

Do Individuals Matter?

BY JOHN WHITFIELD



On December 17, 2010, Mohamed Bouazizi, a Tunisian stallholder driven to despair by poverty, hopelessness, and police brutality, set himself on fire. He died less than one month later. Ten days after his death, demonstrations provoked by his act brought down the Tunisian government. Just under a month later, protestors overthrew the Egyptian government. The revolt spread to Bahrain, Syria, Yemen, and Libya, where in August 2011, Colonel Gaddafi's 42-year reign came to a violent end.

The Arab spring was built on the ability of powerless individuals to transform themselves into a collective force. The movements were effectively leaderless, and

no single man or woman played a decisive role—they self-organized, perhaps aided by the tools of social media. But what if Bouazizi had just gone home peacefully that day? Would something else have triggered the same events, or would those regimes still be in power?

Such questions cut to the heart of how we understand complex systems. Sometimes, the mass can be treated as one thing, such as when physicists study a cloud of molecules. They view the predictable

An informal shrine commemorates the life of Mohamed Bouazizi, the Tunisian stallholder who set himself on fire, sparking demonstrations that toppled the Tunisian government.

properties and behavior of the whole without worrying about what each component is up to. Researchers at the Santa Fe Institute have pioneered the application of similar techniques to biological and social aggregates. “Taking the tools of statistical mechanics and applying them to other fields is very much what SFI is doing,” says paleontologist Doug Erwin, the Institute’s chair of faculty. But the extent to which this approach is applicable is still unclear, which is why Erwin and SFI Vice President Chris Wood decided that the Institute’s fall 2011 Business Network meeting should have the theme “Do Individuals Matter?”

Understanding emergence does not mean discarding the question of individuality and the role of individuals within a system. Rather, Erwin is one of a number of researchers seeking to understand what individuality is and how it comes

individuals. Professor J. Doyne Farmer, External Professor Duncan Foley and other SFI researchers have argued strongly, in fact, that agent-based models based on the rules of individual decision making should be at the heart of government economic policy making.

Bowles also thinks that balancing emergence against individuality could yield insights into history. The idea that individuals can effect historical change is sometimes disparaged as the “Great Man” view, in contrast to the structuralist view that historical change results from people being pushed by larger currents beyond their control. But Bowles cites many cases where individuals or small groups have brought about changes that deserve to be called historic. Examples include the dramatic increase in sharecroppers’ claims on their harvest in West Bengal, the Russian revolution,

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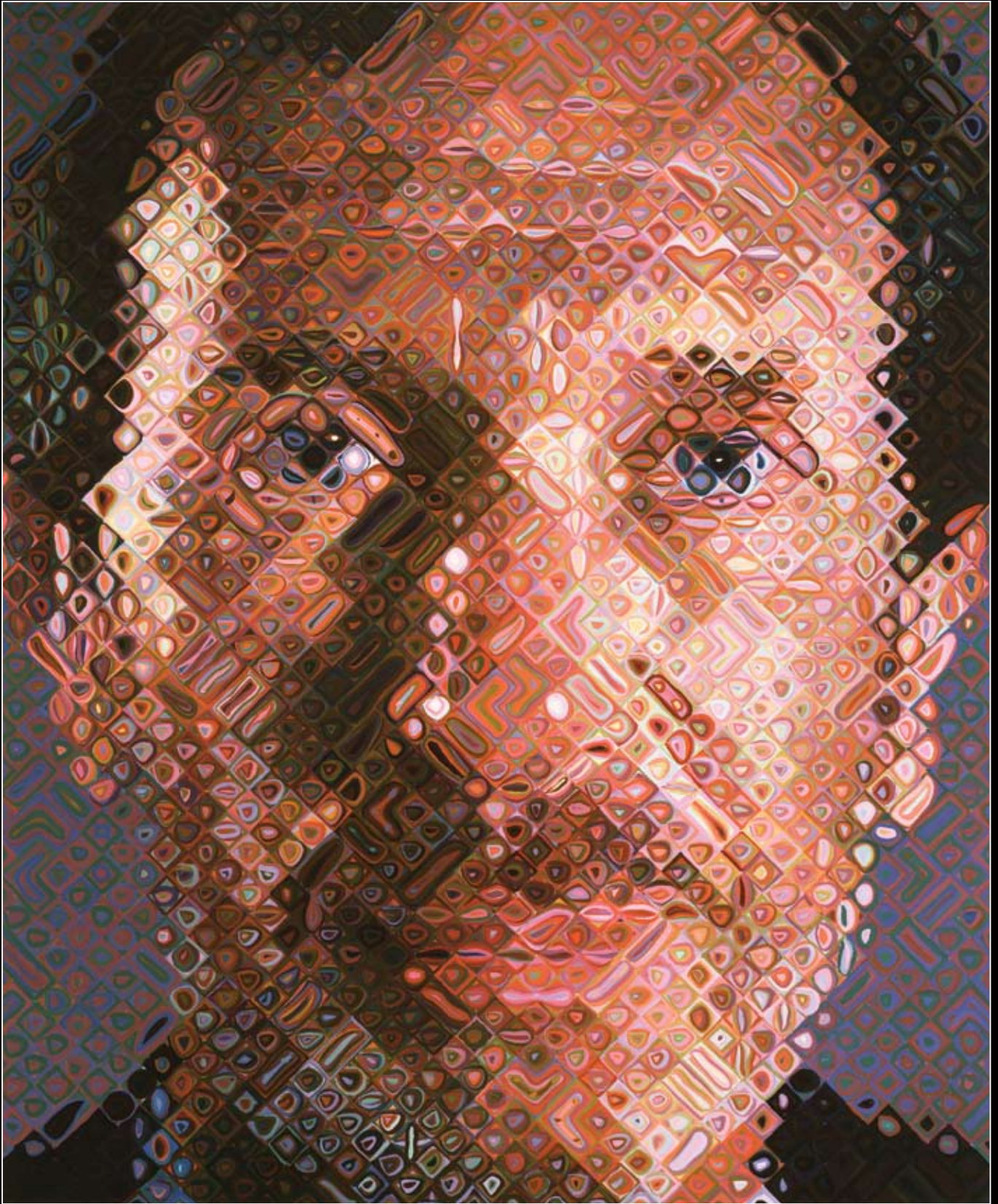
about, and how the differences and interactions between individuals at one level can lead to organization and behavior on a larger scale. “The issue of what an individual is matters a lot,” he says.

