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SOCIAL AND OCCUPATIONAL FACTORS IN THE AETIOLOGY OF SKIN CANCER

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The causes of human cancer, apart from the influence of specific carcinogenic agents and of chemical and physical factors the components of which may or may not be carcinogenic, are to be sought broadly in heredity, age, sex, and certain social and occupational influences. Berenblum (1944), although reintroducing the word "irritant" in a sense in which it is not usually employed, has discussed the two questions: (1) Are all irritants potentially carcinogenic? and (2) Are all carcinogenic agents irritants? To the first he concluded that the answer is "No"; to the second, that all direct carcinogens are irritants. He also concluded that non-carcinogenic irritants may facilitate the progress of a pre-neoplastic lesion to cancer.

There is strong evidence for genetic predisposition in the case of cancer originating in polyposis of the colon, and Jacobsen (1946) has lately added to existing information important material bearing upon a similar predisposition in the case of breast cancer. While it is not strictly correct to speak of cancer itself as heritable, the existence of a cancer diathesis may be held to be established, at any rate in respect of certain histological types and anatomical sites, in man. It has also been experimentally demonstrated for mammary cancer in mouse strains.

Age in man may be assumed to lend its contribution partly through longer exposure to effective stimuli and partly, perhaps, through a changing reactivity of tissues dependent upon hormonic or other chemical influence. Sex, through local injury or inflammation (as in the case of cancer of the cervix), or through hormonal influence (as in the case of ovarian, breast, and prostatic cancer), is clearly an important factor. More remotely, sex influences may also reflect social changes as these impinge upon the marriage rate, fertility, and parity.

The Registrar-General's standardized mortality comparisons (1930–2) suggest that lower socio-economic status predisposes in some way to cancers of the upper alimentary tract and the skin, both of which give a death rate in social class V approximately twice that obtaining in social class I, with a steady gradient in the intervening classes.

Skin cancers, although not numerous in the population by comparison, for instance, with those affecting the breast and alimentary tract, have this advantage—that they can be diagnosed with greater certainty and that there can be little doubt about the accuracy of certifications. The skin, considered as an external organ exposed to recognizable environmental stresses of a chemical or physical kind which vary appreciably both in duration and in degree with social circumstance and nature of employment, may thus prove particularly worthy of investigation from the point of view of cancer aetiology.

It has long been accepted that soot, pitch, tar, and shale oil give rise to occupational cancers of the skin; that *x*-ray burns and prolonged thermal injury can lead to cancerous changes; that chronic ulcers and arsenical and other forms of dermatitis may end in malignant degeneration; and that the starting-points of skin cancers include warts and moles and other initially innocent tumours. But cancer of the skin can also arrive independently of these influences. If social factors can be shown to have importance on the basis of statistical correlations, and if skin cancer (in common with a number of other diseases) is found to discriminate against the less privileged classes, then the most likely local factors would seem to be exposure to atmospheric dirt—whether through grimy occupations or lack of bathing facilities, or both—and, in the case of some other occupations, exposure to the ultra-violet radiations of direct sunlight. This, according to Molesworth (1927), with his extensive Australian experience, may be an important factor in outdoor workers, and especially in those whose skins do not acquire the protection due to tanning. In Australia, as contrasted with England, lupus is very rare and epithelioma of exposed sites very common. If dirt is an important factor, the sites of cancer might be expected to include those in which it is most apt to lodge. The listed sites for skin cancer do, in fact, include the external ear, the canthus of the eye, the umbilicus, the anus, the scalp, and the neck. These sites, like the scrotum, are apt to be more infrequently and ineffectively washed than some other parts, and their anatomical structure encourages the deposition and retention of atmospheric soot or other dirt. It must be noted that the face as a whole has been recorded in some mortality tables (see below) as showing a much higher incidence of skin cancer than other sites; the ear has second place. These parts are exposed to grime and heat in some occupations, but the face is certainly more likely than the rest of the body surface to be subject to daily washing. On the other hand, it is more exposed to the ultra-violet rays of sunlight than any other part. In considering aetiological factors in skin cancer due regard must be paid to the type of cancer as well as to its site. It would be unreasonable to suggest that social or occupational factors play a major part in melanomata originating in pigmented moles or in Kaposi's idiopathic haemorrhagic sarcoma. They might, on the other hand, have a significant association with basal or squamous-celled epitheliomata. Unfortunately—lacking, as we do at present, any

readily available morbidity figures—it is difficult to discover the incidence of the several types of skin cancer or their incidence in relation to site. The best that can be done, therefore, is to consider the mortality of skin cancers as a whole, and their sites where possible, and to see whether any suggestive correlations can be effected with such factors as sex, geography, social class, or occupation. We are here concerned with statistical material drawn from the British Isles only.

