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Sports and Genetics. A Study on Twins (351 pairs) [1]

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President, Medical-Scientific Committee for the Games of the XVII Olympiad

Genetics tends to consider sports from the point of view of selective breeding of horses and of other racing-, hunting- and draught-animals.

The physical characteristics of animal races and sub-races are certainly kept and transmitted through hereditary mechanisms. But in man there is the additional problem of mental life, which is of great importance in sports also, and which poses anew the problem of inheritance. Therefore, we must first demonstrate that hereditary phenomena are important for the *homo sportivus* and then deduct suitable consequences.

The existence of a relationship between genetics and sports may be first of all demonstrated indirectly, on the basis of our knowledge of morphological, functional and auxological hereditary traits of normal man. In this direction Ishidoya, Osborne-De George, Gates, Gedda, Gedda-Serio-Mercuri, Gedda-Sodani, Tanner, and Casa have published significant contributions in the field of Human Genetics.

As for the direct demonstration, this can be derived by studying families of high-performance athletes. Champions' familial anamneses often demonstrate the existence of a concentration in the same family of champions in the same sport. This has been shown by Gedda for Italian champions and by Grebe for Germans. These facts may constitute evidence only if they happen at a high-performance level, for otherwise they could be ascribed to familial environmental influence. But in the case

[1] Paper read on August 31, 1960 at the "Health and Fitness in the Modern World" Congress, held in the Rome Institute of Normal Human Anatomy, from August 29 to September 7, on the occasion of the Games of the XVII Olympiad.

of national records family influence is not sufficient: specific and suitable psychophysical characteristics are needed, demonstrating their hereditary basis by appearing many times in the same family.

Recently, we have carried out extensive researches on sports practice within family groups, a phenomenon which we call " family sportivation " and have analyzed from a qualitative point of view. On the basis of a survey conducted on 220 Italian national champions, we established an " isosportivation " index, as well as an " allosportivation " one, in order to indicate whether and to what extent family sportivation concerns the same sports specialty of the propositus, or a different one.

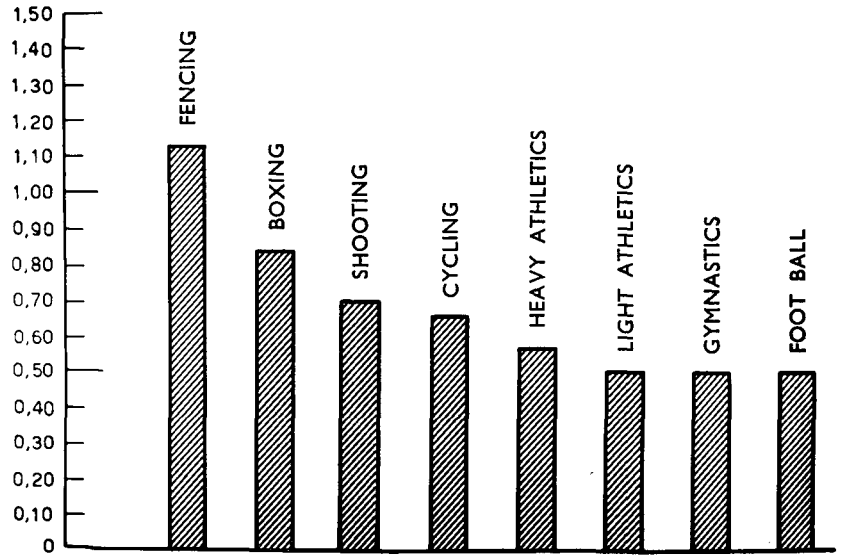

Fig. 1. Family Isosportivation index

Fig. 1 shows that certain sports, like fencing, boxing and shooting appear in the same family more frequently than others. It seems that for these specialties, even more than for others, the higher family frequency might be ascribed to the inheritance of a particular sports phenotype in the champions' family.

Further direct evidence of the influence heredity has on sports may be provided by the study of twins practicing sports. Gedda, as well as Grebe, identified pairs of twins both of whom practiced sports. Similarity among MZ cotwins is highly significant for the importance of hereditary traits in physical exercise. Particularly significant are the known cases of MZ twins concordant as to high records in the same sport, like the Sandre sisters, both French skiing champions (Fig. 2), or the Howe sisters, both U. S. squash champions (Fig. 3), the Collins sisters, both tennis British champions (Fig. 4), and the twin Swiss boxing champions.

Definite evidence based on twin data could only have been provided by a stati-

Fig. 2. The Sandre twins, French skiing champions

stical elaboration of non-selected material. We carried out this research on the basis of an investigation on 1195 twin-pairs and of the statistical analysis of the experimental findings thus obtained.

The study is based on the assumption that individual sports aptitude depends, as far as the body is concerned, on two fundamental factors: an exogenous one, due to environmental conditions such as training, and an endogenous one, related to an individual inherited phenotype. The purpose of our research project was to prove the existence of this second factor and to isolate quantitatively its action.

The large twin material the Mendel Institute has on file has enabled us to organize the survey so as to use the twin-method, by establishing a comparison, in the practice of sports, between the behaviour of pairs with an identical genotype and the behaviour of pairs with a different genotype. It is obvious that if the action of a genotypic (hereditary) factor is added to that of environmental influences, MZ twins will show a higher similarity in the practice of sports.

Fig. 3. The Howe twins U. S. squash champions

Fig. 4. Mary and Anne Collins winning the women's doubles title at Westcliff Hard Courts Lawn Tennis Club

The questionnaire sent to the above mentioned 1241 twin-pairs concerned twins born before 1945 and belonging to pairs with at least one male member. 351 answers have been received so far. These have been tabulated and are presented on pages 391-400.

