Computational choreographies:
Dance gesture between semiotic transduction and Artificial Intelligence

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ABSTRACT

Within the emerging ecosystem of practices that integrate dance and new technologies, the choreographic gesture joins a radically new regime of translation, in which the body is transformed into a diagrammatic form that can be algorithmically manipulated. The article examines how computational systems reconstruct dance by passing through intermediate semiotic languages that select, segment, and reorganize properties of movement. Through three case studies – algorithmic reconstruction of movement, music-to-dance generation, and natural language-to-dance generation – it analyses the transductive processes that make dance manipulable, recombinable, and generable. In this article, building on our analysis, we offer a semiotic perspective on the regimes of intelligibility associated with dance technology, highlighting their limitations and potential as creativity support tools.

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Introduction

Around 1960, researchers began to explore possible forms of collaboration between computers and dance. Even dance, as an art grounded in human movement and seemingly far removed from technological interaction, appeared capable of contributing to the development of a new discipline: the field of *dance technology*. At the core of this emerging convergence was the idea that technology could function as a supportive tool for complex or labor-intensive tasks. At the same time, the project was highly ambitious, supporting the idea of eventually developing a human movement specification language

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that could be understood by both computers and humans. A decisive moment was David Sealy's work at the University of Iowa, where he developed a series of computer programs for *Labanotation* designed to modify and process dance scores entered into the system (1981). Between the 1950s and the early 1970s, authors such as Birdwhistell (1970) and Paul Bouissac (1973) advanced different proposals for the formalization of bodily movement, constructing heuristic models inspired by structuralism. Birdwhistell drew upon the methods of structural linguistics in an attempt to formalize kinesic language as an indicator of the forms of behavior interwoven among individuals (Jolly 2000). By contrast, in Bouissac's work, gesture, examined as part of a project devoted to the structural analysis of acrobatic forms, was recognized for its informational potential rather than treated as evidence of non-observable properties of the subject, such as intention or consciousness. The analysis of a gestural sequence, studied as a form of practice (Kristeva 1968), could consequently benefit from a set of procedures consistent with processes of measurement or automated analysis, including the reduction of the problem to elementary properties or to three-dimensional spaces delimited by the extreme points of movement.

These reflections on the formalization of bodily movement, together with the gradual development of dance technology, coincided with dance's transition into a post-modern era, in which it was finally conceived as a language susceptible to deconstruction and reconstruction and where it was possible to 'set up analytic structures and explode them' (Mackrell 1991). The experiments of the *Judson Dance Theater*, in which choreographic practice, supported by a reflexive awareness of the possibilities of performance, focused on the 'improvisational spontaneity of task-based aesthetics and on the exploration of compositional relations between heterogeneous elements' (Monni 2023), capitalizing on theory. The performative act was thus brought closer to a linguistic act, while preserving a conscious awareness of the pragmatic concreteness of movement.

Contemporary systems associated with dance technology therefore belong to a long tradition of the semiotic formalization of movement. The possibility of reconstructing spatial relations – such as trajectories, curvatures, and synchronizations – through algorithmic procedures has opened numerous opportunities for collaboration among dancers, choreographers, and new technologies. It should nevertheless be remembered that dance 'is structurally held together by a relational synthesis that is constantly renegotiated.' Its computational reconstruction, whatever the intended purpose, therefore constitutes a complex undertaking, precisely because of the specific features of this art of bodily movement, which presents itself as a multimodal language (Pan 2025).

Dance does not possess a stable system of notation comparable, for instance, to that of music. Indeed, music has succeeded in transforming a potentially infinite temporal

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substance into a divisible and reconstructible structure, thereby fostering, over the centuries, the development of numerous forms of notation (Randi 2021). It consequently becomes difficult to address the computational process of dance virtualization, especially when dance is conceived as a universal code, as might be presupposed in the case of computational translation. Dance does not generally rely on rigid, specifically choreographic codifications, although notation systems such as *Benesh Movement Notation* (Benesh and Benesh 1969) represent significant attempts to formalize movement. Instead, it draws on non-exclusive codes, such as those governing facial expression or gestural mimesis (Zelinger 1979). Attempts to reconstruct dance within computational environments have therefore had to negotiate a particularly unstable balance, seeking to preserve both its fluidity and the specificity of the movement by which it is defined.

