ON MIRROR-WRITING AND ITS RELATION TO LEFT-HANDEDNESS AND CEREBRAL DISEASE.

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BUCHWALD and Erlenmeyer have directed attention to what they call *Spiegelschrift* or mirror-writing, because, like the impression of a letter taken upon blotting-paper, it can be most easily read by those not used to it in a mirror, where the reflected image takes the appearance of ordinary writing. This inversion of our written characters is sometimes done as a species of puzzle for amusement or curiosity; but I have lately met with several instances where it was seriously produced, apparently as an imitation of ordinary writing.

E. M. was a paralytic imbecile girl. She was believed to have been hemiplegic on the right side from birth, though the weakness was not decidedly noticed till she was six months old. When admitted into the Larbert Institution in 1875, aged 7 years, she was able to say a few words rather indistinctly. She was found to be subject to occasional visits of epileptic vertigo, and more rarely epileptic fits. She was helpless with the right arm, but able to halt along with the right leg. The outline of the head was rounded, or slightly bulging on the left side above the ear. The girl was active in disposition, mirthful, and somewhat mischievous. About eighteen months ago on the governess commencing to teach her to write, which was done by getting her to copy a lithographed line at the top of the page, the girl formed the

letters with the left hand from right to left in mirror-writing thus—

L. N. (aged 14), genetous imbecile girl, of considerably greater intelligence than the first case, is scoliotic in spine, and deformed in the lower limbs through rickets. The head is of good size and regular shape, save that it is somewhat flattened at the occipital region. There is a bulging behind and above the right ear. The palate is rather unsymmetrical in shape, and some of the teeth are irregularly placed $\frac{1}{2}$. There are eight on the right side of the upper jaw, and eight on the left side of the lower one. She used to be left-handed. This girl also began to write in mirror-writing with her left hand, but was interdicted, and has now entirely given it up. She has been gradually broken from using the left hand, and sews pretty fairly with the right. When I asked her to give me a specimen of the mirror-writing, I found that she could only do it with her left hand. Apparently she can write from right to left with about as much ease as from left to right, but cannot now read it so well; she reads from her lesson-book with some effort words of two syllables, and sews pretty fairly with the right hand. Though she speaks freely on simple subjects, she cannot make any explanation as to the directions which she gives to her writing with either hand; but one cannot expect any analysis of a mental process or complex action from an imbecile girl.

There are two idiot boys in the school who are forming pothooks from right to left, being left-handed, so that in time they would teach themselves mirror-writing.

I have consulted several experienced superintendents of Training Schools for Idiots who have seen no instances of mirror-writing with imbeciles; but Mr. Millard, the Superintendent of the Eastern Counties Asylum, Colchester, has

kindly communicated to me the description of one case. A. B. W., imbecility believed to be congenital, admitted when 12 years old. Teeth pretty good, "spine and limbs partially paralysed," choreic, can walk and run, dress and feed himself. He can do simple sums in subtraction, multiplication, and division; can read, and possesses moral and religious sense; his judgment is defective; knows his right hand from his left. "He writes backward with his left hand, so that it is only legible by turning the paper round or by a mirror."

A friend of mine who had seen the mirror-writing of the imbecile girl was struck at finding the same inversion in one of his own pupils. He was left-handed, and as teachers think it their duty to compel left-handed children to use their right, the boy, finding this difficult, when the teacher was not looking secretly wrote with his left hand, and the result was a page of mirror-writing, which the boy apparently thought was a copy of the lithograph.

