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Twin Studies of Suicidal Behavior

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Research on twin studies of suicidal behavior are reviewed. No methodologically sound study on twins reared apart has yet appeared, and so firm conclusions cannot be drawn from the research. Monozygotic twins reared together do appear to have higher concordance rates for suicide than dizygotic twins reared together. Confounding factors are discussed and suggestions made for future research.

Keywords twin studies, suicidal behavior, confounding factors

One of the few methodologically sound methods for studying whether a behavior or trait is inherited is to use twins. A sound design must compare monozygotic (identical) twins and dizygotic (fraternal) twins—MZ and DZ twins. There are many methodological problems associated with this approach.

(1) Since there is evidence that MZ twins are treated more similarly by their parents than DZ twins (Wilson, 1931), it is essential that a group of MZ twins raised apart be studied. If the members of MZ twins reared apart are found to resemble each other, then the resemblance cannot be attributed to similar rearing, but must result from the genetic resemblance. Many published studies of the genetics of behaviors, especially in earlier times, did not study MZ twins reared apart. For example, in Kallman's (1952) study of homosexuality in MZ and DZ twins, the MZ twins were all reared together. In a review of research on schizophrenia, Slater (1968) reported a concordance rate of 60% for MZ twins reared together, 13% for same-sex DZ twins reared together, and 5% for opposite-sex DZ twins reared together. In the whole history of schizophrenia research up to that time, only 15 MZ twin pairs separated earlier in life, one of whom was schizophrenic, had been identified. The concordance rate was 60 percent. This shows the difficulty in obtaining a large sample of MZ twins

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The Research forum is a section devoted to critical reviews of the scholarly literature on suicide. Reviews should be comprehensive and critical of the research and should make suggestions for future research. The reviews should focus preferably on smaller topic areas which can be examined in detail in a reasonable space.
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separated early in life, one of whom has the target behavior.[1]

(2) In many studies, no effort is made to find DZ twins reared apart. If MZ twins reared apart are more similar than DZ twins reared together, it has been assumed that a genetic factor has been demonstrated. However, for the MZ twins to be reared apart, they must have undergone a trauma in infancy—the death or separation of their parent(s). Thus, current studies prefer that the samples of both the MZ twins and the DZ twins be reared apart (e.g., Bouchard and Hur, 1998) so that both groups are equivalent in experienced trauma.

(3) A further methodological problem in twin studies is the accuracy of establishing zygosity. Before the advent of DNA testing, zygosity was determined by methods such as physical resemblance, blood type, fingerprints, and height. The conclusions from these different measures are not always in agreement. The use of physical resemblance is especially poor. In a study by Scarr-Salpatek, Carter-Saltzman, Katz and Barker (1979) of 342 twin pairs in one community, they found that 28% of the families could not agree on whether the twins were identical or not based on their physical appearance. In a study by Jablon, Neel, Gershowitz and Atkinson (1967) a small sample of twins was given blood testing, fingerprinting and asked their opinion: 122 were DZ serologically, 7 concordant serologically but different morphologically (height, weight and eye/hair color) and so probably DZ, 103 were concordant serologically and morphologically, and 25 were unassigned. The twins' opinion agreed well with the serological assignment (only 5.4% errors), but fingerprinting was less satisfactory (22.6% errors).

(4) Several reports have appeared of a single twin pair, concordant or discordant for suicidal behavior. These reports should not be included in tallies of MZ and DZ twin pairs. First, there may be a bias in whether concordant or discordant pairs are deemed interesting enough to be reported in the scholarly literature. Second, it may be difficult to locate all of the published reports on single twin pairs. For example, Roy (1992) includes a report by Zaw (1981) of a MZ twin pair concordant for completed suicide, whereas Juel-Nielsen and Videbech (1970) list "scattered reports" of MZ twin pairs discordant for suicidal behavior from 11 scholarly reports, none of which were considered by Roy. Thus, the results are likely to be more valid if twin pairs only from large samples are considered.

(5) One simple problem, often overlooked, is that DZ twins can be of opposite sex. Thus, it is important to compare MZ twins with same-sex DZ twins. Kringlen (1986) found that opposite sex DZ twins had lower concordance rates for schizophrenia than same-sex DZ twins.

