ELSEVIER

Evolution and Human Behavior 32 (2011) 63 – 69

Evolution and Human Behavior

Original Article

Disadvantage and prosocial behavior: the effects of the Wenchuan earthquake☆

Li-Lin Rao[a,b], Ru Han[a], Xiao-Peng Ren[a], Xin-Wen Bai[a], Rui Zheng[a], Huan Liu[a,b], Zuo-Jun Wang[a,b], Jin-Zhen Li[a,b], Kan Zhang[a], Shu Li[a,*]

[a]*Institute of Psychology, Chinese Academy of Sciences, Beijing 100101, P.R. China*
[b]*Graduate University of Chinese Academy of Sciences, Beijing 100101, P.R. China*

Initial receipt 19 January 2010; final revision received 11 July 2010

Abstract

The May 12, 2008, Chinese earthquake of 8.0 magnitude on the Richter scale placed residents in devastated areas in a disadvantaged position. We conducted three sequential surveys in both devastated and non-devastated areas to test our hypothesis that residential devastation would evoke more prosocial behavior. As expected, the results revealed that the degree of prosocial behavior increased with an increasing level of residential devastation, but decreased with the passage of time. However, we also found evidence that a catastrophic disaster leaves a long-lasting effect on prosocial behavior. These findings should improve the conceptual understanding of the origin of prosocial behavior.

Keywords: Dictator Game; Disadvantage; Prosocial behavior; Residential devastation; Wenchuan earthquake

> During World War II, an American pilot and a marooned Japanese navy captain are deserted on a small uninhabited island in the Pacific Ocean. There, they must cease their hostility and cooperate in order to survive, in spite of their two countries being at war.
>
> — The plot of *Hell in the Pacific* (John Boorman, director, 1968)

1. Introduction

The origin of cooperative or prosocial behavior is one of the most prominent unsolved problems in current research (Gurven, 2004; Jiménez, Lugo, Cuesta, & Sánchez, 2007; Pennisi, 2005; Van Segbroeck, Santos, Nowe, Pacheco, & Lenaerts, 2008). Various researchers have suggested possible mechanisms for inducing prosocial behavior, such as kin selection (Hamilton, 1964), group selection (Eshel, 1972; Wilson & Sober, 1994), reciprocation (Axelrod & Hamilton, 1981; Trivers, 1971), social exchange (Van Vugt & Van Lange, 2006) and many more.

Recent research (Han, Li, & Shi, 2009) identified an interesting phenomenon in connection with prosocial behavior. In their experimental study, a prosocial behavior, measured by the number of game offers that a child provided to others, was induced when the player was at a disadvantage. They found that preschool children playing in their own classroom made fewer offers in the game than did children playing in a classroom other than their own (Han et al., 2009). The disadvantage, i.e., not being on one's own turf and not having the power to dictate in the Ultimatum Game, was seen as an underlying reason why the children proposed more offers to their partners. Han et al. (2009) considered such a disadvantage to be a somewhat primary cause of prosocial behavior, compared with other causes that have been reported in the literature on cognitive and moral development and socialization (Eshel, 1972; Hamilton, 1964).

Inspired by the Han et al. study, in this article we propose a mechanism that can elucidate a basic premise of prosocial behavior from an evolutionary perspective, that is, why and when people exhibit prosocial behavior.

☆ This study was supported in part by the Knowledge Innovation Project of the Chinese Academy of Sciences (No. KSCX2-YW-R-130, KKCX1-YW-05), the National Natural Science Foundation of China (No. 70671099, 70871110) and the Special Fund for Beijing Key Discipline Construction.

* Corresponding author.
E-mail address: lishu@psych.ac.cn (S. Li).

1090-5138/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.evolhumbehav.2010.07.002

When threatened by natural hazards such as earthquakes, droughts, floods, cyclones, epizootic diseases and wild animals, an independent/isolated individual seems to be helpless and powerless. In the struggle to survive, human beings come to each other's aid at such times (Higgins, 2008; Himma, 1998). Such aid can be possible between relatives, friends, strangers and even enemies. In emergency situations, they may even put their own lives at risk to aid complete strangers (Latane & Darley, 1970).

