CONCORDANCE OF SMOKING HABITS IN
MONOZYGOTIC AND DIZYGOTIC TWINS

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1. PROCEDURE

THE procedure of ascertaining whether the pairs in a series of dizygotic (*i.e.* two-egg) twins differ in respect of some characteristic significantly more often than the pairs in a series of monozygotic (one-egg) twins has frequently been used in genetic studies as a means of ascertaining whether the characteristic being studied is influenced by inherited factors. Sir Ronald A. Fisher suggested that this procedure should be used as a means of ascertaining whether there was objective evidence that the differences observable among mankind, as to whether they chose to smoke and, if so, in what form, were influenced to any important extent by hereditary factors. Frhr. von Verschuer very kindly agreed to co-operate in the experiment and made available for this purpose the list of adult male like-sex twins on the Register of Twins of the Munster Institute of Human Genetics. A questionnaire (reproduced in Appendix I) was prepared by Sir Ronald Fisher and answers to the questions were sought either by mail or personal interview. Sir Ronald Fisher subsequently invited us to prepare a detailed account of this survey and we therefore examined and analysed the completed questionnaires. We have also discussed various points arising from them with Frhr. von Verschuer, with his deputy, Dr G. Koch, and with Fraulein G. Neuhauser of the Institute's staff. We are most grateful to them all for their very kind and generous assistance.

The twins on the register of the Institute of Human Genetics are classified in three "lists"—namely, the Tübingen, Berlin and Frankfurt-am-Main lists—representing the centre at which each list was originally compiled. Each "list" has had a different history which is summarised below. The lists were inevitably suspended during the war, but contact with twins was re-established where possible after Frhr. von Verschuer took up his appointment with the Institute of Human Genetics at Münster.

(i) *The Tübingen list*

Details of the history and members of the Tübingen list up to the early 1950's are given by Frhr. von Verschuer (1954) in his monograph on the subject. The list was compiled during the years 1923-27 by Frhr. von Verschuer who, as a result of his interviews with the twins, came to know them all personally. Indeed, since he first came

in contact with some of them immediately after their birth, he became godfather to a number of them.

At the outset, Frhr. von Verschuer was interested mainly in adult monozygotic twins and this accounts for the predominance of older monozygotic twins in the Tübingen list. To compile the list of twins, Frhr. von Verschuer asked those twins, whom he came across, if they knew of other twins and he also asked hospitals and schools in the Tübingen area to co-operate by asking their patients and children respectively if they happened to have a twin. Where positive replies were obtained, Frhr. von Verschuer interviewed both twins. As a result of the personal contacts which he thus established with the twins, it proved easier to re-establish the Tübingen list of twins after the war than the other lists.

In the early 1950's, when the lists were re-established, Frhr. von Verschuer succeeded in renewing a co-operating relationship with 22 monozygotic and 11 dizygotic male like-sex pairs on the Tübingen list. By the time of the enquiry conducted on behalf of Sir Ronald Fisher (Spring 1957), the numbers of these had been reduced to 19 monozygotic and 7 dizygotic pairs. The questionnaire compiled by Sir Ronald Fisher was sent to all of them. Completed questionnaires were returned by both members of 16 monozygotic and 5 dizygotic pairs; both members of 3 monozygotic and 2 dizygotic pairs did not reply. The replies received from one monozygotic pair and one dizygotic pair on the Tübingen list were not used as in each pair one of the brothers had died prior to the enquiry. The Tübingen list therefore contributed 15 monozygotic and 4 dizygotic pairs to the enquiry.

The replies of all the twins are summarised in Appendix II. In this appendix each pair is given a code number consisting of the letters "M" or "D" to indicate monozygotic or dizygotic, the letters "T", "B" or "F" to indicate the Tübingen, Berlin or Frankfurt list, and a serial number. The two members of a pair have the same serial number and are distinguished by the addition of "a" or "b".

(ii) *The Berlin list*

The Berlin list of twins was collected by Frhr. von Verschuer during the years 1927-42, when he was at the Kaiser-Wilhelm-Institute for Anthropology, Human Heredity and Eugenics in Berlin, through an approach to hospitals and schools as at Tübingen. The history of the Berlin list of twins has been described in a paper by Dr G. Koch (1957) of the Institute of Human Genetics at Münster. At the time Dr Koch wrote his paper (1955-56), the list included 33 monozygotic and 33 dizygotic male like-sex pairs at least one member of whom was then living in Western Berlin. Sir Ronald Fisher's request came at a time when Dr Koch was planning to visit the Berlin twins personally in order to obtain a number of other details about them and Sir Ronald's questions were therefore incorporated in the wider enquiry.

Dr Koch wrote to 21 of the monozygotic pairs and 11 of the dizygotic pairs in Berlin in order to arrange appointments with them to obtain this information at a personal interview. In selecting the twins for this purpose, Dr Koch omitted pairs in which one or both members had died or had not answered a previous communication.

Information about smoking habits was obtained from both members of all 21 monozygotic and 11 dizygotic pairs and is summarised in Appendix II. All these replies are used in this analysis.

(iii) *The Frankfurt-am-Main list*

The Frankfurt-am-Main list was compiled through the Institute of Hereditary Biology at the University of Frankfurt during the years 1935-42. For this list, the main source of information was the Frankfurt Register of Births and this was used in an attempt to obtain as complete a collection as possible of both monozygotic and dizygotic twins. Details of the history of the list are described in a monograph by Dr B. T. Duis (1956). As Dr Duis records, the male like-sex twins on the Frankfurt list in 1952 consisted of 59 monozygotic and 85 dizygotic pairs. In an enquiry conducted in 1952-53, it was found that at least one member of 13 male like-sex monozygotic pairs and 41 male like-sex dizygotic pairs was not living sufficiently close to Frankfurt to take part in that enquiry. These pairs were also excluded from the enquiry conducted on behalf of Sir Ronald Fisher, and after allowing for deaths and a few other changes, Sir Ronald Fisher's questionnaire was sent to 44 male like-sex monozygotic twins and 46 male like-sex dizygotic twins. There was less personal contact with the twins on the Frankfurt list than with those on the other two lists and while information from 4 of the monozygotic pairs was obtained by personal interview, communication with the 86 other pairs was only by correspondence. There was therefore a considerable amount of non-response. One member of 4 monozygotic and 10 dizygotic pairs and both members of 24 monozygotic and 19 dizygotic pairs did not answer. Completed answers were therefore obtained from both members of 16 monozygotic and 17 dizygotic pairs and the details are summarised in Appendix II. All are used in this enquiry. In the opinion of Frhr. von Verschuer, there are unlikely to be other reasons than personal disinclination to co-operate underlying the non-response. Dr Duis (1956) has also commented on the difficulty of obtaining response from members of the Frankfurt list.

