Supplemental Materials

Suggestions for a Parametric Typology of Dance
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Appendix A: The Biological Foundation of Language and Dance

Children exposed to language (spoken or sign) acquire it easily and in pretty much the same order around the world [1–3]. Many argue that this is because language development and use are guided by a genetically endowed mechanism in the brain [4–7, among many]. Neuroimaging, particularly with respect to bilingualism and brain pathologies, confirms this biological mechanism, though the mechanism is neither discrete nor continuous [8–10, among many]. That is, different brain areas are involved in different language abilities, but brain areas responsible for other cognitive abilities may intervene between the areas responsible for the various language abilities. Thus, one can draw a single line around the liver, for example, but one cannot do that for “the language mechanism.”

According to the most widely-discussed theory, that of Noam Chomsky, the initial state of the language faculty at birth consists of minimally specified principles for grammar construction: we are born with the basic building blocks for language [11–13]. What distinguishes one language from another is a set of open parameters on some of those principles. The subconscious task of the child is to set the parameters that distinguish the particular language in the immediate environment, while memorizing the words of that language [14]. As Mark Baker says, “The recipes for speaking English and Navajo are surprisingly similar, once they are properly understood” [15].

The fact that first language acquisition proceeds so similarly around the world provides the strongest evidence for a parametric approach to language typology [16]. More evidence comes from second language learning (L2L) [17, see also 18–20]: phenomena in L2L are fruitfully analyzed as part of the process of resetting parameters from a first language. Support for parameters also comes from language change: many variations in language over time are explainable in terms of changing parameters [21]. While a parametric approach is not the only account of language acquisition, L2L, or language change, it is discussed in virtually every book
on language typology and has spawned the most comparative research. The parametric approach has been applied fruitfully to phonetics and phonology [22], morphology [23], syntax [24], and semantics [25,26].

Parameters allow us to see similarities between languages that are not genetically related and that may have had little to no contact. Via parameters, linguists form a group of Japanese, Barasano (eastern Amazon area), Ika (Nigeria), and other languages [27]; another of Irish, Malagasy (Madagascar), Zapotec (Mexico), and others [28]; and so on. These groupings have allowed us to see patterns in language that might not have been noticed otherwise – patterns that undeniably exist regardless of whether one accepts a Chomskyan explanation of them or not.

Further, there is reason to expect that a parametric approach would be helpful in analyzing dance. Recent analysis of sign languages lends strong and new support for a parametric approach to language typology (even among those with differences of opinion as to what counts as typological parameters [29,30 for example]). The articulators in both spoken and sign languages are a subset of the articulators in dance (so long as we broaden our scope to include sound in dance), but the articulators in sign languages (arms, hands, torso, shoulder, head…) are more prominently like those in dance. One might hope, then, that approaches fruitful in studying sign languages would be fruitful in studying dance.

This hope rests on the obvious fact that dance has a biological base. Learning locomotion is an instinctual process. 95% of the world’s children crawl before they walk [31]. Motor development goes through six milestones: sitting without support, hands-and-knees crawling, standing with assistance, walking with assistance, standing alone, and walking alone [32].

Learning dance traditions, however, need not be a subconscious process, in contrast to acquiring a first language. Some dance traditions are participatory, and we see children embodying the movement without instruction [33,34]. Other dance is performance art, meant for the skilled, while the rest of the community watches. Performance dance is mastered through hard work and study. This might consist of observation of dancers, being coached, or taking lessons from an “official” teacher. We contend that in all cases, one thing the student tries to learn is dance parameters and the consequences of setting them. Dance teachers may never have met the term parameters as used here; nevertheless, among the many tasks and benefits of a dance classroom
[35–36], one is helping students recognize dance parameters and how to adjust them. Sometimes the teachers’ goal may be to help students set the parameters of a particular type of dance so that they can master that dance; other times the teachers’ goal may be to help students learn how to set and reset parameters, so that they can move easily among a variety of dance types.
Appendix B: Cultural Approaches Comparing Dance to Language

Existent approaches to dance typology are based on varied criteria, where several relate it to language. Judith Hanna exemplifies how dance is like poetry and prose in communicating stories, moods, and emotions [37]. Other language-oriented approaches are more structural. Edit Karposi and Ernő Pesovár [38], Adrienne Kaeppler [39], and Peeter Pomozi [40] show that “dialects” of folk dances in Estonia and Hungary can be distinguished via structural linguistic methods.