Mutual aid can serve as an adaptive mechanism to increase an individual's survival opportunities, and thus the reproductive potential for their genetic information, when they are at a disadvantage. Obviously, this adaptive mechanism can impact the survival of the human species as well. Being inclined to give aid when one is oneself in need could enhance the group's interests at the expense of an individual's self-interest. This pattern is often called strong reciprocity (Gintis, 2000; Gintis, Bowles, Boyd, & Fehr, 2003). However, being inclined to give aid when one is oneself in need might also enhance an individual's interests through mechanisms of direct or indirect reciprocity (Axelrod & Hamilton, 1981; Trivers, 1971). The interaction between these two advantages could be the reason why human beings favor group living.

Over a long history of natural selection and evolution, the benefits of mutual aid when a person was at a disadvantage may have been so substantial that individuals who possessed such an adaptive reaction to their inferior/disadvantaged status might have been more successful in passing on their genes to the next generation than individuals without this adaptive reaction, thus causing this capacity to spread through the population. From an evolutionary perspective, such an adaptive reaction to their inferior/disadvantaged status might, very likely, be genetically inherited.

On May, 12, 2008, an 8.0-magnitude (Richter scale) earthquake occurred in Wenchuan, China. It was the deadliest and strongest earthquake to hit China since the Tangshan earthquake in 1976. Official figures confirmed 88,928 dead, as of May 24, 2009, with more than 374,640 listed as injured (Mu, 2009). Direct economic losses reached 1.175 trillion yuan (about US$173 billion), of which more than 70% came from damaged dwellings, school and hospital facilities and infrastructure such as roads and bridges (Mu, 2009; Sun, 2008). Moreover, the earthquake deprived 1.15 million rural people in Sichuan Province of their livelihood, as the tremors wreaked havoc on their leased farmland and forests (Yangtze, 2008). Even giant pandas were forced to be on a diet because the quake damaged bamboo forests (An, 2008). All these factors placed residents in devastated areas in an inferior position in terms of health, property, housing, employment and their residential environment. Therefore, we can logically assume that residents in quake-devastated areas experienced a significant disadvantage following this natural disaster.

The massive earthquake presented us with an opportunity to test the assumption that being at a disadvantage affects prosocial behavior in a real-world setting. We conducted two studies to investigate (1) whether residential devastation stimulated prosocial behavior in the quake areas and (2) whether the degree of prosocial behavior decays with the passage of time.

2. Study 1

2.1. Method

From June to July 2008, a total of 2447 residents in three non-devastated areas (the Tangshan area in Hebei Province, Fujian Province and Beijing City) and in two devastated areas (Sichuan Province and Gansu Province) participated in a post-earthquake survey. All participants were recruited by going door to door and asking people to take a survey, and were given a small present (such as a bar of soap, a towel or a packet of washing powder) in return for their participation. The institutional review board of the Institute of Psychology, Chinese Academy of Sciences approved the project.

The degree of prosocial behavior was assessed using a Dictator Game and a Volunteer Problem. The Dictator Game was derived from Hoffman et al. (Hoffman, McCabe, Shachat, & Smith, 1994; Hoffman, McCabe, & Smith, 1996), whereas the Volunteer Problem was developed based on a true story of a surviving high school teacher (Shi, 2008). The problems are shown here exactly as they were posed to participants, other than being translated.

> DICTATOR GAME: Suppose now that you were provided with ¥100 in cash and asked to propose a division of ¥100 between yourself and an anonymous person:
> you will offer ¥_____ to the anonymous person.
> VOLUNTEER PROBLEM: On May 12, a high school teacher considered switching from a mathematics lecture to a PE (physical education) one, but decided against it. He later found that he would have saved 40 students' lives had he changed the schedule.
> Suppose that you were the teacher and you were faced with an opportunity to engage in a charity work as a volunteer, please indicate the number of days you would be willing to volunteer your services (up to 100 days).

In the Dictator Game, the amount offered by the interviewee was used as the measure of prosocial behavior. In the Volunteer Game, the number of volunteer days was considered as a separate measure of prosocial behavior.

Demographic questions included the respondents' gender, age, education and occupation. To assess the level of residential devastation, a self-evaluation was carried out. Each resident in the devastated areas was asked to classify their residence into one of three categories: slightly devastated, moderately devastated or extremely devastated.

