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It has been frequently said that there are two notable aspects that characterize hominid evolution. The first relates to speech (Lieberman, 1975, 1984, 1991) and the other to manual skill (Napier, 1980; Oakey, 1981). In recent years, much speculation has centered around the archeological evidence concerning both the origins of language (or symbolism) and the beginning of tool making (Schick & Toth, 1993). However, 135 years ago, the French neurologist Paul Broca reported a significant association between speech and manual skill. He found some 95% of aphasia cases appeared to be associated with damage to the left-hemisphere.

Neurologist have an intense interest in handedness as an index of cerebral lateralization. Handedness, the preferential usage of one hand over the other for skilled and unskilled manual activity, is the clearest example of lateralization. Human beings are overwhelmingly right-handed with approximately 90% of the population using the right hand for writing and other unimanual skilled activities. Right-handedness is slightly greater in women ranging from 1% to 4% (Harris & Carlson, 1988).

The relationship between handedness and representation of functions are neither clear nor direct. To date, no specific genetic markers have been associated with human hand preference. In the past 50 years, literally hundreds of papers have been published investigating relationships between hand preference and cognitive functions. Yet there are few solid
findings; because for every paper that finds a link with cognitive deficits or talents, there are others that do not (Bishop, 1990). One reason for this uneven pattern of findings may be that remarkably little attention has been paid to the question of how to assess handedness.

Population variation in handedness is in part genetic and its persistence represents a balanced polymorphism with respect to cognitive ability (Crow, Crow, Done & Heask, 1998). Annett (1985), Annett & Manning (1989, 1990) have proposed that left-handedness is maintained by balanced polymorphism whereby rs + - heterozygotes manifest increased intellectual ability compared with rs - - and rs + + homozygotes. Annett has argued for a heterzygote advantage for rs + - individuals over both rs - - and rs + + people. Since Annett's model is becoming increasingly acceptable (e.g. Corballis, 1991; Brand, 1995; Dellotalas & Curt, 1995) and there are problems inherent in her model (Mc Manus et. al, 1993) and contrary evidences (Mc Manus et.al., 1993, Resch et.al., 1997; Cerone & Mc Keever, 1999), the present investigation is an endeavour to study the Annett's theory of a balanced polymorphism with heterozygote advantage for laterality and ability and to cross validate it according to McManus et.al.'s criterion (1993) using reliable and standardized instruments.

The following specific hypotheses were proposed:

1. The rs + - heterozygotes will manifest increased cognitive ability than rs + + and rs - - homozygotes on non verbal and verbal measures of intelligence.
2. The rs + - heterozygotes will score higher than rs - - and rs + + homozygotes on measures of creativity.

3. There will be a significant interaction of sex and handedness groups on measures of non-verbal, verbal intelligence and creativity.

4. Within right-handed subjects, R1 (weak dextrals) and R2 (less strong dextrals) groups (rs + -) will score significantly higher than R3 (strong dextrals) group (rs + +) on measures of non-verbal, verbal-intelligence and creativity.

To fulfill the objective of the study a 2 x 3 factorial design was used. Sex and handedness were independent variables of the study. Sex had two levels females and males. Handedness had three putative genotypes viz. rs - -, rs + - and rs + +.

The study covered a sample of 2645 subjects (1465-males and 1180 females) in the 1st stage of sampling. Of these, 240 subjects were selected and classified as right-handers, mixed handers and left-handers on the basis of hand preference scores. These subjects were administered hand proficiency task battery on a wide range of tasks and measures of intelligence and creativity. The subjects were further sub divided into putative genotypic groups viz rs - -, rs + - and rs + + on the basis of averaged laterality index \[100 \times \frac{(R - L)}{(R + L)}\] of dotting circles, copying alphabets and tapping alternatively hand skill tasks. The familial sinistrality was also considered while classifying the subjects into homozygous groups. The groups, from most to least sinisteral yielded group sizes of 29 (10 females, 19 males), 51 (18 females, 33 males) and 44 (24 females, 20 males), respectively. The subjects were also divided into three
groups of right-handed subjects only on the basis of McManus et.al. (1993) criterion. The subjects whose laterality indices (L.I.) were negative (i.e. rs = -) were dropped and subjects having laterality indices upto 106.33 were excluded. Subjects having L.I. of 107 and above were equally divided into three groups (40 each) viz., R1 (weak dextrals), R2 (less strong dextrals) and R3 (strong dextrals).