On the basis of these premises, the present contribution examines the semiotic value of dance in the process of its reconstruction within computational systems. If semiotics is the discipline that establishes, from a given point of view, a series of correspondences between otherwise heterogeneous objects (Paolucci 2010), the processes of transduction enacted in contemporary experiments provide a privileged point of departure for reflecting on the value of dance, as well as on the ways in which it is parametrized and codified.

1. History of dance technology

In 1966, Michael Noll, in his essay *Computers and the Visual Arts*, suggested that the arts could benefit from interaction with emerging technologies. In the field of choreography in particular, Noll envisioned that, through interaction with a computer, a choreographer could control the movement of a ballet represented in virtual form. In 1970, Sagasti and Page presented one of the earliest experiments in computer-generated choreography for multiple dancers, effectively realizing Noll's idea, albeit unknowingly. Their program organized performers' spatial displacements on a stage divided into thirteen hexagons, following rules of adjacency and entrance/exit. Positions were determined through a random generator, according to a logic akin to a Markov process.[1] The aim of the experiment was to demonstrate that the computer could support composition without replacing the choreographer. It was staged in 1968 at Penn State University, in a theatrical laboratory: in this context, the program determined the positions of six dancers across 107 movements set to a piece by Vivaldi, functioning as a potentially collaborative tool capable of producing variants from which the choreographer could select.

[6] A Markov process is a stochastic model in which the probability of transitioning to a subsequent state depends solely on the current state, and not on the sequence of preceding states.

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From this point onward, dance technology became a persistent research topic, leading, by the mid-1980s, to the publication of around one hundred essays on computer choreography (Politis 1987). From the 1990s onward, with the imminent emergence of ML systems, the possibilities offered by dance technology began to shift from supporting the creative process toward exploring more complex forms of interaction. In 1997, the choreographer Michael Klien developed the software *ChoreoGraph* with the aim of structuring and controlling, even in live performance, multiple components such as movement, music, video, and lighting according to a 'non-linear' choreographic logic. The first prototype, developed in the MAX environment, allowed modules to be rearranged along a timeline, with dancers receiving cues via on-stage monitors. With Duplex, a choreographic duet created by Klien in 2002 for the Ballett Frankfurt, the system evolved into an algorithmic engine capable of permuting modules in real time while maintaining structural constraints inspired by the classical pas de deux. Within the program, modules were assigned 'weights' and refresh rules to regulate frequency and repetition, so that each performance generated a different yet coherent configuration. The movement vocabulary remained human (choreographer and dancers), while the software produced a 'map' to be interpreted, shifting attention toward the performer's strategic and problem-solving capacities.

The advent of neural networks led to renewed interest in the relationship between choreography and technology, resulting in the development of highly interactive and participatory tools. Nogueira, Menezes, and de Carvalho (2024) estimate that between 2010 and 2023 at least 345 articles have investigated the interaction between ML systems and dance performance, particularly in relation to the development of choreographic *Creativity Support tools* (Shneiderman 2007). For instance, Jadhav, Joshi, and Pawar (2015) developed a system based on a genetic algorithm to generate new steps in Bharatanatyam, a highly codified form of classical Indian dance. More recently, Qin et al. (2023) proposed the model *Dancing Avatar*, a system that generates dance-like human motion videos (ensuring consistency of body and motion) from text and pose inputs using text-to-image diffusion models.

2. Reconstructing the dancing body: A semiotic epistemology

To approach the issue of body reconstruction in dance starting from a semiotic perspective, it is necessary to identify the entry point of our inquiry, which, as may be anticipated, lies in a process of reconstructing the realm of body possibilities in a virtual space. To conceive of the computational reconstruction of a dancer's movements, for instance within a three-dimensional environment, or to encapsulate an expressive style to imitate it or to use its structures to generate new movements, ultimately amounts

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to an act of formal reconstruction. As Wallis (1973) observes, however, the referential value of the choreographic and informational sign is, by its very nature, suppressed by processes of selection, simplification, and interpretation pertaining to its poetic dimension. The attribution of content in dance does not have a necessary character: it is a weakly coded movement, where the segmentation of units remains fluid, and the relation between content and expression is unstable. Movement, in fact, is performed by a practitioner, and even the process of smoothing or fluidifying movement is, to some extent, improvised. As the choreographer Merce Cunningham observed:

> First, I practice with the dancers, then I give them movements and actions to be performed in the dance, but I do not expect from them to repeat them exactly as I do. It is my job to find a way for dancers to move them as they would move themselves and to get most out of it. (Cunningham 1988:233, cited in Zdravkova-Djeparoska 2020)