The boy is 13 years of age, pale, thin and flabby. He is infirm in the legs to such a degree that it might be described as a minor degree of paraplegia. I thought the right leg was weaker than the left, but the boy did not seem to be sure of this himself. The head is somewhat small, but quite as symmetrical as is usually met with; the contour slightly fuller on the left side above the ear. Out of school he still uses the left hand. The teacher describes the boy as rather intelligent, and getting on well at his lessons. On being requested to copy a passage out of a book in mirror-writing, he very soon returned with it fairly copied. I asked him, "Did you write this with your right or your left hand?" at which he said, with some hesitation, that he did it with his right. I told him nobody would be angry with him; when he confessed that he had written it with his left hand, as we had asked him for a specimen of the writing and he could only do it with the left hand. He could read the mirror-writing fluently. It is perplexing that any one should in copying a line lithographed at the top of the page imagine he was correctly reproducing it when he was writing it in an inverse direction.

For example, if any one were told that he must write the

word "wonderful" from right to left, he would commence with the *l*, and trace the letters backwards; while these two pupils not only wrote from right to left, but they inverted the image of the word, so that while the *w* of the copy was on the left, in their imitation it appeared on the right, as if they had scratched on a pane of glass, and turned it and read it on the opposite side. This, of course, is different from ordinary handwriting from left to right, such as was practised by the Hebrews and Etruscans, and in the modern Arabic letters throughout the Mahomedan world. In their manuscripts or lithographs the lines begin at the free side of the page and run to the left, but then the Arabic letters are naturally adapted to be traced in this way, and indeed it would be difficult to form them in any other. Familiar with this writing by my residence in India, I am of the opinion that if it is more difficult to read than the English characters, this is not because it runs from right to left, but, owing to the suppression or uncertain quantity of vowels, the writing is so little phonetic that it needs a knowledge of the language ere one can read a Hindustani or Arabic book. A clerk cannot copy Arabic writing so quickly as English, but this is owing to the nature of the characters, which are more numerous, and most of them having an initial, medial and final form.

I have been told by one who practised mirror-writing for amusement, that it is easier to trace with the left hand, and the following experiment, made by my friend the teacher, will show that there is a physiological tendency with left-handed children to fall into mirror-writing. He took a class of sixty boys and girls, and told them all to write their names with their left hands. All copied as well as they could, writing from left to right. Some two girls and three boys wrote in mirror-writing. These were found to be all left-handed, and the only left-handed in the sixty. It did not appear that these children were conscious that they were writing in an inverse direction different from the rest. The left-handed children went to work instantly without any perplexity, traced their letters better than the other children.

Miss C., the teacher in a public school, took 134 children of the junior division, and, getting the assistance of a

colleague, separated them into small divisions, gave them pencil and paper, and told them to write with their left hands, and not to look on one another's papers. Apparently there were six children known to be left-handed or to have a tendency to use the left hand, and three of these wrote in mirror-writing, and none else. In one experiment it was found that a man who tried to write a few Hindustani words in Arabic characters with his left hand, unconsciously traced the letters from the left in mirror-writing.

Dr. Erlenmeyer, in his interesting pamphlet on the *Physiology and Pathology of Writing*,¹ observes that it seems to be easier to use the arms in a centrifugal direction, the left from the right and the right from the left, the motions not being hindered by the trunk of the body, and that where ease, elegance and security are needed the movements of abduction are always performed. He gives turning a hand-mill, striking a lucifer match, and executing the most brilliant passages on a piano as examples, and assures us that he could easily give more of the kind. In that case his instances do not seem to be well chosen. I have been assured that many of the most striking passages on the piano are performed both to and from the centre, and some exercises requiring skilful execution are certainly done in a centripetal manner; using the sling, bowling and batting in cricket are examples; and in fact, whether in fencing, swimming, sewing, or other actions, movements must be made both from and towards the centre of the body. Nevertheless, taking everything into consideration, it appears true that most actions requiring skill in their performance are done easiest by the arms in a centrifugal direction.