The following psychological instruments/tests were administered to all the subjects.

(I) Handedness Inventory in Hindi (Test for assessing hand preference)

(II) Hand Proficiency Task Battery (to assess hand skill) comprising of 11 tasks viz., copying alphabets, dotting circles, thread pegging, grip power holding, grip power counting, cutting marked paper, pegging holes, screwing holes, tracing stars, tapping alternatively and tapping both hands. The obtained L.I. was factor analysed. All the tasks loaded significantly on one factor. The tasks copying alphabets, dotting circles and tapping alternatively were having highest factor loadings. Their laterality indices were summed up and average was taken for dividing the subjects into different groups.

(III) Standard Progressive Matrices (A Non-Verbal measure of Intelligence).

(IV) Jalota's General Mental Ability Test - Hindi (A verbal measure of intelligence).

(V) Baqer Mehdi's Non-Verbal Test of Creativity.
The three cognitive measures yielded an overall of ten scores viz., non-verbal intelligence-I, verbal intelligence - 4 (scores on verbal ability (V), numerical ability (N), reasoning ability (R) and aggregate (GMAT - 'total')) and creativity - 5 i.e. elaboration non-verbal (EN), Elaboration Verbal (EV), originality non-verbal (ON), originality verbal (OV) and composite (creativity - 'total'). The data were collected into two sessions under standard testing conditions with uniform set of instructions. The subjects were tested in small groups of 10 persons. The data collected on three cognitive measures were processed and analysed.

The findings of the study as detailed through statistical analysis were:

(i) Means and SDs for each variable were computed separately and to know the nature of the distribution the curve was drawn.
(ii) A 2 x 3 ANOVA with unequal cell frequencies weighted with harmonic mean, to see the effect of handedness and its interaction with sex in terms of measures on cognitive tasks (Kepple, 1971).
(iii) Trend analysis through the use of orthogonal polynomials (Winer, 1971) when handedness variable was significant.
(iv) Post-hoc analysis by New-man Keuls Range Test of group differences (Baroota, 1989).

The results obtained can be summed up as follows:

(i) A J-shaped distribution of hand preference scores is obtained with a strong peak at the right most extreme, a less pronounced peak at the left
most extreme and a relatively few individuals clustered around the neutral point.

(ii) A bimodal hand skill distribution is revealed on the basis of averaged laterality indices and exhibit a strong relationship with the direction of hand preference.

(iii) Handedness effect has been significant on non-verbal intelligence. Heterozygous group outscores, homozygous groups on progressive matrices. The expected quadratic relationship in the form of an inverted 'U' between R–L hand skill continuum and non-verbal intelligence is confirmed. The R1 group i.e. weak dextrals out - performs the R2 less strong dextrals on non-verbal measure of intelligence. However, R3 (strong dextrals) performs better than R2 (less strong dextrals).

(iv) Reasoning ability has been found to be the single contributor for significant handedness groups' differences out of four components of verbal intelligence. There is small but significant heterozygote advantage over rs – – homozygotes only. An inverted 'U' quadratic trend is discernible between R – L hand skill and reasoning ability component of verbal measure of intelligence.

(v) In addition to reasoning ability R1 group significantly outperforms R2 group on GMAT - 'total' and verbal ability scores. However R3 (strong dextrals) performed better than R2 (weak dextrals).

(vi) Handedness significantly affects three out of five components of creativity. The heterozygous group performs better than homozygous groups on composite creativity scores, elaboration non - verbal and originality verbal dimensions of creative measure. An inverted 'U' quadratic trend is visible in creativity composite, elaboration non-verbal and originality verbal components of creativity. A significant linear trend also appears for
originality verbal component of creativity. R1 (weak dextrals) outperformed R3 (strong dextrals) on aggregated creativity scores. Significant linear declining trend is discernible in R1, R2 and R3 groups on aggregated creativity scores.

It is concluded that the findings of the present study provide some empirical support to Annett's model of balanced polymorphism with heterozygote advantage for cognitive ability.