TYPES OF DEXTRALITY

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The subject of dextrality is usually treated as if there were but one type of right-handedness, while in reality there are at least three distinct types of right-handedness with three corresponding types of left-handedness, making in all six forms of dextrality.

The following classification of dextrality according to types is based on the varying manner in which right-handed individuals perform bimanual operations, namely, acts requiring both hands, such as swinging a baseball bat and sweeping with a broom. As an illustration of this variation, we may take two famous baseball players, Tyrus Cobb and Rogers Hornsby. Each of these men is right-handed. Both of them perform such operations as throwing the ball, and other unimanual acts, with their right hands; but in bimanual operations they differ, for Cobb bats left-handed and Hornsby bats right-handed, thus exemplifying two different types of dextrality.

The three types to be discussed will be designated by the symbols *A*, *B*, and *C*. Type *A* comprises those whose bimanual preference is divided between right and left. An individual throwing and batting right-handed, but using a broom or shovel left-handed would exemplify type *A*. Type *B* includes those whose bimanual preference is the opposite of their unimanual preference, and is exemplified by Tyrus Cobb who throws right-handed and bats left-handed. Type *C* embraces the individuals whose unimanual and bimanual preference is the same. The ball player who throws, bats, and also uses a spade right-handed belongs in class *C*. Not knowing how Mr. Hornsby uses such instruments as the shovel and spade, we cannot tell whether he belongs in type *A* or *C*. The same doubt does not exist in Mr. Cobb's case,

as will be explained later. I have arranged the types in the above order because *A* seems to be the most common and *C* the least common.

Since this classification is based on the bimanual preference, it will be well at this point to discuss bimanual operations in some detail. In designating bimanual dextrality it is generally agreed to call those individuals 'left-handed' who hold the left hand nearer the business end of the instrument. The typical bimanual operations fall into the following regular series, designated by the instrument employed:

ball bat	pitchfork
golf club	shovel
ax	broom
spade	

From extended observation I am sure that the majority of the human race use the broom and shovel left-handed, and the ball bat right-handed; thus coming under type *A*. In the above series the golf club and ax are on the dividing line, and in the order named, for the ax is more likely to follow the broom, and the golf club will follow the bat unless, as often happens when the preference is left-handed, there are no left-handed clubs available. On this account many golf players have had to develop an artificial right-handedness in swinging the clubs. More than any of the other bimanual operations, the use of the ball bat seems to require the same elements of dextrality which enter into unimanual dextrality.

It should also be noted that there is a great variation in the strength of the natural bias. Some individuals are inveterately left-handed, while others are easily converted. Some children have so little preference as to appear practically ambisinistral. The bimanual bias is seemingly independent of the unimanual, and often is much stronger. I myself have very little preference in unimanual operations, but a very decided natural bias in bimanual acts. It makes little difference which hand I use to throw, or hammer, but I must use a spade right-handed. In others it is often the unimanual

bias which is strong and the bimanual which is weak. In the latter case the subsequent development is into type *A*. When both uni- and bimanual biases are naturally strong, and at the same time opposite, the development is into type *B*.

In order to summarize these facts clearly I shall exhibit them in a tabulated form, employing the symbols: *R*, *R*₁, *R*₂, *L*, *L*₁, *L*₂, and *O*.

R = right-handed, *L* = left-handed, when two symbols are used together, as in the formula *RL*, the first symbol refers to the unimanual preference and the second symbol to the bimanual preference. The dextrality of Tyrus Cobb is then represented by the formula *RL*, because he throws right-handed and bats left-handed, being classified under type *B*. Type *A* is represented by the formula *RR*₁*L*₂ because in type *A* the bimanual operations high in the series follow the unimanual preference, while those low in the series are performed on the other side. A man, therefore, who throws right-handed, bats right-handed, and uses a spade left-handed is represented *RR*₁*L*₂. *O* represents the weak bias approaching an ambisinistral condition. To illustrate I shall label a few individuals of my acquaintance, arranging them in what seems to be the relative frequency of the occurrence of their respective types.

Name	Probable Natural Bias	Habitual Preference	Resulting Type
John C.....	<i>RO</i>	<i>RR</i> ₁ <i>L</i> ₂	<i>A</i>
John R.....	<i>RL</i>	<i>RL</i>	<i>B</i>
Gilbert J.....	<i>RR</i>	<i>RR</i>	<i>C</i>
David R.....	<i>OO</i>	<i>RR</i> ₁ <i>L</i> ₂	<i>A</i>
John J.....	<i>OL</i>	<i>RL</i>	<i>B</i>
John F.....	<i>LO</i>	<i>LL</i> ₁ <i>R</i> ₂	<i>A'</i>
Andrew P.....	<i>LR</i>	<i>LR</i>	<i>B'</i>
Charles H.....	<i>LL</i>	<i>LL</i>	<i>C'</i>
Self, natural.....	<i>OR</i>	<i>RR</i>	<i>C</i>
Self, changed.....		<i>LL</i> ₁ <i>R</i> ₂	<i>A'</i>

John C. throws a ball right-handed, bats right-handed, and pitches hay left-handed; John R. drives a nail right-handed, uses a ball bat left-handed, and shovels left-handed; Gilbert J. did everything right-handed; and so on down the list.

The double representation for myself is necessary on account of the changes I have made as the result of many years' experimenting. At the age of 10 years a broken right arm led me to the discovery that I could eat, or do anything else about as well with my left hand as I had with my right. I immediately became very much interested in the whole subject and tried to see if I could change all my actions, both unimanual and bimanual. There was no difficulty with the unimanual change, except in writing; but the bimanual bias was too deeply seated to make a complete change. It was very little trouble to learn to throw left-handed, but quite difficult to learn the left-handed use of the ball bat and ax, while I have never been able to accustom myself to the left-handed performance of operations low in the bimanual series.

