NEW IDEAS IN PSYCHOLOGY

New Ideas in Psychology 26 (2008) 1–22

www.elsevier.com/locate/newideapsych

Hints of beauty in social cognition: Broken symmetries in mental dynamics

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Abstract

It is a widely held assumption that social cognition is wholly the result of natural selection and learning, debates arising over how much was naturally selected versus how much is learned. I argue here, however, for there being a third factor, namely physics, specifically symmetries and symmetry breakings in neural dynamics. These symmetries manifest themselves in social judgments in a fairly direct way as descending chains of subgroup types in mental social schemata. These schemata are the four models of Alan Page Fiske's relational-models typology. Descending chains of subgroup types are a phenomenon widely observed in nature; their presence in social cognition is consistent with there being a relevant neural network, the activity of which can undergo symmetry breakings. This would be analogous to the neural activity that has been computer modeled in an attempt to explain animal locomotion. This should encourage work towards specifying the particular symmetry groups in social cognition as a step towards devising computer models of the relevant neural mechanism. Approaches to animal locomotion suggest at least the broad outlines of how to proceed. Evidence of symmetry groups in social schemata also supports the view that the innate aspects of social cognition are at least partly structured by dynamics without being encoded in genes, just as the shape of the protective shell of some viruses results from dynamics without being genetically encoded.

Keywords: Cognitive dynamics; Nativism; Reductionism; Relational models; Social cognition; Symmetry; Symmetry breaking; Ultra-Darwinism

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There are hints of beauty in social cognition. As physicists use the term, *beauty* is a "sense of inevitability" resulting from simplicity and principles of symmetry (Weinberg, 1994, pp. 135–136). It is surprising to find hints of beauty in social cognition. Why?

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doi:10.1016/j.newideapsych.2007.01.001

A common assumption in the sciences is that thought is biological; in fact, the biological nature of mind is a working assumption of this article. However, the assumption that social cognition is biological is usually taken to mean that it can be explained wholly in Darwinian terms with no appeal to physics. This is often a tacit assumption (e.g., Katz, 2001; Whiten & Byrne, 1997), but it can also sometimes be a point of conviction (e.g., Dennett, 1995). Although there have been Darwinian attempts to explain visible beauty, e.g., the symmetry of facial features as an indicator of resistance to parasites in a potential mate (Grammer & Thornhill, 1994), Darwinian biology does not contain the same high expectation of symmetry for less tangible manifestations of beauty, such as symmetries in mental representations. Symmetry is simply not a core assumption of Darwinian biology. By contrast, physicists anticipate symmetries virtually everywhere they look. That core features of social intelligence are beautiful means that such intelligence is in some important ways more like something inorganic, such as a crystal or the spiral form of a whirlpool or of a galaxy, than what one typically thinks of as a product of Darwinian tinkering.

1. Symmetry and its undoing

A symmetry is a kind of transformation, a transformation being a rule for moving things around, e.g., a rule for rotating a figure about its central point, or for switching the values of variables in an equation. Such a rule is a mapping from original to image, a symmetry being a transformation in which original and image are the same in whatever respects are deemed relevant. A square, for example, has four rotational symmetries, since a rotation of 90° or 180° or 270° or 360° would result in an image indistinguishable from the original. The square also possesses various mirror symmetries, i.e., symmetries of reflection. So too the switching of values in an equation is a symmetry if the solution remains unchanged, e.g., $x^2 = 4$ is symmetrical insofar as the value of x can be either 2 or -2. Physicists expect equations in true theories to be highly symmetrical. The great symmetries of its equations explains much of the scientific appeal of string theory (Figs. 1 and 2).

Loss of symmetry in a system is known as symmetry breaking. When symmetries are broken, it is virtually never the case that all symmetries are lost, however. Ripples on a pond are an illustration. Initially, every part of the pond is identical to every other part: a high degree of symmetry. The pond surface with a pattern of ripples, by contrast, has less symmetry. It lacks the translational symmetries of the initial state of the pond. It also lacks some of the original rotational and mirror symmetries if the ripples originate from a point that is away from the pond's center. But not all symmetries are lost; any given ripple has infinitely many mirror and rotational symmetries insofar as it approximates a perfect circle.

In an unstable system, a tiny perturbation can result in a dramatic loss of symmetry (Cohen & Stewart, 1997, p. 171). This is known as spontaneous symmetry breaking, and it is the sort of symmetry breaking at issue here. The surrounding environment of the system does not explain the intricacy of the resulting pattern. Consider a chain standing perfectly straight up, each link resting squarely on the link right under it. Intuitively, one knows that this is a highly unstable system and would collapse virtually at once. How so? Suppose that there is a tiny perturbation to the system, such as a fly passing by on one side or something even less noticeable. This is an asymmetry that, thanks to the system's instability, will iterate. In other words, a vanishingly small asymmetry results in a dramatic decrease of symmetry in the standing chain, which thereby collapses into a heap.