2.2. Results and discussion

2.2.1. Sample

Table 1 shows the demographic characteristics of the participants in this study. Comparisons with the 2008 Census

Table 1
Demographic characteristics of the sample

Factor	Study 1	Study 2	
	1st wave (*n*=2447)	2nd wave (*n*=2894)	3rd wave (*n*=3128)
Gender			
Male	968 (39.6)	1079 (37.3)	1181 (37.8)
Female	1469 (60.0)	1782 (61.6)	1924 (61.5)
Unknown	10 (0.4)	33 (1.1)	23 (0.7)
Age			
25 and under	623 (25.5)	562 (19.4)	639 (20.4)
26 to 35	943 (38.5)	1042 (36.0)	1203 (38.5)
36 to 60	819 (33.5)	1183 (40.9)	1199 (38.3)
61 and older	43 (1.8)	82 (2.8)	59 (1.9)
Unknown	19 (0.7)	25 (0.9)	28 (0.9)
Education			
Below high-school graduate	525 (21.5)	939 (32.4)	954 (30.5)
High-school graduate	837 (34.2)	984 (34.0)	861 (27.5)
Beyond high-school graduate	1070 (43.7)	940 (32.5)	1275 (40.8)
Unknown	15 (0.6)	31 (1.1)	38 (1.2)
Occupation			
Civil servant	58 (2.4)	84 (2.9)	117 (3.7)
Employee of public institutions	312 (12.8)	332 (11.5)	369 (11.8)
Enterprises employee	1063 (43.4)	1000 (34.6)	1199 (38.3)
Medical worker	103 (4.2)	103 (3.6)	97 (3.1)
Teacher	253 (10.3)	229 (7.9)	227 (7.3)
Farmer	137 (5.6)	441 (15.2)	326 (10.4)
Student	61 (2.5)	51 (1.8)	90 (2.9)
Other	434 (17.7)	585 (20.2)	528 (16.9)
Unknown	26 (1.1)	69 (2.4)	175 (5.6)

Values are shown as *n* (%).

on available benchmarks (male: 51.50%; female: 48.50%) indicate that females were slightly overrepresented in the sample (*China Statistical Yearbook 2008*, 2008). The participants' occupations spanned a wide spectrum of domains, including civil servants, employees of public institutions, employees of both private and public enterprises, medical workers, teachers, farmers, students and others. Of the 1720 residents surveyed in the devastated areas, 53.4% (918) classified their residence as being in the slightly devastated area, 21% (362) as in the moderately devastated area and 25.6% (440) as in the extremely devastated area.

2.2.2. Prosocial behavior

Figs. 1 and 2 present the result of the residents' reactions to the two questions posed. To examine the relationship between the level of residential devastation and the degree of prosocial behavior in the Dictator Game, a univariate analysis of covariance (ANCOVA) was conducted, using the proposed offer as the dependent variable and the level of residential devastation as the independent variable, and with gender, age and education as covariates. The analysis revealed a significant main effect of the level of residential devastation [$F(3, 2364)=8.29$, $p<.001$, $\eta^2=0.01$], indicating that the degree of prosocial behavior increased with increasing levels of residential devastation. Demographic variables showed significant effects ($ps<.05$) with the exception of gender ($p=.84$). Post hoc least significant difference (LSD) tests revealed that residents in non-devastated areas allocated less money to anonymous counterparts than did those from any of the three devastated areas ($ps\leq.013$) and that residents in the slightly devastated areas offered less money than residents in the moderately devastated areas ($p<.01$). We found no significant difference between residents in the moderately devastated areas and those in the extremely devastated areas ($p=.26$).

A similar trend toward a greater number of volunteer days with an increasing level of residential devastation [$F(3, 2346)=4.82$, $p=.002$, $\eta^2=0.006$], was revealed. Residents in the extremely and moderately devastated areas were willing to volunteer more days than residents in the slightly devastated and non-devastated areas ($ps<.05$), with no significant differences between the first two and between the last two groups ($p=.747$ and .362, respectively).

These findings are consistent with our hypothesis that residents would display a higher degree of prosocial behavior with increasing levels of residential devastation.

Determining how this effect varies over time is, however, also important. According to our disadvantage hypothesis, prosocial behavior is stimulated when individuals are at a disadvantage. An expected corollary to this hypothesis might be that prosocial behavior will fade as individuals move out of their disadvantaged position. The quake-associated

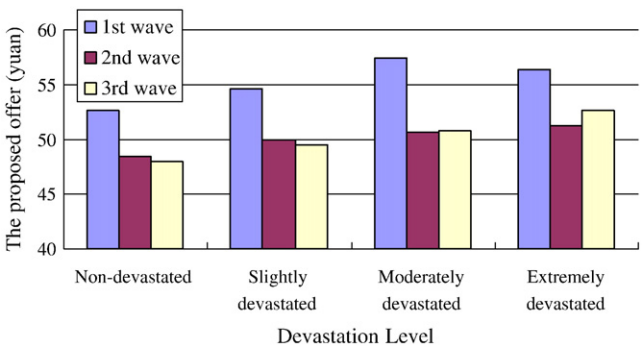

Fig. 1. Results of the Dictator Game. Proposed offers in excess of 100 were coded as missing values.

