progeny there was found a male No. 2 (Fig. 1, No. 3) which bore distinctly the same abnormality except that the twist was to the right.

This male was mated to a normal nosed sister and among their offspring was found male No. 1085 (Fig. 1, No. 4) in which both nasal bones were shortened. The genetic relationships between these animals are shown in figure 2.

The data are insufficient to establish the exact mode of inheritance. The character is so rare that it is very improbable that the wild stock carried it as a recessive character. One possible explanation is that of a dominant unit character with normal overlaps.

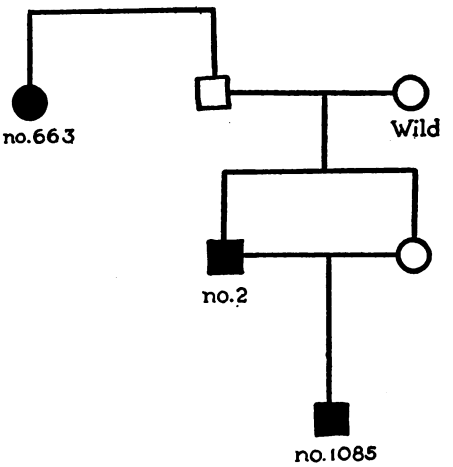

FIGURE 2

Pedigree Chart showing the transmission of a twisted nose through three generations in the House Mouse.

ON THE AMOUNT OF EXTERNAL MIRROR IMAGERY IN DOUBLE MONSTERS AND IDENTICAL TWINS

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Morrill,[1] who in 1919 reviewed the literature upon internal imagery in double monsters, mentioned that there were no data available upon external characters. Wilder[2] examined a case of conjoined twins (Margaret and Mary). In this case there was no asymmetry in the hands and therefore the nature of the imagery could not be determined. But the left sole of Mary was more nearly like the right sole of Margaret than like her own right sole and hence this may be considered a case of mirroring.

Mirror imaging has long been known in twins and has been well studied.

With difficulty, one is able by the aid of a binocular to make out the friction patterns upon the hands and feet of foetuses of seven months or more gestation. The finger tips are usually much wrinkled in uninjected specimens, but by persistence one is able to pinch them flat long enough to record the gross form of the pattern. Head whorls are developed and ear shapes are distinct.

On account of the paucity of data available, it seems worth while to put on record our observations made on foetal monsters, comparing the frequency of mirroring here with that found in a sample series of identical twins.

A series of 14 pairs of identical twins was examined in Boston (see table 1).

TABLE 1

IDENTICAL TWINS

(Spaces left blank indicate lack of asymmetry in the character)

NAME	HANDS	TEETH	HAIR WHORL	EARS	NUMBER OF MIRRORED CHARACTERS DETECTED	NUMBER OF IDENTICAL CHARACTERS DETECTED
Hamilton	*I*		*I*		0	2
Segel	*I*		*I*		0	2
Lightbody	*M*		*I*		1	1
Spector			*I*		0	1
Holland			*I*		0	1
Levy	*I*		*M*		1	1
Morris		*I*	*I*	*M*	1	2
Donnelly			*I*		0	1
Dooling			*I*		0	1
Dooley	*I*	*I*	*M*	*M*	2	2
Cassidy			*I*		0	1
Stall			*I*		0	1
O'Leary			*I*		0	1
Marshall			*I*		0	1
Total					5	18
Total in %					22%	78%

The Lightbody twins show mirroring in the hands, but identity in the head whorl. The Levy twins show mirroring in the head whorl, but identity in the hands. The Morris twins show mirroring in the ear-lobe, but identity in hands and a crooked canine-tooth. The Dooley twins are mirrored in whorl and ears, but identical in teeth and hands. The Hamilton and Segel twins show identity in hands and hair whorls. The remaining eight pairs of twins show identity in hair whorls. Out of 23 asymmetrical characters 5 or 22% were mirrored. In this series, out of 14 pairs of identical twins four pairs showed some mirroring.

The twins exhibiting mirrored hand patterns were both right-handed, indicating that handedness depends upon cerebral dominance and not upon hand form.

A series of ten double monsters was studied. We have separated them into two groups: those joined on the side and those joined ventrally or by the head.

