LETTERS

edited by Jennifer Sills

Bracing for Oil

UNEASINESS HAS SETTLED ON THE UNIVERSITY OF MIAMI'S ROSENSTIEL School of Marine and Atmospheric Science campus as we watch the oil spill slick creep across the Gulf. Although we are on Florida's eastern side, the currents will likely carry the oil to our shores. What would become of the beach surrounding our campus, and the reefs just offshore that we measure and map and monitor regularly?

On campus, we have set up our own drilling rigs, drilling not for oil, but for clean seawater. The tanks housing our corals and fish draw water directly from Biscayne Bay, and we hoped that by digging wells, we could use sand to filter out the incoming pollutants. Results are mixed: One of the wells has produced water of high quality, but the other has high loads of inorganic nutrients, rendering its utility questionable and the security of the water supply uncertain.

Creeping closer. Weeks after the April 2010 Gulf of Mexico oil spill began, a wave of oily tarballs washes over a footprint in Orange Beach, Alabama.

CREDIT: JAY REEVES/AP PHOTO

It is hard to predict how the oil will affect our reefs. Many of the studies on the effects of oil and dispersants on corals were done in the 1970s and early 1980s (*1*, *2*). Although many sublethal effects were reported, acute mortality in connection with oil alone was low. The mucous layer of corals may allow them to slough off oil before it causes damage. The dispersants are more toxic; they can dissolve the corals' mucous layer, which would allow chemicals to penetrate the tissues. Our predictive capacity is further compromised by the wide range of secondary stressors, including coral bleaching, ocean acidification, disease outbreaks, and algal overgrowth. These factors might make the corals even more vulnerable, particularly to toxic exposures.

Powerless, we wait and watch, trying to enjoy our beach but always mindful of the days, perhaps not far off, when tarballs will mingle with the seaweed washed ashore. As we work to mitigate this disaster, we must go beyond a clean up and demand better protection for these devastated and dwindling ecosystems.

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Evolution of Fairness: Cultural Variability

J. HENRICH *ET AL.* ("MARKETS, RELIGION, COMmunity size, and the evolution of fairness and punishment," Research Articles, 19 March, p. 1480) have shown that market integration and participation in world religion covary with fairness. The authors suggest that their results support cultural evolution theories and contradict the hypothesis that successful social interactions in large-scale societies arise to a large extent from an evolved psychology. We believe that their conclusion is based on too simple a view of human morality.

Much research in behavioral economics supports the idea that humans have a sense of fairness that aims to equilibrate exchanges among individuals. In economic games where money needs to be distributed, for instance, people carefully respect everyone's rights over the stake: If the common good is produced by a single person, she is granted more rights over the money (*1*, *2*); similarly, the most productive partner during the joint production phase is favored (*3*, *4*).

Economic games are notoriously underdetermined: Participants are given a lump of money to distribute with no information as to where it comes from, who owned it in the first place, who the receiver is, and so on. As the authors have noted in previous papers (*5*), participants have no choice but to fill this informational gap by drawing on their everyday life experience. Because participants in more market-integrated societies have more experience in sharing goods and investing with others, they spontaneously attribute more rights to the other participant and consequently allow her more money (*6*).

This explanation fits better with the economic literature on institutions and cooperation. Contrary to what the authors suggest, Nobel Prize-winning economists Douglas North (*7*) and Elinor Ostrom (*8*) have shown that cultural variability in cooperation is not explained by different norms but rather by different systems of incentives (reward and penalties) organized by local communities or

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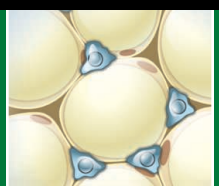

Adipose signals

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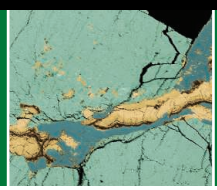

Climate change on early Mars

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States. Thus, an innate preference for fairness is fully compatible with Henrich *et al*.'s results. It is also theoretically more parsimonious and supported by more empirical evidence.

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Evolution of Fairness: Rereading the Data

J. HENRICH *ET AL*.'S RESEARCH ARTICLE ("Markets, religion, community size, and the evolution of fairness and punishment," 19 March, p. 1480) is a valuable addition to the growing literature testing behavioral hypotheses through careful cross-cultural measurement. However, the data they report falsify their theory. The authors propose that increases in third-party punishment of unfairness drove an increase in fairness norms, enabling the emergence of large-scale market economies. Critical to this theory is their hypothesis that exposure to third-party punishment actually elicits an increase in fairness. Relevant to evaluating this hypothesis, the authors conducted two near-parallel economic games: a Dictator Game (in which a "dictator" unilaterally divides a windfall gain with another person—a measure of fairness) and a Third-Party Punishment Game (the Dictator Game with the addition of exposure to possible third-party punishment). Their central hypothesis requires that adding punishment to the Dictator Game will increase fairness, but their data show that the addition of punishment decreases fairness (p. 1483). This finding unambiguously refutes their central hypothesis.