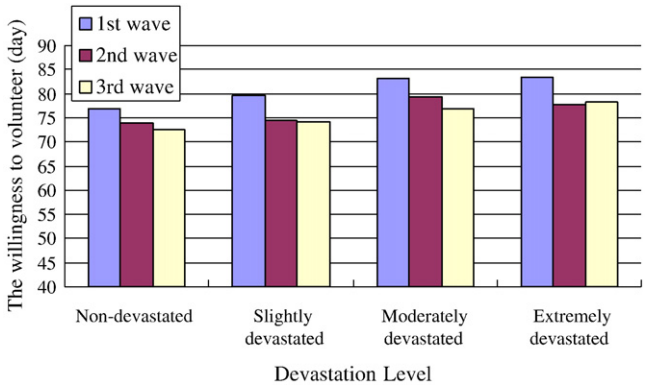

Fig. 2. Results of the Volunteer Problem. Volunteer days in excess of 100 were coded as missing values.

disadvantage, which in our study arose from loss and helplessness, might gradually be alleviated as time elapsed. We therefore further predicted that the degree of prosocial behavior would decline with the passage of time in the devastated areas.

When we considered how this effect would vary over time in the non-devastated areas, two possibilities emerged. Presumably, because the earthquake was enormous, people in the non-devastated areas may also have experienced a sense of disadvantage. If this were true, the degree of prosocial behavior would also be expected to decline with the passage of time in the non-devastated areas as well as in the devastated areas. However, if people in the non-devastated areas experienced a sense of heightened advantage because of the downward comparison, they might actually show a higher degree of prosocial behavior over time as such an advantage would gradually be alleviated with time. In this case, we might expect an interaction between the devastation and time.

3. Study 2

In Study 2, we sought to investigate whether prosocial behavior changed with the passage of time.

3.1. Method

We conducted two additional, successive surveys among residents in the same areas where the first survey was administered. The second and third surveys were identical to the first survey, except that the data were collected in September–October 2008 and in April–May 2009, respectively. Respondents were recruited by going door to door and asking people to participate in the questionnaire. As a result, some respondents participated in all three waves, whereas others participated in some waves, but not others. The demographic characteristics for the samples are presented in Table 1.

3.2. Results and discussion

An ANCOVA with wave and devastation level as fixed factors was conducted to assess differences in the participants' proposed offers among the three surveys, using demographic variables (except occupation) as covariates. The results showed that the main effects of wave and devastation level were significant [$F_{wave}(2, 8008)=100.90$, $p<.001$, $\eta^2=0.025$, $F_{devastation}(3, 8008)=22.31$, $p<.001$, $\eta^2=0.008$], respectively, but the interaction between wave and devastation level was not significant [$F(6, 8008)=1.72$, $p=.111$, $\eta^2=0.001$]. Post hoc LSD tests revealed that respondents in the first wave survey (mean=55.48) proposed to give more money to their anonymous counterparts than did those in the second and third waves (mean=49.94 and 50.18, respectively) ($ps<.001$), with no significant difference between the last two waves. Residents in non-devastated areas (mean=49.68) allocated less money to the anonymous counterparts than did the respondents in any of the three devastated areas ($ps<.001$). Residents in the slightly devastated areas (mean=51.49) offered less money than their counterparts in the moderately and extremely devastated areas (mean=53.10 and 53.19, respectively) ($ps<.01$), with no significant difference between the last two groups.

An analysis of the willingness to volunteer also revealed a significant effect of wave and a significant effect of devastation level [$F_{wave}(2, 7912)=16.45$, $p<.001$, $\eta^2=0.004$ and $F_{devastation}(3, 7912)=16.08$, $p<.001$, $\eta^2=0.006$, respectively, by ANCOVA], but no significant Wave×Devastation interaction. Post hoc LSD tests revealed that respondents were willing to volunteer more days in the first survey (mean=80.63) than in the second and third surveys (mean=76.45 and 75.58, respectively) ($ps<.001$), with no significant difference between the last two surveys. Residents in the extremely and moderately devastated areas were willing to volunteer more days (mean=80.44 and 79.72, respectively) than residents in the slightly devastated and non-devastated areas (mean=75.77 and 74.29) ($ps<.01$), with no significant differences between the first two and between the last two groups ($p=.554$ and .115, respectively).