The answers were first divided into three main groups: I. pairs with both twins practicing sports (cfr. Tab. 1: Yes - Yes); II. pairs with only one twin practicing sports (cfr. Tab. 2: Yes - No); III. pairs with neither twin practicing sports (cfr. Tab. 3: No - No).

In fact, the answers are distributed as shown in Table 4.

The most significant difference concerns the behaviour of MZ and DZ twins in Group II (Yes-No). Dissimilarity in sports practice corresponds to 6% in the case of MZ twins, and to 85% in the case of DZ twins.

This indicates that it is highly unlikely for two MZ twins to differ as to sports practice in general. The four MZ twin-pairs in Group II may then be due to the total of possible errors, caused by the variable sensitivity of si-

Tab. 1. Yes – Yes

Survey Number	Sex	Zygosity	Activity and Performance *				Begin. Sports Act.	Mendel Institute file Number
			A ≃	A ≃	A ≃	A ≠		
			B ≃	B ≃	B ≠	B o		
			C ≃	C ≠	C o	C o		
1	♂♂	MZ		×			( )[2]	2337
2	♂♂	DZ		×			( )	1586
3	♂♂	?[1]				×	( )	—
4	♂♂	?			×		( )	1582
5	♂♂	MZ	×				( )	1636
6	♂♂	MZ		×			( )	3902
7	♂♂	DZ		×			( )	1467
8	♂♂	?			×		) (3	3607
9	♂♂	DZ		×			) (	5593
10	♂♂	MZ			×		( )	684
11	♂♂	MZ	×				( )	5216
12	♂♂	MZ	×				( )	352
13	♂♂	MZ	×				( )	98
14	♂♂	DZ	×				) (	11
15	♂♂	MZ		×			( )	2089
16	♂♂	MZ	×				—	5740
17	♂♂	MZ		×			—	2319
18	♂♂	DZ		×			( )	2973
19	♂♂	DZ		×			) (	3195
20	♂♂	DZ		×			( )	2518
21	♂♂	MZ		×			( )	1688
22	♂♂	?	×				( )	2086
23	♂♂	DZ		×			—	1904
24	♂♂	MZ		×			( )	1213
25	♂♂	DZ			×		( )	1327
26	♂♂	MZ	×				( )	1735
27	♂♂	MZ				×	( )	215
28	♂♂	?		×			( )	—
29	♂♂	?		×			( )	1744
30	♂♂	DZ	×				( )	533
31	♂♂	?			×		) (	1136
32	♂♂	DZ		×			—	1303
33	♂♂	MZ		×			—	3727
34	♂♂	MZ		×			( )	1315
35	♂♂	MZ		×			—	5150

* ≠ dissimilar o not relevant ≃ very similar or equal A, B, C (see Table 5)

[1] Unknown zygosity; [2] = ( ) Similar; [3]) (= Dissimilar

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Tab. 1 *(continues)*. Yes – Yes

Survey Number	Sex	Zygosity	Activity and Performance				Begin. Sports Act.	Mendel Institute file Number
			A ≃ / B ≃ / C ≃	A ≃ / B ≃ / C ≠	A ≃ / B ≠ / C o	A ≠ / B o / C o		
36	♂♂	MZ		×			( )	2621
37	♂♂	DZ			×		—	1996
38	♂♂	MZ	×				( )	4068
39	♂♂	DZ	×				( )	1035
40	♂♂	MZ	×				( )	1707
41	♂♂	DZ		×			—	3779
42	♂♂	DZ		×			( )	3433
43	♂♂	MZ		×			( )	3090
44	♂♂	MZ	×				( )	2639
45	♂♂	DZ	×				( )	1282
46	♂♂	MZ		×			( )	130
47	♂♂	MZ	×				( )	5548
48	♂♂	MZ	×				( )	217
49	♂♂	MZ	×				( )	100
50	♂♂	MZ	×				( )	363
51	♂♂	MZ	×				( )	182
52	♂♂	MZ	×				( )	1605
53	♂♂	MZ		×			) (	56
54	♂♂	DZ		×			( )	1743
55	♂♂	MZ	×				( )	1959
56	♂♂	DZ	×				( )	3339
57	♂♂	DZ		×			—	1630
58	♂♂	MZ		×			( )	198
59	♂♂	MZ		×			( )	198
60	♂♂	MZ		×			) (	864
61	♂♂	MZ		×			( )	81
62	♂♂	MZ	×				( )	1786
63	♂♂	DZ				×	) (	1361
64	♂♂	MZ		×			( )	3091
65	♂♂	MZ		×			( )	4150
66	♂♂	DZ		×			( )	3088
67	♂♂	DZ		×			—	2310
68	♂♂	DZ	×				( )	2816
69	♂♂	MZ		×			( )	2400
70	♂♂	MZ	×				( )	3186
71	♂♂	?			×		( )	3274
72	♂♂	?		×			( )	3057
73	♂♂	MZ	×				( )	148

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Tab. 1 *(continues)*. Yes – Yes

