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Original Article

Local competition increases people's willingness to harm others

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ABSTRACT

Why should organisms incur a cost in order to inflict a (usually greater) cost on others? Such costly harming behavior may be favored when competition for resources occurs locally, because it increases individuals' fitness relative to close competitors. However, there is no explicit experimental evidence supporting the prediction that people are more willing to harm others under local versus global competition. We illustrate this prediction with a game theoretic model, and then test it in a series of economic games. In these experiments, players could spend money to make others lose more. We manipulated the scale of competition by awarding cash prizes to the players with the highest payoffs per set of social partners (local competition) or in all the participants in a session (global competition). We found that, as predicted, people were more harmful to others when competition was local (study 1). This result still held when people "earned" (rather than were simply given) their money (study 2). In addition, when competition was local, people were more willing to harm ingroup members than outgroup members (study 3), because ingroup members were the relevant competitive targets. Together, our results suggest that local competition in human groups not only promotes willingness to harm others in general, but also causes ingroup hostility.

1. Introduction

Humans and other animals frequently engage in competition, for example over resources or territories, mating opportunities, and social status (Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013; Dechenaux, Kovenock, & Sheremeta, 2014; Griskevicius et al., 2009). Such competition may be interference (e.g. physical aggression) or exploitative (e.g. use of the same resources at different times) (Cant, 2012). Many of the first studies in the discipline of behavioral ecology were concerned with predicting evolutionarily stable investments in competition in non-human animals, for example based on ecological factors such as resource distribution, and characteristics of the competitors, such as fighting ability (Maynard Smith, 1974, 1982; Maynard Smith & Parker, 1976; Maynard Smith & Price, 1973; Parker, 1974; Riechert, 2013). This logic has successfully been applied to human interactions to predict when people should engage in costly conflict with others (DeScioli & Wilson, 2011).

Much of the previous research on competition has focused on how the costs of competition can be *avoided*, for example due to conventions of resource ownership or to honest signals (Bradbury & Vehrencamp, 2011; Maynard Smith & Harper, 2003; Zahavi, 1975). However, it is clear that in many situations, costly competition does indeed occur in humans (Frank, 2012; Griskevicius et al., 2009; Hauser, McAuliffe, & Blake, 2009; Jensen, 2010; Simunovic, Mifune, & Yamagishi, 2013; Zizzo, 2003; Zizzo & Oswald, 2001) and other organisms (Cant, English, Reeve, & Field, 2006; Gardner & West, 2004a; Gardner, West, & Buckling, 2004; Inglis, Gardner, Cornelis, & Buckling, 2009; Keller & Ross, 1998; Le Boeuf, 1974; Wilson & Wrangham, 2003). In these cases, an actor pays a cost to inflict a (usually greater) cost on one or more recipients; the costs are paid in any currency, such as food intake or somatic condition, that normally impacts an individual's lifetime fitness.

Here we investigate why people are willing to engage in costly harming behavior. We use this term to refer to cases where both the actor and recipient incur short-term costs, such as physical costs from fighting or social costs from gossip. For present purposes we do not examine behavior where the actor retaliates for the recipient's past actions, i.e. not "revenge" or "punishment" (Jensen, 2010; Raihani, Thornton, & Bshary, 2012), and we also note that harming (or other types of conflict) is not simply the absence of cooperation (Brewer, 1999; Strassmann & Queller, 2010). Specifically, we address how the fitness payoffs of costly harming vary according to the scale of competition. The scale of competition is defined as the extent to which individuals compete with neighbors (for example, in social groups) versus with members of the broad population (Gardner & West, 2004b; West et al., 2006). At one extreme, when competition is local, individuals compete only with social partners in close proximity, as in a spatially structured population. At the other, when competition is global, individuals compete with the entire population and not just with their immediate social partners.

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1.1. Fitness payoffs of harming others

An organism's fitness is determined by its genetic contribution to the next generation in a given environment; competition among individuals (via interference or exploitation) over resources that affect fitness can ultimately be translated into alleles competing for transmission to the next generation. Here, we focus on individuals' direct fitness, often defined as the number of grand-offspring that an individual produces (Davies, Krebs, & West, 2012). When considering selection for a behavior or any other trait, we consider the effects of that trait on an actor's fitness, and compare the actor's fitness to the fitness of the members of the population with whom the actor competes (Fisher, 1930; Haldane, 1932; Wright, 1931). In some populations, individuals only compete with a subset of other members of that population, for example if dispersal is limited or there are geographic barriers to movement. That is, these "structured populations" consist of patches of individuals that compete with each other over resources within each patch but not over resources on other patches (Johnstone, 2008; Taylor, 1992; Wilson, Pollock, & Dugatkin, 1992). In patch-structured populations, an individual's fitness is strongly influenced by its success relative to local competitors within its patch.

When direct fitness depends on success relative to local competitors, it can be beneficial to inflict a cost on those competitors, even at an absolute cost to the actor. That is, when competition is local, costly harming may decrease the actor's absolute payoffs, but it may ultimately increase the actor's payoffs relative to close competitors', and thus increase the actor's overall lifetime direct fitness (Foster, Wenseleers, & Ratnieks, 2001; Gardner & West, 2004b; Johnstone, 2008). Because both actors and recipients incur a cost, the costly harming behavior that we study here is sometimes referred to as "spite" (Gadagkar, 1993; Jensen, 2010). However, because it can allow an actor to outcompete a neighbor and translate a short-term cost into a lifetime direct fitness benefit to the actor itself, such costly harming is not typically called true evolutionary spite (Foster et al., 2001; Gardner & West, 2006; Krupp, 2013).

