test hypotheses and implications derived from CLASH.

R2. Logical Properties of Climate

An important feature of climate is that it offers objective parameters such as temperature that are related to aggression and violence levels (Burke et al. 2015). CLASH is based on the simple fact that any measurable theoretical concept has two statistical properties: (1) it is a measure of central tendency (e.g., mean); and (2) it is a measure of dispersion (e.g., variance). Most previous work has focused on average temperature and has ignored variation in temperature. CLASH focuses on both.

The interesting aspect of seasonal variation is that it is predictable and, therefore, to some degree "controllable." We do not mean that climate (or weather) can be controlled; we mean that it calls for anticipation, foresight, and long-term planning. For example, future orientation can help one mentally prepare for cold winters (e.g., clothes, food, heat source). Self-control is involved because it often takes effortful and costly action in the present to prepare for the future. To illustrate, in agriculture, the farmer needs to plant seeds in the spring and not eat them all in the early fall.

In addition to the statistical properties of "average" and (predictable) "variation," there is another objective property of climate – long-term stability. There is indeed evidence that climate has been exceptionally stable for the 10,000 years (because the Earth's orbit around the sun has not changed during this period). However, around 1950, a new era began, often referred to as the "the human epoch," in which humans started to have a profound effect on the climate by directly contributing to global warming (Richardson et al. 2011). Therefore, CLASH is based on the assumption that people living in different parts of the world, and even different parts of a country, adapt to different yet stable climatological circumstances. The long-term stability of climate is important in many commentaries discussed here because it implies that climate is unlikely to be strongly influenced by other variables such as social-economic and political-historic variables. Instead, CLASH assumes that climate itself causes aggression and violence, and other variables may serve as mediators (e.g., wealth, income inequality, governance, pathogen stress). In short, the link between climate and other variables should be largely unidirectional in terms of causality.

R3. Culture: Evolution and Adaptation

One key assumption of CLASH is that people create and maintain cultures (e.g., norms, institutes, and markets) that help them adapt to relatively stable climatological circumstances, which, in turn, increases their survival and reproduction. Most tasks for survival and reproduction can be accomplished only by a group or society, not by individuals alone. Thus, it is plausible that individuals adapt "through culture" by developing norms and rules, informal networks, and institutions that favor long-term planning and self-control. Humans are "cultural species" (Henrich 2015b, 2015 p. 3; see also Baumeister 2005; Boyd & Richerson 2005, 2009; Carleton & Hsiang 2016). That is, humans have adapted to their environments through many cultural practices, from preparing food to building complex institutions (Carleton & Hsiang 2016). Temperature is the key factor, and humidity may magnify of the

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effects of temperature (**Burke, Sulikowski, Stephen, & Brooks (Burke et al.).**

We emphasize *cultural* evolution because the threats and opportunities relevant to survival and reproduction can be "addressed" using primarily groups rather than individuals. That is, individuals are strongly *interdependent* in adapting to the threats and opportunities posed by both average and seasonal variation in temperature (Balliet et al. 2017; see also Kelley et al. 2003; Van Lange & Rusbult 2012). Examples are collective hunting, food sharing, agriculture, industry, and institutions. Because most tasks are interdependent (rather than independent), individuals adapt to climate not only as individuals, but also as groups and even societies. Thus, it is reasonable to assume that climate, like other features of the physical environment, shapes *cultural evolution.*

We emphasize culture from two distinct processes – "ultimate" *and* "proximal" – which help clarify some of broad issues raised by several commentators, most explicitly by **Cabeza de Baca, Hertler, & Dunkel** (**Cabeza de Baca et al.**); **Campbell**; and **Daly & Krupp**. First, CLASH adopts an *evolutionary* approach to culture. We acknowledge that cultural evolution should not be regarded as completely independent of genetic evolution, as there is strong evidence for culture-gene co-evolution. Second, we adopt an *interdependence* approach that complements a classic evolutionary one, by highlighting the "proximal" role of the current environment as a key ingredient in psychological adaptation (Kelley et al. 2003; Van Lange & Rusbult 2012). However, interdependence can lead to conflicts of interests with other families or groups. Therefore, climate may a powerful ultimate property of the environment that shapes features of interdependence that people, as individuals or groups, face in the here and now, as well as in the future.

