changes in the statistics of PDF orientations, a maximum shock attenuation of 5 GPa seems to be the more realistic value.

The percentage of shocked quartz grains and the number of PDF sets per grain are more sensitive indicators of minor changes in shock pressure than pure PDF orientation statistics. The combination of detailed petrographic investigation and numerical modeling indicates that both of these approaches are essential to reconstruct the preimpact position of rocks and to characterize properly the shock pressure distribution at the scale of an impact structure. Our observations suggest that, in the case of the 10.5-km-diameter Bosumtwi impact structure, the uppermost rocks of the central uplift experienced shock pressures below 30 GPa, whereas pressures up to 40 GPa were recorded for the about-four-times-larger Puchezh-Katunki impact structure (13). Shock attenuation in the uppermost part of a central uplift has been, for the first time, constrained by detailed shock degree profiling at the micron scale. Numerical modeling of this section of the central uplift has then established where this section of the central uplift was located before uplift formation, which was only possible once the shock regime had been established by micropetrography. The results imply that, for moderately sized impact craters, the rise of the central uplift is dominated by brittle failure, whereas in the case of larger impact structures, and also depending on rock properties, the uplifted, relatively stronger shocked rocks may behave in a more ductile manner.

References and Notes
21. Materials and methods are available as supporting material on Science Online.
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Supporting Online Material
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The Spreading of Disorder
Kees Keizer,* Siegwart Lindenberg, Linda Steg

Imagine that the neighborhood you are living in is covered with graffiti, litter, and unreturned shopping carts. Would this reality cause you to litter more, trespass, or even steal? A thesis known as the broken windows theory suggests that signs of disorderly and petty criminal behavior trigger more disorderly and petty criminal behavior, thus causing the behavior to spread. This may cause neighborhoods to decay and the quality of life of its inhabitants to deteriorate. For a city government, this may be a vital policy issue. But does disorder really spread in neighborhoods? So far there has not been strong empirical support, and it is not clear what constitutes disorder and what may make it spread. We generated hypotheses about the spread of disorder and tested them in six field experiments. We found that, when people observe that others violated a certain social norm or legitimate rule, they are more likely to violate other norms or rules, which causes disorder to spread.

In the mid-1990s, the mayor of New York and his police commissioner adopted a “Quality of Life campaign.” Attention was focused on fighting signs of disorder and petty crime. Graffiti was removed, streets were swept, and signs of vandalism were cleared. This initiative was based on the broken windows theory (BWT) of Wilson and Kelling (1). The BWT suggests that signs of disorder like broken windows, litter, and graffiti induce other (types of) disorder and petty crime (2). It was thought that removing these signs of disorder would take away an important trigger of disorderly and petty criminal behavior. After the introduction of the campaign, petty crime rates in New York dropped. Since then, approaches based on the BWT have become popular and have been adopted worldwide (e.g., in various cities in the United States, Great Britain, Netherlands, Indonesia, and South Africa).

BWT may be very popular, but it is also highly controversial. So far, it lacks empirical support, and it fails to specify what constitutes disorder. Studies aimed to test the BWT (3–6) have provided mixed results at best. The National Research Council (NRC) concluded that the research did not provide strong support for the BWT (7). There is also little evidence that broken window policing contributed to the sharp decrease in petty crime in New York (8–10). Moreover, to our knowledge, research on the BWT has so far been correlational, so conclusions about causality are shaky (6, 9). The BWT suggests that a setting with disorder triggers disorderly and petty criminal behavior, but it might be the other way around or both may be caused by a third variable. Furthermore, the BWT gives no insight into what is and what is not a condition of disorder that will spread. Because the BWT forms the backbone of many cities’ defense against the growing threat of disorder and petty crime, these shortcomings need to be addressed.