Following Langer's ideas of *expressive form*, dance emerges when movement is transformed into a virtual gesture, detached from its immediate practical function and reorganized as an expressive symbolic form (1953). However, this symbolic openness is altered when movement is transferred into technological contexts and assigned a specific operational value. Certain features of movement are selected and reorganized according to the semantic and operational coherence prepared by the technological system. Indeed, the isotopization of dance effectively entails a form of 'necrosis' (Basso Fossali 2009), insofar as its value is reconsidered within heterogeneous contexts, such as those in which movement is assigned a specific function. It is nevertheless possible to identify a point of anchorage within the transductive process between dance and technology: reconstructing the body in motion implies the adoption of an epistemology through which dance can itself be conceived as a computational process.

To assume that computational transduction operates merely through the reconstruction of plastic features is already to presuppose the prior identification of an immanent organization. As a practice, dance emerges within a language that establishes the resistance of the dancing body to verbalisation: the moving body can never be fully rendered through verbal discourse; similarly, theory and practice cannot be clearly divided: they develop across different levels and constantly shape one another. Any attempt to formalize a choreographic repertoire, especially when it is connected to social, religious, and aesthetic functions, therefore presupposes an analytical operation of selection. The question, however, is not simply whether it is possible to record the position of the joints while leaving aside aspects such as perceived weight, fatigue, or breathing. More broadly, it concerns the way in which the body can function as a space of mediation between somatic experience and technical formalization. The body does not merely provide data to be measured, but allows embodied qualities to be

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reorganized and translated into operational parameters. Such a translation can never be complete, since the qualities of movement cannot be entirely reduced to a set of measurable coordinates.

The resulting process of formal construction relates to an informational theory of meaning in which dance is understood as a system for activating movement patterns. That is, through the definition of precise algorithms capable of regulating movement and selection, a computational system can focus on the frequency of symbol transmission. In doing so, the variables of a model that would typically be considered static compensate for their own limitations through the presence of multiple parameters which, through an effective design process, become functions capable of accounting for a range of categories.

Computer-based systems can now be understood as fully-fledged semiotic systems, capable of 'providing a scaffolding for human cognition, directing points of view and extending or enhancing our cognitive possibilities and our capacity to know the world' (Paolucci 2021:282). An artificial intelligence system, for instance, grounded in Machine Learning (ML) algorithms, can be considered a genuine system of signification in Eco's sense, that is, linked to the socially conventioned possibility of generating sign-functions (1975:23) (cf. Picca 2025). Of course, anthropological questions concerning the interpretation of dance, as a system of meaning rooted in social contexts or as a language of emotions, shape the epistemological perspective from which the entry point of this investigation is defined. Even in the latter case dance remains a social institution, insofar as emotions themselves are culturally coded and situated (Blacking 1983). This perspective may also be extended through the exploration of enactivist approaches in dance, conceived as an embodied and participatory process of sense-making emerging from an active interaction between individuals, others, and their environment (Van Alphen 2014; Lindberg, Marin and Silverman 2023).

2.1. **Dance as pseudo-language**

According to Margolis (1983), it is difficult to speak of an analogy between dance and language. A dance step, for instance, may exhibit features akin to a 'romantic languor without representing, referring to, exemplifying, or symbolizing such languor' (Margolis 1974). We can insist on this point by establishing a thematic correlation with what has been discussed earlier: the dancing body is both an object of representation and the subject of its own experience. Moreover, performance emerges from the involvement of the body within a cultural context, which activates somatic modes of perception (Sellers-Young 2025) that contribute to shaping the signifying value of the gesture. Dance follows regularities that underlie the sign occurrences taking place during performance. There is nothing particularly new in this perspective: neither in adopting an epistemological paradigm for investigating the language of dance that reveals how it

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is not a language, yet is structured like one (Bannerman 2014), nor in conceiving language itself as governed by hypothetical processes that operate according to regularities rather than strict rules (Paolucci 2010). However, if we are faced with a repertoire of movements that, despite their potential for categorization, are governed by a *ratio difficilis* (Eco 1975), how can we reinscribe this pseudo-language within a computational system? If a code is imposed, even if it allows for various combinations, it inevitably results in a limitation of the range of possible choices. It therefore becomes necessary to shift perspective: according to Blacking, since dance is an embodied system of signification that operates according to its own logic, there is no need to apply linguistic models to it. Its meaning does not lie in its being a code, but in the process and experience that emerge when it is considered as human action and intention (1983). Consequently, Blacking's critique redefines, rather than excludes, the possibility of a computational approach to dance.