It is also possible that people adapt in a proximal manner to longstanding differences in culture. These may or may not be ultimately caused by climate differences. For example, societies may differ largely in terms of social-economic variables, such as income inequality. Societies with high income inequality are characterized by low trust, high corruption, and high violence. In contrast, societies with low income inequality are characterized by high trust, low corruption, and low violence. How is one to adapt psychologically to these differences in terms of proximal causes? We believe research on immigrants is informative. There is evidence that first-generation immigrants who move from lower-trust countries (e.g., Turkey, Poland, Italy) to higher-trust countries (e.g., Denmark, Germany Switzerland) are strongly affected by the high levels of trust in the countries to which they immigrate (Dinesen 2012). They quickly become more trusting, regardless of length of stay (which varied from 1 to 7 years). These findings illustrate the influence of culture on general trust and why genetic differences may be modest (see Van Lange et al. 2014). These findings also illustrate the intimate connection between individual characteristics and group-level characteristics, which is key to cultural evolution (e.g., Henrich 2015a; Van Lange 2015). People are likely to develop trust through social learning and their own direct experience in groups or cultures when it makes sense to do so, for example, if the level of corruption is low and if income inequality is not very high.

In summary, our framework provides an overview of the key assumptions of CLASH, the logic of climate as a determinant of culture, and how culture helps us understand the proximal and ultimate causes of fast versus slow life strategies, future orientation, self-control, and ultimately aggression and violence. This discussion should provide general answers to the many interesting issues raised by the commentators.

R4. Extensions of CLASH

Because climate has not received much scientific attention as a determinant of human behavior, we attempted to provide a simple and parsimonious model by focusing on climate and less on other broad variables, such as wealth. Indeed, in the target article, we discussed the role of wealth as an important variable, because the wealthy are better able to (1) protect themselves against the dangers and harshness of climate and (2) engage in various behaviors inspired by future orientation and self-control (e.g., to save money for the future). This reasoning is in perfect agreement with **Van de Vliert & Daan**, who note that "climatological determinism" is an oversimplification and that other variables (e.g., wealth) could extend, improve, and enrich CLASH. The inclusion of other variables should enhance the breadth, accuracy, and general interest of CLASH.

We see at least four broad extensions of CLASH (see Fig. R1, which acknowledges more extensions, such as religiosity). First, it is plausible that climate, in combination with **wealth**, determines future orientation and self-control. One especially relevant prediction is that monetary resources matter more in demanding climates (e.g., the rich can cope with harsh climates better than can the poor). There is good evidence for this model in other social domains, such as the development of trust in strangers and cooperative enculturation of children (Van de Vliert et al. 2009). These findings are in line with the Climate-Economic Theory of Freedom (Van de Vliert 2013a) and underline the importance of climate *and* wealth to issues that are linked to self-control and aggression. Also, we agree with **Orosz, Zimbardo, Bőthe, & Tóth-Király** (**Orosz et al.**) that wealth can be a consequence of climate. Because seasonal variation can result in adoption of a culture of planning and self-control, milder climates with seasonal variation can yield more resources and wealth. Thus, wealth can serve as a potential mediator between climate and aggression and violence.

Second, in addition to wealth, there is strong evidence that **income inequality** is a powerful determinant of a wide range of variables, including aggression and violence (Kenrick & Gomez Jacinto 2013; see Wilkinson & Pickett 2009). We agree with **Krems & Varnum** on the importance of income inequality. Whether income inequality outperforms climate as a causal agent is to us a secondary issue. For us, the primary issue is whether income inequality influences life strategy, future orientation, and self-control, which, in turn, influence aggression and violence. Above and beyond climate, income inequality is likely to exert direct effects on aggression and violence because people are inequality averse (e.g., Fehr & Schmidt 1999; Van Lange 1999).

