Swedish Early Separated Twins: Identification and Characterization

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Abstract. A sample of twins separated early in life has been identified in the Swedish Twin Registry. When the registry was compiled in 1961 (old cohort) and 1973 (young cohort), one or both members of 961 pairs indicated that they were separated by the age of 10. In May 1979, both members of 698 pairs were alive and were sent a questionnaire concerning the circumstances of separation. Items included reasons and timing of separation, biological relatedness of rearing parents, degree of contact after separation (including whether they lived in the same area, attended the same school, or lived together again), rough measures of selective placement, and current frequency of contact. An attempt was then made to categorize the pairs based on degree of separation. A total of 257 pairs met the criteria: rearing parents of one twin biologically unrelated to rearing parents of the cotwin, twins not living together again after separation, and contact after separation a few times a year or less. As much as 50% were separated by their first birthday, and 80% by the age of five. Various data from the twin registry are presented describing the entire sample of early separated twins as compared to a matched sample of twins reared together.

Key words: Twins reared apart, Twin registry

SAMPLE IDENTIFICATION

A sample of twins separated early in life has been identified in the Swedish Twin Registry [2]. At the time of compilation (1961 for the old cohort and 1973 for the young cohort), one or both members of 961 pairs indicated that they were separated by the age of 10.

Table 1 presents the distribution of these pairs by year of birth and age at separation as reported in the registry. Fifty-eight percent of these pairs are female. Based on the "peas in a pod" question concerning similarity, 25% were diagnosed as MZ, 64% as DZ and 10% as XZ (ie, undiagnosable). These proportions are significantly different from those expected for zygosity in the registry; however, zygosity for many of these pairs may be incorrectly diagnosed. Similarity in childhood is a good indicator of zygosity for twins reared together [1,6]; nevertheless, twins reared apart *by definition* had little opportunity to experience whether or not they were "alike as two peas in a pod".

CIRCUMSTANCES CONCERNING SEPARATION

In May 1979, a short questionnaire concerning circumstances of separation was sent to all 698 pairs in which both members were alive. Items inquiring about timing and reasons for separation; whether the twins lived in the same area or attended the same school; whether they lived together again; frequency of contact; and relatedness, education and occupation of rearing parents were included.

Responses were received from both members of 409 pairs and from one member of an additional 213 pairs. The results of the initial registry questionnaires were verified in that only 3% of the respondents indicated that separation had not occurred before the age of 10; 50% of the pairs were separated by their first birthday and 80% by the age of 5. The reasons for separation were varied, the most common reasons being illness or death of the mother, the mother being single, and/or economic hardship. Although almost all pairs are now aware that they have a twin, 25% had no contact after separation and only 18% lived together again at some time after separation, if only during a short vacation. For 44% of the pairs, the rearing parents of one twin were biologically related to the rearing parents of the other twin. In most of these cases, the biological mother reared one twin and her sibs or parents reared the other. In other cases, various combinations of paternal relatives reared the cotwins.

Because of the multitude of combinations of factors affecting degree of separation, we chose to categorize the pairs based on three criteria: relatedness of rearing parents to each other, frequency of post-separation contact, and whether or not the twins lived together again after separation. The Figure shows a Venn diagram of the intersection of these criteria for the 566 pairs alive in 1981 and in which one or both twins responded to the early environment questionnaire. The 215 pairs in class A were reared by unrelated rearing parents, had contact a few times a year or less often, and never lived together again after separation (Table 2). Pairs in classes B, C, and D met two of the three criteria, and those in E, F, and G met only one.

The distribution of pairs in class A by year of birth and age at separation is presented in Table 3. Sixty-one percent are women, which is not significantly different from expected considering the distribution by age. Once again, MZ twins are underrepresented with 18% (vs 35% in the registry) and XZ twins are considerably overrepresented with 24% (vs

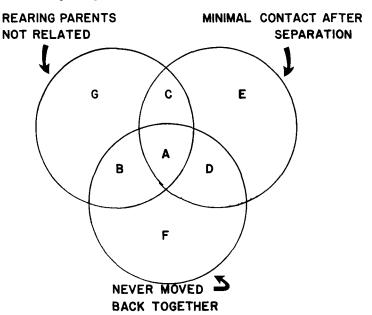TABLE 1 - Twin Pairs Reared Apart Identified at Time of Registry Compilation[a]

Year of birth	Age at separation				Total
	≤1.5	1.6-5	6-10	Other[b]	
Before 1900	36	18	49	37	140
1901-10	67	36	42	44	189
1911-20	111	50	40	44	245
1921-30	87	41	20	24	172
1931-40	47	29	21	16	113
1941-50	32	18	13	12	75
1951-58	12	3	9	3	27
Total	392	195	194	180	961

[a] 1961 for old cohort, 1973 for new cohort.
[b] Twins discrepant by more than 2 years.

