Twin Studies in Humans

Partitioning sources of variation in humans is difficult and results are often misinterpreted:

We expect inherited traits to "run in families" but the environment within the family may also lead to similarities.

Examples; Spoken language, Vitamin deficiency, Kuru

Dizygotic (DZ or fraternal) twins (2 eggs fertilized by 2 sperm) have the same relationship as any other sibs; they may be opposite sexes.

DZ twinning rates vary in different cultures; the high is 40 per 1,000 births in Nigeria and the low is 3 per 1,000 in Japan.

DZ twins always arrive in separate chorions.

Monozygotic (MZ or Identical) twins occur when cells from a fertilized egg separate in an early cell division.

MZ twins have the same genotype and are always the same sex.

The rate of MZ twins is 4-5 per 1,000 births worldwide.

ID twins may come in the same chorion, or in separate chorions.

Comparisons between twins provide some clues as to genetic and environmental roles in variation.

Twins are often dressed and otherwise treated alike, which may minimize the influence of environmental effects.

Ideal cases where MZ twins were separated at birth and reared apart are rare, but have been and continue to be sought.
Comparisons of *Concordance* (twins alike) versus *Discordance* (twins differ) provide some clues as to genetic and environmental contributions;

Identical twins have the same genotype so any differences are attributed to environmental causes. (We assume an equal prenatal environment, but in some cases one twin may receive a "better" blood and nourishment supply, which could affect later development.)

Only 6% of ID twins both develop breast cancer, suggesting that Environment is more important. This is still twice the rate of concordance as is seen in DZ twins, suggesting some genetic component may be involved. We will see how this can be the case when we take a look at the genetics of cancer.

Simply inherited traits show "absolute" concordance in MZ twins, but can differ in DZ twins if at least one parent is heterozygous for the trait.

A high concordance in both types of twins also suggests Environmental factors are key. Example: having or not having measles.

Some "all-or-none" traits such as club foot, schizophrenia, and manic-depressive psychosis have much higher concordance in ID than fraternal twins, implying a genetic factor, but the <100% concordance among ID twins means environment also has a role.
These traits are actually quantitative in nature, meaning that individuals who inherit over a "threshold" number of contributing alleles will most likely develop the trait.

In some families a single gene may be segregating to tip the scales, in others it could be a different gene or several genes. Thus studies based on different families may implicate different genes or even different modes of inheritance.


The risk of schizophrenia is only 0.9% in the overall population, but for a child with both parents affected it is 68%, if one parent is affected, 21% a sib, 13% etc.

Twin comparisons, parent-offspring comparisons, and parent foster-child comparisons and other methods may be used to estimate heritability in humans.

**Heritability and IQ**

Cyril Burt, in England in the 1930s sought out identical twins who had been reared apart and used them to estimate the heritability of human IQ at approximately 0.79. His results were used to set up the education system used in England. In the 1970s it became clear that he made up many of his twin sets, and his work was discredited. In fact, his estimates are not out of line with other studies that are presumably honest.
Shockley (transistor inventor) and Jensen have argued that racial differences measured in IQ cannot be "corrected" by education (environment) since "genes are the primary factor". Several experiments in education dispel their argument!

Remember that:

1) Measuring IQ as a single number score has obvious limitations.

2) $H^2$ only estimates genes that are segregating, not those that are present in common.

3) $H^2$ estimates are valid only for the population measured and in the environment measured. IQ tests were originally standardized using white middle class Americans.

4) Learning in humans most certainly has a gene-by-environment interaction component that is ignored in making estimates. (Some people learn better orally, others visually, etc.)

A continuing study of twins reared-apart that has been underway for some time at the University of Minnesota continues to provide fascinating insights into "genetic predispositions".

A web site that will guide you to various ongoing twin studies can be found at [http://ibgwww.colorado.edu/lts/links.htm](http://ibgwww.colorado.edu/lts/links.htm)