Third, we also share the view that **political and historic circumstances** can shape aggression and violence in

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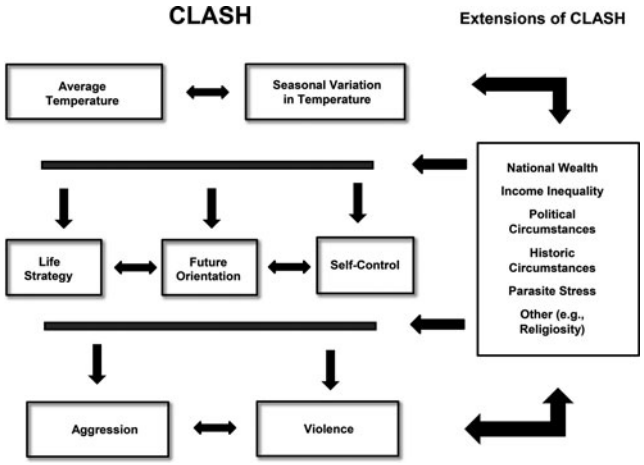

Figure R1. Model of CLimate, Aggression, and Self-control in Humans (CLASH) with extensions.

critical and enduring ways. It is possible that these circumstances, such as degree of democracy and history of colonialism, are partially shaped by differences in wealth and income equality. Countries around the world differ considerably in terms of wealth (Dohmen et al. 2015). This has been true in the past, is true now, and will likely be true in the future. Climate may be one of the ultimate causes of wealth and income inequality because the development of productive and sustainable agriculture is partially conditioned by high temperature and lack of water. One might also argue that differences in wealth and income inequality are responsible for political circumstances, such as the historical geography of colonialism (**Roscoe**; **Van Voorhees, Wilson, Calhoun, Elbogen, Beckham, & Kimbrel** [**Van Voorhees et al.**]).

Of course, the determinants and especially the consequences of colonialism are complex. What does a history of power imbalance and intergroup conflict do to a culture? Although answering this complex yet important question is challenging, we agree that it may well be the history of intergroup conflict that underlies the types of aggression and violence that are so strongly associated with temperature (**Burke et al.**). We also agree that power relations can be a source of conflict and aggression, as **Weick, Vasiljevic, Uskul, & Moon** (**Weick et al.**) suggest. Further, Weick et al. suggest there exists a close association between climate and power distance. It is possible that power distance, future orientation, and self-control go hand in hand within the same culture. Thus, although historic and political circumstances represent numerous different facets, it is possible that they are at least partially rooted in climatological differences (see also Van de Vliert & Tol 2014).

Finally, one natural circumstance that is closely linked to climate is the threat of parasites. Pathogen stress is a concept often used in reference to infectious disease, which is a major source of morbidity and mortality (e.g., Guernier et al. 2004; Schaller, 2006, 2016). According to the evolutionary Parasite Stress Theory of Sociality, humans and other animals adapt to parasite stress by dividing into in-groups and out-groups (Fincher & Thornhill 2012). This leads to in-group favoritism and out-group hostility (Fincher & Thornhill 2012; see also Murray & Schaller 2016; Schaller 2016). The Parasite-Stress Theory of Sociality has also been applied to the classic cultural dimension of individualism versus collectivism (Fincher et al. 2008; Hofstede 2001) – a dimension that is strongly linked to crossing in-group and out-group boundaries (e.g., Gelfand 2012; Gelfand et al. 2004). For example, intergroup stress is far more intense in collectivistic cultures, which are more prevalent in warmer locations with less seasonal variation.

R5. Evidence for CLASH

Climate is one of the most stable and far-reaching features of our physical environment and shapes the natural, social, economic, and political-historic character of the world around us. Indeed, one could argue that climate is an ultimate cause of culture. Yet wealth, income inequality, political-historic circumstances, pathogen stress, and perhaps other broad variables (e.g., religiosity, age) could all be ascribed the conceptual status of mediators. Therefore, as **Mell, Safra, Baumard, & Jacquet** (**Mell et al.**) suggest, it is theoretically possible that the direct (unmediated) impact of climate is negligible. It is also possible that even when numerous mediators are included, climate still has a direct influence on culture. These are empirical questions. But even if any effect of climate completely "disintegrates" (as Mell et al. stated in their abstract) when other variables are included as predictors of aggression and violence, it is still important to understand the causal role of climate. Climate can serve as a conceptual starting point for many processes at the level of culture and society. As noted by Burke et al. (2015), variables such as wealth and income inequality are "bad controls" because they may well be shaped by climate.