These results indicate that prosocial behavior decreased with the passage of time, which further supports the disadvantage hypothesis. At the same time, our data revealed that a higher degree of prosocial behavior continued to be associated with an increasing level of residential devastation in the second and third surveys, implying that, to some extent, the residential devastation effect remained robust over a 1-year period. This led us to question whether the effect of a catastrophic disaster on prosocial behavior would persist over even longer time scales.

The largest earthquake of the 20th century based on death toll was the 1976 Tangshan earthquake, which occurred in Hebei Province (Spiqnesi, 2004). The number of deaths initially reported by the Chinese government was 655,000, with 164,000 people recorded as being severely injured (1976 Tangshan Earthquake, 2009). If the answer to our question is positive, then non-devastated residents in Hebei Province could be expected to display a higher degree of prosocial behavior than their counterparts in other non-devastated areas, where a catastrophic earthquake had never occurred. We therefore contrasted the data of respondents in the Tangshan area of Hebei Province (quake-experienced areas) with those of respondents in other non-devastated areas (non–quake-experienced areas: Fujian Province and Beijing City). Our results showed the following.

With wave and quake experience (quake-experienced vs. non–quake-experienced) as fixed factors and demographic variables as covariates, ANCOVAs revealed significant effects of quake experience [for the Dictator Game, $F(1, 2448)=10.46$, $p=.001$, $\eta^2=0.004$; for the Volunteer Problem, $F(1, 2448)=6.60$, $p=.01$, $\eta^2=0.003$]. The main effect of wave was also significant [for the Dictator Game, $F(2, 2448)=19.24$, $p<.001$, $\eta^2=0.015$; for the Volunteer Problem, $F(2, 2444)=3.10$, $p<.05$, $\eta^2=0.003$]. We found no significant interactions

between wave and quake experience [for the Dictator Game, $F(2, 2448)=1.86$, $p=.16$, $\eta^2=0.002$; for the Volunteer Problem, $F(2, 2444)=1.58$, $p=.21$, $\eta^2=0.001$]. Respondents in Hebei Province proposed giving more money to their anonymous counterparts (mean=51.01) and were willing to volunteer more days (mean=75.61) than those in other non-devastated areas (mean=48.05 and 72.91, respectively).

The results of our survey were consistent with publicized reports that residents in Hebei Province showed a higher degree of prosocial behavior than their counterparts from other non-devastated areas. The largest personal donation for the Wenchuan earthquake was reportedly provided by an orphan from the Tangshan earthquake, who donated 100 million RMB to Sichuan Province (Zhang Xiangqing, from a recipient to a giver, 2008), and Tangshan City in Hebei Province was also reported as the city which provided the largest donation in China (Zhu & Wang, 2008). In addition to the financial support, a group of 13 peasants from Hebei Province voluntarily rushed to Sichuan Province at their own expense to help quake victims (Wang, 2009).

These findings strengthened our hypothesis that the effect of a catastrophic disaster on prosocial behavior can be long lasting.

4. General discussion

The aim of the present study was to examine the role that being at a disadvantage played in the development of prosocial behavior in an out-of-laboratory setting. Data collected from residents in both non-devastated and devastated areas showed that residents in more devastated areas demonstrated more prosocial behavior, but the degree of prosocial behavior declined with the passage of time. These findings suggest that prosocial behavior can be induced in individuals by being at a disadvantage.

Indirect evidence for our claim includes the fact that commitment works best under harsh conditions: the more individuals are challenged by nature to survive, the more compelled they are to cooperate with each other in durable relationships (De Vos, Smaniotto, & Elsas, 2001). A number of experimental studies, which have used either explicit or implicit methods, have shown that an adaptive reaction to inferior/disadvantaged status can be found in modern humans. For example, once primed with a signal of advantage or power, e.g., money, individuals preferred to play alone and work alone, made fewer requests for help and showed reduced helpfulness toward others (Vohs, Mead, & Goode, 2006). Upper-socioeconomic status participants (at an advantage) displayed more disengagement cues and fewer engagement cues than lower-socioeconomic status participants (at a disadvantage) (Kraus & Keltner, 2009). When considered from the perspective of the disadvantage hypothesis, these independent studies appear to be strongly in agreement with it and with each other.