Survey Number	Sex	Zigosity	Activity and Performance				Begin. Sports Act.	Mendel Institute file Number
			A ≃	A ≃	A ≃	A ≠		
			B ≃	B ≃	B ≠	B o		
			C ≃	C ≠	C o	C o		
74	♂♂	MZ	×				( )	1804
75	♂♂	DZ		×			) (	2705
76	♂♂	DZ		×			) (	1805
77	♂♂	DZ			×		) (	419
78	♂♂	DZ				×	—	2026
79	♂♂	DZ				×	( )	1930
80	♂♂	DZ				×	—	2220
81	♂♂	DZ				×	( )	2830
82	♂♂	DZ		×			( )	3502
83	♂♂	DZ				×	) (	2784
84	♂♂	MZ				×	) (	2732
85	♂♂	DZ			×		) (	2147
86	♂♂	MZ				×	) (	110
87	♂♂	?				×	—	089
88	♂♂	MZ		×			( )	1779
89	♂♂	?				×	( )	1990
90	♂♂	MZ				×	—	2168
91	♂♂	DZ				×	—	1277
92	♂♂	DZ		×			( )	1644
93	♂♂	DZ		×			( )	3034
94	♂♂	DZ				×	—	1806
95	♂♂	DZ				×	) (	3296
96	♂♂	DZ			×		—	2152
97	♂♂	MZ		×			( )	1531
98	♂♂	DZ			×		—	3148
99	♂♂	DZ			×		—	3172
100	♂♂	MZ			×		( )	3252
101	♂♂	MZ			×		—	3147
102	♂♂	DZ		×			) (	3251
103	♂♂	DZ	×				( )	3007
104	♂♂	MZ	×				—	333
105	♂♂	MZ		×			) (	3197
106	♂♂	DZ			×		) (	3173
107	♂♂	MZ		×			( )	1858
108	♂♂	DZ				×	—	2376
109	♂♂	MZ	×				((	128
110	♂♂	DZ				×	))	1868
111	♂♂	DZ		×			) (	1367

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Tab. 1 *(continues)*. Yes – Yes

Survey Number	Sex	Zygosity	Activity and Performance				Begin. Sports Act.	Mendel Institute file Number
			A ≃	A ≃	A ≃	A ≠		
			B ≃	B ≃	B ≠	B o		
			C ≃	C ≠	C o	C o		
112	♂♂	DZ				×	) (	1132
113	♂♂	MZ	×				) (	2951
114	♂♂	DZ		×			( )	2169
115	♂♂	DZ		×			—	1250
116	♂♂	DZ			×		( )	3731
117	♂♂	MZ				×	—	1340
118	♂♂	DZ			×		) (	5819
119	♂♂	DZ			×		( )	2252
120	♂♂	DZ		×			( )	2322
121	♂♂	?	×				( )	2709
122	♂♂	DZ				×	( )	5676
123	♂♂	DZ		×			) (	576
124	♂♂	MZ		×			( )	71
125	♂♂	DZ			×		—	266
126	♂♂	DZ			×		( )	1956
127	♂♂	MZ		×			( )	1918
128	♂♂	MZ		×			) (	38
129	♂♂	DZ		×			) (	2780
130	♂♀	DZ				×	) (	3279
131	♂♀	DZ				×	—	1347
132	♂♀	DZ			×		( )	2801
133	♂♀	DZ			×		—	1871
134	♂♀	DZ				×	—	2144
135	♂♀	DZ			×		—	3078
136	♂♀	DZ				×	—	3876
137	♂♀	DZ			×		( )	2995
138	♂♀	DZ				×	) (	1656
139	♂♀	DZ				×	—	19
140	♂♀	DZ			×		—	77
141	♂♀	DZ			×		—	188
142	♂♀	DZ				×	—	2552
143	♂♀	DZ			×		) (	1283
144	♂♀	DZ				×	—	3165
145	♂♀	DZ			×		) (	3222
146	♂♀	DZ			×		) (	1384
147	♂♀	DZ				×	) (	3137
148	♂♀	DZ		×			—	1702
149	♂♀	DZ		×			) (	2540

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Tab. 1 *(continues)*. Yes – Yes

Survey Number	Sex	Zygosity	Activity and Performance				Begin. Sports. Act.	Mendel Institute file Number
			A ≃	A ≃	A ≃	A ≠		
			B ≃	B ≃	B ≠	B o		
			C ≃	C ≠	C o	C o		
150	♂♂♀	DZ		×			( )	1458
151	♂♂♀	DZ			×		) (	3985
152	♂♂♂	DZ				×	) (	3189
153	♂♂♂	DZ		×			—	3742
154	♂♂♂	MZ	×				( )	2316
155	♂♂♂	MZ	×				( )	2305
156	♂♂♂	MZ		×			( )	1243
157	♂♂♂	DZ		×			) (	2091
158	♂♂♂	MZ	×				( )	1566
159	♂♂♂	DZ				×	—	—
160	♂♂♂	MZ	×				( )	5711
161	♂♂♂	DZ				×	—	2112
162	♂♂♂	?				×	( )	—
163	♂♂♂	?	×				) (	—
164	♂♂♂	DZ				×	) (	—
165	♂♂♂	?				×	) (	—

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Tab. 2. Yes – No

Survey Number	Sex	Zygosity	Sports. act. *		Mendel Institute file Number
			proposit.	cotwin	
1	♂♀	DZ	2	0	509
2	♂♀	DZ	2	0	381
3	♂♀	DZ	1	0	3307
4	♂♀	DZ	2	0	725
5	♂♀	DZ	3	0	2845
6	♂♀	DZ	2	0	1659
7	♂♀	DZ	1	0	1491
8	♂♀	DZ	2	0	1873
9	♂♀	DZ	1	0	2875
10	♂♀	DZ	3	0	2637
11	♂♀	DZ	2	0	3522
12	♂♀	DZ	1	0	3668
13	♂♀	DZ	3	0	3470
14	♂♀	DZ	2	0	3764
15	♂♀	DZ	2	0	1619
16	♂♀	DZ	2	0	5211
17	♂♀	DZ	3	0	34
18	♂♀	DZ	2	0	75
19	♂♀	DZ	3	0	5456
20	♂♀	DZ	2	0	1928
21	♂♀	DZ	1	0	1595
22	♂♀	DZ	3	0	2010
23	♂♀	DZ	3	0	2167
24	♂♀	DZ	1	0	2186
25	♂♀	DZ	3	0	—
26	♂♀	DZ	2	0	1476
27	♂♀	DZ	3	0	1244
28	♂♀	DZ	2	0	1609
29	♂♀	DZ	3	0	1396
30	♂♀	DZ	2	0	2672
31	♂♀	DZ	3	0	2497
32	♂♀	DZ	3	0	1879
33	♂♂	DZ	2	0	310

