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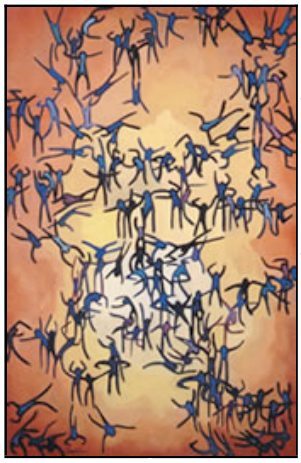
Hub caps could squash STDs

Philip Ball

Identifying high-risk carriers of infectious diseases is worth the effort.



Human relationships: one big scale-free family

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Sexually transmitted diseases (STDs) call for discrimination. Containing the spread of an STD by focusing on promiscuous individuals, who are most likely to pass it on, should be cheaper and more effective than large-scale random campaigns, according to two new mathematical analyses[1,2].

Why? Because the web of human sexual contacts is scale-free - there is no typical number of sexual partners[3]. Many people have few partners; a few have many. And diseases propagate differently through scale-free networks than through networks in which contacts between individuals are purely random.

An epidemic spreads through a random network only when the disease is transmitted faster than a certain threshold value. A disease can be eliminated from a randomly connected population by keeping the transmission rate below this threshold, for example by immunization.

But there is no such threshold in scale-free networks, so even a very slow-spreading disease can be sustained at a low incidence throughout the population[4]. And calculations now show that uniform, random immunization would fail to eradicate the disease.

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The upside to scale-free networks is that they are characterized by a scattering of very highly connected nodes - 'hubs' that hold the web together. The hubs in this case are individuals who have many sexual contacts.

So immunizing promiscuous individuals could effectively curtail transmission of an STD at relatively little cost. In other words, by severing the hubs' connections, the web rapidly falls apart, say Romualdo Pastor-Satorras of the Universitat Politècnica de Catalunya in Barcelona, Spain, and Alessandro Vespignani of the Abdus Salam International Centre for Theoretical Physics in Trieste, Italy.

The problem is finding the hubs - promiscuous individuals are notoriously hard to identify. Fortunately, as Zoltán Dezsö and Albert-László Barabási of the University of Notre Dame in Indiana show, any targeting of hubs, however imperfect, raises the threshold spreading rate above zero, offering a chance to stamp out the disease for good.

"Even modestly effective attempts to uncover and treat the hubs, if carried out systematically, are more successful than policies based on large-scale but random distribution of the available treatments," say Dezsö and Barabási. If strongly focused, control and prevention campaigns should work even if they don't always hit their targets, both teams of researchers agree.

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