Scrotal Cancer

In a very interesting paper on the social distribution of cancer of the scrotum and penis, E. L. and N. M. Kennaway (1946) indicated that cancer of the scrotum, unlike cancer of the penis, has (quite apart from the occupational cases) a definite social class distribution, and that its mortality, and presumably its incidence, should be considerably reduced by the elimination of causal social factors. It would even seem proper to infer from the evidence presented that if all classes could enjoy the advantages experienced by social class I (Registrar-General's classification) —whether in respect of freedom from cutaneous irritants or of facilities for frequent bathing, or both—scrotal cancer would disappear. The suggestion was made in an earlier paper by E. L. Kennaway (1925) that atmospheric soot may be the operative factor and that all town dwellers are in some very slight degree liable to chimney-sweep's cancer. The scrotum and penis, as contiguous parts and both protected from sunlight, supply particularly convincing data. Possibly the rugose character of the scrotal integument facilitates the lodgment of grime in undue degree.

In view of the importance of these conclusions it was deemed of interest to examine the statistics of skin cancer generally, excluding the penile and scrotal forms, to measure the magnitude of the problem, the secular trend, the geographical incidence, and the possible relationship between cutaneous cancer and social and environmental factors.

The data utilized in this study were obtained from the Annual Reports of the Registrar-General for the United Kingdom and Eire, and particularly from the Decennial Supplement, 1931, containing occupational mortality tables for England and Wales. For the most recent statistics of the disease in England and Wales we would like to thank Dr. Percy Stocks, who supplied us with the unpublished data of the age incidence for the years 1942 and 1943.

Incidence of Skin Cancer

The mortality due to skin cancer is not numerically unimportant, since in 1943 it caused 1,094 deaths—626 were in males and 468 in females.

(a) Secular Trend.—The secular trend of the age-specific death rates has recently been described by Stocks and Mackay (1946) for the period 1911–44, and they stated that the skin cancer mortality began to decline at ages over 55 about 1931. They also presented data in the form of a Comparative Mortality Index (1938 basis) for each year between 1933 and 1944 for males and females separately, and their results are reproduced in Table I. In stressing the merits of this new method of measurement Stocks and Mackay state: "This comparative mortality index shows at a glance how the real rate of mortality at all ages compares with that in the year 1938 taken as a basis. Furthermore, by simply dividing one index by another the proportionate increase or decrease in any one year compared with any other year can be arrived at." The figures in the table indicate that a satisfactory improvement has occurred in recent years, and it is reflected in the fact that the average C.M.I. both for males and for females in the two years 1943–4 was 15% less than the corresponding values in 1933–4.

TABLE I.—*Comparative Mortality Index (1938 Basis), Cancer of Skin (Scrotum excepted)*

Year	Male	Female	Year	Male	Female
1933	1·032	1·078	1939	0·942	0·873
1934	1·021	0·965	1940	0·932	0·896
1935	0·960	0·986	1941	0·945	0·850
1936	1·024	0·989	1942	0·849	0·890
1937	0·997	0·992	1943	0·938	0·881
1938	1·000	1·000	1944	0·812	0·860

(b) Geographical.—There is a distinct geographical picture in the mortality from skin cancer in the United Kingdom and Eire, and since each country classifies its statistics according to a uniform standard—namely, No. 53 of the Detailed International List of Causes of Death (Fifth Revision, 1938)—the variance in their statistical experience must be ascribed to the influence of some localized causal factor rather than to any divergence in classification. Here it may be of interest to specify what is officially included under the heading No. 53 of the International List. The following is the specification according to the manual published in 1940:

* Cancer of abdominal wall
* ,, ,, anus
,, ,, auricle of ear
,, ,, buttock
,, ,, canthus
,, ,, cheek (external)
,, ,, ear
,, ,, face
,, ,, nose
,, ,, perineum
,, ,, pinna
Cancer of scalp
,, ,, umbilicus
Epithelioma of neck
* Malignant dermatitis
* Pitch cancer
Rodent ulcer (site stated)
* Rodent ulcer (site not stated)
* Tar cancer
* *X*-ray cancer
* Epithelioma (unqualified)

*Denotes that the cause of death is referred by the Registrar-General for England and Wales to the certifying practitioner for further information.