In the present study, we conducted six field experiments that address these issues. Our first step was to conceptualize a disorderly setting in such a way that we can link it to a process of spreading norm violations. Social norms refer either to the perception of common (dis)approval of a particular kind of behavior (injunctive norm) or to a particular behavior common in a setting (descriptive norm) (11–16). Injunctive norms affect behavior because they provide information about which behavior is most appropriate in a

Faculty of Behavioral and Social Sciences, University of Groningen, 9712 TS Groningen, Netherlands.
*To whom correspondence should be addressed. E-mail: K.E.Keizer@rug.nl

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given situation [e.g., (17–19)]. For example, the antilitter norm is a widely held injunctive norm [e.g., (20, 21)]. The extent to which an injunctive norm affects behavior depends on how much the norm is on people’s minds (22, 23). For example, an antilitter norm will be more on people’s minds when they see someone picking up a piece of litter (which shows disapproval of littering) (12) or simply see a norm stated on a sign (24, 25). Descriptive norms affect behavior because they provide information about which behavior is most common in a given situation. For example, a littered setting shows that it is common to litter and will therefore enhance littering (11, 26, 27). Similar to injunctive norms, the more conspicuous the descriptive norm, the more strongly it influences behavior. For example, the probability that a participant litters in a littered setting is enhanced when a lot of litter is present or when the participant watches someone littering (11). Injunctive and descriptive norms can be in conflict, as for example in a setting where it is common to litter even though littering is commonly disapproved of. Thus, settings described in BWT as disorderly (e.g., a littered setting) can be conceptualized as settings in which descriptive and injunctive norms are in conflict. The next question then is how behavior is influenced by such a setting.

Injunctive-norm information in a persuasive message is more effective when accompanied by descriptive norm information that is in alignment rather than in conflict with that message (24, 28–30). For example, a sign drawing attention to the antilitter norm is more influential in reducing littering when placed in a nonlittered setting than when it is placed in a prelittered setting (31). Thus, a setting with graffiti, described by the BWT as a setting showing disorder, can cause the spraying of graffiti because it inhibits the injunctive antigraffiti norm. In honor of the individual who first described this process, we call this the Cialdini effect. The important question for the BWT is whether or not it also causes disorderly (or petty criminal) behavior in general. The question we will address is the following: Do more people litter or even steal in a setting where the antigraffiti norm (injunctive norm) is in conflict with the descriptive norm (setting shows it is common to spray graffiti)?

The Cialdini effect has its basis in people’s tendency to reason “if a lot of people are doing this, it’s probably a wise thing to do” and to do what they observe others are doing (32). However, we believe that there is another, goal-driven mechanism at work as well, which is particularly important for the spread of disorder. Much conformity to injunctive norms is the result of people pursuing the goal to act appropriately. However, people can also pursue a hedonic goal directed at feeling better right now or a gain goal directed at guarding and improving one’s resources. All three goals can be in conflict, and the weakening of one is likely to bring another goal to the fore (33). In a given situation, the goal to act appropriately is weakened when people observe that others seem-

![Fig. 1.](image_url)
Participants were people in the public space judged to be 18 years or older. There were no signs in any of the studies that they were aware of being observed by the experimenter. We distinguished between a contextual norm (which the participant witnessed having been violated) and a target norm (a violation committed by the participant). What we manipulated were the indications that the contextual norm was being violated. What we observed as a dependent variable was the relative number of individuals who then violated the target norm, which was inconvenient or costly to follow in this situation. We predicted that disorder (violation of contextual norm) would spread (violation of target norm). To study the robustness of this cross-norm inhibition effect, we conducted six different studies. For ease of description, let us call the situation in which the contextual norm is violated (i.e., inappropriate behavior by others is being displayed) the disorder condition and the one in which it is not violated the order condition. Other factors possibly influencing the results were kept constant between conditions (no signs of other norm or rule violations, same weather conditions, and same period of the day). A confederate posted out of sight observed whether participants did or did not violate the target norm. Gender was coded at first but turned out not to have any impact on the results and was dropped in later experiments. The arrangements in all experiments were such that it was virtually impossible for people not to notice the violations of injunctive norms (such as graffiti, wrongly parked bicycles, and fireworks).

In study 1, the setting was an alley in Groningen located in a shopping area and commonly used to park bicycles. In the order condition, the walls of the alley were clean (Fig. 1A), whereas in the disorder condition they were covered with graffiti (Fig. 1B). A standard prohibition sign (a round red sign with a round white center) indicated that it was prohibited to lock bicycles to the fence. The right sign (our contextual norm) in-}

Fig. 2.