Tab. 2 *(continues)*. Yes – No

Survey Number	Sex	Zygosity	Sports. act.		Mendel Institute file Number
			proposit.	cotwin	
34	♂♂	DZ	3	0	89
35	♂♂	DZ	1	0	—
36	♂♂	?[1]	0	3	3848
37	♂♂	DZ	2	0	1759
38	♂♂	MZ	2	0	2138
39	♂♂	DZ	3	0	2888
40	♂♂	DZ	3	0	2412
41	♂♂	DZ	1	0	1478
42	♂♂	DZ	2	0	1987
43	♂♂	DZ	3	0	18
44	♂♂	DZ	0	3	47
45	♂♂	?	3	0	—
46	♂♂	DZ	3	0	1810
47	♂♂	?	2	0	1269
48	♂♂	DZ	2	0	2650
49	♂♂	DZ	2	0	585
50	♂♂	DZ	0	2	1480
51	♂♂	?	2	0	—
52	♂♂	MZ	3	0	1864
53	♂♂	?	3	0	—
54	♂♂	MZ	3	0	2666
55	♂♂	MZ	3	0	2328
56	♂♂	DZ	2	0	5450
57	♂♂	DZ	2	0	1746
58	♂♂	?	3	0	—
59	♂♂	DZ	3	0	2115
60	♂♂	DZ	2	0	1246
61	♂♀	DZ	3	0	1964
62	♂♀	DZ	3	0	1731
63	♂♀	DZ	3	0	1943
64	♂♀	DZ	0	1	1479
65	♂♀	DZ	2	0	3154
66	♂♀	DZ	2	0	2266

* Numbers 1, 2 and 3 of this column refer to the data given by the questionnaire for the twin practicing sport:

1. When only the kind of the sport practiced by the twin is known;
2. When sport, specialty or individual role are known;
3. When sport, specialty or individual role, and titles obtained are known.

0 (zero) indicates the twin not practicing sports.

Tab. 3. No – No

Survey Number	Sex	Zygosity	Mendel Institute file Number
1	♂♂♀	DZ	2037
2	♂♂♀♀	DZ	—
3	♂♂♀♀♀	DZ	2730
4	♂♂♀♀♀♀	DZ	2648
5	♂♂♂♂	MZ	1801
6	♂♂♀♀♂	DZ	2158
7	♂♂♂♂	DZ	3404
8	♂♂♂♂	DZ	3481
9	♂♂♀♀♂	DZ	138
10	♂♂♂♀♀	MZ	2426
11	♂♂♂♀♀	DZ	3654
12	♂♂♂♂	?	1655
13	♂♂♂♀♀	DZ	1724
14	♂♂♂♂	MZ	2254
15	♂♂♂♂	MZ	1255
16	♂♂♂♂	MZ	1976
17	♂♂♂♂	?	711
18	♂♂♂♂	MZ	2151
19	♂♂♂♂	DZ	2202
20	♂♂♂♂	MZ	1510
21	♂♂♀♀♀	DZ	1980
22	♂♂♀♀♀	?	1698
23	♂♂♀♀♀	DZ	2195
24	♂♂♀♀♀	DZ	1741
25	♂♂♂♂	DZ	1787
26	♂♂♀♀♂	DZ	1902
27	♂♂♂♂	MZ	1631
28	♂♂♂♂	MZ	85
29	♂♂♂♂	DZ	1278
30	♂♂♂♂	MZ	3190
31	♂♂♀♀♂	DZ	—
32	♂♂♂♂	DZ	1492
33	♂♂♂♀♀	DZ	2913
34	♂♂♂♂	DZ	3693
35	♂♂♀♀♀	DZ	2056
36	♂♂♀♀♀	DZ	3598
37	♂♂♀♀♂	DZ	1487
38	♂♂♂♂	MZ	3603
39	♂♂♂♂	MZ	446
40	♂♂♂♂	DZ	8141
41	♂♂♀♀	DZ	1995
42	♂♂	DZ	071

Tab. 3 *(continnes)*. No – No

Survey Number	Sex	Zygosity	Mendel Institute file Number
43	♂♂	MZ	2060
44	♂♂♀♀	DZ	3038
45	♂♂♂♂	DZ	2290
46	♂♂♂♂	DZ	3196
47	♂♂♀♀♂	DZ	1451
48	♂♂♂♂	DZ	2490
49	♂♂♂♂	MZ	1366
50	♂♂♂♂	MZ	5007
51	♂♂♂♂	DZ	1257
52	♂♂♂♀♀	DZ	3022
53	♂♂♂♀♀	DZ	—
54	♂♂♂♂	DZ	3110
55	♂♂♂♂	MZ	2485
56	♂♂♂♂	DZ	2390
57	♂♂♂♂	?	2166
58	♂♂♀♀♀♀	DZ	—
59	♂♂♀♀♀♀	DZ	—
60	♂♂♀♀♀♀	DZ	—
61	♂♂♂♀♀	DZ	3350
62	♂♂♀♀♀	DZ	—
63	♂♂♀♀♀	DZ	—
64	♂♂♀♀♀	DZ	—
65	♂♂♂♀♀	?	2003
66	♂♂♂♀♀	DZ	2754
67	♂♂♂♀♀	MZ	2087
68	♂♂♂♀♀	DZ	—
69	♂♂♂♂♂	MZ	2464
70	♂♂♂♂	?	—
71	♂♂♂♂	DZ	2135
72	♂♂♂♂	?	2210
73	♂♂♂♀♀	DZ	—
74	♂♂♂♂	DZ	3002 TV bis
75	♂♂♂♂	MZ	1373
76	♂♂♂♂	MZ	2347
77	♂♂♂♂	MZ	50
78	♂♂♀♀♀	DZ	—
79	♂♂♂♂	DZ	1870
80	♂♂♀♀♀	DZ	—
81	♂♂♀♀♀	DZ	—
82	♂♂♀♀♀	DZ	2835
83	♂♂♀♀♀	DZ	1436
84	♂♂	MZ	9

