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Twin Pair Analysis of Some Palm Indexes

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SUMMARY

The heritability of two main line indexes (DLI and TLI), a palm crease index (API), and an ulnarity index (UI) were investigated by using twin pair methodology for quantitative traits.

The analyses of the data allow to conclude that both DLI and API, which have been used to evaluate the obliquity of the main lines and the distal crease of the palm, should not be considered as depending upon an important genetic component. Otherwise, data on TLI and UI, while showing inconsistencies with the theoretical expectations, may be considered as genetic traits.

The grade of transverseness of both the main lines and the creases of the palm are considered to be powerful indicators of chromosomal aberrations and other constitutional diseases (Holt, 1961; Penrose, 1963; Uchida and Soltan, 1963; Miller and Giroux, 1966; Giroux and Miller, 1967; etc.).

Among the indexes used to evaluate the obliquity of the main lines of the palm, the *D* and the *T* line indexes (DLI and TLI) are considered to be informative. Concerning the palm creases, only one quantitative method seems to exist. It was suggested by Saldanha (1968) and named *average palm index* (API). In the same paper, Saldanha also proposed an *ulnarity index* (UI) to evaluate the intensity of the ulnar shifting of the *t* triradius.

In the present paper the heritability of these four indexes was investigated by twin pair methodology for quantitative traits.

Material and Method

All the analyses were performed on the palm prints of a sample of 90 Caucasoid like sex twin pairs (20 MZ-MM, 28 DZ-MM, 18 MZ-FF, 24 DZ-FF), randomly collected in elementary schools. Their zygosity was thoroughly investigated in the Department of Medical Genetics of the State University of Campinas, SP, Brazil. The means for age in years were calculated for each group as follows: MZ-MM = 8.95 ± 0.48; DZ-MM = 9.11 ± 0.30; MZ-FF = 7.67 ± 0.35; DZ-FF = 9.04 ± 0.41.

In the prints of both hands of each cotwin the four indexes were obtained as follows:

(1) The DLI was determined by the ratio *ax/ad*. In this formula, *ad* stands for the distance between the triradii *a* and *d* obtained by drawing a straight line to join both triradii, and *ax* is the distance between the *a* triradius and the intersection (*x*) of *ad* and the *D* main line.

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(2) The TLI was calculated by the ratio aT/at. In this formula, aT is measured on the straight line normal to ad, drawn to join the a triradius with the T main line. The lenght of this line when the t triradius level is attained is considered as the at distance.

(3) The API was calculated according to the type of the transverse creases observed in each case. Thus, for the normal type of Brander (1940; cf. Saldanha, 1968) with the distal and proximal transverse creases completely separated, Saldanha (1968) recommends the formula $(d''—d') \mid \bar{d}$, being $d''=l''—f''$, $d'=l'—f'$, and $\bar{d}=l''—l'$; where l'' is the ending of the distal transverse crease on the hypothenar area, f'' is the ending of the distal crease on the second interdigital area, l' is the ending of the proximal transverse crease in the thenar area, and f' is the ending of the proximal transverse crease on the hypothenar area. For the transitory types of Brander, Saldanha (1968) considered two other points, c'' and c', which represent the intersection points of the oblique line on the distal and proximal transverse lines, respectively. The formula for API becomes for these cases $(\bar{d}+d_2+d_1) \mid \bar{d}$, where $d_2=c''—f''$ and $\bar{d}=l''—l'$. For the typical simian creases, API = 1.

(4) The UI was calculated as suggested by Saldanha (1968), i.e., $a't/a'd'$, where $a'd'$ is the distance between the triradii a and d projected on a parallel to ad drawn through the t triradius, while $a't$ is the distance between a' and the t triradius.

The hypothesis of genetic determination of the indexes was tested by comparing the correlation coefficients, the within-pair variances, the covariances, and the total variances, estimated for MZ and like sex DZ twin pairs. Holzinger's formula for heritability (Holzinger, 1929; Clark, 1955) was not applied to the data because of the misleading picture of the role of genes and environment it may give (Kempthorne and Osborne, 1961; Beiguelman, 1970).