Fig. 3.
and walked the 200-m detour to the temporary entrance that was pointed out by the sign. Violating the “no throughway” ordinance meant stepping through the gap in the fence. Subjects (N=44 in the order condition and N=49 in the disorder condition) were all people who came to collect their car from the car park. A group of people approaching the fence was counted as one subject.

Again there was a clear cross-norm inhibition effect. Of the participants in the order condition (where bicycles were not locked to the fence), 27% stepped through the gap in the fence, compared with 82% of the participants in the disorder condition (where bicycles were attached to the fence). The difference is significant χ²(1, 93) = 27.791, P < 0.001.

Would this also hold for a rule set by a private company that is not enforced with sanctions? In study 3, a parking garage adjacent to a supermarket and health club was used in which the contextual norm established by the private company is to return shopping carts to the supermarket after loading groceries into one’s car. A very visible sticker with the text: “please return your shopping carts” attached to the entrance doors of the parking garage focused attention on this normative request (Fig. 3). In the order condition, the garage was clear of shopping carts that were not returned. In the disorder condition, there were four unreturned shopping carts standing around in disarray. The (unreturned) carts used in the disorder condition had no coin deposit system, so people were not financially encouraged to return them. To discourage people who just arrived from using the shopping carts and thus removing the disorder, we smeared the handle bars of the carts with petroleum jelly. Participants (N=60 in each condition) were visitors of the supermarket and a health club who came to collect their car from the multilevel parking garage. Only people not using a shopping cart were included. The target norm was the anti-litter norm, already used in study 1. The dependent variable was whether or not participants who returned to their car littered a flyer (the same flyer as used in study 1) that was placed under the driver’s side windshield wiper of their parked car. The results show that even with this private request, a considerable cross-norm inhibition effect could be observed. Of the participants in the condition without shopping carts, 30% littered the flyer, compared with 58% of the participants in the condition for which unreturned shopping carts were present. The difference is significant χ²(1, 120) = 9.766, P = 0.002.

Is disorder only linked to visual cues of norm violation? Would the cross-norm inhibition effect be of any influence when the contextual norm was merely audible? In our fourth study, we focused on a national law as a contextual norm. In Netherlands it is prohibited by law (with a €50 fine) to set off fireworks in the weeks before New Year’s Eve. We wanted to find out, 2 weeks before New Year’s Day, whether an offense against this national law would induce people to litter. In contrast to studies 1 to 3, the contextual norm was not made conspicuous (say by a sign stating the law). The law about fireworks is well known, and thus we expected participants to be aware of the firework law. The law against littering is not mentioned in the same legal document and was not made conspicuous either (say by a sign stating the law). In setting up the study 4, we wanted to set up an inhibition effect, but we also wanted to observe the normative effect, so we set the stage for a contrast between the order and disorder conditions.

The results of study 4 provided evidence for both effects. Of the participants in the baseline order condition (no graffiti, no littering), 13% stole the envelope compared with 27% of the participants in the graffiti disorder condition. The difference is significant χ²(1, 131) = 4.122, P = 0.035.

The results of study 5 proved to be robust. Compared with the baseline order condition (in which 13% stole the envelope), 25% of the subjects in study 6 stole the envelope in the litter disorder condition. The difference is again significant χ²(1, 143) = 3.545, P = 0.047. It is highly unlikely that this effect is due to a guess about the likelihood of law enforcement triggered by littering. People are not likely to infer a low likelihood of law enforcement against stealing from the fact that people littered the street, because in Groningen littering is generally tolerated by the police whereas stealing is not. The most likely interpretation of these results is, as before, that one disorder (graffiti or littering) actually fostered a new disorder (stealing) by weakening the goal of acting appropriately.

Our conclusion is that, as a certain norm-violating behavior becomes more common, it will negatively influence conformity to other norms and rules. The effect was not limited to social norms but also applied to police ordinances and even to legitimate requests established by private companies. The mere presence of graffiti more than doubled the number of people littering and...
staining. There is a clear message for policymakers and police officers: Early disorder diagnosis and intervention are of vital importance when fighting the spread of disorder. Signs of inappropriate behavior like graffiti or broken windows lead to other inappropriate behavior (e.g., litter or stealing), which in turn results in the inhibition of other norms (i.e., a general weakening of the goal to act appropriately). So once disorder has spread, merely fixing the broken windows or removing the graffiti may not be sufficient anymore. An effective intervention should now address the goal to act appropriately on all fronts.