The twins on all three lists were classified as monozygotic or dizygotic primarily on the basis of morphological characteristics. It was also possible to obtain information about the blood groups of many of the pairs, and in all cases complete similarity was found between the blood groups of the twins identified as monozygotic on the basis of morphological characteristics. Details of the blood groups, where available, are listed in Appendix II.

All twins were thus classified as monozygotic or dizygotic a long time

prior to the time at which they were asked for information about their smoking habits.

2. SMOKING HABITS OF THE TWINS

Each person in the enquiry was asked certain questions about his smoking habits at the time of the enquiry and about his past smoking history. The main particulars about his smoking habits provided by each informant are summarised in Appendix II. For a few individuals, the information was provided by someone other than the person to whom the questionnaire was addressed, and where this occurred the fact is noted in Appendix II. In all such cases, we examined whether the informant was likely to be in a position to supply accurate information and we found no reason for rejecting the information as likely to be inaccurate. Where the two twins replied in identical words, we examined the handwriting on the original replies to see if one had replied for both and we invariably found the writing to be different.

As might be expected, the informants differed widely in their smoking habits: there were relatively few classes of smoker that were not represented. For the purpose of classifying the informants according to their smoking habits, we have adopted what, we hope, are broad common-sense distinctions. The main principles of classification adopted by us are the following:—

1. The non-smokers at the time of completing the questionnaire were first distinguished from those who smoked to some extent.

2. Those who were non-smokers at the time of the enquiry were divided into those who had never smoked and those who were ex-smokers, and the latter were sub-divided according to the type of product they had formerly smoked. There were insufficient ex-smokers to justify sub-division according to the amount previously smoked or the date or age of giving up smoking.

3. Those who were smokers at the time of the enquiry were divided between regular smokers and occasional smokers. For this purpose, an occasional smoker was defined as a person who smoked less than one cigarette or one pipe a day or not more than one cigar a week (*i.e.* having a weekly consumption averaging not more than 6 cigarettes or 6 pipes or one cigar). Anyone smoking more than this was considered to be a regular smoker.

4. The regular smokers were divided into those who smoked one type of product (*i.e.* cigarettes or a pipe or cigars) exclusively or predominantly and those who smoked more than one type of product (*i.e.* mixed smokers). A smoker was considered to smoke one type of product predominantly if his consumption of other types of products was only "occasional"—*i.e.* did not average more than 6 cigarettes or 6 pipes or one cigar a week as the case might be.

5. Regular cigarette smokers were divided into smokers of packeted (*i.e.* machine-made) cigarettes, smokers who rolled their own cigarettes (*i.e.* hand-rolled cigarettes) or both.

6. Cigar smokers were divided into cigar or stumpen* smokers respectively. Stumpen smokers were defined as those who specifically mentioned stumpen in their replies although it was appreciated that, as questions had not been asked about stumpen as such, some smokers of stumpen might have replied in terms of the generic heading of cigars. The consumption of cigarillos, not uncommon in Germany, was not specifically asked about nor specifically mentioned in replies.

* Stumpen are cigars of slightly shorter length generally having a rectangular cross-section.

7. Mixed smokers were divided into appropriate groups.

8. Smokers of packeted cigarettes were sub-divided into three broad consumption levels. There were insufficient smokers of the other types of product to justify sub-division by level of consumption, and in particular there was the possibility that some of the quantities mentioned by cigar smokers really referred to stumphen or cigarillos.

9. Six informants supplied insufficient information to enable them to be completely classified.

If the 168 men whose replies have been used in this enquiry, are classified according to their smoking habits, using the foregoing principles, the following figures are obtained :—

TABLE 1
Smoking habits of twins in the enquiry

Classification code no.	Classification	Monozygotic individuals	Dizygotic individuals
	<i>Non-smokers</i>		
1	Non-smokers who had never smoked .	21	17
	Non-smokers who are ex-smokers—		
2	(a) Non-smokers who formerly smoked cigarettes exclusively or predominantly	3	3
3	(b) Non-smokers who were ex-smokers of cigarettes and cigars, having formerly smoked both more than occasionally	1	...
4	(c) Non-smokers who were ex-smokers but did not specify the type of product previously smoked	2	3
	<i>Occasional smokers—</i>		
5	(a) of cigarettes	4	1
6	(b) of cigars	...	3
7	(c) of a pipe	...	1
8	(d) who did not specify the product usually smoked	...	1
	<i>Regular cigarette smokers—</i>		
	Packeted cigarette smokers—		
9	(a) very light smokers (less than 5 cigarettes a day)	7	3
10	(b) moderate cigarette smokers (5-24 cigarettes a day)	48	19
11	(c) heavy cigarette smokers (25 or more cigarettes a day)	1	...
12	Cigarette smokers who roll their own cigarettes	1	...
13	Smokers of both packeted and hand-rolled cigarettes	...	1
	<i>Regular stumphen and cigar smokers—</i>		
14	(a) Stumphen smokers	2	1
15	(b) Cigar smokers	7	3
16	<i>Regular pipe smokers</i>	1	2
	<i>Regular mixed smokers—</i>		
17	(a) Cigarettes and cigar smokers . .	3	...
18	(b) Cigarettes and pipe smokers . .	1	4
19	(c) Cigar or stumphen and pipe smokers .	2	2
	Total	104	64

3. THE CONCORDANCE OF SMOKING HABITS IN MONOZYGOTIC AND DIZYGOTIC TWINS

In classifying the twins according as the smoking habits of the members of a pair of twins are concordant or discordant, a number of questions arise when seeking to decide what constitutes similarity of habit. For example, should a man who has ceased to smoke cigarettes be considered as similar in habit to one who still smokes cigarettes or to a non-smoker or is he in a category by himself and dissimilar to both? Is an occasional smoker of cigarettes basically similar in habit to a non-smoker or to a regular but light cigarette smoker or does he differ from both? Corresponding difficulties also arise in deciding whether a smoker who smokes one type of product exclusively or predominantly (*i.e.* a second type of product only occasionally) is similar or dissimilar to a smoker who smokes both types of product more than occasionally.

There is no simple solution to such problems. All that can be done is to state clearly the bases of classification that have been adopted and to consider all reasonable alternative bases for classification. We have therefore considered a number of alternatives and since the details given in Appendix II are sufficient to enable any alternative classification to be considered, we set out below only the main alternative bases of classification that we have examined.