(6) Related to this is the fact that the concordance rates sometimes vary by sex, and so the sex of the twins should be taken into account. Kringlen (1986) found that MZ female twins had higher concordance rates for suicide than MZ male twins.

(7) One useful technique when studying MZ twins is to find MZ twins *discordant* for the target behavior, for then, since the twins are identical genetically, any differences between them must result from experiential factors. For example, in a study of MZ twins discordant for schizophrenia, Pollin and Stabenau (1968) found that the schizophrenic member was more likely to have a central nervous system disease as a child, birth complications and somatic illnesses and to be smaller when born.

(8) Many other problems and biases are present in twin studies (see Kendler,

[1]In research on the genetics of a personality trait, every MZ twin pair separated early in life can be studied, for all the members can be given a personality test. But for rare behaviors such as schizophrenia and suicide, most such pairs have to be discarded since neither member has the target behavior.

1993). For example, it has been noted that there may be a recruitment bias in the seeking of twins to participate in research—Lykken, McGue and Tellegen (1987) found that male twin pairs and DZ twin pairs are less likely to volunteer for research studies than females and MZ twins.

THE DATA ON SUICIDAL BEHAVIOR IN TWINS

Completed Suicides

The results of the following studies are summarized in Table 1.

Kallman's (1953) report of a twin study of suicide is especially poor. He reports that 1 and possibly 3 more MZ twin pairs out of 18 pairs were condordant for completed suicide as compared to 0 out of 21 DZ twin pairs.[2] In this report he does not define what he means by "possibly concordant," he does not describe the source of the twins, and he does not report the sex of the twin pairs (other than stating that the definitely concordant twin pair was male). It may be assumed that the MZ and DZ twins were all raised together. In reviewing this study, Haberlandt (1967) notes that "possibly concordant" means that one twin completed suicide while the other twin showed non-lethal suicidal behavior (a suicide attempt or suicidal ideation).

In earlier reports by Kallman (Kallman et al., 1946, 1947, 1949) results from this sample were also reported. In the 1946 and 1947 reports, the sex of the twin pairs was noted, but none of the 3 MZ twin pairs or the 8 DZ twin pairs were concordant. These 11 cases were part of Kallman's series of some 2,500 twin pairs obtained from mental institutions, tuberculosis hospitals, old age homes and "certain other sections" in the state of New York. In the 1949 report, the sample had grown to 24 twin pairs. None of the 8 MZ twin pairs or the 16 DZ twin pairs were concordant, but the sex of the DZ twin pairs is not stated. In these reports, Kallman also refers to six or seven historical cases. It is by no means clear whether his 1953 report includes these historical cases or not.

Juel-Nielsen and Videbech (1970) reported on twins from a Danish registry, comprising all twins born in Denmark 1870–1920. This twin sample is of same-sex twin pairs. In 19,484 cases, one or both twins died before the age of six, leaving 11,828 twin pairs alive for at least six years. Of these 6,723 were traced and 4,565 untraced. In the sample involving suicides studied by Juel-Nielsen and Videbech 19 pairs were MZ (14 males and 5 females) and 58 were DZ (42 males and 16 females). Four (3 males and 1 female) of the 19 MZ twin pairs were concordant for completed suicide versus none of the 58 DZ twin pairs. These same data appear to have been reported by Hauge, Harvald, Fischer, Gotlieb-Jensen, Juel-Nielsen, Raebild, Shapiro and Videbech (1968), but these authors did not disaggregate the data by sex.

Juel-Nielsen (1979) later reported on 10 of the MZ twin pairs (of whom 1 was only "probably" MZ) from the Danish Twin study concordant for affective disorder. Of these 10 pairs, only 3 pairs were concordant for completed suicide.

Harvald and Hauge (1965) also reported data from this sample of twins and reported that 4 of the 21 MZ twin pairs were concordant for suicide (19%),

[2]Lester (1968) noted that many authors (e.g., Fuller and Thompson, 1960) cite Kallman's (1953) study as showing that there are no genetic factors in suicide. In fact, counting the three possibly concordant MZ twin pairs in his sample as concordant, a Fisher exact test shows $p = 0.04$ in favor of MZ twins being more concordant than DZ twins, which is statistically significant (Lester, 1968).