TABLE 2 - Distribution According to Three Criteria for Separation: Both in a Pair Alive in June 1981 (See Fig. 1)

	Old cohort		New cohort		Total
	Pairs	Single[a]	Pairs	Single[a]	
A	69	36	71	39	215
B	46	11	24	14	95
C	5	6	11	8	30
D	29	13	17	8	67
Other (outside A,B,C,D)	59	19	36	22	136
Insufficient data	11	7	5	0	23
Total	219	92	164	91	566

[a] Only one member of pair responded.

Figure

6%). The pairs in class A may be considered as "most separated", especially the 112 pairs separated on or before their first birthday. However, the entire sample is of value when the various factors of separation are included as independent variables and their importance is assessed.

The latest mortality update of the Swedish Twin Registry indicates that both members of 649 pairs were alive in June 1981. One or both members of 46 pairs had died since 1979 and in 3 pairs one twin had emigrated.

TABLE 3 - Group A. Most Separated Twin Pairs, Both Alive 1981

Year of Birth		Age at separation			Total
		≤ 1.5	1.6-5	6-10	
Before	1900	3	0	3	6
	1901-10	11	10	3	24
	1911-20	29	12	5	46
	1921-30	32	20	7	59
	1931-40	19	22	11	52
	1941-50	11	7	1	19
	1951-58	7	1	1	9
Total		112	72	31	215

REPRESENTATIVENESS

The question of representativeness of the entire sample of twins reared apart has been preliminarily adressed in two ways. For both cohorts, a control sample of reared together twins matched on sex, age and presumed zygosity has been drawn. For the old-cohort twins, comparisons of means and standard deviations for height, weight, some alcohol measures and socioeconomic status (SES), and of percents for smoking status, urban/rural residence, and attendance in advanced education, provide an indication of how similar twin individuals who were reared apart are to other twin individuals (Table 4).

Reared apart twins were significantly different in weight, SES as measured by the National Opinion Research Council rating scale, percent living in towns as children, and percent continuing education above obligatory schooling. These significant comparisons suggest that older separated twins lived in more rural settings as children, had somewhat lower socioeconomic status as adults, and less frequently continued their education beyond obligatory schooling. Reared apart twins appeared to drink less of the alcoholic beverages; however, this difference is not significant.

For the young cohort, information on SES, urban/rural residence, and schooling was not available for these analyses. On the other hand, data are available on shortened versions of the Eysenck instability and extroversion personality scales [4]. The only measures for which reared apart twins differ are instability and coffee consumption, with higher scores on both measures (Table 5). On the basis of these preliminary results, one can conclude that reared apart twins as individuals are representative for height, weight, alcohol consumption and extroversion when compared to a matched sample of twins reared together. The older separated twins had a somewhat depressed living standard and the younger separated twins are somewhat more instable than twins reared together of the same age and sex.

TABLE 4 - Comparisons of Twins Reared Apart and a Matched Sample of Twins Reared Together — Old Cohort

	Reared apart			Reared together		
	$\overline{X}$	SD	(N)	$\overline{X}$	SD	(N)
Height	165.55	8.78	(1064)	165.96	8.15	(1119)
Weight	69.22	11.03 *	(1084)	68.08	11.40	(1135)
Beer	54.99	123.75	(1042)	64.61	132.61	(1025)
Wine	18.79	72.36	(1042)	25.63	100.13	(1025)
Spirits	64.90	224.18	(1042)	77.56	236.42	(1025)
Total alcohol	138.68	326.48	(1042)	167.80	363.12	(1025)
Heavy consumption	0.53	2.10	(1021)	0.63	2.78	(1007)
Coffee	4.11	2.08	(970)	4.10	2.09	(982)
SES	57.95	10.15 *	(727)	60.53	10.90	(749)
% Never smokers	60.6			60.5		
% Towns as child	5.7	*		10.1		
% Towns as adult	18.7			20.4		
% Above oblig. schooling	18.7	*		28.0		

* Reared apart and reared together twins differ significantly, P ≤ 0.05.