Human behavior is perhaps the most obvious area where SFI scientists consider both the individual and the collective. Behavioral economics, as practiced by SFI Professor Sam Bowles and External Professor Herbert Gintis, uses experiments to reveal the traits that underpin human decision making. People, it turns out, have a host of motives beyond simply maximizing expected material gains. They fear losing more than they desire winning, they copy their peers, they get overconfident when things are good, and they run scared when things change. They reciprocate, reward, and punish one another even at individual cost. You can only get a full picture of the economy if you understand what drives

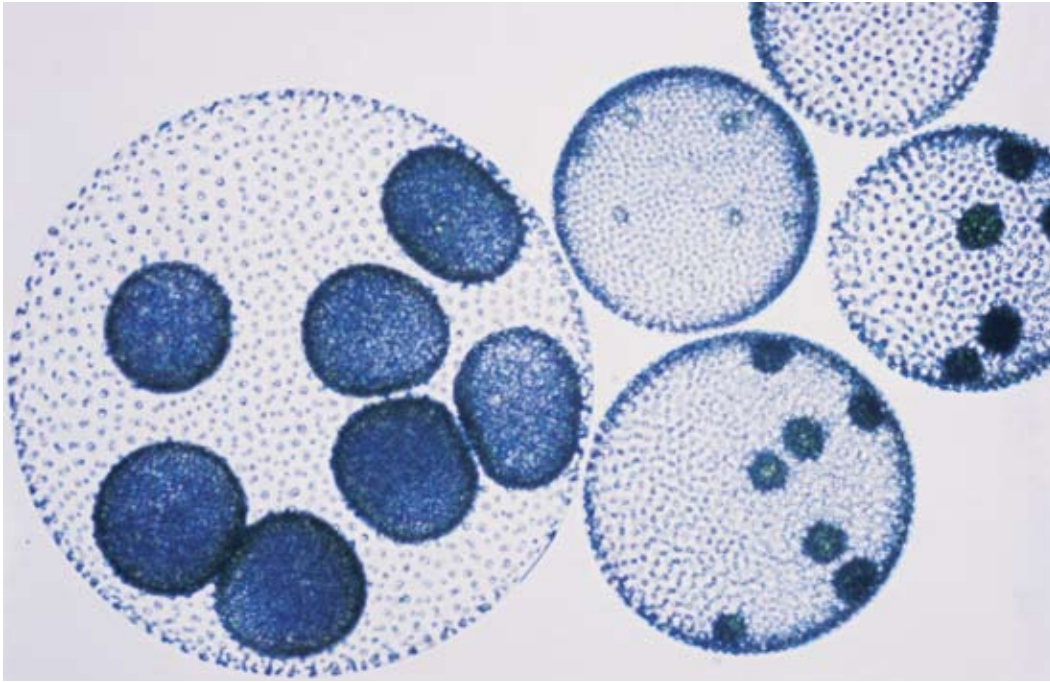
the US civil rights movement, and the decline of foot-binding in China and of female genital mutilation in West Africa. All involved rapid shifts where one way of doing things, which had endured for millennia, crumbled and gave way to another.

So, when can a small number of people make a big difference? Bowles suspects that individual actions are important in societies poised on the cusp of two different states—when a society is, in other words, a dynamical system teetering between two stable equilibria, requiring only a small push to send it toward one state or the other. (With hindsight, the Arab world seems to have been in just

Right: Relationships among individuals at one level can lead to organization and behavior on a larger scale. Here, artist Chuck Close combines hundreds of individual images to create a composite portrait.



