



JONATHAN BLAIR/CORBIS

Activities that build relationships are good for the brain.

SOCIAL NETWORKS

# Better together

*Social ties go hand-in-hand with cognitive health. Now researchers are trying to determine why engaging with others helps to keep the brain healthy.*

BY CHELSEA WALD

When Laura Fratiglioni looked at the data her team had collected on ageing and cognitive decline, she noticed something odd: after the age of 80, women in Stockholm were more likely than men to get dementia. Other research revealed the same trend outside of Sweden, too. Could it be that women's brains were more prone to dementia than men's, or was there some other aspect of their post-80 lifestyles causing the decline?

When they delved into the data, Fratiglioni and her colleagues found an irony: that women's well-known longevity was also their undoing. "Women are more frequently alone when they reach the age of 80 or 85 because women are more often married to older men — and in general, men die earlier than women," says Fratiglioni, who is a neurologist and director of the Aging Research Center of the Karolinska Institute in Stockholm. And, as Fratiglioni's team concluded in its seminal paper<sup>1</sup>, it is this isolation that is correlated with increased risk of dementia.

Since this work in the 1990s, the link has grown clearer. Several longitudinal studies, as well as brain studies, have shown that social ties are associated with better cognition. It is as though our friends and family can make us brighter, perhaps by stimulating thinking and reducing stress. If that is true, then working on our social networks when we are young could pay off later, by delaying both the normal decline that accompanies ageing and the pathological deterioration associated with dementia. Researchers are trying to work out which aspects of our networks do the most good, and what mechanisms link our social lives and our biology.

## RICH RELATIONSHIPS

Over the past two decades, scientists have found associations between richer social ties — multiple links with friends, family and the community — and a variety of positive health outcomes, from reduced susceptibility to the common cold to greater life expectancy.

Initially, Fratiglioni and colleagues were uncertain whether their findings were real or whether they could be explained by reverse

causation. That is, because participants were followed for only three years on average, the team may have missed subtle, early signs of dementia that were already affecting relationships at the outset, meaning that when dementia became apparent it would seem to have been caused by degraded networks. But, in a later analysis<sup>2</sup> volunteers were followed for longer. Those who developed the disease did so about six years after monitoring began, making it less likely that undetected symptoms were biasing the results. The authors reached a similar conclusion: that the social component of any leisure activity protected against dementia as much as the mental and physical components did.

Other groups have also found support for a causal link. A six-year study in the United States by a team at the Harvard School of Public Health in Boston, Massachusetts, found that social integration — assessed by marital status, volunteer activity and frequency of contact with family and neighbours — helped to delay memory loss in older people<sup>3</sup>. The team found that memory among the least integrated declined twice as fast as it did for the most integrated. And they found no evidence of reverse causation.

The link could also apply to younger people. An analysis of survey data collected from 35- to 85-year-old Americans found that, at any age, people with more contacts and social support performed better on tests of executive function and memory<sup>4</sup>. Although this conclusion is debated, the researchers suggest that any relationship is likely to be reciprocal — cognitive function affects social engagement and vice versa.

## DIGGING DEEP

Because studies use a variety of measures for both social network and cognitive function, the reason for the link has been hard to pin down. Almost by definition, people with strong social networks tend to have more access to information, resources, and assistance and advice from other people than do those who are isolated. But social support — even if it is well meaning — can also have negative effects on well-being, for example when it is perceived to be intrusive or controlling. "The degree and quality with which we have our social interactions impacts our entire brain and body," says cognitive psychologist Timothy Verstynen at Carnegie Mellon University in Pittsburgh, Pennsylvania.

Perhaps that shouldn't be surprising. Social networks have existed long before sites such as Facebook, and it seems that they have been an essential part of being human since our brains began tripling in size some 2 million years ago. The social-brain hypothesis, proposed by anthropologist Robin Dunbar of the University of Oxford, UK, states that primates' disproportionately large brains evolved to handle the complex demands of social living, with human brains being the most disproportionate of all.