To avoid comparisons based on direct standardized death rates, which for Northern Ireland, Eire, and Scotland would be subject to large sampling errors in view of the small number of deaths on which the age-specific death rates in these countries are based, the analysis was made on the basis of indirect standardization. For this purpose the age mortality rates from skin cancer for males and females in England and Wales for the triennium 1941–3 were used as a "yardstick." These rates at ages were applied to the populations at the corresponding age groups in each of the three countries in question and the calculated or expected number of deaths for males and females were thus obtained. The number of deaths actually recorded in each country during the triennium was then compared with the calculated number, and the significance of the difference was measured by the formula:

$$\frac{\text{Actual} - \text{Calculated}}{\sqrt{\text{Calculated}}}$$

When the difference in any instance exceeded three times its sampling error the result was regarded as being statistically important. The results are given in Table II, in which the excess mortality from skin cancer in both parts of Ireland as compared with England and Wales is

TABLE II.—*Showing the Actual and "Calculated" Number of Deaths from Skin Cancer during the Period 1941–3*

Country	Males			Females		
	Act.	Cal.	$\frac{\text{Act.}-\text{Cal.}}{\sqrt{\text{Cal.}}}$	Act.	Cal.	$\frac{\text{Act.}-\text{Cal.}}{\sqrt{\text{Cal.}}}$
Scotland ..	150	208	−4·0	174	156	+1·4
Northern Ireland	98	56	+5·6	60	37	+3·8
Eire	230	156	+5·9	120	90	+3·2

noteworthy. For males and females the difference between the actual and calculated number of deaths is five times and three times, respectively, greater than its sampling error.

In Scotland the female experience was only slightly in excess, but for males the recorded deaths were much fewer than would be expected to occur according to the statistical experience of males in England and Wales.

Sites of Skin Cancer

In view of the high mortality from skin cancer in Ireland as compared with that in England and Wales, and also of the fact that its statistical distribution according to site of occurrence is published in more detail in Northern Ireland than is the case for the other home countries, it was of interest to ascertain the frequency of site involvement in that region of the country. The results for the period 1941–3 are shown in Table III.

TABLE III.—*Incidence of Skin Cancer According to Site in Northern Ireland*

Site	Males		Females	
	No.	%	No.	%
Cheek	7	7·1	5	8·3
Ear	20	20·4	—	—
Face	53	54·1	46	76·7
Perineum	—	—	1	1·7
Scalp	4	4·1	2	3·3
Umbilicus	—	—	1	1·7
Neck (skin of)	4	4·1	—	—
Abdominal wall	1	1·0	—	—
Nose	1	1·0	—	—
Other skin	8	8·2	5	8·3
	98	100·0	60	100·0

It will be noted that for both sexes the face is the principal location. Face, cheek, and ear in males account for 81.6% of the skin cancer deaths. For females, face and cheek contribute 85%. No female deaths from cancer of the ear are recorded. Dr. Berenblum suggested to us that protection of the female ear from sunlight by hair might have to be considered in explanation of this sex difference. Without more detailed information bearing on occupations, these figures cannot be fully explained. Since a high proportion of the population in Ireland are agricultural workers and the women are included among these, suspicion might seem to fall on sunlight rather than atmospheric soot; but here it should be noted that Ireland has a humid atmosphere very different from that, for instance, of Australia. No similar figures relating to the site of lesions in urban England are available for comparison.

Social Status

In the very interesting statistics which the Registrar-General has published in the Occupational Mortality Tables for England and Wales covering the period 1930–2 he has concentrated chiefly on the age period 20–65 years, and the standardized mortality ratios which he has published relate to this period of working life. There were sound reasons which justified or determined this age restriction. But in a discussion of occupational influence on disease, particularly in relation to cancer, it is obviously important to include, if possible, the statistical experience after age 65, because many of the deaths occur at this stage of life, and it may be that an occupational factor in the causation of cancer, at least in some sites, may not fully declare itself until the man has retired from work. But a difficulty arises and it has been indicated by the Registrar-General in the following terms: "Statement on the Census Schedule of the former occupation of retired males tends to be omitted as life advances, whereas in death registration the statement of the last occupation can nearly always be obtained, and the result is that at ages after 60 the population returned as never occupied is too large, and the populations of the occupied are too small, to correspond with deaths similarly classified."