Henrich *et al*. also assert that their data—showing patterned cultural variability in cooperation—can determine whether modern levels of generosity and altruism are driven by an evolved social psychology or by cultural processes. The authors claim that their data decisively favor the cultural processes hypothesis. Yet nothing in their data can test (even in principle) whether it is psychological or cultural processes (or both) that cause these cross-cultural differences. Only long-abandoned instinct-as-reflex theories expect invariant responses in the face of different social inputs. By contrast, modern adaptationist theories predict that our evolved social psychology will be calibrated by relevant environmental inputs. Many of these inputs—such as the local value of long-term cooperative relationships and the fidelity of reputations—are likely to covary with market integration, making it at least as likely that an evolved, context-sensitive social psychology is driving the results that the authors observe. That is, psychological and cultural theories both predict cross-cultural variation.

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Response

OUR RESEARCH ARTICLE DOES NOT ARGUE that elements of an evolved social psychology are unimportant, as Baumard *et al*. suggest. Nor do we believe, as Delton *et al*. propose, that purely genetically evolved mechanisms, rooted in kinship and reciprocity, are sufficient to account for the massive expansion of cooperation in the past 10 millennia and the diversity of human sociality. We argue that understanding this expansion requires the integration of work on both cultural and genetic evolution.

Baumard *et al*. misunderstand the work we cite on the evolution of norms (*1*–*4*), as well as that of North and Ostrom. The cited work asks two questions of innate learning heuristics: (i) Under what conditions can these adaptive learning mechanisms yield self-reinforcing stable equilibria ("norms") at which individually costly behaviors are sustained, and (ii) what happens when groups stuck at different stable equilibria interact and compete (*5*)? Thus, we draw on work that explicitly theorizes the origins and evolution of "incentive systems" given what we know empirically about human psychology and learning.

Both our theoretical approach and our empirical evidence are convergent with approaches suggested by North and Ostrom, who have emphasized the importance of norms, institutions, and learning and culture [pp. 89, 17, and 75 in (*6*); p. 75 in (*7*); pp. 42, 86, 87, and 135 in (*8*)].

Baumard *et al*. claim that much research supports the idea "that humans have a sense of fairness," but the four papers they cite are limited to Dictator Games among undergraduates. Although we strongly suspect that there are innate elements to human fairness (*9*, *10*), the empirical findings cited are neither applicable to our recent paper nor established beyond Western undergraduates, who are but one population in a broad spectrum of human diversity (*11*, *12*).

Baumard *et al*.'s concerns about underdetermination in our economic experiments are unfounded; in the protocols we administered across 15 diverse populations, property rights (money was "given to the pair"), the origins of the money, and what players know (and do not know) about the receiver were made explicit and held constant across sites. Analyses using our measures of comprehension and formal education (*10*), as well as our post-game interviews, revealed no hint that systematic misunderstandings of the instructions (e.g., regarding property rights) affected the findings. Of course, if different populations hold different learned and internalized norms from daily life regarding property rights, this would support our theoretical view.

Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the previous 3 months or issues of general interest. They can be submitted through the Web (www.submit2science.org) or by regular mail (1200 New York Ave., NW, Washington, DC 20005, USA). Letters are not acknowledged upon receipt, nor are authors generally consulted before publication. Whether published in full or in part, letters are subject to editing for clarity and space.

Finally, Baumard *et al*. explain the strong statistical relationship we found between markets, religion, and community size by noting that people in market societies have more experience with "sharing." Empirically, this view is inconsistent with substantial anthropological evidence for intensive food sharing, especially in the smallest-scale societies (*13*). Delton *et al*. also refer to a relationship between market integration with "cooperative relationships" and the "fidelity of reputations," implying that in the smallest-scale human societies (such as foragers), long-term cooperative relationships have relatively less value than among Americans, and that reputations in these face-to-face communities have lower fidelity than among Western urbanites. Such a proposal runs contrary to all available evidence (*14*, *15*).