SOURCE: W.-X. ZHOU ET AL., *PROC. BIOL. SCI.* 272, 439–444 (2005).

The link between social network, cognition and brain size occurs not only at the species level, but also at the individual level. Dunbar, working with psychologist James Stiller at Nottingham Trent University, UK, found a correlation between the size of a person's network and their performance on tests of both memory and 'theory of mind' — the ability to understand another person's thoughts<sup>5</sup>. Dunbar, with US and UK colleagues, also found that the grey-matter volume of parts of the prefrontal cortex vary with social-network size, as well as with performance on theory-of-mind tasks<sup>6</sup>. The prefrontal cortex is essential for social cognition: it handles information processing, planning, working memory, language and attention. Further research by Dunbar and others revealed a standardization to human social groups, from an intimate support clique of 3–5 individuals to a broad active network of 150 people (see 'Social animals').

A similar link has been found for other brain regions. The volume of the amygdala, the almond-shaped emotion centre deep in the brain, correlates with the size and complexity of a person's social network. And grey-matter density in certain parts of the temporal lobe, which is associated with social perception and associative memory, has been found to vary according to the size of volunteers' Facebook networks<sup>7</sup>. Some researchers, including Fratiglioni, suspect that the cognitively demanding act of socializing can actually build up the brain — like exercising builds up muscles. This 'brain reserve' may then act as a buffer against functional loss, even in the face of conditions such as Alzheimer's disease.

Whether this social stimulation can form the basis of a medical intervention is under investigation. Last year, researchers led by gerontologist and biostatistician Hiroko Dodge of Oregon Health & Science University in Portland hooked up internet-based face-to-face communications systems in volunteers' homes. Using the system, participants, whose average age was just over 80, spoke with trained interviewers for 30 minutes a day for 6 weeks. After the intervention, volunteers performed better in language-based tests of executive function, for example, when they were asked to name as many words as possible that belonged to a certain category<sup>8</sup>. "Surprisingly, we found a big effect," Dodge says.

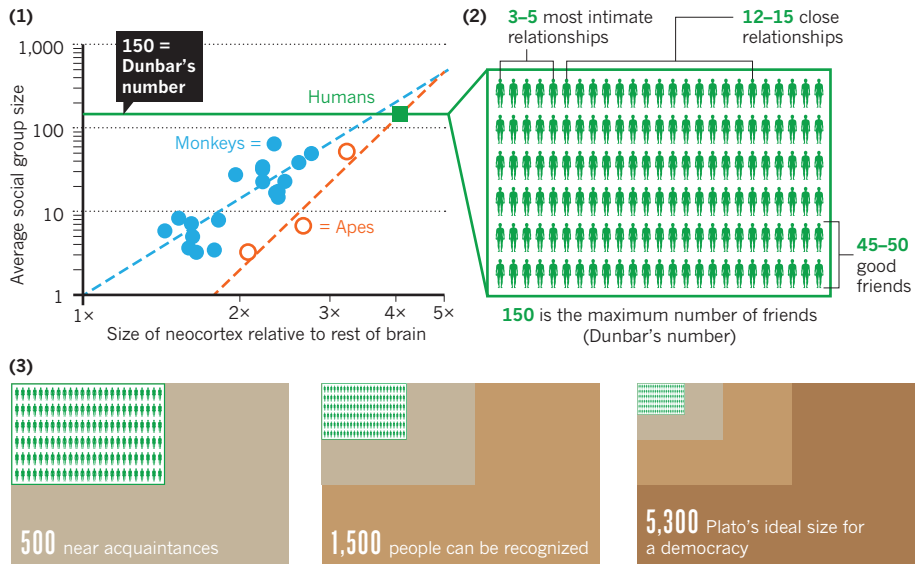
Dodge hopes to run a larger and longer study, with the goal of showing that such short conversations might delay the onset of dementia. She is optimistic about the uptake — should this simple system prove successful. Unlike physical and cognitive exercises that require special effort, she says, "talking with people is so natural".