From an examination of the available data for the period 1930–2 the Registrar-General was satisfied that the error introduced in this way was of much less importance than at the previous census. "At ages 65–70 the transfer of the population, if spread evenly over the occupied classes, would increase the numbers at risk by only 3% throughout, and reduce the mortality rate in the same proportion." At ages 70–75 the reduction in mortality would amount to approximately 6% and at age 75 plus to about 11%.

To test the possible effect of this transference on the mortality from cutaneous cancer the standardized mortality ratio at age 65 plus was calculated for certain combinations of the Registrar-General's five social classes: I and II representing professional and executive classes; III, skilled workers; IV and V, unskilled workers and labourers. (The standardized mortality ratio (S.M.R.), usually expressed on a percentage basis, indicates whether the recorded deaths in an occupation are equal to, greater than, or less than the "expected" number.)

The trend of the ratios according to their social significance was then compared with that shown by the similar ratios for the age period 26–65, which may be regarded in the present instance as the "control series." If there be a parallelism in the trend in the ratios at the two contrasted age periods, then it would be fairly legitimate to assume that the apparently disturbing phenomenon to which the Registrar-General called attention is not of very serious import so far as cutaneous cancer is concerned. The results are stated in Table IV, where it will be observed that the correlation between mortality and social status shown for males and females in the age group 20–65 is also evident in the age group 65 years and upwards, but more so for females than for males. In view of this fair degree of similarity of gradient of the mortality of each of the two age groups it seemed legitimate to aggregate the statistical experience and base the discussion on the combined age group 20 years and upwards, as has been done in Table IV.

TABLE IV.—*Actual and Calculated Deaths and S.M.R. from Skin Cancer during 1930–2 in England and Wales*

Social Class	Age Group								
	20–65 Years			65+ Years			20+ Years		
	Act.	Exp.	S.M.R.	Act.	Exp.	S.M.R.	Act.	Exp.	S.M.R.
Males:									
I and II	87	120	73	286	303	94	373	424	88
III	242	257	95	472	534	88	714	791	90
IV and V	244	199	123	579	404	143	823	603	136
Married women:									
I and II	49	54	91	34	49	69	83	103	81
III	107	114	94	90	86	105	197	200	99
IV and V	92	79	116	76	59	129	168	138	122

For wives, the S.M.R. in the combined classes I and II is 81, and it increases uniformly, attaining a value of 122 for those lowest in the economic scale. This marked association in the case of wives would seemingly rule out the possible influence of a purely occupational causation. On the other hand, the less uniform gradient in the mortality of males according to social grade would suggest that both occupational and environmental factors may be involved. In an attempt to disentangle any such causal connexion, the standardized mortality ratios for particular occupations were placed into four groups:

Group A represents workers with advantages in the matter of opportunity for cleanliness and working largely indoors. This

group, in which there were 13 occupations, comprises the professional classes, clerical grades, typists, and policemen. Their social and economic equivalents in terms of the Registrar-General's classification are represented by social classes I, II, and III.

Group B is composed mainly of occupations, nine in number, which are ascribed to social classes III, IV, and V. They are : coal hewers and getters ; coal, other workers below ground ; coal, other workers above ground ; iron-ore mine workers below ground ; stone-miners and quarriers ; potters, ware makers, etc. ; textile strippers and grinders, cotton ; bricklayers, masons, etc. The work involved is heavy and dirty, especially in the coal-fields, but the workers in coal, who numerically dominate the group, probably utilize to an increasing extent the facilities for cleanliness afforded by pithead baths. Long exposure to sunlight is not a particular hazard in these occupations.

Group C.—In this group there are five occupations : agricultural and gardeners' labourers (social class IV) ; builders' labourers (social class V) ; other workers (navvies) in buildings, etc. (social class V) ; water transport and dock labourers (social class V) ; general labourers and unskilled workers (social class V). The men engaged in them perform arduous labour involving grime and dirt. The workers tend to conform to types either indifferent to or having inadequate opportunity for desirable standards of cleanliness. They also include categories working in the open air.

Group D is composed of only two occupations : furnacemen and rollers and skilled assistants (social class III) ; boiler firemen and stokers (social class IV). This group relates to men higher, on the average, in the social and economic scale than either group B or C, but the men experience in their occupation the effects of prolonged exposure to both grime and excessive heat.