If climate is irrelevant, then CLASH is a theoretical exercise of no detectable scientific value other than perhaps serving a heuristic (idea-inspiring) function. The same would be true if there is a third variable that influences all of the variables in CLASH. These issues are empirical and testable. In our view, they are worth testing, not only because the role of climate in human behavior has received little empirical attention, but also because fast life strategy, future orientation, self-control, aggression, and violence are essential to the functioning of individuals and societies.

A few commentaries contain new data relevant to CLASH. For example, **IJzerman, Čolić, Hennecke, Hong, Hu, Joy-Gaba, Lazarević, Parzuchowski, Ratner, Schubert, Schütz, Stojilović, Weissgerber, Zickfield, & Lindenberg** (**IJzerman et al.**), on the basis of data from 14 countries, maintain that distance from the equator is significantly associated with self-reported self-control (Tangney et al. 2004) and strongly correlated with hot daily weather ($r = -.90$). Finding a significant correlation in an analysis in which the variation is rooted in 14 countries can be impressive, even though it may not be robust even if only a few countries are added to the sample (for related complexities, see Pollet et al. 2014). The conclusion that distance from the equator is not a competitive predictor (ranked as 14th) may derive from the limited variance of the 14 countries analyzed in terms of climate and climate-related variables (e.g., pathogen stress).

As noted earlier, we do not think that climate should outperform these broad variables – CLASH was developed to acknowledge the role of climate. Moreover, we want to examine extensions of CLASH to test whether the effects

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of climate are mediated by other variables (see Section R4 addressing extensions of CLASH). We share the view of **IJzerman et al.** that CLASH could be enriched by a greater appreciation of social influences (see the later discussion on the role of social development in our response to commentaries by **Bulley, Pepper, & Suddendorf** (**Bulley et al.**); **Frankenhuis, Fenneman, Van Gelder, & Godoy** (**Frankenhuis et al.**); and **Simpson & Griskevicius).** Finally, we think that most commentaries, with or without data, point to the potential importance of boundary conditions, which we discuss next.

R6. Boundary Conditions of CLASH

R6.1. Only the Northern Hemisphere?

In their commentary, **Fuentes, Kissel, Oka, Sheridan, Kim, & Piscitelli** (**Fuentes et al.**) make the important point that archaeological and paleoanthropological data conflict with CLASH. They note that this evidence suggests that in ancestral times, poverty was not stronger in countries closer to the equator. We acknowledge that the logic and availability of data needed to understand climate in combination with other broad variables in ancestral times pose a serious challenge to the evolutionary aspects of CLASH. What we regard as equally puzzling is that Fuentes et al. provide some evidence that CLASH receives support on the Northern Hemisphere (accounting for 10% of the variance in homicide), but not in the Southern Hemisphere. We limited CLASH to the Northern Hemisphere because of a lack of data (in a relative sense) and because the Northern Hemisphere contains a larger amount of land and a larger number of people. Although there is already some evidence of CLASH in both hemispheres (e.g., see commentary by **Van der Vliert & Daan**), more research is required to determine whether CLASH applies to both hemispheres. The two hemispheres differ greatly in terms of population density. People and groups do need to interact to aggress, and high density and crowding are associated with high levels of aggression (e.g., Lawrence & Andrews, 2004; Russell, 1983).

R6.2. Only humans?

As the name conveys, CLASH was developed as a theoretical model of aggression and self-control in humans. **Tops & Van der Linden** note that CLASH may not be generalizable to or reconcilable with other animals. From an evolutionary perspective, this may indeed pose challenges. As we outline in the target article, animals are highly responsive to climate. Hibernation, migration, and hoarding are among the most well-known examples. Other animals might also have some "foresight." One crucial difference between humans and other animals is that aggression is a means for ensuring survival and good reproductive outcomes for many carnivores, but generally not for humans.