TABLE 1. **Summary of the Studies of Samples**

		MZ	DZ	p~
Completed Suicide				
Haberlandt (1967)	males	0 of 2	0 of 2	–
	females	0 of 2		
Juel-Nielsen & Videbech	males	3 of 14	0 of 42	.003
(1970)	females	1 of 5	0 of 16	
^Juel-Nielsen (1979)	males	2 of 6		
	females	1 of 4		–
^Harvald & Hauge (1965)	unknown	4 of 21		
	same-sex		0 of 38	–
	opposite		0 of 37	
Kallman & Anastasio	male	0 of 1	0 of 3	
(1946, 1947)	female	0 of 2	0 of 3	–
	opposite		0 of 2	
Kallman et al. (1949)	male	0 of 4		
	female	0 of 4		–
	unknown		0 of 16	
#Kallman (1953)*	unknown	1 of 18	0 of 21	.46
Roy et al. (1991)	males	5 of 53	2 of 112	.035
	males	2 of 5		
	females	0 of 4	0 of 1	.80
	opposite		0 of 1	
Suicidality				
Kallman (1953)	unknown	4 of 18 (CS-AS/SI)	0 of 21	.04
Roy et al. (1995)	males	2 of 13 (CS-AS)	0 of 1	
	females	8 of 13 (CS-AS)	0 of 4	.12
	opposite		0 of 4	
Statham et al. (1998)	males	164 of 401 (SI-SI)	73 of 235	
	females	412 of 936 (SI-SI)	140 of 540	< .001
	opposite		205 of 604	
	males	48 of 401 (AS-AS)+	0 of 235	
	females	271 of 936 (AS-AS)	0 of 540	< .001
	opposite		0 of 604	

*The concordant pair was male
#Each later report from Kallman and his colleagues includes the twins from the earlier reports
^Most of these pairs were included in Juel-Nielsen and Videbech (1970) report
+The concordance is for "serious" attempts
~ The probabilities were calculated by the present author omitting opposite sex twin pairs. For small samples Fisher's exact test was used, for large samples the chi-square test.

zero of the 39 same-sex DZ twin pairs and zero of the 37 DZ opposite-sex twin pairs.

Roy, Segal, Centerwall and Robinette (1991) reported data from the NAS-NRC Twin Registry formed from a search of all

birth certificates for white male multiple births for 1917–1927 in 39 American states. Both twins had served in the armed forces in 15, 924 of the twin pairs located. Zygosity of the twins was established with an algorithm using blood type, responses to a questionnaire, fingerprints, eye and hair color, height and weight. The typing has been found to be 90% accurate. Of the twin pairs, 165 contain at least one completed suicide. Five of the 53 MZ twin pairs were concordant for completed suicide versus 2 of the 112 DZ twin pairs. These percentages (9.8% versus 1.8%) were found by Roy et al. to be statistically significant at the .035 level.

Roy et al. also collected a sample of 11 twin pairs with at least one completed suicide from responses to a letter requesting such pairs and from two "other sources of referral." Two of the 9 MZ twin pairs were concordant for completed suicide versus neither of the 2 DZ twin pairs. The two concordant MZ twin pairs were both male, the seven non-concordant twin pairs comprised three male pairs and four female pairs. The two non-concordant twin pairs were female-female and female-male (see point [5] above in the Introduction).

Nonfatal Suicidal Behavior

The results of the following studies are summarized in Table 1.

Roy, Segal and Sarchiapone (1995) studied 32 twin pairs from a study of twins together three extra cases found by the investigators, one member of which had completed suicide. Of the 26 MZ twin pairs (13 male pairs and 13 female pairs), 10 co-twins had attempted suicide (2 men and 8 women); of the 9 DZ twin pairs (1 male pair, 4 female pairs and 4 opposite-sex pairs), none of the co-twins had attempted suicide. Roy, et al. noted that 10 of the 35 pairs were concordant for psychiatric diagnosis (9 of the MZ twin pairs and one DZ twin pair).

Statham et al. (1998) studied a twin sample of 2,716 pairs collected by the Australian National Health and Medical Research Council. The zygosity was based on self-report, but a comparison of self-report and DNA testing for 190 pairs from the sample revealed 100% agreement. The concordance rates were higher for suicidal thoughts in the MZ twins than in the same-sex DZ twins (44% vs. 26% for females and 41% vs. 31% for males) and for serious suicide attempts (29% vs. 0% for females and 12% vs. 0% for males).