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Tab. 3 *(continues)*. No – No

Survey Number	Sex	Zygosity	Mendel Institute file Number
85	♂♂	DZ	1379
86	♂♀	DZ	3074
87	♂♀	DZ	—
88	♂♀	DZ	—
89	♂♂	MZ	1285
90	♂♀	DZ	—
91	♂♀	DZ	—
92	♂♂	?	2136
93	♂♀	DZ	—
94	♂♀	DZ	—
95	♂♂	MZ	4073
96	♂♀	DZ	—
97	♂♂	MZ	3192
98	♂♂	DZ	2072
99	♂♂	DZ	65
100	♂♂♀	(Triplets 2 MZ 1 DZ)	2619
101a	♂♂	DZ	—

Tab. 3 *(continues)*. No – No

Survey Number	Sex	Zygosity	Mendel Institute file Number
102	♂♀	DZ	2253
103	♂♀	DZ	2396
104	♂♂	DZ	2762
105	♂♀	DZ	3212
106	♂♂	DZ	2465
107	♂♂	?	1412
108	♂♀	DZ	3942
109	♂♂	DZ	2898
110	♂♂	DZ	2142
111	♂♀	DZ	3370
112	♂♀	DZ	2603
113	♂♀	DZ	3754
114	♂♂	DZ	1496
115	♂♀	DZ	2460
116	♂♀	DZ	2075
117	♂♂	DZ	1498
118	♂♂	DZ	1318
119	♂♂	MZ	64
120	♂♀	DZ	1723

Tab. 4

	Number of cases		Yes — Yes		Yes — No		No — No	
	f	%	f	%	f	%	f	%
MZ	92	26	61	37	4	6	27	23
DZ	227	65	88	53	56	85	83	69
Unknown Zygosity	32	9	16	10	6	9	10	9
Total	351	100	165	100	66	100	120	100

milarity criteria, and to the possibility of operator mistakes in interpreting the answers.

More eloquent results are obtained by analyzing the answers of Group I (Yes-Yes.)

In order to properly analyze MZ and DZ twins who affirmed that they both practice sports, we have established a further scale of criteria of similarity (cfr. Tab. 5). The methodology we adopted was the following: we established four criteria of similarity: the first one (A), more general, concerned similarity as to the kind of sports practiced

(for instance, heavy or light athletics, football, etc.); the second (B), concerned the specialty practiced within a given sport (for instance walking, running, jumping) and (in the case of team-sports) the specialty role (back, goalkeeper, etc.); the third criterium (C), concerned performance similarity on the basis of the results obtained; a further criterium, not ranked with previous ones, and which we are not going to discuss here, concerned the starting-age similarity in the various sports.

The result of this analysis is shown in Table 5, which demonstrates that the simi-

Tab. 5. Analysis of the answers of Group 1 (Yes – Yes)

	A B C ≠ o o		A B C ~ ≠ o		A B C ~ ~ ≠		A B C ~ ~ ~		
	f	%	f	%	f	%	f	%	
MZ	6	17	4	13	25	41	26	70	
DZ	25	69	23	74	32	52	8	22	
Unknown Zygosity	5	14	4	13	4	7	3	8	
Totals	36	100	31	100	61	100	37	100	165

A Kind of sport B Individual role in the kind of sport C Titles obtained

larity-dissimilarity ratio in the two series of twins follows peculiar, i. e. opposite patterns.

In fact, in MZ twins, the lowest percentages belong to groups presenting dissimilarity as to kind of sports practiced, or as to individual role within the same kind of sport; while the highest percentage is found where there is similarity as to kind of sport, as to specialty within the kind of sport, and as to performance. It is worth stressing that the latter percentage is very high (70%).

DZ twins, on the contrary, present the highest percentage (69%) in the group of cotwins with the lowest similarity as to sports, and the lowest percentage (22%) in the group of cotwins with the highest similarity as to sports.

The results of these analyses are illustrated by the graphs in Fig. 5.

The results provided by the twin-method are the most classical for demonstrating the existence of a hereditary component in a given biological phenomenon.

Among MZ twins we also note two particular phenomena (cfr. Tab. 6). The first one, appearing in 5 fully concordant pairs, consists in the geometrical symmetry of the roles twins undertake in team competitions. In the observed pairs, for instance, one twin was a right winger and his cotwin a left winger, or other equivalent roles, in football teams; or they were respectively back or forward, right or left in a basketball team (Pairs 13, 44, 49, 51, 55).

The second phenomenon, observed in certain MZ twins discordant as to their

role, is even more interesting. In fact, in this case, if one twin is a forward and his cotwin a back, they tend to undertake in the two teams roles enabling them to play in unbroken contact such as, for instance, left winger — right back, as if creating a particular intra-pair competition within the general team competition (Pairs 1, 26, 38).

We are thus in a position to confirm, through this extensive twin analysis, the hereditary basis in sports activity in man. Theoretical and practical conclusions may derive from this statement, which I will not undertake to discuss widely in the present paper.

From the theoretical point of view we may assume that the specific sports genotype, being composed of normal character factors, is transmitted as a dominant. This is what I have been maintaining for some years, and Grebe holds the same opinion.