(i) *Concordance in respect of smoking in any form*

The first basis of comparison between the monozygotic and dizygotic twins was whether or not the informants were smokers. The theoretically clear-cut distinction between smokers and non-smokers was blurred by two marginal groups—those who were occasional smokers and those who formerly smoked but no longer were regular smokers at the time of the enquiry (*i.e.* the ex-smokers). Consequently, the informants were analysed on three different bases.

(a) *Analysis into smokers and non-smokers.* In this analysis, occasional smokers were treated as being smokers and ex-smokers as being non-smokers. Consequently, if the members of a pair of twins were *either* both present non-smokers (whether or not they were ex-smokers) *or* both present regular or occasional smokers, the pair were classified as “like” in their smoking habits. Otherwise, they were classified as “unlike”. This analysis gave the following results:

TABLE 2
Concordance in respect of smoking—Analysis 1

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	43	19
Unlike	9	13
Total	52	32

(b) *Analysis into regular smokers and others.* In this analysis, the ex-smokers and occasional smokers were treated as being non-smokers and smokers were taken to comprise only those who were regular smokers at the time of the enquiry. Consequently, if the members of a pair of twins were *either* both non-smokers, ex-smokers or occasional smokers *or* both present regular smokers, the pair were classified as "like" in their smoking habits. Otherwise, they were classified as "unlike". This analysis gave the following table :

TABLE 3
Concordance in respect of smoking—Analysis 2

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	43	17
Unlike	9	15
Total	52	32

(c) *Analysis into "smoked sometime" and "never smoked".* In this analysis, occasional smokers and ex-smokers were both treated as smokers. Consequently, if the members of a pair of twins were both *either* present or past regular or occasional smokers *or* had both never smoked, the pair were classified as "like" in their smoking habits. Otherwise, they were classified as "unlike". The analysis on this basis gave the following results :

TABLE 4
Concordance in respect of smoking—Analysis 3

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	47	25
Unlike	5	7
Total	52	32

(ii) *Analysis by type of product smoked*

The next step was to classify the twins according to the type of products smoked. As before, a number of alternative analyses had to be examined. The following analyses are in terms of the products smoked by the informants at the time they replied to the questionnaire. If ex-smokers were classified according to the type of products.

they last smoked, we would be classifying ex-smokers according to the products they smoked, say, 2, 5 or 10 years ago and current smokers according to the products which they smoked at the time of the enquiry and which might have differed from those smoked in past years. We do not know the precise types of product and quantities smoked by the twin of an ex-smoker at the time the latter gave up smoking.

(a) *Analysis by types of products and amounts smoked.* In table 1, in which the informants were classified according to their smoking habits, there were altogether 19 different categories. Two of these categories (namely, categories 4 and 8) were in the nature of residual categories into which informants were classified when they had provided insufficient information about types of products smoked or formerly smoked. This therefore left 17 detailed categories into which the informants were analysed when they provided full information about their smoking habits. Consequently, the two members of a pair of twins were considered as "like" if they both fell into the same one of these 17 groups. Otherwise they were classified as "unlike". This analysis yielded the following results :

TABLE 5
Concordance in respect of products smoked—Analysis 1

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	26	7
Unlike	24	21
Total	50	28

(b) *Analysis by types of products and amounts smoked (reduced number of categories).* Since it might be argued that the classification of informants into 17 categories for the purpose of the foregoing analysis overstated the distinctions that really existed between smokers, an analysis was therefore made in which the number of different categories was reduced. Thus, non-smokers, ex-smokers and occasional smokers were treated as being in effect non-smokers; smokers of packeted and hand-rolled cigarettes were treated as both being cigarette smokers and the distinction between the different levels of cigarette smokers was dropped. Consequently, the two members of a pair of twins were treated as "like" if they both fell into any one of the following 7 categories and "unlike" if they fell into different categories :

1. Non-smokers, ex-smokers and occasional smokers.
2. Cigarette smokers.
3. Stumpen or cigar smokers.
4. Pipe smokers.

5. Cigarette/cigar smokers.
6. Cigarette/pipe smokers.
7. Cigar or stumphen/pipe smokers.

The classification of each pair of twins on this basis gave the following results :

TABLE 6
Concordance in respect of products smoked—Analysis 2

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	33	11
Unlike	19	21
Total	52	32

(c) *Analysis by regularly-smoked products.* In the preceding analyses, those who smoked more than one type of product, except where the second product was smoked only occasionally (as already defined), were treated as being in a separate category from those who smoked only one of the products concerned—*i.e.* those who smoked both cigarettes and cigars were considered as falling into a different category from those who smoked only cigarettes. It might be argued, however, that the two members of a pair of twins who smoked the same product either by itself or in combination with some other product should be regarded as “like” in their smoking habits. In other words, if one twin smoked cigars *and* cigarettes and his brother smoked either cigarettes *or* cigars, the pair should be regarded as “like” in their smoking habits since they had in common a product which was either their main form of consumption of tobacco or at least a considerable proportion of their total consumption of tobacco. For this analysis, packeted and hand-rolled cigarettes were both regarded as cigarettes, and stumphen and cigars were both regarded as cigars; occasional smokers and ex-smokers were regarded as non-smokers. The twins were therefore re-classified on this basis and this gave the following results :

TABLE 7
Concordance in respect of products smoked—Analysis 3

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	38	15
Unlike	14	17
Total	52	32