Since dance cannot be directly formalized as a fully coded language, computation cannot limit itself to encoding its units and meanings. It must instead pass through an intermediate level of description: a second semiotic system through which correlations, segmentations, and operational regularities can be constructed. It is no coincidence that dance technologies may be regarded as transductive devices. Joshi and Chakrabarty (2021), in introducing the concept of *Dance Automation*, classified its possible forms into six categories: *dance representation, dance capture, dance semantics, dance generation, dance-processing approaches, and dance automation systems*. Although not all these operations constitute a direct semiotic transduction between fully formed systems, each involves a transfer from one domain to another (Paolucci 2010). The mediating language does not translate dance in its entirety; rather, it provides a relational structure through which certain properties of movement become formalizable in accordance with the technology under consideration. Dance is thus reinscribed through music, natural language, notation, or other descriptive systems, each of which selects and organizes different properties of movement.

This process is primarily intersemiotic in nature, since it brings heterogeneous systems of signification into relation. It may, however, assume a semi-symbolic mode of operation when the relation between the two languages is not based on a rigid correspondence between individual units, but on homologation between categories: for example, between musical continuity and kinetic fluidity, rhythmic discontinuity and gestural segmentation, or sonic intensification and the expansion of movement. The computational system therefore constructs an intersemiotic interface in which certain categories belonging to the mediating language are correlated with categories of movement, without this correlation constituting a fully stable or univocal code. In this way, the computational reconstruction of dance does not reduce it to a stable code, but preserves its status as a pseudo-language, together with its aleatory and processual character.

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The following pages will therefore examine the transductive processes that make it possible to reconfigure dance as a practice within computational systems designed to support creativity and interaction. Drawing on three strands of research, the present study identifies three forms of computational transduction of the language of dance:

- Algorithmic reconstruction of dance
- Music-to-dance transduction
- Natural language-to-dance transduction

3. Computational transductions of dance

3.1. **Algorithmic reconstruction of dance**

Forms of human–AI dance are constituted through a creative and kinematic collaboration between human and artificial intelligence, in which the two (or more) agents involved are capable of influencing one another's decision-making processes (Marin-Bucio 2026). The analysis here developed focuses on *Cyber Subin*, a project created by Klunchun and Pataranutaporn (2024).

The Human–AI Co-Dancing system developed for *Cyber Subin* provides a particularly useful case through which to examine the algorithmic reconstruction of dance. Designed to demonstrate how computational models may incorporate choreographic principles through processes of movement transduction, the system allows human performers and virtual agents to collaborate in real time in the production of choreographic forms. By encoding principles extracted from the traditional Thai dance *Mae Bot Yai*, the computational model can manipulate the movements of a virtual avatar, endowing it with what may be described as a form of 'choreographic intelligence.' The construction of this intelligence requires the choreographic principles underlying the traditional repertoire to be translated into algorithmic procedures capable of modifying the avatar's movement data. The resulting computational model is integrated into an interactive web-based interface and rendered through a three-dimensional graphics engine. Dancers, choreographers, and spectators can consequently control its choreographic parameters through voice commands, menus, and sliders. By modifying these parameters in real time, users may alter the avatar's movement qualities, select the body parts upon which the algorithms operate, or combine different choreographic principles during the performance.

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The choreographic principles are computationally rendered through mathematical filters, temporal variations, inverse-kinematic procedures, and transformations of the avatar's animation data. They derive from the six principles formulated by the Thai choreographer Pichet Klunchun within *No. 60*, a project based on the deconstruction of the choreographic forms of *Mae Bot Yai* (see Fig. 1):

- ***Energy concerns*** the dynamic quality and vitality of movements and choreographic phrases, including variations in force, momentum, acceleration, and deceleration.
- ***Circles & Curves*** concerns the circular trajectories, arcs, and curved lines traced by the body in space, as well as the opposition between rounded and linear movement patterns.
- ***Axis Points*** identifies the joints and bodily segments that function as axes of rotation, orientation, and balance, establishing the principal pivot points around which movement is organized.
- ***Synchronous Limbs*** concerns the coordination of different limbs, sides, and regions of the body, exploring the relation between synchronous and asynchronous movement.
- ***External Body Spaces*** describes the spatial configurations and geometrical relations produced between the body and its surrounding environment, including the directions, planes, and dimensions through which it moves.
- ***Shifting Relations*** concerns the manner in which transitions between poses and movements direct the spectator's attention towards different bodily regions and actions, while producing continuity between successive forms.