A simple numerical example illustrates how the scale of competition affects harming: imagine a population of 10 individuals, each of which has 3 units of some currency that translates into fitness. Suppose first that the population is structured into 5 isolated patches of resources, each containing two competing individuals (local competition). Finding an individual's reproductive success in a structured population requires two steps: first, we determine an individual's within-patch fitness by comparing her payoff to her patch-mates' (i.e. her local competitors); and second, we compare that individual's within-patch fitness to the within-patch fitness for all members of the population across all patches. So if A spent 1 unit to reduce B's payoff by 2 units, this would result in a 2:1 within-patch fitness advantage for A, compared to a 1:1 ratio if A had not harmed B. If individuals on other patches do not harm each other (and thus each has a 1:1 within-patch fitness ratio), A's within-patch fitness is high relative to the rest of the population. Harming is thus beneficial to A under local competition.

In contrast, if competition occurs against the broader (global) population, the benefit of outcompeting local interactants via costly harming will not outweigh its cost. To illustrate this, now we imagine that the 10 individuals instead live in an unstructured population. In this case, all individuals can access all the resources and not just local ones, i.e. all members of the population compete globally. To find an individual's reproductive success in a population without structure, we simply compare her payoffs to the payoffs of all others in the population. If A spent 1 unit on making B lose 2, this harmful act would mean she has 2 units relative to 25 held by all 9 others in the population. If she had not harmed B, she would have 3 units relative to the 27 held by all 9 others. A is thus relatively better off if she does not invest in harming B, because harming B does not increase A's reproductive success (2:25 fitness advantage from harming versus 3:27 from not harming) when competition is global.

This shows why individuals should adopt different strategies regarding costly harming behavior in different competitive situations (Gardner & West, 2004b; see also Supplementary material, available on the journal's website at www.ehbonline.org), for example when competing locally in spatially structured populations (Rand, Armao, Nakamaru, & Ohtsuki, 2010). As humans likely encounter both local and global competition within their lifetimes, one should expect human psychology to have evolved to respond to cues of local competition with more harmful behavior, as this has direct fitness benefits, and to be less harmful when such cues are absent. For example, one would predict that people will assess how many others they compete with over a given resource, and incur greater costs to harm any single given competitor if there are few competitors than if there are many competitors (Garcia & Tor, 2009).

1.2. Evidence for the effects of the scale of competition

There is some empirical evidence to suggest that local competition does foster costly harming in non-humans (Bshary & Bergmüller, 2008; Foster et al., 2001; Gardner & West, 2006; Krupp, 2013; Muir, 1996; West & Gardner, 2010). Virulent bacteria produce antimicrobial chemicals (bacteriocins) which kill close competitors, but whose production is also costly for the producer (Riley & Wertz, 2002). Bacteriocin production increases with the proportion of competition occurring locally (Chao & Levin, 1981; Gardner et al., 2004; Inglis et al., 2009). In the parasitoid wasp *Copidosoma floridanum*, some individuals develop as sterile soldiers that attack their siblings (Gardner, Hardy, Taylor, & West, 2007; Giron, Dunn, Hardy, & Strand, 2004). However, competition is likely always local (Gardner & West, 2004a), and in general few studies have manipulated the scale of competition explicitly. Similarly, the scale of competition was not addressed in other empirical studies of costly harming, e.g. in *Wolbachia* bacteria (Hurst, 1991), a green-beard gene in *Solenopsis invicta* fire ants (Keller & Ross, 1998), social insect worker policing and sex ratio manipulation (Foster et al., 2001; Gardner & West, 2004b), and sperm of *Fusitriton oregonensis* snails (Pizzari & Foster, 2008). Thus, while there is evidence from various taxa that costly harming behavior exists, there are no explicit tests of the effect of the scale of competition, and no studies in humans.

1.3. Overview of the present research

In a set of three studies, we tested the prediction that people will be more willing to incur costs to harm others when competition is local than when it is global, and in doing so, obtain higher payoffs. We provide a game theoretic illustration of this prediction in the Supplementary material (available on the journal's website at www.ehbonline.org). Our empirical test was a laboratory economic game where each player could harm two partners by spending money from her own endowment to make each partner lose four times that amount (Abbink & Herrmann, 2011; Abbink & Sadrieh, 2009; Zizzo & Oswald, 2001). Players competed to be the highest earner within sets of three partners who could harm each other (local competition) or among all sets of participants in the experimental session (global competition). A potential issue with such games is that people may behave differently with money they have just been given arbitrarily than with money that they have earned (Harrison & El Mouden, 2011; Zizzo, 2004). One could predict that a person would be less willing to spend her own money on reducing others' when she and others have earned their money. We tested this prediction in study 2, where participants had to complete short tasks before receiving their endowments.

In these two studies, people had the option to harm two social partners, who were also their competitors in local competition. One would expect that if people had the opportunity to also harm other players, the predicted increase in harming under local competition should be targeted toward those local competitors, and not toward other players. Although people tend to behave more favorably to perceived neighbors