From the practical point of view we may state that the hereditary constitutional component gives a clear picture of the importance of exogenous factors, such as training, which may only produce results within the variability allowed by the genotype. We may also stress the importance of family investigations in recruiting new sportsmen and in orientating young men towards specialty and individual role in sports.

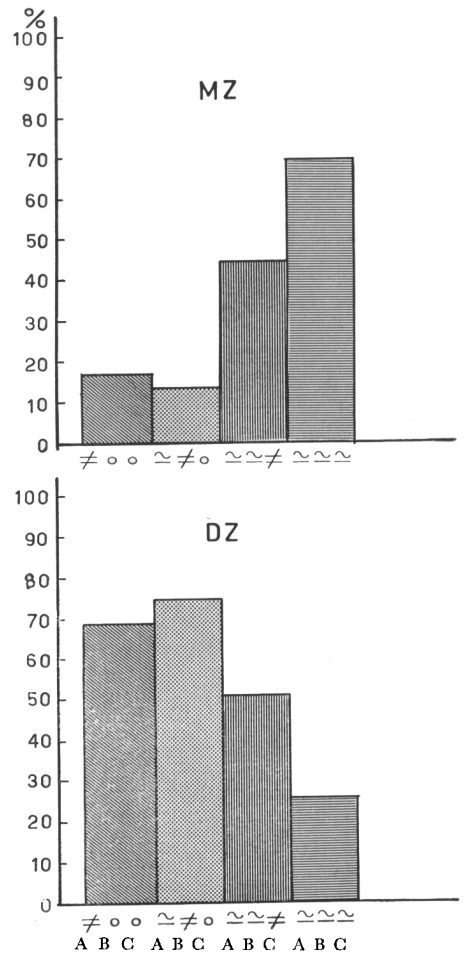

Fig. 5. Graphic of percentages as found in Table 5

Tab. 6

Survey Number	Symmetry
13	Left winger – right winger (Football)
44	right half-winger – left half-winger (Football)
49	left half-back – right half-back (Football)
51	left half-winger – right half-winger (Football)
55	left back – right back (Basketball)
1	right winger – left back (Football)
26	right forward – left back (Basketball)
38	right winger – left back (Football)

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Riassunto

L'A., elaborando i dati dedotti da 351 schede di una inchiesta rivolta a 1.241 coppie gemellari, dimostra il differente comportamento delle coppie MZ e DZ nei riguardi del fenomeno sportivo. Con un primo criterio di analisi, relativo alla pratica dello sport in genere, si constata infatti che il caso di un gemello che pratica uno sport e del cogemello che non pratica nessuno sport corrisponde al 6% nei gemelli MZ e all'85% nei gemelli DZ. Un secondo criterio di analisi riguardava il tipo di sport nelle coppie in cui entrambi i gemelli sono sportivi e qui si è potuto constatare che il medesimo tipo di sport è più frequente nelle coppie MZ che in quelle DZ. Con un terzo criterio riguardante il ruolo individuale ed il rendimento sportivo, l'A. ha potuto stabilire che la distribuzione delle coppie DZ ha, rispetto alla concordanza, un andamento inverso a quello delle coppie MZ. L'A. conclude che l'attività sportiva, oltre alle influenze esogene (ambiente sociale, allenamento, livello economico ecc.) è certamente condizionata anche da fattori genotipici ereditari.

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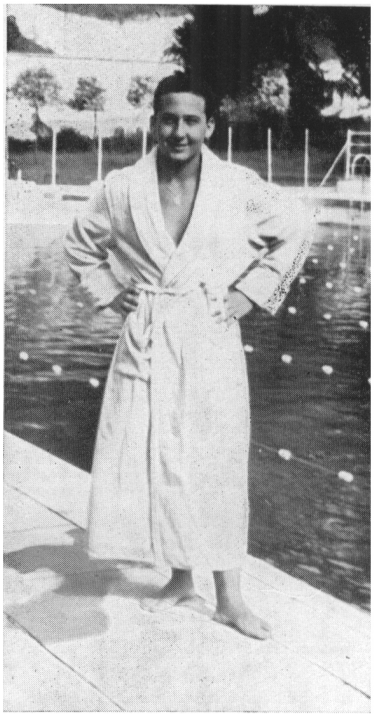
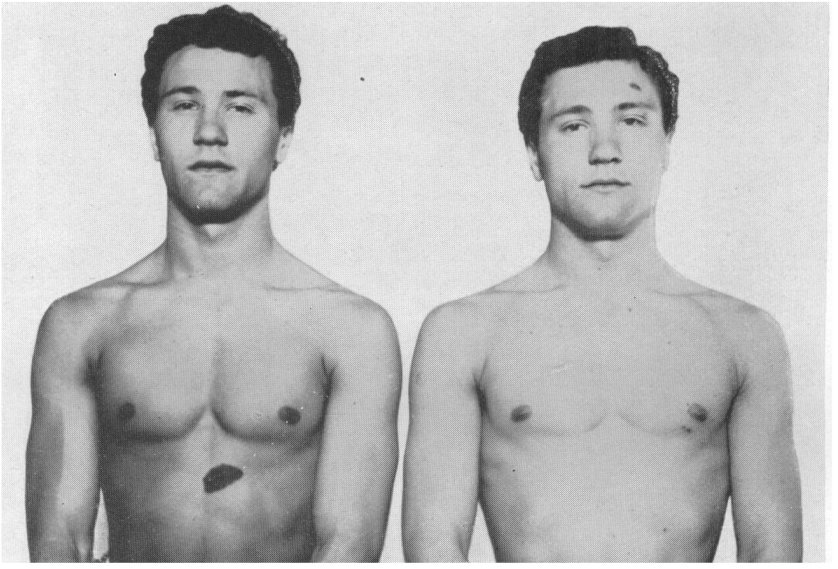
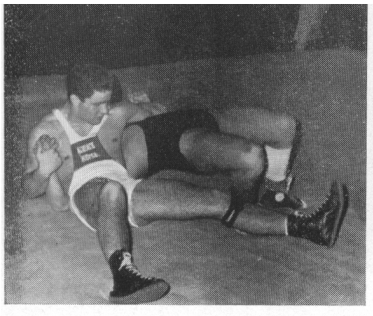
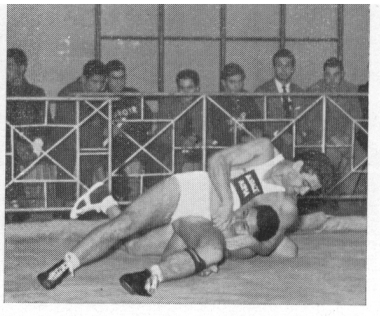