R6.3. Only young males?

Marsh correctly notes that most aggression and violence are committed by young people, especially young males. We do not know the strength of the relation between age and distance from the equator (or, more precisely, average temperature and seasonal variation), but even a small relation could serve as a moderator or, perhaps, as a mediator if climate somehow caused this age difference. **Krems & Varnum** discuss the importance of sex ratio. **Simpson & Griskevicius** note that survival and reproductive success are determined by competition for status and resources among young men. Although there is an emerging psychological literature indicating than men and women may differ in their expressions of aggression, most forms of physical aggression and violence, especially in intergroup settings, are committed by young men. Thus, CLASH may be especially relevant to young men. In our view, this constitutes a promising topic for future research.

R6.4. Only some parts of the world?

In their commentary, **Prudkov & Rodina** report evidence that violent crime in Russia is more prevalent in colder climates with more seasonal variation, which contradicts CLASH. We can think of three possible explanations for their findings. First, Russia excludes latitude areas lower than Madrid or Rome (areas where pathogen stress is weak or absent), whereas it includes areas with extremely harsh winters in the north (the average temperature in Yakutia in January is –38.6°C [–37.5°F]). Perhaps this level of harshness overshadows the influence of predictable seasonal variation. Second, although we agree that within-country comparisons allow for some control for social-economic and political-historic variables, it might be speculated that poverty overpowers the role of climate in northern Russia — with its history of communist values and strong centralized government in Moscow. Third, it is also possible that (harsh) climate needs to be viewed in combination with differences in wealth to understand aggression and violence (see Van de Vliert 2013a).

R6.5. Suicide

The connection between aggression and suicide is interesting (**Van der Linden**). Suicide rates do tend to be higher in countries at high latitudes and with more seasonal variation (see also White et al. 2015). Although suicide is sometimes portrayed as "impulsive," it may also be planned, often following one or more suicide attempts (Hawton 2007). Thus, the link between self-control (or future orientation, in a more spiritual sense as in an afterlife) and suicide is not entirely clear. Self-harm also differs from other-harm, because other-harm is often motivated by self-protection. Thus, we do not expect parallel results for aggression and self-harm, but consider it interesting that climate might ultimately help us understand yet another big issue – suicide.

R6.6. What about prosocial behavior?

Konrath argues that warmer climates with less variation may also be climates in which more prosociality and helpful behavior are observed. Indeed, there is research indicating the proximal influence of physical warmth on trust and prosocial behavior (e.g., Williams & Bargh 2008; IJzerman & Semin 2009). We suggest that aggression does not exclude prosociality or closeness. Burke et al. (2015) reported that intergroup conflict is more prevalent in warmer cultures. It is possible that a strong sense of "in-group love" may sometimes go hand in hand with some "out-group hate" because an emphasis on collectivism tends to lead to a sharper differentiation between us and

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them (see also Gelfand et al. 2004; Yamagishi & Mifune 2009). Thus, it is possible that warmth is predictive of intergroup hostility, but with a simultaneous tendency to help those that belong to the in-group, tend to be similar to the self, or are otherwise psychologically close.

R6.7. Prediction, prospection, or both?

In their commentary, **Baumeister, Clark, & Kim** (**Baumeister et al.**) thoughtfully argue that predictable seasonal variation can lead to prospection rather than prediction (also see Baumeister et al. 2016) People want not only to predict the future, but also to "prepare" for the future – an important complement to CLASH. Although climate is generally predictable, we agree that people may also "mentally prepare" for the future. For example, in countries far from the equator, especially where the winter is characterized by clouds and rain, with little sunshine, there are people who save money so that they can afford to visit sunny places. We agree that prediction *and* prospection are both important and complementary and may be related in similar ways to a slow life strategy, future orientation, and high self-control.