**INFLAMED THINKING**

There is, however, more to the brain than the number of little grey cells. White matter functions like "wires that connect brain areas together", supporting many aspects of cognition, says Verstynen. White-matter integrity is

**SOCIAL ANIMALS**

In primates, the size of social circles correlates to the relative size of the neocortex compared with the rest of the brain (1). In humans, Dunbar's number is a suggestion of the amount of relationships a person can maintain. Human social networks seem to be split into hierarchies (2, 3), with group sizes varying by a factor of about three.



known to correlate with cognitive performance, and, in 2014, Verstynen's team revealed a link between white-matter integrity and the richness of a person's web of social interactions<sup>9</sup>. "Social-network diversity is affecting the efficiency of those wires," says Verstynen.

To explain the link between social networks and white matter, Verstynen turns to inflammation. Isolated individuals have higher levels of inflammation than those who live in a social milieu; this inflammation is comparable with that of those who smoke or who are obese. "The greater your inflammation in the body, the more you inflame myelin in the brain," Verstynen says, referring to the sheaths that protect nerves, "and sometimes that leads to degradation of the myelin."

If this is true, Verstynen says, then isolation could create a feedback loop: a reduction in social network diversity could raise levels of inflammation, damaging the white matter. That could lead to poor decision making, which in turn could lead to further shrinkage of the social network. In other words, losing friends could alter brain biology in a way that leads to losing even more friends. This might sound bleak, but "there is hope," says Verstynen. He suggests that interventions that increase someone's social network diversity or reduce systemic inflammation "might be able to break this circuit and improve brain health".

Online networks may help to decrease isolation, particularly for those with limited mobility. In a study of older people living alone,

medical sociologist Shelia Cotten of Michigan State University found that using the Internet helped to reduce feelings of loneliness and increase connections with friends and family<sup>10</sup>. Social ties, including online ones, have the potential to "provide emotional support and also provide informational support that help people make important life decisions", she says.

Sites such as Facebook could be as important for a healthy lifestyle as the gym, so long as it helps to build and maintain a strong network. "I tell people, it's very important, especially when we are getting older, to continue to be active in all three components — that is, mental, physical and social," Fratiglioni says. Five years ago, she decided to follow her own advice and took up tango. The dance style is "unbelievable", she says — "very social, very emotional, very physical". In other words, it's the perfect medicine. ■

*Chelsea Wald is a freelance science writer based in Vienna.*

1. Fratiglioni, L., Wang, H.-X., Ericsson, K., Maytan, M. & Winblad, B. *Lancet* **355**, 1315–1319 (2000).
2. Wang, H.-X., Karp, A., Winblad, B. & Fratiglioni, L. *Am. J. Epidemiol.* **155**, 1081–1087 (2002).
3. Ertel, K. A., Glymour, M. M. & Berkman, L. F. *Am. J. Public Health* **98**, 1215–1220 (2008).
4. Seeman, T. E. et al. *J. Gerontol. B Psychol. Sci. Soc. Sci.* **66**, 1141–1152 (2011).
5. Stiller, J. & Dunbar, R. I. M. *Soc. Netw.* **29**, 93–104 (2007).
6. Lewis, P. A., Rezaie, R., Brown, R., Roberts, N. & Dunbar, R. I. M. *Neuroimage* **57**, 1624–1629 (2011).
7. Kanai, R., Bahrami, B., Roylance, R. & Rees, G. *Proc. R. Soc. Lond.* **279**, 1327–1334 (2012).
8. Dodge, H. H. et al. *Alzheimers Dement.* **1**, 112 (2015).
9. Molesworth, T., Sheu, L. K., Cohen, S., Gianaros, P. J. & Verstynen, T. D. *Soc. Cogn. Affect. Neurosci.* **10**, 1169–1176 (2015).
10. Cotten, S. R., Anderson, W. A. & McCullough, B. M. *J. Med. Internet Res.* **15**, e39 (2013).