(d) *Analysis on the basis of direct comparison between twins.* All the foregoing analyses of twins into pairs who were "like" or "unlike" in their smoking habits have in effect involved a two-stage classification procedure. That is, each informant was first classified into one of a number of categories according to his current and past smoking habits and then each informant was compared with his twin to see if the two had been put into smoking categories which, for the purpose of the particular analysis, were accepted as being the same. This procedure had the advantage that all the criteria required for classification of the twins were explicitly stated and that the exercise of personal judgment was almost wholly eliminated. The procedure was completely reproducible and every person repeating the classification should obtain the same result. On the other hand, this reproducibility and relative simplicity had two disadvantages. Firstly, it did not allow for cases in which concordance of smoking habit was doubtful. For each pair of twins, the decision was either "like" or "unlike" but there were, on any set of definitions, a number of pairs whose differences in smoking habits were marginal. Secondly, the procedure opened the door to certain "forced distinctions". Thus, a person smoking 6 cigarettes a week would be classified as an "occasional" smoker, while one smoking 8 cigarettes a week would be classified as a "regular" cigarette smoker. This example did not in fact occur—in the nearest actual case, one man smoked 5 cigarettes a week and his twin 21-35 cigarettes a week, but the possibility of "forced distinctions" remains inherent in the procedure. This type of forced distinction can, however, be met by introducing a larger degree of personal judgment in assessing the concordance of each pair's smoking habits. Further, the procedure adopted had the disadvantage that certain subtle differences were inevitably neglected. For example, in the case of ex-smokers no account has been taken of the extent to which external factors (in the form of major illness or medical advice) forced an otherwise willing smoker to give up smoking. In the case of occasional cigarette smokers, no account has been taken of the way in which they described themselves. Their descriptions of themselves were, in fact, about equally divided between "smoker" and "non-smoker". In the case of those who occasionally smoked a second type of product in addition to regular smoking of some other product, no account has been taken of the fact that the smoking of a small number of cigarettes by one who was normally a cigar or pipe smoker might be a very minor matter, which could be regarded as little more than a social gesture, whereas even the occasional smoking of a pipe, as a second form in which tobacco was taken, would be of much more significance since it at least involved the carrying of a pipe for the purpose. These distinctions can, of course, be introduced by specifying much more detailed bases of classification.

Sir Ronald Fisher has personally made an assessment of the concordance of the smoking habits of the members of each pair of

twins, taking such points into consideration and using the categories of "like", "doubtful" and "unlike", with the following results :

TABLE 8*
Concordance in respect of products smoked—Analysis 4

Smoking habits	Number of pairs	
	Monozygotic	Dizygotic
Like	34	11
Doubtful	6	4
Unlike	12	17
Total	52	32

* Information about two additional pairs of twins has become available since Sir Ronald Fisher (1958) made a preliminary analysis.

4. DISCUSSION

The three lists of twins are obviously not homogeneous. The lists were compiled at different times, in different ways, for different purposes, with a different degree of closeness of relationship to the compiler and with different histories of loss and wastage. In the present enquiry, the proportion of non-response was different in the different lists. In particular, the non-response was greatest in the Frankfurt list, although in this list it occurred in the two types of twins in practically equal proportions. Nevertheless, we see no reason why any of these differences should have produced bias or unrepresentativeness in the twins as far as smoking habits were concerned. Indeed, from the point of view of smoking habits, many of the twins were obtained on a "prospective" basis—*i.e.* they were recruited many years before they started to smoke.

The analysed questionnaires of the Tübingen list covered 15 monozygotic and 4 dizygotic male like-sex twins, the Berlin list 21 monozygotic and 11 dizygotic pairs and the Frankfurt list 16 monozygotic and 17 dizygotic pairs. The age distribution of the 84 pairs is shown in table 9 on page 428.

As will be seen, the monozygotic twins in the Tübingen and Berlin lists are older on the average than the dizygotic twins. The two sets of Frankfurt twins are more closely matched in age, doubtless as a result of the different method of recruitment already described. If, as may well happen, the passage of time encourages divergences in the smoking habits of twins, the difference in average age between the Tübingen and Berlin monozygotic and dizygotic twins would produce differences between the smoking habits of the monozygotic twins to a greater extent than between those of the dizygotic twins.

In this event, the preceding analyses would have understated the greater degree of concordance that exists in the smoking habits of monozygotic twins as compared with dizygotic twins.

TABLE 9
Age distribution of twins used in main analyses

Age	Monozygotic twins				Dizygotic twins			
	Tubingen	Berlin	Frankfurt	Total	Tubingen	Berlin	Frankfurt	Total
20-24	...	1	3	4	...	4	5	9
25-	...	7	5	12	...	4	4	8
30-	...	2	1	3	1	1	2	4
35-	2	3	1	6	2	1	2	5
40-	5	2	3	10	...	1	...	1
45-	5	1	...	6	...	...	2	2
50-	1	...	2	3	1	...	1	2
55-	1	2	...	3	...	...	...	...
60-	...	1	...	1	...	...	...	...
65-	...	1	1	2	...	...	...	...
70+	1	1	...	2	...	...	1	1
Total	15	21	16	52	4	11	17	32

On the other hand, it might be argued that the two members of the monozygotic pairs may be found more frequently to be living in close proximity to each other than dizygotic twins and that it is this proximity, rather than any genetic factor, which has produced the greater concordance that exists in the smoking habits of monozygotic twins. We therefore analysed the degree of proximity of residence of the twins, distinguishing the three lists. The results were as follows :

TABLE 10
Proximity of residence

List	Monozygotic twins			Dizygotic twins			Total
	Same address same town	Different address same town	Different town	Same address same town	Different address same town	Different town	
Frankfurt .	7	6	3	8	5	4	33
Tubingen .	3	4	8	1	1	2	19
Berlin .	8	8	5	7	2	2	32
Total .	18	18	16	16	8	8	84

Thus, in Frankfurt, the monozygotic twins and dizygotic twins were almost equally distributed between the three different categories of proximity ; elsewhere, the dizygotic twins were proportionately

found more frequently at the same address than the monozygotic twins. If proximity of residence encourages similarity of smoking habits, then greater concordance is to be expected between the dizygotic than the monozygotic pairs in the Tübingen and Berlin lists. There is, therefore, no evidence to suggest that the greater concordance of smoking habits in monozygotic pairs than in dizygotic pairs was due to more frequent proximity of residence.

In fact, if the monozygotic and dizygotic pairs are combined and analysed for concordance of smoking habits in terms of table 2 (*i.e.* according as the pairs of twins are "like" or "unlike" in respect of being smokers or non-smokers), the following relationship between concordance of habit and proximity of residence is obtained :

TABLE 11

Proximity of residence and concordance of smoking habit by twin pairs—I

Smoking habits (per analysis used in table 2)	Same address same town	Different address same town	Different town
Like	24	19	19
Unlike	10	7	5
Total	34	26	24

Thus proximity of residence of the members of a pair of twins does not appear to exercise any marked influence in leading them both to be smokers or both to be non-smokers. On the other hand, if both members of the pair do in fact smoke, there is more frequent concordance in respect of the types of product smoked between the members of pairs resident at the same address in the same town than between the members of pairs resident in different towns. The following table compares proximity of residence and concordance of smoking habit in terms of the definition of concordance used in table 6 above :

TABLE 12

Proximity of residence and concordance of smoking habit by twin pairs—II

Smoking habits (per analysis used in table 6)	Same address same town	Different address same town	Different town
Like	20	14	10
Unlike	14	12	14
Total	34	26	24

The pairs living at the same address are, as might be expected, very much younger on average than the pairs living apart.