To conclude, we agree that the evidence for or against CLASH is hard to evaluate at this point. As with most new programs of research, we start by developing the logic, specifying the model, and outlining extensions and boundary conditions. We do not think it is essential to examine the competitive status of climate relative to other determinants of life strategy, future orientation, self-control, and aggression and violence. The first goal is to provide tests of the hypotheses that can be derived from CLASH and its extensions, which we discuss in Section R9.

R7. Remaining Issues Raised by CLASH

R7.1. Which climates are harsher?

We have assumed that extreme climates, both hot and cold, are harsh. Some commentators raise the possibility that warmer climates are generally less harsh (**Baumeister et al.**, **Burke et al.**, **Orosz et al.**). Humidity can also magnify the effects of harsh climates (Burke et al.). One parsimonious model is that extreme temperatures are aversive, exhausting, and taxing. One important question is how well people can protect themselves from harsh climates – cold *and* hot. Importantly, CLASH also explicitly considers other climate-related features of the environment that may be harsh, especially pathogen stress (e.g., Fincher & Thornhill 2012; Murray & Schaller 2016). Pathogen stress is higher in warmer and hotter climates than in milder and colder climates, because seasonal variation reduces parasite survival. Infectious diseases caused by parasites may also make the environment harsh in a more proximal sense. In addition, coping with seasonal cold and its consequences (e.g., anticipation of food shortage) calls for more planning and self-control than does coping with heat and its consequences (e.g., parasites).

R7.2. Cultural evolution, genes, intelligence, narcissism, and machiavellianism

We highlight the role of culture, in both an "ultimate" and a "proximal" sense. Evolutionarily, we assume that climate influences culture (e.g., institutions, norms, beliefs). We agree that social development is important to consider when talking about culture, as noted by some commentators (**Bulley et al.**, **Frankenhuis et al.**, **Simpson & Griskevicius**). Culture is strongly embedded in social development, as parenting and education are strongly guided by relatively local institutions, norms, and beliefs. Here too, we believe there is ultimate and proximal influence. As noted by Simpson and Belsky (2016), children growing up in harsh and unpredictable environments are likely to receive less sensitive parenting and adapt by adopting a faster life strategy (e.g., earlier sex and parenthood). Proximally, institutions such as schools differ in terms of how much investment in the future is communicated and valued, and so culture may also provide many "nudges" toward a slow versus fast strategy, future orientation, and self-control. Frankenhuis et al. discussed internal predictive adaptive responses (PARs) with a focus on those who have been exposed to similar environmental conditions, but differ in their somatic age. Even under similar conditions, those of higher somatic age tend to adopt a faster life strategy. Thus, life strategy can also be triggered by internal processes. Even if somatic age is higher, on average, in warmer climates, somatic age differences can still be explained by Life History Theory.

It is also interesting that CLASH receives support from cross-national research on bullying (**Volk**). It may be that power distance and honor (Nowak et al. 2016; **Weick et al.**) play an important role and that such cultural influences may occur early in life. **Wiessner** provides several cultural illustrations to make the point that "culture matters for life history trade-offs." Societies also sometimes transition to democratic institutions, which is likely to bring greater equality in income and opportunities. We agree that these transitions are important because they make the environment less harsh and more predictable for the most vulnerable members of society.

In their commentaries, **Boutwell & Winegard**, **Campbell**, and **Daly & Krupp** suggest that we overlooked past work by Rushton (1995; 2000b), who proposed a strong link between genes and traits such as intelligence, and that this would account for race differences. However, Rushton devoted relatively little attention to *cultural* evolution or proximal processes, which are central tenets of CLASH. Rushton also focused on intelligence, whereas CLASH does not explicitly address intelligence, even though we acknowledge that intelligence is related to future orientation and self-control. And finally, we are not aware of any strong support for the idea that genes explain differences in intelligence *between* and within the races (see Henrich 2015b).

Sternberg asks whether the concepts of life strategy, future orientation, and self-control could be parsimoniously replaced with (state) general intelligence. We think not. Although intelligence may be related to future orientation and self-control, they are distinct concepts. Self-control can be trained, is contextual (e.g., being silent at a funeral), and is state related (e.g., influenced by exhaustion), whereas general intelligence tends to lack these characteristics. We do think that this point deserves future research, not only because parsimony is important, but also because state intelligence may be linked to climate, or at least heat. For example, heat poses serious challenges to neurocognitive functioning (e.g., Mazloumi et al. 2014).