DISCUSSION

Lester (1968) noted that the size of the samples typicaly used in these twins studies is woefully small. Assuming a suicide rate of 10 per 100,000 per year, then the chance of finding concordant pairs in Kallman's (1953) sample of 39 twin pairs is 39×10^{-4} or one two-hundred and fiftieth of a pair.

In many of the more recent reports, one of the twin pair is still alive and so may become suicidal and even complete suicide later. As a result, the true concordance rate may be higher than calculated. For example, the discordant DZ twins reported by Holland and Gosden (1990) were only 20 years old. In addition, the surviving twin may receive some psycghological or psychiatric treatment (formal or informal) that may reduce the likelihood of suicide, thereby reducing the concordance rate.

There are many confounding factors to be taken into account in twin studies on suicide. Segal and Bouchard (1993) found that the grief reaction after the loss of a twin is more intense in MZ twins than in DZ twins. This more intense grief reaction may be a confounding factor in the higher concordance rate for suicide in MZ twins.

Statham et al. (1998) found that the MZ twins in their sample had much more frequent social contact than the DZ twins,

raising the possibility of a contagion effect. However, their sample consisted of 2,716 twin pairs, with high concordance rates for serious attempted suicide in the MZ twins (a total of 319 MZ twin pairs were concordant for serious suicide attempts) and zero concordance in the DZ twins. Yet they report data on ages at attempting suicide in only nine pairs. In 3 of these pairs, the ages of the twin at the time of the attempts were almost the same—2 MZ twin pairs and 1 DZ twin pair—a surprise since the concordance rate for DZ twin pairs was reported as zero percent. In only one of these three twin pairs was the twin ignorant about the suicide attempt of the co-twin, thus ruling out contagion. The numbers reported by Statham, et al. in this section of their report make no sense, and so their import cannot be gauged.

It has been noted that there is a possibility that it is a psychiatric disorder which is behind the higher concordance rate for suicide in MZ twins. Statham, et al. (1998) tried to control for this variable by calculating a multiple regression to predict suicidal behavior in MZ and DZ twins. For the MZ twins, controlling for psychiatric history and psychosocial variables did not eliminate the significance of attempting suicide in the twin as a predictor of attempting suicide in the co-twin. For the DZ twin pairs, however, attempting suicide in one twin did not predict attempting suicide in the co-twin after controls for psychiatric diagnosis and other variables.

The trait for suicide is obivously not exclusively genetic and dominant, since this would result in a 100% concordance rate in the MZ twin pairs. Psychosocial factors and stressors must play a role. In addition, there is obviously a high concordance in these twin pairs for psychiatric illness, particularly affective disorders. Thus, it is hard to know whether the low but significantly higher concordance rate for suicide in MZ twins is simply a result of the increased concordance for psychiatric illness. For example, Juel-Nielsen (1979) noted that two of the three MZ twin pairs concordant for completed suicide in his sample were also concordant for manic-depressive disorder and the third pair was concordant for manic-depressive disorder/affective personality disorder.

SUGGESTIONS FOR FUTURE RESEARCH

Two suggestions can be made for future research. First, the rarity of completed suicide makes it unlikely that researchers will soon identify enough MZ and DZ twin pairs raised apart to satisfy the demands of a sound twin study of completed suicide. Thus, it would seem imperative to switch to nonfatal suicidal behavior as the target behavior to be studied.

Second, since obtaining MZ and DZ twin pairs raised apart is critical, it would useful for suicidologists to collaborate with Bouchard's twin study ongoing at the University of Minnesota in which twin pairs separated early in life and raised apart are being studied.

REFERENCES

Bouchard, T. J., & Hur, Y. M. (1998). Genetic and environmental influences on the continuous scales of the Myers-Briggs Type Indicator. *Journal of Personality*, *66*, 135–149.

Fuller, J. L., & Thompson, W. R. (1960). *Behavior genetics*. New York: Wiley.

Haberlandt, W. F. (1967). Aportación a la genética del suicidio. *Folia Clinica Internacional*, *17*, 319–322.

Harvald, B., & Hauge, M. (1965). Hereditary factors elucidated by twin studies. In J. V. Neel, M. W. Shaw & W. J. Schull (Eds.), *Genetics and the peidemiology of chronic disease*, pp. 61–76. Washington, DC: USGPO.