When the concordance or discordance of smoking habits in monozygotic and dizygotic pairs is analysed according to the three lists, it is found on the basis of the analysis used in table 6, that the Frankfurt list is markedly different from the other two lists as the following table shows :

TABLE 13
Smoking habits

	Monozygotic pairs			Dizygotic pairs		
	Alike	Unlike	Total	Alike	Unlike	Total
Tubingen . . .	7	8	15	1	3	4
Berlin	13	8	21	6	5	11
T and B . . .	20	16	36	7	8	15
Frankfurt . .	13	3	16	4	13	17
	33	19	52	11	21	32

All the evidence, however, points to the Frankfurt list as being equally or more representative than the other two. Thus,

- (1) As already stated, the monozygotic and dizygotic twins are more closely matched in age in the Frankfurt list than in the other lists, and the higher average age of the monozygotic twins, as compared with dizygotic twins, in the Tubingen and Berlin lists may tend to understate the degree of concordance of smoking habits in the monozygotic twins to the concordance in dizygotic twins.
- (2) The method of recruitment adopted in collecting the Frankfurt list would be more likely to ensure collection of a totally unbiased sample of the two types of twins.
- (3) Frhr. von Verschuer (1939) has expressed the view "that only every fourth pair of twins is monozygotic". Since all monozygotic twins are of the same sex, every eighth pair of twins would consist of monozygotic male twins and, correspondingly, 3 of every 16 pairs of twins would be male dizygotic twins. The expected ratio of male monozygotic twins to male dizygotic twins in a random sample of the population would therefore be 2 to 3. The number of monozygotic and dizygotic pairs of male like-sex twins in the Frankfurt list in 1952 was 59 and 85. On a 2 to 3 ratio the expected numbers in a total of 144 male like-sex twin pairs would be 58 monozygotic pairs and 86 dizygotic pairs respectively. The ratio of the numbers of twins of the two types in the Frankfurt list in 1952 was therefore extremely close to what might have been expected on a random sample

of the population. We see no reason why any of the wastage or non-response that subsequently occurred would be likely to have introduced a bias favouring concordance in the smoking habits of monozygotic twins.

- (4) We have compared the numbers of smokers found among the dizygotic twins in each of the lists—a “ smoker ” for this purpose being a person who defined himself to be a smoker—with the number that would have been expected in an equal number of randomly selected and unrelated men of the same ages, in view of the percentage of smokers found in Western Germany as a whole in 1957. The figures are as follows :

TABLE 14
Expected and actual smokers among dizygotic twins

List	Dizygotic twins	
	Expected number of smokers	Observed number of smokers
Frankfurt	25	20
Tubingen and Berlin	22	17

While it is, of course, the concordance in the smoking habits of the dizygotic pairs that has been used throughout as the control by which the characteristics of the monozygotic pairs have been judged, the figures in table 14 show that, in incidence of smoking, the dizygotic pairs in the Frankfurt list and in the other two lists combined are representative of the public as a whole to an equal degree.

We can therefore see no reason for doubting the reality of the definitely more frequent occurrence of concordance of smoking habits in monozygotic than in dizygotic twins. Although the data were not designed for the application of chi-square tests, the formal probabilities of getting as great or greater departures from those expected on the null hypothesis of equal concordance supply satisfactory indications that the disparity of proportions observable between the two classes of twins is not reasonably ascribable to chance.

Frhr. von Verschuer and his colleagues had carried out a serological analysis of the blood of many of these twins and the available information has been recorded in Appendix II. As a first step in analysing the nature of any genetic factor that may be thought to influence smoking habits, we have analysed the blood groups of the present smokers (including occasional smokers), ex-smokers and non-smokers respectively to see if any marked differences were found in their blood groups. The results are set out in table 15 overleaf.

5. SUMMARY

1. An enquiry was carried out to ascertain whether there was objective evidence that the differences in smoking habits among mankind were influenced to any important extent by hereditary factors. For this purpose, information about the smoking habits of adult male like-sex twins on the Register of Twins of the Munster Institute of Human Genetics was obtained by mail or personal interview. The analyses were based on replies from 52 monozygotic and 32 dizygotic pairs of twins.

2. The twins were classified according to whether the smoking habits of the members of a pair were concordant or discordant.

TABLE 15
Blood groups in relation to smoking or non-smoking

Blood groups	Smoker	Ex-smoker	Non-smoker	Total
A	23	3	5	31
A ₁	2	...	2	4
A ₂	2	...	2	4
A ₃₍₁₎	1	...	...	1
A ₁ B	2	...	...	2
AB	4	...	...	4
B	5	1	...	6
O	17	2	9	28
Total	56	6	18	80
M	14	1	1	16
N	14	2	5	21
MN	26	3	12	41
Total	54	6	18	78
Rh+	9	1	1	11
rh-	3	...	4	7
Total	12	1	5	18

The first basis of comparison was whether or not the informants were smokers. Several different definitions of a smoker were used in turn and on all these definitions, concordance of smoking habits was found more frequently in monozygotic than in dizygotic twins.

3. The twins were also classified according to the types of product smoked. As before, a number of alternative bases of classification were used and again it was found that the smoking habits of monozygotic twins were more concordant than those of dizygotic twins.

4. A number of factors which might be thought to have affected the comparability or representativeness of the two sets of twins was discussed. As a result, it was concluded that there would seem to be no reason for doubting the reality of the more frequent occurrence of concordance of smoking habits in monozygotic than in dizygotic twins.

5. Information about the blood groups of many of the twins in the enquiry was available and was analysed according to smoking habits.

6. REFERENCES

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APPENDIX I

QUESTIONNAIRE

1. Name and Profession.
2. Age.
3. Place and date of birth.
4. Domicile.
5. Are you a smoker now or a non-smoker?
6. Do you smoke predominantly cigarettes, cigars or a pipe?
7. Do you take snuff?
8. Do you chew tobacco?
9. What is your daily (weekly) consumption of cigarettes, cigars, tobacco, chewing tobacco and snuff?
10. When did you smoke for the first time?
11. Have you smoked continuously since then?
12. When and why did you stop smoking?
13. Did you smoke less or more after marrying?
14. Have you smoked less or more during an illness, during the war, or for economic reasons?

APPENDIX II

Abbreviations used

<i>Number</i>	<i>Proximity of residence</i>	<i>Classification of smoking habits</i>
M = Monozygotic	A = Same town, same address	As per Table 1
D = Dizygotic	B = Same town, different address	
T = Tubingen list	C = Different town	
B = Berlin list		
F = Frankfurt-am-Main list		

NOTE.—Details of changes in consumption due to wartime supply difficulties have been omitted from "Past Smoking History".