The possibility of catastrophic disasters having long-lasting effects may suggest that future research should continue to test for the presence of links between historical disadvantage and present behavior. Considering that an awareness of disadvantage might gradually become subconscious, we suggest that future research utilizing experimental as well as other investigational methods examine the relationship between nations which have experienced many historical disasters and the degree of prosocial behavior (or presence of a collectivist culture). Indirect evidence consistent with this reasoning has been obtained in a recent work by Bowles (2009), which indicated that frequent warfare made altruistic cooperation among group members essential to survival (Bowles, 2009).

This research may also have implications for thinking about the influence of affluence on the transition between collectivism and individualism. Collectivists are considered to be more cooperative and reciprocal, whereas individualists are more competitive (Mead, 1976). The strongest correlation between individualism and various variables has been with affluence [e.g., Hofstede (1980) reported a correlation of 0.82 between the two; see also Kashima & Kashima, 2003; Triandis, 2001]. As countries become more affluent, they seem to become more individualistic (Kashima & Kashima, 2003; Triandis, 2001). Vohs, Mead, and Goode (2006) found that money brings about a self-sufficient orientation in which people prefer to be free of dependency and dependents (Vohs et al., 2006). From our perspective on disadvantage, the influence of affluence on individualism could be perceived as an influence of disadvantage or advantage on individualism. As the level of affluence gradually increased, people would experience a greater and greater feeling of advantage. Experiencing a sense of advantage might reduce the tendency to supply mutual aid and lead to social independence, i.e., “doing one’s own thing”. As we perceive it, individualism may not be directly influenced by affluence, per se, but by a reduction in the sense of disadvantage. That is, the influence of affluence on individualism may be mediated by a sense of disadvantage.

Note that disadvantage can be experienced collectively, i.e., both sides are disadvantaged, or individually, i.e., one side is disadvantaged and the other is not. In the Han et al. (2009) study in which only one party was disadvantaged and the other was not, aid tended to be directed toward the party who was not at a disadvantage. In this situation, although the givers were inclined to give aid even though they were the ones in need, their welfare may have been enhanced through mechanisms of direct or indirect reciprocity. In our study, a collective situation in which both parties were disadvantaged, aid may also have been directed toward others. In such a situation, we can readily imagine mechanisms that would detect the degree to which others are in the same predicament and cause disadvantaged persons to calibrate their behavior toward other disadvantaged persons accordingly. The inclination of individuals to give aid when they are themselves in need might enhance group welfare at the expense of the individuals’ welfare. In a nutshell, prosociality may increase during times of disadvantage in the

struggle for survival and may also be affected by whether others are also disadvantaged.

Our result might be considered as supportive of the postulate that experiencing a natural disaster raises mortality salience and that mortality salience increases prosocial behavior, a perspective that was suggested by terror management theory (Jonas, Schimel, Greenberg & Pyszczynski, 2002). However, our result is also consistent with the findings of Navarrete et al. that priming the need for social assistance will increase people's support of an ingroup ideology, a concept which challenged the terror management theory (Navarrete, 2005; Navarrete, Kurzban, Fessler, & Kirkpatrick, 2004). Note that mortality salience will carry with it a sense of disadvantage, whereas disadvantage can be experienced without mortality salience. Therefore, our disadvantage theory may provide a much simpler, perhaps broader, explanation for prosocial behavior.

Despite the fact that our hypothesis was generally supported, some potential limitations exist in our study. First, we did not measure the baseline level of prosocial behavior apart from any influence of the earthquake. Preferably, we would have measured the degree of prosocial behavior before the earthquake across the devastated and non-devastated areas. However, because the earthquake occurred unpredictably, we were unable to conduct a pretest, even if we had desired to do so. A second limitation is that ideally the devastated and non-devastated areas should have been evaluated as to their social characteristics before sampling, but the need to begin research soon after the earthquake prevented a thorough sociological examination of the research areas. Future research should attempt to locate areas that are as similar as possible for more directly comparable research. Third, although the effect sizes in our study are small in spite of the large sample size, because we used demographic variables as covariates, these small but significant effect sizes are reliable and translate into minor but meaningful influences on the prosocial behavior. Fourth, the questions provided in our survey were hypothetical. Ideally, data about real behavior measures of prosocial behavior should have been collected. However, in the quake areas, especially in the most devastated areas, asking the respondents to incur any actual cost in order to collect real-life behavioral measures of prosocial behavior would not have been appropriate or ethical. On the other hand, we were also advised not to give the devastated residents cash in the devastated areas, as such a gift might lead them to respond as dole receivers rather than as respondents. Since the respondents bore no actual costs by giving a seemingly prosocial answer to our questions, we cannot rule out the possibility that the participants were simply attempting to appear more prosocial in order to elicit more aid from the researcher. Fifth, the Volunteer Problem may have confounded prosociality with regret or guilt. As an attempt to arouse in the respondents a desire to exhibit volunteer behavior, the revised story was designed and presented as a prelude. Although the result of the Volunteer Problem was consistent with that of the Dictator Game, we acknowledge this limitation and suggest that future work, if any such opportunity arises, should address the ambiguities that may have arisen because of using the Volunteer Problem.

