Twin Studies: Researching Genes and Environment

Twin studies concentrate on identical (monozygotic; MZ) and non-identical (dizygotic; DZ) twins. MZ twins have the same genetic make-up. The ideal experiment would be to separate the MZ twins at birth, and raise them in different environments. Then to see if the twins showed the same behaviour, which must then be due to genes. This is the "MZ apart" twin study.

A concordance rate is calculated, and if it was 100%, it would show that if one twin had the behaviour, then the other twin always did as well.

But, in reality, twin studies depend on volunteers: they may have been separated at any age, and the environments may not be that different. Bronfenbrenner (1986) reported correlation rates of 0.86 for particular behaviours when the "MZ apart" were reared in similar environments, and 0.26 when in different environments. Because of the many confounding variables, twin studies are thus, technically, quasi-experimental designs (1).

"MZ apart" twin studies would be "true" experiments if the following controls were possible: separation of the twins at birth, and each twin raised in a completely different environment (figure 1). There are ethical problems with such a study, and this is why volunteers are used who have already been separated by circumstances (ie: opportunism).

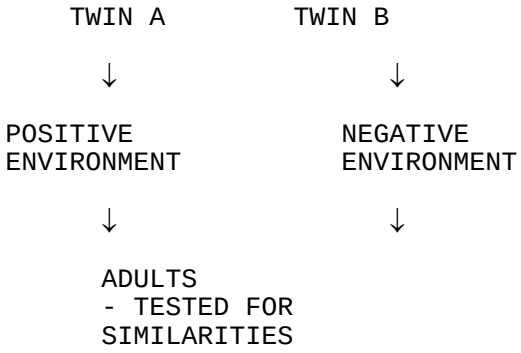

Figure 1 - Criteria for "true" experiment with "MZ apart" twin studies.

The true separation of the twins is the biggest problem for "MZ apart" studies. For example, Jackson (1960) reviewing the studies, available at that time, of "MZ apart" for schizophrenia could only find two pairs of twins who were genuinely reared apart. These two pairs

produced a concordance rate of 100%.

While Gottesman and Shields (1972) reported eight such studies giving seventeen pairs genuinely reared apart; the concordance rate for those twins was 62%. But the age of separation varied from "soon after birth" to "between 3-8 years old". In some cases, the twins were reunited.

Because of this problem and thus the small number of MZ twins raised separately, most studies compare the concordance rates of MZ twins reared together ("MZ together") with DZ twins reared in the same environment ("DZ together").

Gottesman and Shields (1972) made two predictions about heritability and "MZ together" and "DZ together" studies:

a) If genetic differences are of no importance the concordance rates in MZ and DZ co-twins should be the same;

b) If genes are important, MZ co-twins should be affected more often than DZ co-twins.

Bouchard and McGue (1981) reviewed 111 studies on intelligence between family members, and calculated the concordance rates in table 1. Scarr (1997) expanded the work.

RELATIONSHIP	NUMBER OF PAIRS	CONCORDANCE RATE
MZ together	4672	0.86
apart	65 (158)	0.72 (0.65)
DZ together	5546 (8600)	0.60 (0.55)
apart	(112)	(0.35)
Siblings together	26 473	0.47
apart	203	0.24

Figures in brackers = Scarr (1997)

Table 1 - Concordance rates for intelligence from Bouchard and McGue (1981).

However, despite all the difficulties, twin studies are still useful (table 2). In fact, there are growing in popularity in both medicine and psychology as shown by the existence of twenty major twin registers worldwide (Ohlson 2002).

STRENGTHS	WEAKNESSES
- show genetic contribution to behaviour; ie: control environmental variables	- many studies based on retrospective data
- more ethical than equivalent experiment	- small samples usually
- study over long period	- different definitions of behaviour used in different studies
- findings of genetic causes removes blame from parents for child's problems	- twins share same environment in womb, so cannot completely remove environmental influences from "MZ apart" studies
- allows more detailed study of genetics than with siblings and other family members	- desire to explain social inequalities down to genes (Ohlson 2002)
- twins raised in same environment do have different experiences (non-shared environment; Dunn and Plomin 1990)	- whether trait is nature or nurture is meaningless because it is combination of both
	- downplay role of parents who treat identical twins as same
	- environment assumed to be equal challenged by non-shared environment (Sham 1996)
	- what is actually inherited because genes code for physical aspects of the brain and body which leads to behaviour, but genes do not code for behaviour

Table 2 - Main strengths and weaknesses of twin studies.