Monozygotic twins

Number	Age at 1.1.58	Proximity of Residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-T-1a	40	A	5-6 cigarettes a day	Began at 17 or 18, smoked less after marriage	10	...
M-T-1b	40	A	"Rather heavier smoker" (of cigarettes) than his brother (Note: M-T-1b asked M-T-1a to reply on his behalf)	...	10	...
M-T-2a	78	B	4-5 cigars a week	Began at 16. Gives up smoking during illness	15	...
M-T-2b	78	B	1-2 cigars a day but this is slightly less than usual on account of illness	Began at 18	15	...
M-T-3a	44	A	Some 15 filter tipped cigarettes a day "according to my mood"	Began at 18	10	...
M-T-3b	44	A	"Non-smoker for 3½ years"	Formerly smoked cigarettes; began at 18; gave up 3½ years ago after illness "on doctor's advice and at my own wish"	2	...
M-T-4a	53	B	50 cigars and 1 packet of tobacco a week	Began at 18. Smoked mainly cigarettes before marriage	19	...
M-T-4b	53	B	5 cigars a day	Began at 18. Smoked less after marriage	15	...
M-T-5a	48	C	Very heavy cigarette and cigar smoker	Began at 20. Smoked more after marriage	17	...
M-T-5b	48	C	8-10 stumphen a day (in a pipe-type holder)	Began at 28. Gives up when ill	14	...
M-T-6a	58	C	5-8 cigars a day, more on Sundays and certain festive occasions	Began at 18. Smoked cigarettes and pipe also during war. Usually gives up when ill. Quantity smoked varies as funds permit	15	...
M-T-6b	58	C	12 cigarettes and about 10 cigars a week. Describes himself as a cigar smoker	Began at 18. Gives up when ill	17	...

Monozygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-T-7a	49	C	About 5 cigarettes a week mainly when in company and therefore intermittently. Describes himself as a "smoker"	Began at 17. Gave up periodically on account of asthma. Smoked more when aged 20 to 30	5	...
M-T-7b	49	C	3-5 cigarettes a day, increasing up to 10 in company	Began at 22. Gives up during respiratory illness	9	...
M-T-8a	48	B	Non-smoker	...	1	...
M-T-8b	48	B	An occasional cigarette. Describes himself as a "smoker"	Began before 18. Apparently gave up more than once. Last resumed 2 years ago	5	...
M-T-9a	44	A	7 cigarettes a day	Began at 18. Reduced consumption gradually after marriage	10	...
M-T-9b	44	A	About 15 cigarettes a day	Began at 18. Gave up for 6 weeks after operation in 1952	10	...
M-T-10a	39	C	15 cigarettes a week	Began at 16 or 17	9	...
M-T-10b	39	C	About 50 cigarettes a week	Began at 16. Reduced by one-third after marriage. Gave up for 8 and 6 weeks in 1942 and 1955 respectively during illness	10	...
M-T-11a	42	C	24 cigarettes (Reval*) or more and some cigars a day	Began at 14	17	...
M-T-11b	42	C	12 cigarettes (Reval) a day; 18 on Sundays (Note: M-T-11a also replied on behalf of	Began at 14 M-T-11b)	10	...
M-T-12a	48	C	10 cigarettes a day	Began at 16	10	...
M-T-12b	48	C	About 12 cigarettes a day	Began at 24. Formerly smoked less. Smokes more now as result of business worries. Gave up for 6 months in 1944 as result of war wounds	10	...

* Reval is a particular brand of cigarettes

Monozygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-T-13 ^a M-T-13 ^b	49 49	B B	10 cigarettes a day 10 cigarettes a day	Began at 32 Began at 17	10 10	... ...
... ...	82 Died 24.1.56	B ¹ B	2-3 cigars a day Smoked 10 cigars a day (<i>Note</i> : Information provided by his twin)	Began at 20 Began at 20	15 ...	... ...
M-T-14 ^a	41	C	About 8-10 cigarettes a day	Began at 17. Smoked more during war, gave up for 5 weeks in 1954 owing to operation, then resumed smoking gradually increasing to present level	10	...
M-T-14 ^b	41	C	5-6 stumphen a day	Began at 24. Gave up temporarily for 4 weeks on account of illness	14	...
M-T-15 ^a M-T-15 ^b	38 38	C C	8-10 cigarettes a day since 1955 Non-smoker	Formerly smoked less Smoked from 18 but gave up in 1945 when POW	10 4	... ...
M-B-1 ^a M-B-1 ^b	77 77	C C	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
M-B-2 ^a M-B-2 ^b	37 37	C C	20 cigarettes a day 20 cigarettes a day (<i>Note</i> : M-B-2 ^a provided information about but happened to visit his twin at the time of enquiry)	Began at 18. Smoked more after marriage Began at 18. Smoked more after marriage M-B-2 ^b who is normally resident in U.S.A.,	10 10	... ...
M-B-3 ^a M-B-3 ^b	45 45	B B	25-30 cigarettes a day 20-25 cigarettes a day	Began at 16. Gave up temporarily in 1955 during illness Began at 15. Gave up 1945-46 for lack of funds	11 10	... ...

Monozygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-B-4a	44	C	$\frac{1}{2}$ packet pipe tobacco (= 50 grams) a week	Began at 16. Smoked less after marriage. Sometimes gives up to economise	16	...
M-B-4b	44	C	12 cigarettes a day (Note: Information about M-B-4a provided by M-B-4b)	Began at 16. Smoked more in war	10	...
M-B-5a	44	C	50 grams of tobacco a week in form of hand-rolled cigarettes	Began at 18. Gave up for six months in 1955 during illness	12	...
M-B-5b	44	C	6 cigarettes a day	Began at 16. Gave up or reduced on occasions. Smoked less after marriage	10	...
M-B-6a	36	B	Non-smoker	Never smoked	1	...
M-B-6b	36	B	3-4 cigarettes a day	Began at 23. Gave up on occasions on health grounds. May smoke more in company or during intense mental work	9	...
M-B-7a	29	A	8-12 cigarettes a day	Began at 18. Gave up temporarily during severe illness	10	A ₁ B M Rh+
M-B-7b	29	A	12-15 cigarettes a day increasing to 25-30 when working hard mentally. Smokes occasional cigar	Began at 19. Twice gave up for 3 and 7 months respectively. Gives up during illness	10	A ₁ B M Rh+
M-B-8a	55	B	About 20 cigarettes a day	Began at 28	10	...
M-B-8b	55	B	Non-smoker	Never smoked	1	...
M-B-9a	25	A	Mainly pipe-smoker—3-4 average size pipes and 4-6 cigarettes a day	Began at 18. Gave up for 6 weeks in 1954	18	A MN
M-B-9b	25	A	About 8-10 cigarettes a day	Began at 21	10	A MN
M-B-10a	27	A	20-25 cigarettes a year, only in company	Began at 16	5	...
M-B-10b	27	A	20-25 cigarettes a year, only in company (Both twins described themselves as "smokers")	Began at 16	5	...

Monozygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-B-11a M-B-11b	56 56	B B	1 cigar a day Non-smoker	Began at 18 5 cigarettes daily until 1951; began at 18. Gave up on health grounds	15 2	... ...
M-B-12a M-B-12b	24 24	A A	About 80 cigarettes a week Up to 10 cigarettes a day	Began at 16 Began at 16. Gave up once when ill	10 10	... ...
M-B-13a M-B-13b	27 27	B B	Up to 10 cigarettes a day Up to 10 cigarettes a day	Began at 18 Began at 18; gave up from time to time for health reasons. Smoked less after marriage	10 10	O N rh— O N rh—
M-B-14a M-B-14b	25 25	A A	6 cigarettes a day 5 cigarettes a day	Began at 18. Gives up when ill Began at 18. Gives up when ill	10 10	... ...
M-B-15a M-B-15b	32 32	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	A ₁ MN rh— A ₁ MN rh—
M-B-16a M-B-16b	35 35	C C	10-15 cigarettes a day 1-2 cigars a day; 50 grams tobacco every 3 or 4 days	Began at 17 Began at 21. Smoked very little in 1947-48 for economic reasons; stopped tem- porarily in 1954 after operation	10 19	... ...
M-B-17a M-B-17b	61 61	B B	60-80 cigarettes a week 15-20 cigarettes a day	Began at 17 Began at 15. Gives up when ill	10 10	A ₁ MN Rh+ A ₁ MN Rh+
M-B-18a M-B-18b	68 68	B B	60 cigarettes a week 15 cigars a week	Began at 31 Began at 20	10 15	... ...
M-B-19a M-B-19b	31 31	B B	Non-smoker Non-smoker	Never smoked Never smoked	1 1	O MN O MN

Monozygotic twins—Continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-B-20a M-B-20b	28 28	A A	100 cigarettes a week Non-smoker	Began at 19 Began at 23; smoked 2 cigars and 12 cigarettes a day until 6 months ago when he gave up for health reasons	10 3	O N Rh + O N Rh +
M-B-21a M-B-21b	27 27	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
M-F-1a	36	B	15 cigarettes a day (120 a week)	Began at 18. Smoked more during war. Smokes less during illness	10	A N
M-F-1b	36	B	3-4 cigarettes a day	Began at 19	9	A N
M-F-2a	44	B	5-8 cigarettes a day	Began at 18. Smoked less during an illness	10	AB M
M-F-2b	44	B	3-4 cigarettes a day; more at weekends	Began at 17	9	AB M
M-F-3a	67	C	Non-smoker	Began at 17; formerly smoked 10-15 cigarettes a day; gave up 9 months ago after operation	2	A MN
M-F-3b	67	C	10-20 cigarettes a day	Began at 17	10	A MN
M-F-4a M-F-4b	26 26	B B	10 cigarettes a day 10 cigarettes a day	Began at 16 Began at 16	10 10	A N A N
M-F-5a M-F-5b	51 51	B B	1 cigar a day (5-6 a week) 6 cigarettes a day	Began at 18 Began at 17-18. Smoked less during war. Gives up when ill	15 10	A MN A MN
M-F-6a M-F-6b	27 27	B B	Non-smoker Non-smoker	Never smoked Never smoked	1 1	O MN O MN

Monozygotic twins—continued

Number	Age at I.I.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
M-F-7a M-F-7b	26 26	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	O N O N
M-F-8a M-F-8b	40 40	C C	Non-smoker Non-smoker	Never smoked Began at 17 to smoke in company ; gave up in 1948 after illness	1 4	O MN O MN
M-F-9a M-F-9b	44 44	A A	2-3 cigarettes a day ; 10 a day at weekends 4 cigarettes a day (30 a week)	Began at 20. Gives up when ill Began at 16. More during war ; gives up when ill	9 9	O MN O MN
M-F-10a M-F-10b	24 24	A A	Non-smoker Non-smoker	... ...	1 1	A ₂ MN rh- A ₂ MN rh-
M-F-11a	29	C	18 cigarettes a day	Began at 16. Gave up from 1949-54. Re-started and gradually increased con- sumption	10	B MN
M-F-11b	29	C	12 cigarettes a day	Began at 25. Often gives up for short time	10	B MN
M-F-12a M-F-12b	23 23	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
M-F-13a M-F-13b	23 23	A A	10 cigarettes a day 8 cigarettes a day	Began at 18 Began at 17. Gives up during illness	10 10	A ₂ M Rh+ A ₂ M Rh+
M-F-14a M-F-14b	50 50	A A	10 cigarettes a day Non-smoker	Began at 18 Always a non-smoker	10 1	O MN Rh+ O MN Rh+
M-F-15a M-F-15b	28 28	A A	15-20 cigarettes a day 10-12 cigarettes a day	Began at 21. Smoked more after marriage Began at 20. Smoked more after marriage	10 10	A MN A MN
M-F-16a	30	B	10-12 cigarettes a day ; an occasional pipe	Began at 15-16	10	A MN
M-F-16b	30	B	About 12 cigarettes a day	Began at 16	10	A MN

Dizygotic twins

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
D-T-1a D-T-1b	38 38	B B	15 cigarettes a day when funds permit About 10-15 cigarettes a day	Began at about 20 Began at 23	10 10	... ...
D-T-2a	54	C	6-12 cigarettes a day; a pipe on rare occasions	Began at 18. Smoked more during war when supplies available	10	...
D-T-2b	54	C	Non-smoker	Began at 20; 1-5 cigarettes a day; gave up at age of 50. on health grounds. Smoked more during war	2	...
...	Died	C	...	...	...	...
...	24.4.57 52	C	10-12 cigarettes a day	Began at 19	10	...
D-T-3a D-T-3b	34 34	C C	6 cigarettes a day Non-smoker	Began at 19. Smoked more during war Began at 18; gave up on health grounds at date not specified	10 4	... ...
D-T-4a	35	A	Non-smoker	Began at 20; gave it up in 1948 when he was smoking 25 cigarettes a day on health and economic grounds	2	...
D-T-4b	35	A	12 cigarettes a day; 20 a day on rest days	Began at 18. Gave up when ill	10	...
D-B-1a	43	C	2 packets (50 grams) of pipe tobacco a week and 3 cigars on Sundays; cigar- ettes very rarely	Began at 15. Smoked 40-60 cigarettes a day during war until taken POW. Smoked more after marriage	19	A ₂₀ MN rh-
D-B-1b	43	C	4 cigarettes and 2 pipes a day; no cigars	Began at 18	18	O M Rh +
D-B-2a D-B-2b	36 36	A A	Non-smoker 12 cigarettes a day	Began at 14. Smoked less during war and post-war years for economic reasons	1 10	... ...

Dizygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
D-B-3 ^a D-B-3 ^b	25 25	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
D-B-4 ^a D-B-4 ^b	29 29	A A	6 cigarettes a day 2 cigarettes a day	Began at 17 Began at 20; did not smoke in 1952 because of illness	10 9	B B
D-B-5 ^a D-B-5 ^b	26 26	B B	"Non-smoker" 6-9 cigarettes a day	Began at 20 as "occasional smoker up to 10-day" Began at 18. Gives up temporarily for health or economic reasons	8 10	B M O MN
D-B-6 ^a D-B-6 ^b	24 24	A A	6-8 cigarettes a day 12 cigarettes a day and a packet of pipe tobacco weekly	Began at 18 Began at 17	10 18	... ...
D-B-7 ^a D-B-7 ^b	28 28	B B	About 10 cigarettes a day and/or 2-3 packets of cigarette tobacco a week About 12 cigarettes a day	Began at 18. Gives up temporarily for health or economic reasons. Smoked slightly more after marriage Began at 16. Smoked more after marriage	13 10	... ...
D-B-8 ^a D-B-8 ^b	34 34	C C	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
D-B-9 ^a D-B-9 ^b	23 23	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
D-B-10 ^a D-B-10 ^b	21 21	A A	Non-smoker Non-smoker	Never smoked Never smoked	1 1	... ...
D-B-11 ^a D-B-11 ^b	21 21	A A	1-2 cigarettes a day in company Non-smoker	Began at 18 ...	9 1	... ...

Dizygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
D-F-1 <i>a</i>	26	A	Non-smoker	Never smoked	1	A N
D-F-1 <i>b</i>	26	A	Non-smoker	Never smoked	1	A N
D-F-2 <i>a</i>	22	A	12 cigarettes a day (84 a week)	Began at 18; gave up for 6 months on one occasion following operation	10	A N
D-F-2 <i>b</i>	22	A	3-4 cigarettes a week. Describes himself as an "occasional smoker"	Began at 18	5	A N
D-F-3 <i>a</i>	31	C	30 cigarettes a week and a packet of pipe tobacco fortnightly	Began at 16; stopped for 6 weeks in 1944 following operation	18	O M
D-F-3 <i>b</i>	31	C	1 small packet of pipe tobacco a week	Began at 17; reduced consumption on marriage	16	O N
D-F-4 <i>a</i>	35	A	3 cigars a day from 1957	Began at 18; smoked 10 cigarettes a day 1949-1956 prior to which he smoked less	15	A M
D-F-4 <i>b</i>	35	A	3 cigarettes a day	Began at 19	9	A M
D-F-5 <i>a</i>	20	A	50 grams of pipe tobacco and 10 cigarettes a week	Began at 18. Occasionally gave up for 1-2 months. Gives up during illness	18	AB MN
D-F-5 <i>b</i>	20	A	Non-smoker	A "passionate" non-smoker	1	A N
D-F-6 <i>a</i>	49	B	10 cigarettes a day	Began at 14	10	AB N
D-F-6 <i>b</i>	49	B	Non-smoker	Never smoked	1	A MN
D-F-7 <i>a</i>	29	B	Non-smoker	Began at 16; gave up in 1950 on health grounds	4	A N
D-F-7 <i>b</i>	29	B	20-50 cigarettes a week, varies a lot	Began at 14; changed level of consump- tion from time to time on economic grounds	10	O N
D-F-8 <i>a</i>	24	A	"Non-smoker"; a pipe on rare occasions	Began at 14	7	...
D-F-8 <i>b</i>	24	A	"Non-smoker"; a cigar on rare occasions	Began at 15	6	...

Dizygotic twins—continued

Number	Age at 1.1.58	Proximity of residence	Smoking habits at time of enquiry	Past smoking history	Classification of smoking habits	Blood groups and factors
D-F-9a D-F-9b	21 21	B B	3 cigars a day, 15 a week 12 cigarettes a day	Began at 16 Began at 14	15 10	O M O M
D-F-10a D-F-10b	23 23	A A	6 cigarettes a day Non-smoker (Note: Information for both twins provided)	Began at 18 by their father	10 1	... ...
D-F-11a D-F-11b	26 26	C C	6-12 cigarettes a day Non-smoker	Began at 20 Began at 17, gave up in 1953	10 4	A MN B MN
D-F-12a D-F-12b	50 50	C C	10 stumpen a day 2 cigars a day	Began at 23 Began at 30	14 15	O N O MN
D-F-13a D-F-13b	78 78	B B	10 cigars a day and 100-150 grams pipe tobacco a week 150 grams pipe tobacco a week	Began at 17-18. Smoked less during war Began at 18. Prior to 1914 smoked mainly cigars, thereafter mainly a pipe with cigars now and then	19 16	O MN O MN
D-F-14a D-F-14b	36 36	B B	Non-smoker 20 cigarettes a day	Never smoked Began at 16	1 10	A M A M
D-F-15a D-F-15b	25 25	A A	10-15 cigarettes a day Non-smoker	Began at 16 Began at 15; smoked 10 cigarettes a day until recently when he gave up for "common-sense reasons"	10 2	A MN A M
D-F-16a D-F-16b	30 30	A A	About 6 cigarettes a day Non-smoker	Began at 18 Never smoked	10 1	A MN O MN
D-F-17a D-F-17b	49 49	C C	"A non-smoker"—rarely a cigarette or cigar (preferably the latter) in company "More a non-smoker than a smoker"	... Began during the war but never smoked much. Average of 1 cigarette or 1 cigar a week. Smoked more during the war	6 6	A MN A N