The statistical experience of each of these four categories of workers aged 20 years and upwards from skin cancer during the triennium 1930–2 is shown in Table V. It will

TABLE V.—*Actual and Calculated Numbers of Deaths and S.M.R. from Skin Cancer in Four Different Groups of Male Workers aged 20 years and upwards during 1930–2 in England and Wales*

Group	No. of Occupations	Deaths		S.M.R.
		Actual	Calculated	
A	13	103	148	70
B	9	130	127	102
C	5	511	319	160
D	2	27	12	225

be seen from the figures that there would appear to be both a social and an occupational factor involved in the causation of skin cancer, and that the latter is seemingly the more important. In group A, representing as it does workers who have a high standard of cleanliness, the mortality is 30% below the average, but in groups C and D it is 60% and 125% respectively in excess.

An attempt was made to evaluate the incidence of skin cancer amongst married women in groups A, B, C, and D. The experiment was not entirely successful because some of the occupations which provide the male groups were not listed for women in the Mortality Supplement, since only a few deaths from all causes occurred in them during the period 1930–2. The number of occupations for which the facts were ascertainable was 7 in group A, 6 in B, 4 in C, and 2 in D. This reduction detracts somewhat from the reliability of the calculated mortality ratios, which for age 20 and upwards were found to be:

Group	Actual Deaths	Expected Deaths	S.M.R.
A	12	16	75
B	29	25	116
C	96	63	152
D	1	3	—

The operation of a causal social factor is evident in the gradient of the S.M.R.s from group A to group C—a gradient similar in character to that shown for males. The data in group D are insufficient for comment.

Unfortunately we have no means of ascertaining the specific sites involved in the excess indicated in groups C and D for males, as the Registrar-General does not publish the statistics for individual sites. The reason is, of course, the paucity of existing data. It would nevertheless be instructive if the statistics were available, particularly in their relation to occupation. The social circumstance and occupation of sufferers from skin cancer affecting sites which tend to retain dirt (ear, canthus of the eye, umbilicus, anus, scalp, and neck), and of cancers in other parts (face and hand) exposed to light, would make an interesting special inquiry for hospital departments of dermatology employing a standard method of recording. In view of the comparative rarity of cases, such an inquiry would need to be collectively, perhaps internationally, organized. We know from the information published for the other home countries that the face is the principal site involved. In Northern Ireland it constituted 54% of the total deaths from skin cancer for males (82% if cheek and ear are included) during the period 1941–3. The ear had second place with 20%. Somerford (1930), from a study of cases of cutaneous cancer, 57 of which were squamous-celled and 175 basal-celled, found that the face was the most common situation for both forms. From this he drew the following conclusion: "This fact in our opinion is against an occupational cause, since the face is the part of the body least likely to be brought into contact with irritating substances used in any occupation." This conclusion (for the face is the only part never covered) is not justified. In several of the occupations named (groups B, C, and D), grime or heat, or grime plus heat, are surely agents which cannot be overlooked. In others, outdoor work with long exposure to sunlight must be taken into account. According to group D of the present series, an occupational factor does seemingly operate, but at present it cannot be said if the facial site is the main involvement. More detailed statistics of location are required before any dogmatic assertions can be justified.

It would be an interesting paradox if soot and sunshine should both prove to have aetiological importance in skin cancer. In practice, however, it would be reasonable and not inconsistent to purify the atmosphere, to provide the people with baths, and to suggest protective measures for those unduly exposed to the radiations of the sun.

Summary and Conclusions

The annual number of deaths from cancer of the skin, excluding that of the penis and scrotum, is approximately 1,000 per annum in England and Wales, and the mortality in males is about 70% in excess of that in females.

The mortality for both males and females from cutaneous cancer is much greater in Ireland than in England and Wales, whereas the Scottish male experience is decidedly more favourable.

The face is the principal site involved. The ear is next in frequency.

The mortality has a definite gradient with social grouping for the wives of workers, but for the males it would seem to have both a social and an occupational relationship, and the latter is seemingly the more important.

These findings, and the anatomical character of some of the sites affected, suggest, on the one hand, that atmospheric soot or other grime (as in the case of scrotal cancer) may need to be considered as an aetiological factor. On the other hand, ultra-violet radiation from the sun may be responsible for skin cancers in exposed sites. Heat, or heat plus grime, may be

operative in such occupations as that of furnacemen, if face and hands should be shown to be frequently involved in these workers.

Classification according to site in official returns is needed to increase the value of correlations with occupational or other social factors. Correlations with geography, or hours of sunlight in different parts of the British Isles and elsewhere, should also have value.