The standard deviations of the estimates were calculated as: $B\sqrt{[2/(n+1]}$ for the between-pair variance (B); $W\sqrt{[2/(n+2)]}$ for the within-pair variance (W); $\sqrt{\{(1/2)[B^2/(n+1)+W^2/(n+2)]\}}$ for the covariance (s_{wx}) and the total variance (s_x^2); and $[BW/(B+W)^2]\sqrt{\{8(2n+3)/[(n+1)\ (n+2)]\}}$ for the intraclass correlation coefficient (r_i), being n in all cases the number of twin pairs.

Results and Discussion

1. D Line Index (DLI)

According to the data in Tab. ,I DLI cannot be considered as a trait which depends upon an important genetic component, since both the correlation coefficient and the covariance of MZ and DZ pairs are similar, either for males or females. Actually, the r_i of DZ females is numerically larger than that estimated for MZ pairs. In accordance to these results, also the within-pair variance has not differed, either among males ($F=2.06$, $P > 0.05$) or females ($F = 1.33$, $P > 0.05$).

Tab. I. DLI in twins
[N = 90 pairs]

Estimate	MZ-MM	DZ-MM	MZ-FF	DZ-FF
B	0.117 ± 0.036	0.159 ± 0.042	0.115 ± 0.037	0.177 ± 0.050
W	0.018 ± 0.005	0.037 ± 0.009	0.046 ± 0.014	0.061 ± 0.017
s_{wx}	0.049 ± 0.018	0.061 ± 0.021	0.035 ± 0.020	0.058 ± 0.026
s_x^2	0.068 ± 0.018	0.098 ± 0.021	0.080 ± 0.020	0.119 ± 0.026
r_i	0.733 ± 0.100	0.626 ± 0.112	0.433 ± 0.184	0.489 ± 0.151
n	20	28	18	24

2. T Line Index (TLI)

The data on TLI (Tab. II) show that, as a general picture, the results favour the hypothesis of quantitative inheritance for this trait, if allowance is made for an inconsistency with the theoretical expectation. Thus, both the correlation coefficient and the covariance of MZ cotwins are about twice the figures estimated for DZ pairs, and no significant differences are found for the total variance ($F = 1.10$, $P > 0.05$ among males; $F = 1.27$, $P > 0.05$ among females). The discrepant result concerns the within-pair variance of the female twins, which does not show a significant difference when DZ are compared to MZ pairs ($F = 1.75$, $P > 0.05$), as the male twins do ($F = 3.00$, $P < 0.05$).

Tab. II. TLI in twins
[N = 90 pairs]

Estimate	MZ-MM	DZ-MM	MZ-FF	DZ-FF
B	0.041 ± 0.013	0.030 ± 0.008	0.058 ± 0.019	0.037 ± 0.010
W	0.003 ± 0.001	0.009 ± 0.002	0.008 ± 0.003	0.014 ± 0.004
s_{wx}	0.019 ± 0.006	0.011 ± 0.004	0.025 ± 0.010	0.011 ± 0.006
s_x^2	0.022 ± 0.006	0.020 ± 0.004	0.033 ± 0.010	0.026 ± 0.006
r_i	0.851 ± 0.060	0.549 ± 0.129	0.754 ± 0.010	0.437 ± 0.160
n	20	28	18	24

3. Average Palm Index (API)

The figures presented in Tab. III oppose difficulties for concealing a genetic hypothesis for API. While the correlation coefficients are in the direction theoretically expected, i.e., greater values for MZ as compared to DZ pairs, figures in opposite direction are observed for covariance among males. Other discrepant results are:

(1) the within-pair variance of DZ females does not differ significantly from that calculated for MZ pairs ($F = 1.70$, $P > 0.05$); (2) the total variance of DZ males is significantly larger than that of MZ pairs ($F = 3.79$, $P < 0.05$).