Other approaches are ethnological [41,42], and others more widely anthropological [43,44]. Some focus on a particular society; Judith Vail looks at choreographic methods for portraying “Swedishness”, an interesting issue given increasing multiculturalism in Sweden [45].

Others offer a global picture, where here we consider a noted one, though by no means universally accepted. Alan Lomax spearheads one that relates dance typology to music and language [46]. Lomax collaborated with Irmagard Bartenieff and Forrestine Pauley to point out aspects of dance determined by age, sex roles, socio-economic situation, and cultural affiliation, forming the basis for the cross-cultural dance analysis “Choreometrics” [47,48]. Lomax and Pauley made a film of 700 dance performances, analyzing them via computer with respect to over 500 factors, and relating patterns of movement to culture [49]. As John Bishop says, “…they found that elements of performance style were consistent within cultures, and that clusters of these style elements correlated with elements of productivity and social organization” [50]. For example, they connect the “straight line arm movements” of dancing Navajo girls to the one-dimensionality of women scraping manioc; the “curving two dimensional arm style” of dancing Polynesian girls to the two dimensionality of grinding flour; the “spiraling aerobics” three dimensional arm path of Indonesian candle dancers to three-dimensionality in processing rice bundles in thresher [51]. They repeatedly arrive at the conclusion that there are “a few very large and very old style traditions” [52] organized into cultural hierarchies [53]. Certainly, film (like photography) is a representation of reality. As such, it is influenced by cultural factors and the personal considerations of those making the film with respect to what they want to relate to the audience [54]. So the concentration on culture by Lomax and colleagues is expected.
Our approach does not consider culture for the reasons stated in the text. However, while we consider only physical factors, we do not suggest that our approach is itself a-cultural. The very factors we consider are influenced by our way of viewing the body and the world. The way we organize information is influenced by social/educational institutions. Further, we are influenced by having read dance scholars who bring up physical factors chosen for their connection to cultures—so they are “stacked” toward culture. In spite of this unavoidable complexity, we proceed, aiming for as much objectivity as possible.
Appendix C: Parameters in Language

Here we mention four parameters. We claim no analogy between any specific language parameter and specific dance parameters we suggest later. Indeed, the parameters below are syntactic, whereas with dance we are proposing something more akin to phonetics than syntax. We pick these parameters only to give a glimpse of this approach’s usefulness to language typology – where we spin this out only for the first parameter since it offers immediate demonstration.

Please note that individual speakers may play with language, sometimes violating parameters. In English assertions subjects precede predicates: *I am happy*. But we could invert, producing the poetic *Happy am I*. (Constituent order at the sentence level can be accounted for by interaction of parameters [55].) Likewise, a ballerina might employ turn out. But she could use parallel feet in a particular figure, and with fine effect. The parameters do not stymie expression, but allow us to distinguish the canonical from the unusual.

(a) The **Head Parameter** accounts for the fact that (in general) a language consistently places the head of a syntactic phrase initially or finally within the phrase. For example, in Nepali an object precedes the verb (V); in English it follows [56]:

(1) *Keta-le [VP euta syau lyauncha].*

boy-agent [one apple brings] ‘The boy [VP brings an apple].’

Since the V (boldfaced) is the head of the V phrase (VP), (1) shows Nepali is a head-final language, while its translation shows English is head-initial.

This parameter accounts for a range of otherwise seemingly disparate differences between languages. For example, in languages in which a V precedes its object, a preposition (P) also precedes its object, since the P is the head of the prepositional phrase (PP). In languages in which a V follows its object, a “preposition” also follows its object (so we have “postpositions”), as in Nepali:

(2) *Keta-le euta syau [PP park ma] lyauncha*

boy-agent one apple [park to] brings ‘The boy brings an apple [PP to the park].’
Without the Head Parameter, the fact that in a given language the order of V and its object is the same as the order of P and its object is accidental; with the parameter, it is predicted, along with other syntactic behaviors [57].

(b) The **Pro-drop Parameter** accounts for the fact that some languages require the sentence subject to be explicitly expressed (such as English), while other languages do not (such as Italian, in (3)) [58].

(3) Non viene.
   not comes ‘{He/She/It} is not coming.’

(c) The **Serial Verb Parameter** distinguishes between languages which allow only one main V in a VP (such as English) and languages which allow more than one (such as Thai) [59]. (4) is a single Thai clause with six Vs (each boldfaced) [60]:

(4) Malee .wp4 troŋ jɔn khâam saphaan ʔɔŋk paj
    Malee run go-straight reverse cross bridge exit go
    ‘Malee ran straight back, crossing the bridge, away from the speaker.’