TABLE 5 - Comparisons of Twins Reared Apart and a Matched Sample of Twins Reared Together — Young Cohort

	Reared apart			Reared together		
	$\overline{X}$	SD	(N)	$\overline{X}$	SD	(N)
Height	168.77	8.75	(557)	169.48	8.50	(555)
Weight	65.92	11.76	(561)	64.60	11.30	(558)
Beer	1.98	3.75	(530)	1.90	3.71	(532)
Wine	1.66	3.75	(492)	2.01	4.10	(517)
Spirits	4.58	13.27	(476)	3.63	6.66	(488)
Total alcohol	7.93	16.63	(505)	7.32	10.39	(517)
Coffee	4.48	2.89 *	(552)	4.15	2.49	(553)
Instability	3.23	2.42 *	(559)	2.86	2.33	(560)
Extroversion	4.65	2.12	(559)	4.66	2.22	(559)
% Never smokers	42.3			46.6		
% Divorced	10.5			8.3		

* Reared apart and reared together twins differ significantly, P ≤ 0.05.

TWIN SIMILARITY

Height and Weight

Height and weight are useful "anchor" points for comparisons of twin data, as twin similarity for these measures is well documented. For height in particular, one would not expect an effect of early separation on twin similarity. Thus, the second type of analyses addressing the issue of representativeness was a comparison of intraclass correlations for the presumed zygosity groups by reared apart status and cohort. Intraclass correlations were computed using a double-entry file and corrected for age and age at separation (for the reared apart twins).

The only significant differences in correlations for height are for old cohort MZs and young cohort XZs (Table 6). In both cases, the reared apart (RA) correlation is lower than the reared together (RT) correlation. While the MZ correlations are close to the median of 0.93 reported by Mittler [5] for height, the DZ correlations are considerably greater than the median of 0.48. For the RA twins incorrect zygosity diagnosis could bias the DZ correlations upward. Assortative mating for height would also increase the DZ correlations. This is a more plausible explanation in light of the elevated DZT correlations. The MZA correlations were slightly lower than those reported by Farber [3].

Only one comparison of RA and RT twins was significant for weight, ie, for old cohort DZ pairs. This difference was also in the expected direction, with RA less similar than RT twins. Otherwise, the correlations are remarkably similar for the two samples. Whereas the DZ correlations are quite close to the median of 0.58 reported by Mittler, the MZ correlations for all subsamples are lower than the expected 0.91, and especially pronounced in the older cohort. The MZA correlations are also lower than those reported by Farber. It is difficult to say whether this is a phenomenon specific to Swedish twins, whether it reflects a bias due to self-report (similarity decreasing with increasing inaccuracy in reported weight), or whether it reflects other factors of importance.

RA twins do not seem to significantly differ from a matched sample in similarity for height and weight; however, neither sample fully meets expectations. The need for corrected zygosity diagnosis is emphasized before further conclusions can be drawn.

Other Selected Variables

Preliminary analysis of selected variables in the registry has also begun for all RA twins and the matched sample of RT twins. Intraclass correlations based on a double-entry technique have been computed for coffee and alcohol consumption measures in both cohorts as well as for smoking status in the old cohort and short-form Eysenck personality inventory scales in the young cohort. All correlations were corrected for age and age at separation (RA sample).

For the old cohort, all MZ correlations, except heavy consumption in RA twins, reached significance (Table 7). This was also the only measure for which RA and RT twins differed significantly. RT correlations were generally greater than RA correlations. All DZ correlations, except for coffee in RA twins and wine and heavy consumption in RT twins, were significant. RA twins were significantly different from RT twins for coffee and total alcohol. Unlike the MZ comparisons, RA twins more often had greater correlations. This may reflect a greater mixture of MZ pairs in the DZA group. Fewer of the XZ correlations were significant for either group. In every case for which RA and RT twins differed, the lesser correlation was not significantly different from zero.

