

GRAY MATTER

Does Breast Milk Have a Sex Bias?

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In 1973, the biologist Robert Trivers and the computer scientist Dan Willard made a striking prediction about parents and their offspring. According to the principles of evolutionary theory, they argued, the male-to-female ratio of offspring should not be 50-50 (as chance would dictate), but rather should vary as a function of how good (or bad) the conditions are in which the parents find themselves.

Are the parents' resources plentiful — or scarce? The Trivers-Willard hypothesis holds that when their conditions are good, parents will have more male offspring: Males with more resources are likely to gain access to more females, thereby increasing the frequency with which their genes (and thus their parents' genes) are preserved in future generations. Conversely, male offspring that lack resources are likely to lose out to males that have more resources, so in bad conditions it pays for parents to “invest” more in daughters, which will have more opportunities to mate.

It follows, as a kind of corollary, that when parents have plentiful resources they will devote those resources more to their sons, whereas when resources are scarce, parents will devote them more to their daughters.

In short: If things are good, you have more boys, and give them more stuff. If things are bad, you have more girls, and give more of your stuff to them.

Is this hypothesis correct? In new research of ours, to be published in the April issue of *The Journal of Experimental Child Psychology*, we suggest that in the case of breast-feeding, at least, it appears to be.

In recent years, evidence has emerged suggesting that in various mammalian species, breast milk — which is, of course, a resource that can be given to children — is tailored for the sex of each offspring. For example, macaque monkey mothers produce richer milk (with higher gross energy and fat content) for sons than for daughters, but also provide greater quantities of milk and higher concentrations of calcium for daughters than for sons.

There is also some evidence of sex-biased milk production among human mothers. A group of women studied in Massachusetts, for example, produced higher-quality milk, with greater energy, lipids and other constituents, for their sons than for their daughters. Economically sufficient Kenyan

mothers, according to another study, produced milk with higher fat concentration for their sons than for their daughters, whereas the reverse was true for poorer mothers.

The aim of our research was to figure out how to study the divergent effects of breast milk on sons and daughters on a much larger scale. Our solution: to look at twins.

In light of the emerging evidence of sex-specific variation in breast milk quality, the Trivers-Willard hypothesis implies that breast-feeding may be less beneficial for opposite-sex twins than for same-sex twins. Same-sex twins, after all, can benefit from their mother's sex-tailored breast milk just as non-twins can. However, the breast milk of mothers of opposite-sex twins cannot be tailored for either sex. Perhaps it is selectively tailored for the wrong sex part of the time, or for neither sex all of the time.

Thus, the Trivers-Willard hypothesis led us to surmise that opposite-sex twins would be disadvantaged for health and growth. This would be reflected in their being shorter and weighing less than same-sex twins.

Using data from the National Longitudinal Study of Adolescent Health — a large, nationally representative, long-term behavioral and medical study of young Americans — we tested this idea. More than 20,000 adolescents were interviewed in their homes several times: once in 1994 or 1995, and again in 1996, 2001 to 2002, and 2007 to 2008. The subjects' self-reported height and weight were recorded at all four points, and their height and weight were also directly measured by interviewers from 2007 to 2008, yielding five data points. Information about breast-feeding was provided by mothers.

Our study focused on 546 same-sex individual twins (277 females and 269 males) and 233 opposite-sex individual twins (120 females and 113 males). Using all five measures of height and weight, we compared their growth over time.

We found that breast-fed same-sex twins were indeed either slightly taller or substantially taller than breast-fed opposite-sex twins at four of the five time points (the exception was the first, when they were just entering adolescence). Same-sex twins were, on average, nearly one inch taller than their opposite-sex counterparts. Similarly, same-sex twins were substantially heavier than the opposite-sex twins except during the first measurement period. The same-sex twins were, on average, 12 pounds heavier than the opposite-sex twins.

To the best of our knowledge, ours is the first study to demonstrate that there are observable physical consequences of sex bias in human breast milk. Additional research is needed, of course, to confirm the presence of sex bias in human breast milk and the differences in the quality of breast milk in accordance with the conditions of the parents. But for now, the Trivers-Willard hypothesis seems to hold.