A large number of previous studies on prosocial behavior have focused on the characteristics of the individuals who were being cooperated with. Individuals were reported to show more prosocial behavior to closer kin (Hamilton, 1964), to people who exhibit the traits of the group (Eshel, 1972; Wilson & Sober, 1994) and/or to those who made concessions (Axelrod & Hamilton, 1981; Trivers, 1971). From our perspective, the basic premise of prosocial behavior should be the decision as to whether "to do or not to do," whereas choosing whom to do it to and how to do it should constitute only a secondary, albeit important, role.

The experimental study of Han et al. (2009), which used preschool children as subjects, demonstrated that prosocial behavior could be observed to exist in children when they were at a territorial disadvantage. This current field study, which used adults in devastated and non-devastated areas as subjects, demonstrated that after being threatened by a catastrophic earthquake, people exhibited more prosocial behavior as the level of residential devastation increased. In general, disadvantage falls accidentally on individuals over the course of their lives. Human beings are threatened not only by natural hazards, but also by human activities such as drug use, social violence and terrorism. We hope that these two turf-related studies will aid in a better understanding of the basis for prosocial behavior.

Acknowledgments

We are indebted to the respondents for their participation in the survey; to the editor, Dr. Daniel Fessler, and to anonymous referees for their comments; and to the Longnan Committee of the Communist Party of China, the Longnan Municipal People's Government, the Longnan Municipal Science & Technology Bureau and SinSource HR Management Co. for their assistance with data collection. Drs. Rhoda E. and Edmund F. Perozzi assisted in English and content editing.

References

1976 Tangshan Earthquake. (2009). Retrieved September 29, 2009, from http://en.wikipedia.org/wiki/1976_Tangshan_earthquake.

An, L. (2008). Giant pandas forced to be on diet after quake damaged bamboo forests. Retrieved June 22, 2008, from http://news.xinhuanet.com/english/2008-06/22/content_8418538.htm.

Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211*, 1390–1396.

Bowles, S. (2009). Did warfare among ancestral hunter-gatherers affect the evolution of human social behaviors? *Science, 324*, 1293–1298.

China Statistical Yearbook 2008. (2008). Beijing: China Statistics Press.

CRIEnglish.com. (2008). Zhang Xiangqing, from a recipient to a giver. Retrieved May 30, 2008, from http://english.cri.cn/4406/2008/05/30/1701@363663.htm.

De Vos, H., Smaniotto, R., & Elsas, D. A. (2001). Reciprocal altruism under conditions of partner selection. *Rationality and Society, 13*, 139–183.

Eshel, I. (1972). On the neighbourhood effect and evolution of altruistic traits. *Theoretical Population Biology, 3*, 258–277.

Gintis, H. (2000). Strong reciprocity and human sociality. *Journal of Theoretical Biology, 206*, 169–179.

Gintis, H., Bowles, S., Boyd, R., & Fehr, E. (2003). Explaining altruistic behavior in humans. *Evolution and Human Behavior, 24*, 153–172.

Gurven, M. (2004). To give and to give not: The behavioral ecology of human food transfers. *Behavioral and Brain Sciences, 27*, 543–559.

Hamilton, W. D. (1964). The genetic evolution of social behaviour. *Journal of Theoretical Biology, 7*, 1–52.

Han, R., Li, S., & Shi, J. -N. (2009). The territorial prior-residence effect and children's behavior in social dilemmas. *Environment and Behavior, 41*, 644–657.

Higgins, E. T. (2008). Culture and personality: Variability across universal motives as the missing link. *Social and Personality Psychology Compass, 2*, 608–634.

Himma, K. E. (1998). Positivism, naturalism and the obligation to obey law. *Southern Journal of Philosophy, 36*, 145–162.

Hoffman, E., McCabe, K., Shachat, K., & Smith, V. (1994). Preferences, property rights, and anonymity in bargaining games. *Games and Economic Behavior, 7*, 346–380.