In the relations of uni- and bimanual preference, a curious fact develops which might be anticipated from the results set forth in the above table. There is no such combination as RR_2L_1 , or LL_2R_1 —stated positively:

- (1) XR_1L_2 is always RR_1L_2 , type A ;
- (2) RL_1X_2 is always $RL_1L_2 = RL$, " B ;
- (3) RX_1R_2 is always $RR_1R_2 = RR$, " C .

As a matter of course, when R and L are interchanged we get:

$$\begin{aligned} XL_1R_2 &= LL_1R_2 & A' \\ LR_1X_2 &= LR_1R_2 = LR & B' \\ LX_1L_2 &= LL_1L_2 = LL & C'. \end{aligned}$$

Hence the statement made above, that there is no doubt in the case of Mr. Cobb, for knowing from baseball records (1) that he is RL_1X_2 the X is easily determined to be L by the above formulæ. When one is seen throwing right-handed and batting left-handed then it is certain that he would pitch hay left-handed.

It will be seen that in type A the unimanual preference can be deduced from the observation of one high and one low bimanual operation; in type B the low bimanual operation can be deduced from one unimanual and one high bimanual; in type C the high bimanual can be deduced from one uni-

manual and one low bimanual. It would be possible by training to develop artificial exceptions to the above equations. This actually happens in the use of scythe and golf club, because left-handed implements are not available to any great extent; but even in such cases it is only for the one operation that the preference is disturbed. The individual who uses a scythe right-handed, contrary to preference, continues as before in all other operations. I have never observed a single exception to the above formulæ, which could not be clearly proved to be artificial.

In this same connection, a hypothesis may be ventured concerning cross-handed batting, being stated tentatively because my observation of this phenomenon has been limited to some ten or twelve individuals. A cross-handed batter is an amateur baseball player who stands on the wrong side of the plate when at bat, if you judge the correct side by which hand is held nearer the outside end of the bat. The player who thus stands on the wrong side of the plate must bat with his wrists crossed, thus shortening the reach of his bat by two or three inches. The one act of cross-handed batting puts an individual in a sub-class of type *B* and indexes completely all his other actions, both unimanual and bimanual. To see a man standing on the north side of the plate and batting cross-handed is to know that in everything else he is strictly *RL*, and that he is so addicted to the left-handed performance of bimanual operations that he will not put his right hand further out than his left even though he prefers to stand on the left side of the plate. Professional players, at least in the major leagues, are not allowed to bat cross-handed and so the natural *RL* cross-hander generally becomes an artificial *RR₁L₂*, though sometimes he steps to the other side of the plate and remains *RL*, true to type.

The six forms of dextrality existing in practice are then:

1. <i>RR₁L₂</i>	<i>A</i>	4. <i>LL₁R₂</i>	<i>A'</i>
2. <i>RL</i>	<i>B</i>	5. <i>LR</i>	<i>B'</i>
3. <i>RR</i>	<i>C</i>	6. <i>LL</i>	<i>C'</i>

and these resolve into the three types:

A.	RR_1L_2	LL_1R_2
B.	RL	LR
C.	RR	LL .

B is the ideal type, from the standpoint of symmetrical bodily development.

It should be remarked that not all acts requiring the use of both hands are bimanual in the sense here used. The holding of a rifle requires both hands, and the playing of the violin requires both hands, and normally it is the left hand which is held furthest from the body in each operation; yet in such cases nothing is indicated as to bimanual dextrality, for the act is unimanual as far as dextrality is concerned and the left hand is simply acting under the direction of the right as when it bears the baseball mitt or the warrior's shield. Accordingly the *RR* billiard player will hold his left hand nearer the distant end of the cue, for he is really performing a unimanual operation in which the left hand plays a passive rôle.

The overlooking of the phenomena of bimanual dextrality gives rise to such misstatements as that of Dr. Ernest Jones (2) when he says: "It is exceptional to find a right-handed individual who does not perform some actions better with the left hand." And the failure to observe the types of dextrality may possibly explain some of the failures to obtain definite results in the investigations of the heredity of dextrality. It is undoubtedly hereditary, but that is about all one can safely say. Dr. F. Ramaley (3) concludes that dextrality is probably a Mendelian recessive, but Dr. W. M. Barrows has removed that hypothesis from the field by the discovery of two families in each of which both parents are left-handed, and the children a mixture of right and left. It is possible that a study of pedal dextrality will also be necessary before the heredity question can be cleared up, for the inheritance may go back and forth from hand to foot as in the case of club foot and claw hand.

In the frequent observations made on the 'spade foot' the fact is always overlooked that the foot used in spading

is determined entirely by the bimanual dextrality. Any individual who is XXL_2 will use his left foot on the spade, an occasional cartoonist to the contrary notwithstanding. L. G. Smith (4) says boys always leap on the spade foot. If this be true, then a very important connection has been established between pedal dextrality and bimanual dextrality.

It must be borne in mind, however, that the faculty of springing and kicking are as independent of each other as uni- and bimanual dextrality, and possibly occurring in somewhat the same ratio, that is, the great majority of people kick with the right foot, while the most of them probably spring with the left. My observation of pedal dextrality has been limited, but has always borne out the above statements; so I suggest the probability that the right-handed forms of types A and B kick with the right foot and spring with the left, while C uses the same foot for both actions.

It will be seen from the above remarks that scientific investigations of dextrality should always be accompanied by determination and analysis of the types.

REFERENCES

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4. SMITH, L. G. A Brief Survey of Left-handedness. *Ped. Sem.*, 1917, 24, 19-35.
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