Table 2 shows the number of mirrored and identical characters detected in double monsters joined at one side. In the six double monsters

TABLE 2

DOUBLE MONSTERS JOINED AT SIDE

(Spaces left blank indicate lack of asymmetry in the character)

SPECIMEN	HANDS	FEET	HAIR WHORL	EARS	NUMBER OF MIRRORED CHARACTERS DETECTED	NUMBER OF IDENTICAL CHARACTERS DETECTED
Carnegie 1616	*M*	*M*	*M*		3	0
Carnegie 3328	*M*	*M*	*M*	*M*	4	0
Carnegie 2107	*M*	*M*	*I*		2	1
Harvard 5834	*I*				0	1
Harvard 10477	*M*				1	0
Warren Dr. Perley	*I*				0	1
Total					10	3
Total in %					77%	23%

joined upon the side we have found 10 or 77% mirrored and 3 or 23% which are identical. Four monsters out of six showed external mirroring.

TABLE 3

DOUBLE MONSTERS JOINED VENTRALLY

SPECIMEN	HANDS	FEET	HAIR WHORL	EARS	NUMBER OF MIRRORED CHARACTERS DETECTED	NUMBER OF IDENTICAL CHARACTERS DETECTED
Dr. Parker Warren	*I*		*I*	*M*	1	2
Dr. McCollem Carnegie 3713	*I*	*I*	*I*		0	3
Warren Dr. Torbert	*I*	*I*	one head	two ears	0	2
Total					0	0
Total in %					1	7
					13%	87%

The results for the ventrally joined monsters are tabulated in a similar fashion in table 3. Among three ventrally joined monsters showing asymmetries, one pair of characters is mirrored and 7 pairs are identical. One monster out of three showed mirroring.

Although granting the high probable error present through the meagreness of our data, nevertheless, there appears to be a distinct difference in the relative numbers of mirrored and identical characters correlated with the two modes of union. Among the laterally joined monsters, 10 out of 13 asymmetrical pairs of characters or 77% are mirrored. Among the ventrally joined monsters 1 out of 8 asymmetrical pairs of characters or

13% were mirrored. This may be contrasted with our findings for identical twins where 5 out of 23 asymmetrical characters or 22% were mirrored.

It is well established that gross internal mirrorings in double monsters are more frequent than in identical twins. It may be conceived that early and complete separation of twins leaves each individual independent to develop the asymmetries determined by their identical heredity. Where later fission or incomplete separation takes place the dual organism develops as a whole with mirror tendencies, some of which may be overcome by the normal body orienting tendency of the individual.

Since one individual of a pair of twins or a monster is normal with regard to the orientation of unpaired asymmetries such as the head whorl and viscera, etc., whereas the other may have any condition between complete reversal of all patterns and the normal orientation, we may think of the former individual as the pattern and the second as the mate influenced toward mirror imaging by its relative position, orientation and time of separation from the pattern individual.

In two of our monsters joined upon the side, the left individual was the pattern or normally oriented twin as indicated by the reversal of head whorl in the right twin. The other specimens gave no data upon this point, since both individuals had similarly oriented whorls.

Summary.—1. A series of 10 double monsters was examined for external asymmetries. Out of 6 monsters joined upon the side, mirrored characters were found in 4. Among these there were found 10 mirrored pairs of characters and 3 identical pairs.

2. Among 4 double monsters joined ventrally or by the head, 3 showed asymmetries of which 1 pair of characters was mirrored and 7 pairs were identical.

3. Among 14 pairs of identical twins all showing asymmetries, 4 pairs showed some mirroring. Among all the twins together, 5 characters or 22% were mirrored, while 18 or 78% were identical.

4. Some mirroring was found in 29% of the twins, 33% of the monsters joined ventrally and 66% of the monsters joined laterally.

5. Relative position, orientation and time of separation may be factors involved in determining mirroring both in double monsters and in identical twins.

I am indebted to the Warren Museum of the Harvard Medical School, Dr. G. L. Streeter of the Carnegie Institution, and Professor G. H. Parker for specimens employed in this study.

[1] Morrill, C. V., *Anat. Record*, June, 1919.

[2] Wilder, H. H., quoted from H. H. Newman, *The Biology of Twins*, Univ. of Chicago Press, Chicago, **1924.**