Dr. Wilbur of Syracuse (N. Y.) has kindly sent me specimens of the performance of a man who could write the same words with both hands at once, the right hand in the usual way, the left in the mirror-writing; but as he could also do the same feat with both hands moving from left to right in ordinary text, it seems to be more a piece of sleight-of-hand than any obedience to a physiological tendency. Dr. Wilbur

¹ 'Die Schrift, Grundzüge ihrer Physiologie und Pathologie von Dr. Albrecht Erlenmeyer;' Stuttgart, 1879.

mentions the case of a left-handed child who, when beginning to read, asked his father what "efiw" was. On being told that there was no such word, the child brought his book and pointed out the word "wife." The boy for some time after made similar mistakes. Such inversions not unfrequently occur in teaching imbecile children to read; they will call "no," "on," or "was," "saw." At Larbert we generally taught them small words before teaching them the letters.

Buchwald, in a contribution to the Berlin 'Klinische Wochenschrift,' three years ago, gave the case of a man of 45, who presented the ordinary symptoms of apoplexy with hemiplegia of the right side. After the somnolence had disappeared, which for some days followed the attack, it was found that he was aphasic. He was induced to try writing with the left hand, as he could not do it with the right. He wrote in a very skilful manner his name in mirror-writing from right to left, as well as the numerals from 1 to 10, except the figure 8, which he had forgotten. The inverse direction of his writing was pointed out to him, but he could not be induced to try writing from left to right. His name and some figures being written out and held before him, he copied them awkwardly, but again fell into the mirror-writing. After a time he traced the numbers 1, 2, 4, 6, 8, and 9 correctly, but gave 3, 5, and 7 in mirror-writing. He was asked to multiply a few figures, and the ciphers were correctly put down for him; he wrote the sum from right to left. In this case he must have multiplied the numbers in his mind and then recorded the result in mirror-writing. The patient remained about six months in the hospital at Berlin, during which time, though the aphasia, agraphia, and alexia disappeared, the tendency to mirror-writing still persisted. He gave himself great trouble in trying to copy writing from left to right; he said that he could not perform it in this direction with the left hand; when he again had the use of the right hand he would do it correctly. In trying to trace the letters from left to right he was obliged to use the half-paralysed right hand to help the left, otherwise the operation miscarried. The 5 was the most difficult to form. Even with the right hand he traced the cipher in mirror-writing, at least he could not manage the hook of the 5 otherwise.

The best known example of a change from right-handed to left-handed writing, Dr. Erlenmeyer tells us, is that of the MS. of the 'Codex Atlanticus' of Leonardo da Vinci, in the Ambrose Library at Milan. It was generally said that in adopting this singular style of writing Leonardo wished to preserve his work from the eyes of superficial readers; but we can now give another explanation. There is a diary in the National Library at Naples, of the priest Antonio de Beatis, who in 1517 travelled in the train of the Cardinal of Arragon, through Germany, the Netherlands, and France. The Cardinal visited Leonardo da Vinci, who passed the last years of his life in the neighbourhood of Amboise, in a villa given to him by Francis I. De Beatis remarks of the famous artist, in his journal, "that nothing more of value in painting could be expected of him, as he had paralysis of the right hand." It would appear from this that Leonardo da Vinci, being unable to use his right hand, wrote with his left, and fell into the practice of writing from right to left, in obedience to a tendency which we have sought to illustrate.

It may be asked, is the image or impression, or change in the brain-tissue from which the image is formed in the mind of the mirror-writer, reversed like the negative of a photograph; or if a double image be formed in the visual centre, one in the right hemisphere of the brain and the other in the left, do the images lie to each other in opposite directions, e.g. C on the right side and $\complement$ on the left side? We can thus conceive that the image on the left side of the brain being effaced through disease, the inverse image would remain in the right hemisphere, which would render the patient apt to trace the letters from right to left, the execution of which would be rendered all the more natural from the greater facility of the left hand to work in a centrifugal direction. Moreover, when one used the left hand to write, there would probably be a tendency to copy the inverse impression or image on the right side of the brain. Probably it would be well to collect more examples of mirror-writing, and to study them carefully before indulging in speculations; but it seems to me that there are grounds for suspecting that in some of the cases the mental image was really reversed, as well as the copy reproduced on the paper.