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It is fascinating that narcissism is higher in countries closer to the equator (**Jonason & Schmitt**). It is plausible that warmer climates, food shortage, and high narcissism go together, because narcissists are to place their own needs ahead of others', which could enhance their survival and reproduction. Jonason and Schmitt's reasoning extends CLASH by offering the intriguing possibility that aggression may be more quickly activated in warmer climates with less variation as a means of survival, with enduring food shortage as one of the more important "triggers." Thus, we suggest that CLASH can be extended in important ways by examining individual differences, including narcissism and traits related to conflicts of interests and situations of scarcity, such as empathy, trust, and prosocial orientation (for a review, see Van Lange et al. 2013).

R7.3. Life History Theory concepts

CLASH is partially rooted in concepts of Life History Theory. We agree with **Barbaro & Shackelford** that Life History Theory is described in somewhat different ways in the literature, which can lead to differences in understanding (and, perhaps, misunderstanding). Also, the concepts of harshness and unpredictability are perhaps in need of further specification and clarification, especially when applied to complex human behaviors such as aggression and violence. The perspective of CLASH is that harshness and unpredictability are relatively independent constructs. However, in our characterization of climates, we described warmer and colder climates as harsh (see above), but colder climates with seasonal variation as being also predictable. This aspect of predictability of seasonal differences in temperature is essential to CLASH because it provides the basis for slower life strategy, future orientation, and self-control. If cold climate were completely unpredictable, CLASH would anticipate that people would adopt faster life strategy, shorter-term orientation, and less self-control. According to CLASH, future orientation and self-control are adaptive only when there is a threshold level of predictability, which ultimately provides the basis for some "control" over the environment.

Cabeza de Baca et al. (last paragraph) clarified their position with the following summary: "Climatic variation ultimately causes evolved biogeographical LH [life history] variation, which proximally explains a complex of biological and behavioral LH traits, among which are future orientation, self-control, violence, and aggression." This position is quite consistent with CLASH, except that CLASH explicates the power of culture (in an ultimate and proximal manner) in shaping future orientation, self-control, and the likelihood of aggression and violence. We also noted that heat can exert direct effects on all of these variables.

R8. Future Avenues of CLASH

We regard the focus of CLASH on climate as a stable feature of the natural environment that includes the logical properties of a central tendency (mean) and dispersion (variance), as a novel theory. We should also note that research on climate is challenged by the fact that many broad variables may be associated with climate, such as wealth, income equality, pathogen stress, and governance. Rather than providing competitive tests of the predictive value of each variable, we recommend an approach that examines whether (1) climate is associated with aggression and violence (along with life strategy, future orientation, and self-control); (2) climate is associated with several broad variables; and (3) these variables might mediate the effects of climate, which we conceptualize as a long-term stable feature of the natural environment that may shape individuals and culture in very important ways.

One major issue left to explore is what role life strategy plays in climate's shaping of an individual and in understanding violence and aggression. We have emphasized future orientation and self-control as outgrowths of slow life strategies, but there is more to it. The tendency to prioritize risk over safety and to prioritize short-term risky gain over longer-term safety is one central aspect of a fast life strategy (e.g., Frankenhuis et al. 2016). Clearly, morbidity and mortality risks are often strongly involved in intergroup aggression and especially intergroup violence. It may be that individuals who have adopted fast life strategies are those especially likely to initiate conflict, to never "back off," and perhaps to favor honor over death (e.g., Cohen, 1998; Nisbett 1993; Nisbett & Cohen 1996; Nowak et al. 2016). And as discussed earlier, young men might be especially sensitive to excessive risk taking in various life domains, including intergroup conflict (see Van de Vliert et al. 1999; see also **Barbaro & Shackelford**, **Simpson & Griskevicius**, and **Wiessner**).