MZ pair no. 130.
Vittorio and Ettore F. took part in the Piedmont regional *Swimming* competitions for deaf-mutes.



MZ pair no. 217.
Alessandro and Bruno P. II Series Italian *Greco-Roman wrestling* champions.





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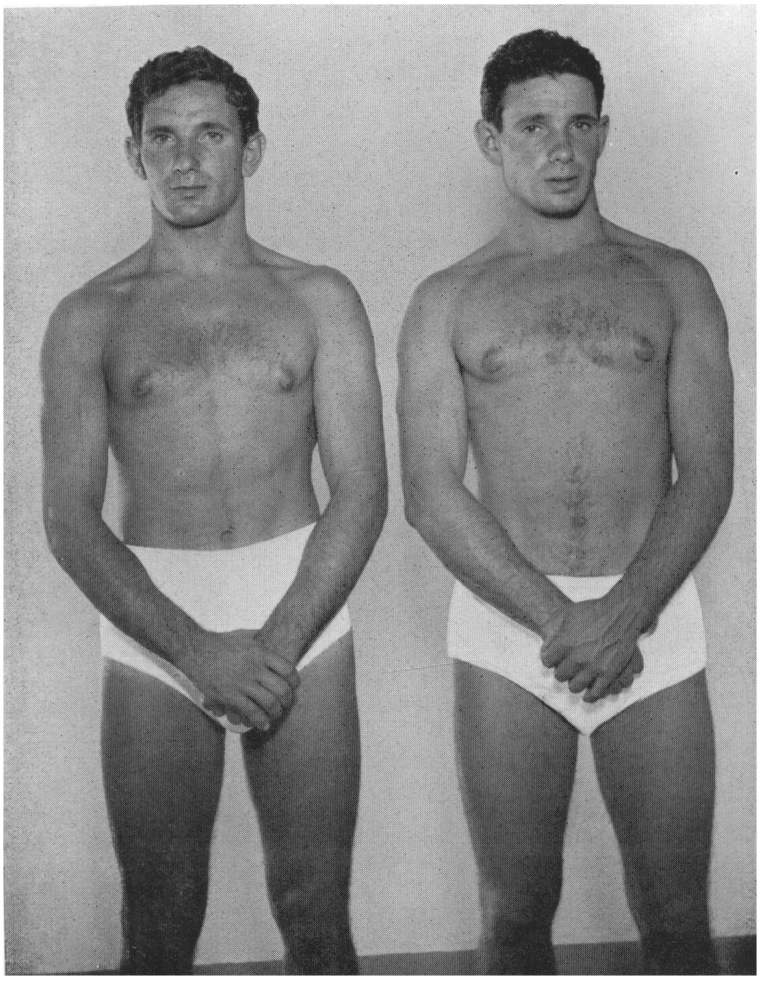
MZ pair no. 1605.
Romano and Graziano G. *Cycling* winners of many regional competitions.

MZ pair no. 1959.
Aldo and Vittorio S. *Canoeing*.



MZ pair no. 5225.
Carlo and Giuseppe L. *Swimming* and *Canoeing* winners of many military local competitions.

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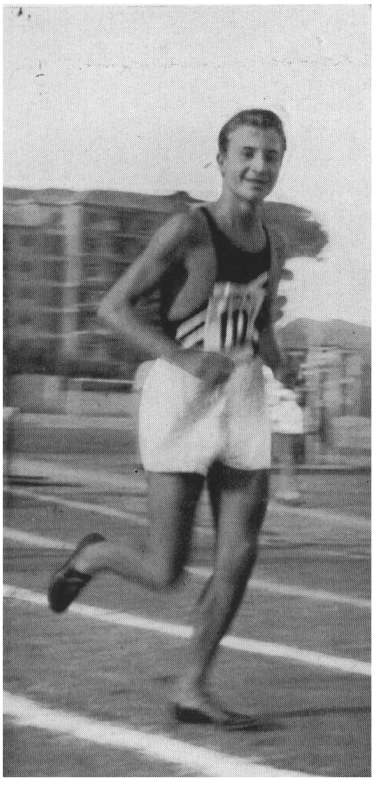
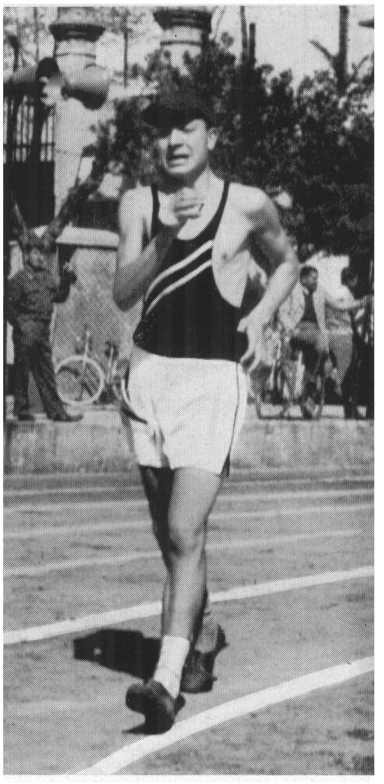
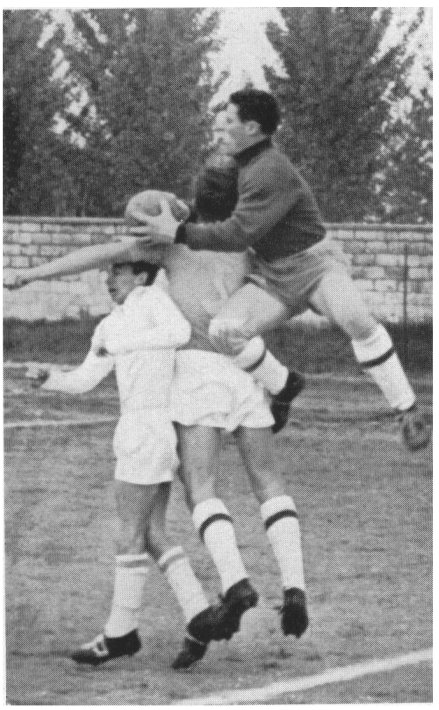