Hoffman, E., McCabe, K., & Smith, V. (1996). Social distance and other-regarding behavior in Dictator Games. *American Economic Review, 86*, 653–660.

Hofstede, G. (1980). *Culture's consequences: international differences in work-related attitudes*. Beverly Hills: Sage Publications.

Jiménez, R., Lugo, H., Cuesta, J. A., & Sánchez, A. (2007). Emergence and resilience of cooperation in the spatial prisoner's dilemma via a reward mechanism. *Journal of Theoretical Biology, 250*, 475–483.

Jonas, E., Schimel, J., Greenberg, J., & Pyszczynski, T. (2002). The scrooge effect: Evidence that mortality salience increases prosocial attitudes and behavior. *Personality and Social Psychology Bulletin, 28*, 1342–1353.

Kashima, Y., & Kashima, E. S. (2003). Individualism, GNP, climate, and pronoun drop: Is individualism determined by affluence and climate, or does language use play a role? *Journal of Cross-Cultural Psychology, 34*, 125–134.

Kraus, M. W., & Keltner, D. (2009). Signs of socioeconomic status: A thin-slicing approach. *Psychological Science, 20*, 99–106.

Latane, B., & Darley, J. M. (1970). *The unresponsive bystander: Why doesn't he help?* New York: Appleton-Century Crofts.

Mead, M. (1976). *Cooperation and competition among primitive people*. Boston: Beacon.

Mu, X. (2009). China reports 88,928 deaths in natural disasters last year. Retrieved May 24, 2009, from http://news.xinhuanet.com/english/2009-05/24/content_11428593.htm.

Navarrete, C. D. (2005). Death concerns and other adaptive challenges: The effects of coalition-relevant challenges on worldview defense in the US and Costa Rica. *Group Processes & Intergroup Relations, 8*, 411–427.

Navarrete, C. D., Kurzban, R., Fessler, D. M. T., & Kirkpatrick, L. A. (2004). Anxiety and intergroup bias: Terror management or coalitional psychology? *Group Processes & Intergroup Relations, 7*, 370–397.

Pennisi, E. (2005). How did cooperative behavior evolve? *Science, 309*, 93.

Shi, C. -D. (2008). "PE lecture saved them": A report on Yinghua junior high school. Retrieved November 14, 2008, from http://news.xinhuanet.com/sports/2008-11/14/content_10359086.htm.

Spiqnesi, S. J. (2004). *Catastrophe! The 100 greatest disasters of all time*. New York: Kensington Publishing Corp.

Sun. (2008). Over 87,000 feared dead in May 12 earthquake, economic losses hit 845 bln yuan. Retrieved September 4, 2008, from http://news.xinhuanet.com/english/2008-09/04/content_9768900.htm.

Triandis, H. C. (2001). Individualism and collectivism: past, present, and future. In Matsumo D. (Ed.), *Handbook of Culture and Psychology* (pp. 35-50). New York: Oxford University Press.

Trivers, R. L. (1971). The evolution of reciprocal altruism. *The Quarterly Review of Biology, 46*, 35–57.

Van Segbroeck, S., Santos, F. C., Nowe, A., Pacheco, J. M., & Lenaerts, T. (2008). The evolution of prompt reaction to adverse ties. *BMC Evolutionary Biology, 8*, 287.

Van Vugt, M., & Van Lange, P. A. M. (2006). The altruism puzzle: psychological adaptations for prosocial behavior. In Schaller M, Simpson J. A, Kenrick D. T. (Eds.), *Evolution and social psychology* (pp. 237-261). Madison, CT: Psychosocial Press.

Vohs, K. D., Mead, N. L., & Goode, M. R. (2006). The psychological consequences of money. *Science, 314*, 1154–1156.

Wang, Y. (2009). Moving China 2008: thirteen famers from Tangshan (in Chinese). Retrieved February 5, 2009, from http://news.cctv.com/china/20090205/113251.shtml.

Wilson, D. S., & Sober, E. (1994). Reintroducing group selection to the human behavioural sciences. *Behavioral and Brain Sciences, 17*, 585–654.

Yangtze, Y. (2008). More than 600,000 Sichuan migrant workers return home jobless after quake. Retrieved July 3, 2008, from http://news.xinhuanet.com/english/2008-07/03/content_8484508.htm.

Zhu, W., & Wang, S. (2008). Moving 2008: charity, gratitude, volunteer (in Chinese). Retrieved December 20, 2008, from http://news.xinhuanet.com/newscenter/2008-12/20/content_10529461.htm.