Second, although we have reviewed some evidence supporting CLASH, it is clear that the key mediators – fast versus slow life strategies, future orientation, self-control – still need to be empirically addressed. The link between climate and self-control is one that is most strongly in need of empirical investigation. Although self-control can be measured in various ways, we suggest that it is important to focus on the behavioral aspects of self-control. For example, paradigms such as the "marshmallow test" seem very suitable for assessment of the development of self-control (Mischel, 2012; Mischel et al. 1988). Generation of adult versions of behavioral self-control, as well as behavioral measures that address self-control in intergroup contexts, is clearly an important way in which key hypotheses of CLASH can be tested. Also, inspired by several commentators (e.g., **Campbell**, **Sternberg**, **Cabeza de Baca et al.**, **Jonason & Schmitt**) we suggest that cross-national research on personality, such as assessments of conscientiousness (De Vries & Van Gelder 2013), along with measures of (state) intelligence, "dark" personalities (narcissism, machiavellianism, psychopathy, sadism), trust, and prosociality, may help illuminate whether the mediators of CLASH need to be refined or revised.

Finally, to broaden the implications of CLASH beyond aggression and violence, it may be promising to examine other cultural expressions of life strategy, long-term orientation, and self-control. For example, in recent research we found that professional soccer coaches are more quickly fired and hired in warmer countries with less seasonal variation (Van Lange et al. 2016). Further, **Volk** found evidence in a sample of 40 countries that the severity of bullying may also be related to climate. We agree with **Volk** that it would be interesting to examine what the ultimate and proximate mechanisms might be, whether they are related to in-group and out-group differences, and whether bullying and its escalating forms are a matter of "thoughtful" action or impulse. It is possible that self-

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control failure accounts for the more severe forms of bullying.

Future research might also assess various expressions of life strategy, future orientation, and self-control. For example, commitment to insurance and financial planning (e.g., retirement packages), setting of longer-term health goals (e.g., successfully dieting), long-term commitment to large organizations (Solinger et al. 2008), tendency to resist bribes and corruption (Köbis et al. 2016), and commitment to other collective goals (e.g., environmental issues [Parks et al. 2013]).

R9. Concluding Remarks

CLASH provides a novel theoretical basis for understanding climatological influence on culture and human behavior to help understand the differences in aggression and violence around the world. Empirically, CLASH is young. Only time will tell whether CLASH, and its extensions, will be substantiated, modified, or replaced by alternative theories. At the very least, we hope it is a fertile theory that will spawn research so that CLASH has the potential to grow and mature. We greatly appreciate the thoughtful comments of those who responded to our target article. Their comments have helped identify potential weaknesses of the model, gaps in the model that need to be filled, important boundary conditions, and topics for future research.

CLASH also addresses one of the most pressing topics of our day – climate change. When people think about the consequences of climate change, they normally focus on weather, crops, islands sinking, glaciers melting, and polar bears losing their habitat. People rarely think about increasing levels of aggression and violence as consequences of climate change (Plante et al. 2017). Between the years 1880 and 2015, the 16 hottest years have been the last 16 years, with 2015 being the hottest ever (National Centers for Environmental Information 2015). As time goes on, temperatures are likely to increase further, whereas variation is likely to decrease further. This is bad news for the planet, and not just for the crops either. Climate-related aggression and violence levels in humans are also likely to increase.

CLASH is novel because of its focus on climatological influences, its link with psychological concepts such as time orientation and self-control, and its ambition to extend to social-economic, political-historic, and climate-related environmental variables. As the title conveys, CLASH emphasizes how climate might shape culture, how culture in turn shapes individuals and groups, and how individuals and groups sometimes behave in an aggressive and violent manner. Clearly, cultural differences are all around us, from language, cognition, and affect to norms, institutions, and markets. Climate provides a new, broad scientific perspective that helps us understand, and perhaps appreciate, cultural differences. We believe that understanding aggression is one of the most important steps in reducing hostility and conflict, as well as in promoting trust and cooperation between "we" and "them" in a world that is growing smaller and smaller – and warmer and warmer.

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NOTE

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[The letters "a" and "r" before author's initials stand for target article and response references, respectively]

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