TABLE 6 - Intraclass Correlations[a] for Height and Weight in Twins Reared Apart and a Matched Sample of Twins Reared Together

		Old cohort				Young cohort		
		TRA (N pairs)		TRT (N pairs)		TRA (N pairs)		TRT (N pairs)
Height[b]								
	MZ	0.82	*	0.90		0.92		0.84
		(111)		(149)		(57)		(58)
	DZ	0.62		0.70		0.72		0.70
		(278)		(366)		(160)		(160)
	XZ	0.86		0.84		0.61	*	0.84
		(26)		(29)		(56)		(54)
Weight[b]								
	MZ	0.74		0.73		0.82		0.86
		(113)		(153)		(59)		(58)
	DZ	0.34	*	0.48		0.58		0.57
		(282)		(374)		(162)		(160)
	XZ	0.56		0.60		0.45		0.67
		(29)		(29)		(56)		(55)

[a] Corrected for age and age at separation (TRA).
[b] At time of registry compilation (1961 old cohort, 1973 young cohort).
* Reared apart and reared together twins significantly different, P ≤ 0.05.

TABLE 7 - Intraclass Correlations[a] for Twins Reared Apart and Reared Together - Old Cohort

	MZA		MZT		DZA		DZT		XZA		XZT
Coffee	0.31		0.51		0.11	*	0.30		0.05		0.59
Total Alcohol	0.71		0.64		0.47	*	0.27		0.41		0.56
Beer	0.24		0.38		0.46		0.35		−0.00		0.15
Wine	0.18		0.40		0.24		0.10		−0.07	*	0.65
Spirits	0.78		0.73		0.31		0.16		0.58	*	−0.04
Heavy consumption	0.14	*	0.50		0.13		0.08		0.03		0.38
Ever-never smoking	0.52		0.62		0.37		0.49		0.55		0.58
	N = 111-120		N = 122-146		N = 271-293		N = 271-353		N = 23-27		N = 22-30

[a] With age and age at separation (TRA) partialled out.
* Reared apart and reared together twins differ significantly, P ≤ 0.05.

TABLE 8 - Intraclass Correlations[a] for Twins Reared Apart and Reared Together - Young Cohort

	MZA		MZT		DZA		DZT		XZA		XZT
Coffee	0.30		0.56		0.22		0.28		0.31		0.44
Total alcohol	0.42		0.60		0.17		0.28		−0.06	*	0.72
Beer	0.10		0.30		0.14		0.25		0.00		0.31
Wine	0.17		0.46		0.31	*	0.63		−0.14		0.26
Spirits	0.70		0.58		0.10		0.22		−0.04	*	0.74
Instability	0.18		0.37		0.01		0.18		0.21		0.06
Extroversion	0.54		0.44		0.29		0.26		0.06		0.21
	N = 36-59		N = 48-59		N = 121-159		N = 123-160		N = 46-57		N = 41-57

[a] With age partialled out.
* Reared apart and reared together twins differ significantly, P ≤ 0.05.

The young cohort correlations (Table 8) were very similar to the old cohort correlations, particularly so for the MZ groups. All MZT correlations were significant, whereas beer, wine, and instability for the MZA were not significant. In no case did the MZA and MZT differ significantly. All DZT correlations were also significant in the young cohort. Beer, spirits and instability were not significant for the RA twins. Only the correlation for wine was significantly greater in DZT than DZA; however, RT correlations were generally greater. Only the XZ correlations for coffee were significant in both separation groups.

In summary, most MZ and DZ correlations are significant in both cohorts. RA twin correlations differed significantly from RT ones for only a few variables, and except for spirits and total alcohol consumption, have generally lower correlations. Other conclusions regarding these samples must await verification of zygosity diagnosis in the RA sample.

REFERENCES

1. Cederlöf R, Friberg L, Jonsson E, Kaij L (1961): Studies on similarity diagnosis in twins with the aid of mailed questionnaires. Acta Genet Med Gemellol 11:338-392.
2. Cederlöf R, Lorich U (1978): The Swedish Twin Registry. In Nance WE, Allen G, Parisi P (eds): Twin Research: Part C, Biology and Epidemiology. New York: Alan R. Liss, p 189-195.
3. Farber SL (1981): Identical Twins Reared Apart: A Reanalysis. New York: Basic Books.
4. Floderus B (1974): Psycho-social factors in relation to coronary heart disease and associated risk factors. Nord Hyg Tidskr. Suppl. No. 6.
5. Mittler P (1971): The Study of Twins. Harmondsworth, England: Penguin Books.
6. Sarna S (1977): Zygosity diagnosis in epidemiological twin studies: by blood markers and by questionnaire. Univ of Helsinki Press No. 23.

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