(d) The **Reflexive Domain Parameter** accounts for distribution of reflexives. In general reflexives occur in sentences that contain another noun phrase referring to the same person (the antecedent). In some languages, such as English, the antecedent must be local (typically in the same clause):

(5) Jack likes himself.

(6) *Jack knows [I like himself]. (cf. Jack knows [I like him].)

In (5) *Jack and himself are in the same clause; but in (6) they are not, so (6) is ungrammatical (indicated by the asterisk).

In other languages, such as Mandarin, the antecedent need not be local [61]:

(7) Zhangsan shuo [Wangwu zhidao [Lisi chang piping ziji]]
    Zhangsan said Wangwu knew Lisi often criticized self
    ‘Zhangsan said Wangwu knew Lisi often criticized one of them.’

Ziji is the reflexive. Lisi (local) can be its antecedent. But Wangwu or Zhangsan (not local) can also be its antecedent. So (7) is multiply ambiguous.
Appendix D: Parameters in Computer Approaches

Representing human movement is a research focus in biomechanics, graphics, vision, and machine-learning. In these areas often the goal is generating stylistically consonant movement for robotics or film animations [62]. Representations of movement are meant to allow a machine to duplicate human movement. Strategies for learning movement styles from a corpus of examples range widely, including singular-value decomposition, principal-components analysis, hidden Markov models, probability distributions over the space of all possible poses, linear models, nonlinear optimization techniques, and probabilistic graphical representations. These “forward simulation” methods generate movement from a mathematical model. While such an approach can go beyond kinesiology to capture stylistic trends and even to distinguish styles of different choreographers, the focus is not on understanding types of movement, but on generating movement that follows a given style (i.e., maintains a given setting of parameters) [63]. The right representation for a computer to replicate dance however, is different from the one that humans use, given that the figures on a computer screen are not subject to the forces and needs imposed by a body (which has weight and physiological limitations) moving through space and time. Thus we do not consider further these proposals.
Appendix E: Physical Factors Noted in Cultural Approaches Compared to a Parametric Approach

Physical factors come up in virtually every discussion of dance typology. Here we mention just a few that overlap in many ways with the analyses given in other cultural approaches.

Vladimir Mutavdži looks at 17 steps (slides, leaps, hops, and so on) and analyzes their coordinative complexity (uses, ordering, and interaction) in various dances, distinguishing five types of Serbian folk dances [64]. Susan Self considers multiple factors in Scottish dance, including number of steps, movement relationship to music and tempo, effects of shoe choice, body posture, qualities of limb movements, shifts in weight, and foot alignment [65]. In a global context, Lomax and colleagues distinguish motion qualities, summarized as [66]:
(a) body parts habitually involved, (b) the body attitude, (active stance), (c) the shape and dimension of movement, (d) the way direction changes in movement, (e) movement qualities such as relative smoothness and tempo, (f) torso-unit relationship, (g) the degree and kind of synchrony between movers, and (h) features of group formation.

In examining Ubakala dance-plays of Nigeria, Judith Hanna comes up with several categories of factors relevant to a physical analysis, including (and we paraphrase here) [67]:

(a) use of space, including direction of movement and eye and body focus, (b) rhythm, where time and flow mix, as in meter, accent, and tempo, (c) dynamics, including expended energy, tension, and relaxation, and (d) characteristic body use, including posture, position and movement of head, torso, arms and so on.

With respect to Lomax and colleagues, our alignment parameters might overlap with their factors (b) and (f) (depending on how theirs are to be understood); our parameter of Direction overlaps with their (c); our parameters of Rhythm and Quality overlap with their (e). Likewise, our parameters of Space and Rhythm largely coincide with Judith Hanna’s factors of the same name, and our parameters of Quality and Tenseness overlap with her factor “dynamics,” while our alignment parameters look like a subset of her factor “characteristic body use” (depending on how this factor is to be understood). Our parameter of Sequencing overlaps with Vladimir Mutavdži’s “ordering” factor.
References and Notes


24. Baker [15].


49. Alan Lomax and Forrestine Paulay, film: “Dance and Human History: Movement style and culture #1” (Berkeley, CA: University of California Extension Media Center *UCEMC* #9429, 1974).


57. Baker [15].