Tab. III. API in twins
[N = 90 pairs]

Estimate	MZ-MM	DZ-MM	MZ-FF	DZ-FF
B	0.072 ± 0.022	0.253 ± 0.067	0.104 ± 0.034	0.081 ± 0.023
W	0.014 ± 0.004	0.073 ± 0.019	$0.020 + 0.006$	0.034 ± 0.009
s_{wx}	0.029 ± 0.011	0.091 ± 0.035	0.042 ± 0.017	0.024 ± 0.012
s_x^2	0.043 ± 0.011	0.163 ± 0.035	0.062 ± 0.017	0.057 ± 0.012
r_i	0.667 ± 0.120	0.552 ± 0.128	0.681 ± 0.121	0.412 ± 0.171
n	20	28	18	24

4. Ulnarity Index (UI)

The data presented in Tab. IV show that only the figures of UI calculated for male twin pairs are in perfect accordance to the theoretical expectations for quantitative inheritance. As a matter of fact, no significant differences are observed when the total variances of both types of male twin pairs are compared ($F = 1.34$, $P > 0.05$), while the within-pair variance of DZ cotwins shows a significant larger value as compared to that presented by MZ pairs ($F = 2.44$, $P < 0.05$). Moreover, the figures for covariance and correlation coefficient of MZ pairs are about twice those of DZ twins.

Concerning the females, the total variance of MZ twins is discrepantly too large as compared to that of DZ pairs ($F = 19.00$, $P << 0.05$), while the covariance in both types of twins presents similar figures. Otherwise, the difference between the correlation coefficient of MZ and DZ females is larger than it is expected for additive inheritance.

Tab. IV. UI in twins
[N = 90 pairs]

Estimate	MZ-MM	DZ-MM	MZ-FF	DZ-FF
B	0.060 ± 0.018	0.063 ± 0.017	0.068 ± 0.023	0.034 ± 0.010
W	0.016 ± 0.005	0.039 ± 0.010	0.007 ± 0.002	0.029 ± 0.008
s_{wx}	0.022 ± 0.010	0.012 ± 0.001	0.030 ± 0.011	0.032 ± 0.006
s_x^2	0.038 ± 0.010	0.051 ± 0.001	0.038 ± 0.011	0.002 ± 0.006
r_i	0.569 ± 0.146	0.237 ± 0.174	0.810 ± 0.080	0.071 ± 0.204
n	20	28	18	24

Conclusions

From Tables I-IV it may be concluded that genetic studies on DLI and API seem to be hopeless, while TLI and UI may be considered, as a first approximation, as genetic traits. The inconsistencies of the data with the theoretical expectations for quantitative traits under twin pair analysis may be probably connected with sexual expression of these traits and/or the technical deficiencies of the determination of the indexes. Therefore, it seems that Cummins main line index (Cummins and Midlo, 1961), in spite of being time consuming, should be considered as the most informative of the main line transverseness, since, according to Pons (1961 a, b), it shows a high degree of heritability either in twin or family studies.

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Riassunto

Facendo uso della metodologia gemellare per i caratteri quantitativi è stata studiata l'ereditarietà di due indici delle linee principali (DLI e TLI), un indice delle creste palmari (API) e un indice di ulnarità (UI).

L'analisi dei dati permette di concludere che né il DLI né l'API, che sono stati usati per valutare l'obliquità delle linee principali e della cresta distale del palmo, possono essere considerati come geneticamente condizionati. D'altra parte il TLI e l'UI, benché i dati non siano del tutto corrispondenti all'attesa teorica, possono essere considerati come caratteri genetici.

Résumé

Appliquant la méthodologie gémellaire pour les caractères quantitatifs, une étude a été conduite sur l'hérédité de deux indices des lignes principales (DLI et TLI), un indice des crêtes palmaires (API) et un indice d'ulnarité (UI).

L'analyse des résultats permet de conclure que ni le DLI ni le API, qui ont été employés afin d'évaluer l'obliquité des lignes principales et de la crête distale de la paume, peuvent être considérés comme génétiquement conditionnés. Par ailleurs, le TLI et le UI, quoique le résultat présente quelque différence par rapport à l'expectation théorique, peuvent être considérés comme des traits génétiques.

Zusammenfassung

Die Anwendung der Zwillingsmethode auf quantitative Merkmale diente zur Untersuchung der Erblichkeit zweier Hauptlinienindexe (DLI und TLI), des Palmarleisten- und des Ulnaritätsindexes (API und IU).

Bei Untersuchung des Schrägheitsgrades der Hauptlinien und der distalen Palmarleiste führte eine Analyse der Daten zu dem Schluss, dass weder DLI noch API als erbbedingt anzusehen sind. TLI und UI hingegen können als Erbmerkmale betrachtet werden, wenn auch die Daten nicht ganz der theoretischen Erwartung entsprechen.

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