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THE MEASUREMENT OF HUMAN SKILL*

BY

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The Grouping and Stability of the Constituent Items in Skill Performance

I now turn to the second of our three main problems—that of the grouping and stability of the constituent items in a skilled performance. This has been more often studied outside than inside the laboratory. The reason is that fully controlled investigations have been far too occupied with skill of the detailed repetitive kind, the order of constituent items being as definitely prearranged as their character. In daily life this happens very rarely. Variety of order or sequence is combined with a high degree of uniformity of issue or aim.

In *Live Hands*† a former Cambridge University golf captain has written what Bernard Darwin calls "an impassioned plea" for hands as the key to the game. He watched an Open Championship in America, and thus he describes the play of the experts: "Through the feel of their hands they swung the club head and brought it to the ball with the maximum speed and accuracy at the moment of impact. It seemed as if they had stayed behind the ball until after it was hit and that the whole weight of the body flowed in behind the shot." And so also for every other game of skill. The expert may discover his own key, the one thing or the few things that must be used with conscious effort and then everything else will happen right. The bother is that the expert is apt to treat his key as the master, whereas differences of bodily build, and consequently the mechanics of bodily action, should make it clear that in this case, as in many others, one man's salvation is another man's downfall.

We will begin with some simple but most illuminating experiments which have, however, received little attention. They are concerned with the "sense" or direction of movement in the manipulation of controls. Any direction or sense of control movement can easily be made to produce any corresponding movement of display: an upward adjustment of a lever, for example, may produce an upward, downward, right, or left movement of a pointer or a spot of light. Under these circumstances practically everybody will inevitably tend to make fewer mistakes with the up–up relation and then more and more, culminating with the up–down relation. Speaking generally, whenever, as in every form of skill, sensory reactions of differing mode have to be combined some combinations are fundamentally easier and more efficient than others. The study of these preferred combinations opens up an immense field of experiment which has so far been little explored.

It is possible to alter the sense of the manipulatory movement during the course of the experiment without the knowledge of the operator. Nearly everybody now makes a greater amount of error. But the increase is significantly greater in some cases than in others. Some operators make the display the "key," and are delicately perceptive of any change in visually presented motion. These are readily adaptable, changing an upward into a downward bodily action very often without at all definitely knowing what they have done. Others make their "key" the feel of the movement itself, and for these the required adaptation is relatively difficult. It seems as if, paradoxically, the muscular part of the skilled operation is the more efficient the less is known about it. There may be, and I think there are, instances in which the exact opposite is the case, but it is not very easy to find them.

Even when this does happen, as perhaps sometimes in the "feel of the hands" in golf, it never is the whole of the movements that emerge into consciousness. In this instance the enormously complicated follow-through of the whole body, with its complete readjustment of posture, "flows in" automatically. And when we think about it this becomes less paradoxical than it seems at first. For absolutely every skill has its immensely complex embryological basis, the first 40 weeks of which in the vast majority of human performers has proceeded with strikingly little direction from the enteroceptive senses. During this early period all the major fundamental phenomena of posture are achieved. It is customary to regard them as coming to centre about and grow out of the three main types of postural reflex—the attitudinal, the righting, and the statokinetic. But these have none of the fixity and individualization which the later reflexes, dominated by external stimuli and the play of the special senses, show. They appear, disappear, and reappear. Though their pattern remains reasonably constant the ancillary movements which stream out from them change in order, direction, and number as they start now from one position and now from another.

Yet the structure which is later going to dominate all this machinery of the motor and muscular systems, as everybody knows, appears remarkably early and long before it can have much effective use. When the time comes for senses like the eyes and ears and for the central nervous system to play the leading parts in development—for learning proper to take the place of maturation—they have an immense and complex substratum of movement to play with.

So it is not as surprising as might be supposed that one of the very common features of diminishing skill is an increased awareness of what the whole body is doing. We found that the air pilot, fresh and keen, follows his instruments and their signals closely and lets all his bodily equipment, so to speak, do as it likes. When impulses from the body do "rise into consciousness," as the common phrase puts it, they are interpreted in terms of the machine, as in steep turns and banks, in rapid acceleration, in climb and dive. But as he gets tired and his skill tends to break up, the messages from the body become, in their own right, insistent and oppressive. He is cramped, too hot, or too cold; there is pressure here and there; sometimes it seems that the instruments cannot possibly be right.

The really important upshot of all this is that every skill has its key features. They differ from case to case and

* The second of two Oliver-Sharpey Lectures given at the Royal College of Physicians of London on Jan. 23. The first lecture appeared in last week's issue.

† E. M. Prain. London: Adam and Charles Black. 1946.