Chuck Close Arne, 1999-2000 oil on canvas 102" x 84" © Chuck Close, courtesy The Pace Gallery Photo by: Ellen Page Wilson / Courtesy The Pace Gallery Réunion des Musées Nationaux



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Volvox, a colonial algae, defies definition because it is both an individual and a colony. Unlike multicellular organisms, a colonial organism, if separated, can survive on its own.

such a state, although detecting this beforehand is a difficult challenge, of course.)

Bowles compares this with the process of speciation, where long periods of stasis are followed by bursts of change, and where a small, isolated population of plants or animals can evolve independently into something new. “A lot of the machinery of speciation may explain the emergence of entirely new institutions in history,” says Bowles. On the other hand, that doesn’t mean the group doesn’t matter. What humans do depends on both their individuality and their surroundings. “The beliefs and preferences people have are shaped by the kind of society they live in, and the way they make their living. It’s implausible to take the individual as given, without recognizing that the individual is a product of what you’re trying to explain,” says Bowles.

A biologist would call this niche construction. It is the process by which individual animals and plants shape their environments, which in turn goes on to shape evolutionary history. Erwin believes that niche construction has been important in major evolutionary transitions, and

many have involved the creation of new types of individuals, as formerly independent entities have teamed up to make something novel. Examples include the merging of cells that gave birth to eukaryotes, or the merging of individual insects into a colony, or the merging of speakers of many dialects into a nation sharing a national language.

Over the past 25 years, most research has viewed major evolutionary transitions as arising from new ways

to transmit information, such as in the form of genes. Missing from this argument, says Erwin, is an appreciation of the wider context in which such changes take place. This includes the physical environment, such as the climate; the ecological environment, such as the networks of food webs and mutualisms; and the internal, biological environment, such as the networks of genes that control development and determine how information is used. “It’s about trying to embed the issue of individuality in a larger context,” says Erwin. “We need to understand the relationships between these things.”

Erwin is particularly focused on understanding the ecological, environmental, and genetic conditions that may have facilitated the Cambrian explosion: the brief geological moment about 540 million years ago when the diversity of multicellular animals took off, and the range of body plans that we still see in today’s animals made their debut in the fossil record. Just as in Bowles’ view of humans and their societies, Erwin is interested in how individuals shape their environments and vice versa. One innovation in the Cambrian,

for example, was the emergence of organisms burrowing into the seabed as a way of life. This niche construction introduced oxygen into the sediment, encouraged microbial growth, and so increased the organic matter—food—available to life. Thus burrowing organisms changed the evolutionary pressures on their own and other species, and perhaps created new opportunities that led to increased diversity.

If you're talking about trilobites or snails, it's easy to understand what's meant by an individual. Biologists understand individuality by reference to properties such as an ability to replicate, or a clearly defined boundary with an environment. But many living things, such as viruses, or the clonal aspens growing in the hills around the Institute, don't fit neatly into such boxes. "Biology doesn't have a good definition of an individual,"

nant animals to recognize their place, because it reduces their costs of fighting. This frees up time and energy, and also allows new behaviors by increasing the differences—asymmetries—between individuals. The dominant members of a primate group, for example, can intervene in and subdue fights between their subordinates, because both parties recognize the dominants' superiority. This consensus is a statistic, a measure and memory of the environment that changes relatively slowly, despite change and turnover at the lower level. This is a common feature of hierarchically organized, multilevel systems, such as a body that remains recognizably itself even though it is always making and discarding cells.

A multicellular body and a primate power structure are very different in some ways, of course. But each gives its members, be they cells or mon-

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says SFI External Professor Jessica Flack. To rectify this deficit, Flack and her collaborators are focusing on how different levels of organization—larger structures that emerge from the coming together of many individuals at a lower level—arise in biology.

Perhaps counterintuitively, she believes that a key process is conflict, arising through differences in individuals' interests or the information they have. This means that when individuals interact, they disagree with one another in some way. But repeated interactions allow each individual to gain a picture of its place within the whole, and so allow consensus to develop.

Primate groups, for example, have stable power structures that result from the outcome of many fights. Antagonism never stops, because individuals are always probing the hierarchy. But once there is broad agreement on who can dominate whom, it benefits both subordinate and domi-

keys, a predictable place in an uncertain and changing world. "There are fundamental features of both that are similar," says Flack. "A primary driver of evolutionary change is the reduction of uncertainty." She and her colleagues believe that the ability of conflict to create cohesion is an organizing principle that applies to both a body and a power structure, and they are working on extending these ideas into a definition of individuality based in information theory, says Flack.

Ultimately, they and other SFI researchers are showing that emergence and individuality are not opposites. Rather, they are different angles from which to see the world. But only when combined do they offer a whole picture. ◀

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