References and Notes


Germ Cell–Intrinsic and –Extrinsic Factors Govern Meiotic Initiation in Mouse Embryos

Yanfeng Lin,* Mark E. Gill,* Jana Koubova, David C. Page

Retinoic acid (RA) is an essential extrinsic inducer of meiotic initiation in mammalian germ cells. However, RA acts too widely in mammalian development to account, by itself, for the cell-type and temporal specificity of meiotic initiation. We considered parallels to yeast, in which extrinsic and intrinsic factors combine to restrict meiotic initiation. We demonstrate that, in mouse embryos, extrinsic and intrinsic factors together regulate meiotic initiation. The mouse RNA-binding protein Dazl, which is expressed by postmitotic germ cells, is a key intrinsic factor, enabling those cells to initiate meiosis in response to RA. Within a brief developmental window, Dazl-expressing germ cells in both XX and XY embryos actively acquire the ability to interpret RA as a meiosis-inducing signal.

Diploid eukaryotes generate haploid cells via meiosis, a program of two successive cell divisions preceded by one round of DNA replication. The onset of this program is referred to as meiotic initiation. In mammals, debate has focused on whether meiotic initiation is promoted by factors extrinsic or intrinsic to germ line cells (1–6). Meiotic initiation in female mice, commencing at embryonic day 12.5 (E12.5) (7, 8), is induced by an extrinsic factor, retinoic acid (RA) (8–10), but RA alone cannot account for the exquisite temporal and cell-type specificity of meiotic initiation. Although diverse somatic cell types are exposed and respond to RA during mammalian development (11), meiotic initiation is limited to the germ line. Indeed, embryonic germ cells do not respond specifically to RA until their migration ends, at the developing gonad. Does meiotic initiation in mammals also require an intrinsic competence factor expressed in germ cells? Consider the yeast Saccharomyces cerevisiae, in which meiosis is induced by a nutrient-depleted environment (12). For an S. cerevisiae cell to be competent to initiate meiosis in response to this extrinsic cue, the cell must express the a/a mating-type heterodimer (13). We wondered whether an analogous interplay of extrinsic and intrinsic factors governs meiotic initiation in mammals.

We considered the possibility that the Dazl (Deleted in azoospermia-like) gene might be an intrinsic meiotic competence factor, given the location and timing of its expression. In both XX and XY mouse embryos, germ cells begin to express Dazl at about the time of their arrival at the gonad, between E10.5 and E11.5 (14). No somatic lineage has been shown to express Dazl (15). Furthermore, Dazl-deficient mice are infertile because of germ cell–differentiation defects (16–19). These defects are more consistent and pronounced in inbred C57BL/6 mice (19) than in noninbred mice (16–18). Accordingly, we analyzed Dazl function in inbred C57BL/6 animals. We began by testing whether germ cells survive in Dazl-deficient embryonic ovaries as germ cells of Dazl-deficient C57BL/6 embryonic testes undergo apoptosis, beginning by E14.5 (19, 20). We detected two germ cell markers—endogenous alkaline phosphatase (AP) activity (21) and mouse vasa homolog (MVH) protein (22)—in the ovaries of wild-type and Dazl-deficient embryos (fig. S1, A and B). We also found MVH protein in wild-type and Dazl-deficient neonatal ovaries (fig. S1C), which indicates that Dazl-deficient ovarian germ cells survive embryonic development (fig. S1, A and B) and persist through birth (fig. S1C).

We then compared the nuclear morphology of germ cells in wild-type and Dazl-deficient ovaries at E15.5. By this stage of development, many germ cell nuclei in wild-type ovaries exhibit the chromosome condensation that characterizes early meiotic prophase (Fig. 1A). By contrast, germ cells in Dazl-deficient ovaries do not display such condensation (Fig. 1A), which suggests that Dazl function might be required for meiotic prophase to occur. We then examined the expression of Stra8, which is required for premeiotic DNA replication and the subsequent events of meiotic prophase in germ cells of embryonic ovaries (8). As expected,