EXAMPLE OF TWIN STUDIES

Gottesman and Shields (1972) is a classic example of the use of the twin study method with schizophrenia.

The researchers found 55 patients diagnosed between 1948-64, who were twins and would co-operate in the study. All of these co-twins were attending a London psychiatric clinic and were diagnosed as schizophrenic.

Twenty-four of the patients were a MZ twin, and the others a DZ twin. The study was interested in the concordance rate for schizophrenia in the twins. This study attempted to interview as many of the twins as possible. Thus diagnosis was done after face-to-face interview, which is not always the case in twin and adoption studies.

Using a criteria of "diagnosed with schizophrenia and hospitalised", the concordance rates were 42% for MZ twins and 9% for DZ twins. This difference is assumed to

be due to the role of genetics in the disorder.

However different definitions produced different concordance rates: for example, "hospitalised with psychotic illness" (not schizophrenia) produced a rate of 54% for MZ twins and 18% for DZ twins. While a definition of "abnormal" gave rates of 79% and 45% respectively (Davison and Neale 1996).

TWIN STUDIES TODAY

Twin studies are used for three reasons today:

i) To establish the genetic overlap between different syndromes.

Kendler et al (1987) found evidence of a "genetic distress" that is a combination of both anxiety and depression. The statistical techniques used produced a common genetic origin (technically a 30% loading) for these two disorders among over 3000 pairs of twins.

While Kendler et al (1995), using the Virginia Twin Register of female pairs (1033 pairs), have found shared genetic factors for major depressive disorder and generalised anxiety disorder, and for phobia, panic disorder and bulimia.

ii) To show the continuity of genetic factors at different stages of an illness.

Kendler et al (1993a) again using the Virginia Twin Register on two separate occasions, one year apart, found that genes accounted for approximately 50% of liability for major depressive disorder on both occasions.

iii) To find the relationship between genetic and mediating or environment factors in the development of an illness.

It is possible to build models to explain the basis of mental disorders. Kendler et al (1993b) studied the development of major depressive disorder and adverse life events over one year with the same sample as Kendler et al (1993a). From their statistical analysis, the researchers produced a three layer model (which accounted for 50% of variance) of the causes of major depressive disorder:

- Distal layer: genetics; parental warmth and childhood parental loss.

- Intermediate layer: neuroticism; lifetime trauma; past depression.
- Proximal layer: social support; recent difficulties; recent stressful life events.

Using twin studies in this way has led to attempts to produce heritability estimates for mental disorders - eg: schizophrenia 68% (Kendler 1983); bipolar disorder 59% (Bertelsen et al 1977) (2).

All of the uses of twin studies today are combined with statistical techniques developed in biometrics. For example, structured equation modelling (SEM), which gives a pattern of predicted correlations that are compared to the findings (eg: Clifford et al 1984).

FOOTNOTES

1. Cook and Campbell (1979) defined quasi-experiments as "experiments that have treatments, outcome measures, and experimental units, but do not use random assignment to create the comparisons from which treatment-caused change is inferred".

Quasi-experiments do not have the randomisation of participants or the clear control of variables found in "true" experiments. Technically, the "true" experiment is the only method by which causation can be established.

2. A common way of estimating heritability is Holzinger's Index (Nurnberger and Berrettini 1998):

$$\text{Heritability} = \frac{\%\ \text{MZ concordance} - \%\ \text{DZ concordance}}{100 - \%\ \text{DZ concordance}}$$

Thus using Bouchard and McGue's (1981) figures for MZ of 0.86 and 0.60 for DZ gives a heritability of intelligence of 65% (or 0.65).

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