Hauge, M., Harvald, B., Fischer, M., Gotlieb-Jensen, K., Juel-Nielsen, N., Raebild, I., Shapiro, N., and Videbech, T. (1968). The Danish twin register. *Acta Geneticae Medicae et Gemellologiae*, *17*, 315–331.

Holland, T., & Gosden, C. (1990). A balanced chromosomal translocation partially segregating with psychiatric illness in a family. *Psychiatry Research*, *32*, 1–8.

Jablon, S., Neel, J. V., Gershowitz, H., & Atkinson, G. F. (1967). The NAS-NRC twin panel. *American Journal of Human Genetics*, *19*, 133–161.

Juel-Nielsen, N. Suicide risk in manic-depressive disorders. In M. Schou & E. Stromgren (Eds.), *Origin, prevention and treatment of affective disorders*, pp. 269–276. New York: Academic, 1979.

Juel-Nielsen, N., & Videbech, T. (1970). A twin study of suicide. *Acta Geneticae Medicae et Gemellologiae*, *19*, 307–310.

Kallman, F., & Anastasio, M. (1946). Twin studies on the psychopathology of suicide. *Journal of Heredity*, *37*, 171–180.

Kallman, F., & Anastasio, M. (1947). Twin studies on the psychopathology of suicide. *Journal of Nervous and Mental Disease*, *105*, 40–55.

Kallman, F., De Porte, J., & Feingold, L. (1949). Suicide in twins and only children. *American Journal of Human Genetics*, *1*, 113–126.

Kallman, F. J. (1952). Twin and sibship study of overt male homosexuality. *American Journal of Human Genetics*, *4*, 136–146.

Kallman, F. J. (1953). *Heredity in health and mental disorder*. New York: Norton.

Kendler, K. S. (1993). Twin studies of psychiatric illness. *Archives of General Psychiatry*, *50*, 905–914.

Kringlen, E. (1986). Genetic studies of schizophrneia. In G. D. Burrows, T. R. Norman & G. Rubinstein (Eds.), *Handbook of studies on schizophrenia*, pp. 45–69. New York: Elsevier.

Lester, D. (1968). Note on the inheritance of suicide. *Psychological Reports*, *22*, 320.

Lykken, D. T., McGue, M., & Tellegen, A. (1987). Recruitment bias in twin research. *Behavior Genetics, 17*, 343–362.

Pollin, W., & Stabenau, J. (1968). Biological, psychological and historical differences in a series of monozygotic twins discordant for schizophrenia. In D. Rosenthal & S. Kety (Eds.), *The transmission of schizophrenia*, pp. 317–332. New York: Pergamon.

Roy, A. (1992). Genetics, biology, and suicide in the family. In R. W. Maris, A. L. Berman, J. T. Maltsberger & R. I. Yufit (Eds.), *Assessment and prediction of suicide*, pp. 574–588. New York: Guilford.

Roy, A., Segal, N. L., & Sarchiapone, M. (1995). Attempted suicide among living co-twins of twin suicide victims. *American Journal of Psychiatry*, *152*, 1075–1076.

Roy, A., Segal, N. L., Centerwall, B. S., & Robinette, C. D. (1991). Suicide in twins. *Archives of General Psychiatry*, *48*, 29–32.

Scarr-Salpatek, S., Carter-Saltzman, L., & Katz, S., & Barker, W. (1979). *Twin method*. Lawrence Erlbaum. Mahwah, NJ.

Segal, N. L., & Bouchard, T. J. (1993). Grief intensity following the loss of a twin and other close relatives. *Human Biology*, *65*, 87–105.

Slater, E. (1968). A review of earlier evidence on genetic factors in schizophrenia. In D. Rosthenal & S. Kety (Eds.), *The transmision of schizophrenia*, pp. 15–26. London: Pergamon.

Statham, D. J., Heath, A. C., Madden, P. A. F., Bucholz, K. K., Bierut, L., Dinwiddie, S. H., Slutske, W. S., Dunne, M. P., & Martin, N. G. (1998). Suicidal behaviour. *Psychological Medicine*, *28*, 839–855.

Wilson, P. T. (1931). A study of twins with special reference to heredity as a factor determining differences in environment. *Human Biology*, *6*, 324–354.

Zaw, K. M. (1981). A suicidal family. *British Journal of Psychiatry*, *139*, 68–69.