(a)

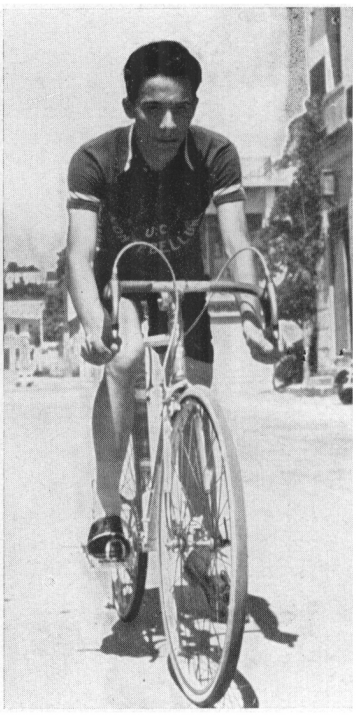


(b)

DZ pair, no. 3175.
B. (*a*) Giuseppe, winner of several *running* competitions (3,000 mts). and (*b*) Paolo, regional *walking* champion (10 Kms.).



(a)



(b)

DZ pair, no. 3189.
G. (*a*) Francesco, *Goalkeeper* of the « Vitt », winning team of *football* regional competitions; and (*b*) Giuseppe, took part in various regional *cycling* competitions.

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RÉSUMÉ

L'A., par l'élaboration des données déduites de 351 fiches d'une enquête adressée à 1.241 couples gémellaires, démontre la différence de comportement chez les couples MZ et DZ en ce qui concerne le phénomène sportif. Par un premier critérium d'analyse, relatif à la pratique du sport en général, l'on constate, en effet, que le cas d'un jumeau qui pratique du sport tandis que l'autre n'en pratique pas correspond au 6% pour les couples MZ et au 85% pour les DZ. Un deuxième critérium d'analyse concernait le type de sport pratiqué par les couples dont tous les deux jumeaux étaient sportifs. La concordance pour le type de sport pratiqué avait une fréquence plus élevée pour les jumeaux MZ que pour les D.Z. Un troisième critérium concernant la spécialité sportive et la performance a permis à l'Auteur de démontrer que la distribution des couples DZ, en ce qui concerne la concordance, est opposée à celle des couples MZ. L'A. conclut que l'activité sportive, à part les influences exogènes (milieu social, entraînement, niveau économique, etc.) est certainement conditionnée aussi par des facteurs génotypiques héréditaires.

SUMMARY

After elaborating the data supplied by 351 questionnaires of a survey addressed to 1,241 twin-pairs, the Author shows differences in the behavior of MZ and DZ twin-pairs as to the sports phenomenon. By a first criterium of analysis, relative to sports practice in general, intra-pair dissimilarity is found to correspond to 6% in the case of MZ and to 85% in the case of DZ twin pairs. A second criterium of analysis concerned the kind of sport practiced by pairs concordant as to sports practice in general: the observed concordance as to the kind of sport practiced was more frequent in MZ then in DZ twin-pairs. By a third criterium concerning individual role and performance, the Author has been able to demonstrate that the distribution of DZ pairs, as to concordance, follows opposite patterns than that of MZ pairs. The Author concludes that sports activity, besides exogenous influences, (social environment, training, economic level etc.) is certainly also conditioned by genotypic, hereditary factors.

ZUSAMMENFASSUNG

Nachdem er eine Ausarbeitung der Angaben von 351 Fragebogen einer Untersuchung über 1.241 Zwillingspaaren gemacht hat, beweist der Verfasser die Verschiedenheit von EZ und ZZ Zwillingspaaren im spörtlichen Phänomen. Mit einem ersten Sportsübung-im allgemeinen-betreffenden Analyskriterium findet man eine Diskordanz in der Sportsübung im allgemeinen innerhalb eines Paares von 6% für EZ und 85% für ZZ Zwillingspaaren. Ein zweites Kriterium betraf die Art Sport in den Paaren mit beiden spörtlichen Zwillingen: Konkordanz war häufiger in EZ als in ZZ Zwillingspaaren. Mit einem dritten eigener Rolle- und Performance-betreffenden Kriterium konnte der Verfasser festsetzen dass die Verteilung von ZZ Zwillingspaaren, in Vergleich zur Konkordanz, umgekehrt als jene der EZ ist. Der Verfasser kommt zum Schluss dass der Sport, ausser äusserlichen Einflüsse (Umgebung, Trainierung, u. s. w.) sicherlich auch erbbedingt ist.

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