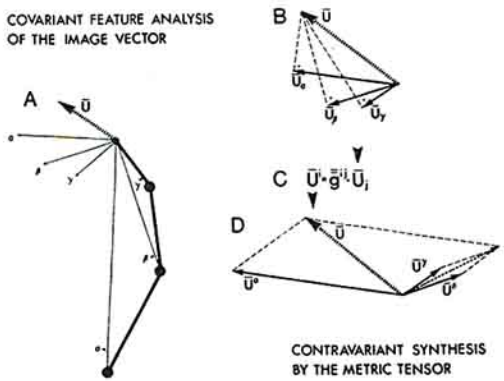

FIG. 4. Covariant analysis and contravariant synthesis via a metric tensor. (A) Given a two-dimensional intended vector $\bar{U}$ and three α, β, γ axes of an overcomplete reference-frame, the decomposition could be performed by a two-step operation. (B) Firstly, covariant components of $\bar{U}$ can be established, using the geometry of the two-space, to any number of directions independently. (The perpendicular projections, i.e. inner products, provide the 'features' of the desired $\bar{U}$ vector in any coordinate direction.) (C) Secondly, provided that the α, β, γ space is geometrical and its metric tensor is available (in contravariant expression), the corresponding set of contravariant components can be established. (D) Contravariant components, which physically generate the displacement vector $\bar{U}$. (As shown in B, the added up covariant components do not even point into the direction of $\bar{U}$.)

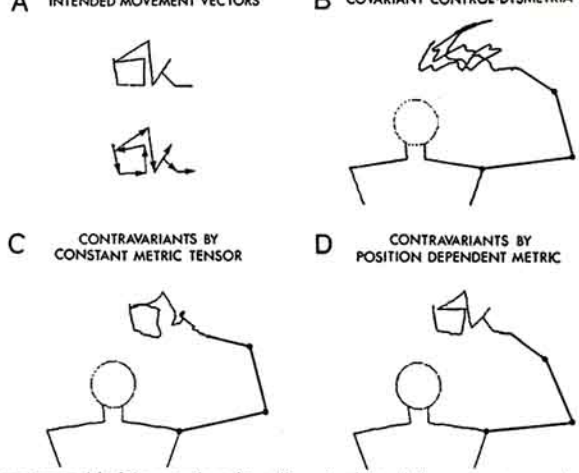

FIG. 5. Computer model of the execution of two-dimensional intended movement vectors by a three-segment limb, using the covariant analysis and contravariant synthesis, via a metric tensor. (A) Letters OK, representing two-dimensional intended movement vectors by each segment of the letters. (B) Dysmetric writing: the intended vectors are decomposed into covariant components (as in Fig. 4B), and the three-segment arm is moved directly according to the *covariant* components. Note the ataxic, 'dysmetric' movement which, characteristically, is better in some directions, while much worse in others. (C) Introducing a matrix of 3×3 constants as a metric tensor of the α, β, γ space, the covariant components are transformed into contravariant (physical) components, which are capable of executing the intended vectors. The characteristic distortion of the writing is the result of the position-independence of the metric. (D) Execution of the intended vectors by using a position-dependent metric, where the embedding of the three-space into the internal hyperspace is homomorphic at each point of the writing; i.e. the CNS hyperspace is curved.