Delton *et al*.'s concerns about the relationship between our Dictator Game (DG) and Third-Party Punishment Game (TPG) stem from their belief that our approach assumes that only social norms affect experimental results. However, we argue that culturally evolved norms influence decision-making along with other factors (such as material costs and benefits), which is why we equalized the stakes across sites and controlled for income and wealth. Reflecting this, we proposed that the drop in TPG offers relative to the DG arises from the interaction of two factors (pp. 56 to 61 in our supporting online material). First, empirical work suggests that when punishments or rewards are added to a situation, they may reduce intrinsic motivations toward some goal or norm (*16*). If punishing is structurally limited or weak, the net effect of adding this threat to a social interaction may be to reduce motivations to be social. However, if the punishment threat is increased, the net result will be greater social behavior than in the nonincentivized situation. Second, our TPG adds only limited punishment to a DG. The most our punishers can do is to reduce a players' take by 30%. Consequently, it seems likely that offers went down in our TPG because the game adds a punishment threat (reducing intrinsic motivations) but provides limited punishment opportunities—creating insufficient compensatory incentives. This explains why punishment increased offers slightly in the Ultimatum Game (UG), relative to the DG, whereas it reduced offers in the TPG; the UG has potent punishment. Thus, TPG mean offers could be raised by increasing the opportunities for punishment. This underlines the fact that our experiments were not designed to assess the relative efficacy of third-party punishment on prosocial outcomes, but rather to compare a fixed punishment opportunity across populations. Analyses of the differences in DG and TPG offers (table S18 in our supporting online material) suggest that adding limited punishment reduces those prosocial motivations linked to world religions.

We agree that applying evolutionary theory can generate context-dependent theories about psychology (*9*, *17*). However, when one takes the classic models seriously, without applying ad hoc verbal extensions, the implications are clear: Genetic mechanisms based on kinship, reciprocity, and signaling are alone insufficient to account for the scale, temporal trajectory, and variation in human cooperation (*9*, *18*, *19*).

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CORRECTIONS AND CLARIFICATIONS

This Week in *Science*: "Glacial gas" (25 June, p. 1609). The first five words should not have run. The first sentence should read, "A series of sudden and large warming episodes, called Dansgaard-Oeschger events, interrupted the cold conditions of the last glacial period." The sentence has been corrected in the HTML version online.

Editors' Choice: "Caught in the net" by C. Ash (11 June, p. 1328). In the second sentence, "apatite skeletons" should have been "aragonite skeletons."

News of the Week: "APA seeks to overhaul personality disorder diagnoses" by C. Holden (12 March, p. 1314). Andrew Skodol was incorrectly identified. He is a psychiatrist at the University of Arizona College of Medicine in Tucson.

Cover Caption: (26 February, p. 1049). The cover caption did not sufficiently acknowledge the airborne laser mapping project called "B4." In the image credit, the following should have been added parenthetically after "the B4 Project": "(Ohio State University, U.S. Geological Survey, National Center for Airborne Laser Mapping, UNAVCO, and Optech International; www.earthsciences.osu.edu/b4)."

Reports: "Slip in the 1857 and earlier large earthquakes along the Carrizo Plain, San Andreas Fault" by O. Zielke *et al*. (26 February, p. 1119). In note 11, the description of the source of the data used in this study was incomplete, and in note 28, the airborne laser mapping project called "B4" was insufficiently acknowledged. Note 11 should have read: "This LiDAR point cloud was gathered by the National Center for Airborne Laser Mapping using an Optech ALTM 3100 in a Cessna 310 aircraft flying at 600 m above ground level with a 70-kHz pulse rate and ±20° scan angle. The ~1-km-wide survey comprised five overlapping swaths. These data are version 1.01 of the B4 project data, which use Kendrick's 26 November 2005 GPS processing with the KARS software. Points with location accuracies of better than a few decimeters have densities of 2 to 4 per m^2 along the 1857 reach, which allowed us to download 0.25 to 0.5 m per pixel Digital Elevation Models computed using a local binning approach (www.opentopography.org)." The following line should have appeared at the end of note 28: "The 'B4 Project' (www.earthsciences.osu.edu/b4) collected LiDAR point cloud data along the southern San Andreas and San Jacinto Faults. Data acquisition and processing were performed by the National Center for Airborne Laser Mapping (NCALM). The project was led by Ohio State University and USGS with funding from the Division of Earth Sciences Geophysics program at the NSF. Optech International contributed the ALTM3100 laser scanner. UNAVCO and Southern California Integrated GPS Network assisted in GPS ground control. Numerous volunteers and landowners made the project possible."

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