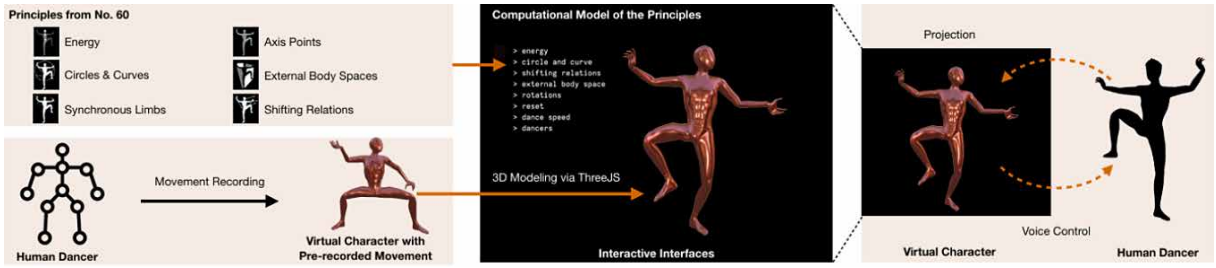


Figure 1. Technical pipeline of the Human–AI Co-Dancing project. Reproduced from Pataranutaporn et al. (2024, Fig. 5), © 2024 the authors, licensed under CC BY 4.0.

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Although the development of the system begins with motion-capture recordings of professional dancers, which are required to animate the avatar's digital skeleton, the body of the dancer gradually gives way to an animated corporeal envelope devoid of an autonomous self. The computational model establishes pertinent thresholds of excitation and inhibition that delimit the avatar's field of possible forms. The algorithmic operations applied to the recorded movement focus specifically on defining thresholds of inertia and saturation, in the sense proposed by Fontanille (2008). At this level, the kinematic engine redistributes the actantial roles involved in the performance. The avatar's movement is organized in relation to an auto-tracking camera whose displacement keeps the digital figure constantly centered within the screen. At the same time, gradients of velocity and the degree of synchronization between poses are modulated in response to the dancer's instructions, since voice commands allow the performer to recalibrate the relevant parameters during the act of co-dancing. Agency is therefore distributed across a network of mediations that tends to minimise the centrality of the fleshly body in favour of the digital nature of the choreographic undertaking.

The project subsequently developed into an experimental workshop in which human dancers were invited to perform alongside the digital avatar, each responding to the movements of the other. It therefore situates itself within the domain of posthuman performance, insofar as the value of the event no longer resides exclusively in either the human body or the digital figure, but in the forms of interaction established between them. If dance is 'held together structurally by a relational synthesis, which is constantly renegotiated' (Vézina 2006:45), Cyber Subin produces a corresponding repositioning of meaning: participatory practice and the complex mechanism of shared affordances give rise to a new choral configuration.

A critical qualification is nevertheless necessary. Although remarkable from the perspective of its transductive construction, such an assemblage risks assuming the character of an *exercice de style*. Its most visible effects appear to derive from the dissociation between the figures occupying the stage, a dissociation intensified by the evident limitations of the digital puppet's movements and resulting in a persistent sense of disjunction between human and machine, particularly when the number of virtual avatars increases.[2] From a semiotic perspective, and more specifically from that of the enunciation in progress, the virtual avatar seems to contribute primarily to the plane of expression, without fully constituting itself as a body capable of functioning as a vector of impulses and resistances. Fontanille's account of the body, acquiring the status of an actantial basis (2013), makes it possible to specify this limitation. If corporeal individuation emerges through the tension between programming and the body's inertia, through its capacity to resist, deviate from, or exceed the prescribed course of action, the avatar appears, by

[2] A practical demonstration of the project is available at the following link: https://www.youtube.com/watch?v=-f2pSC58tWg

contrast, as a predominantly heteronomous actant, whose movements tend to coincide with the operational logic of the system. The margin of indeterminacy through which a body imposes its own conditions upon action is missing. Indeed, sudden changes in rhythm such as failures, delays, perturbations, and deviations should therefore constitute the potential conditions under which the avatar may cease to function as a simple expressive output and begin to emerge as a semiotically individuated body-actant.

3.2. **Music-to-dance transduction**

The creation of new dances remains an open challenge in the field of emerging technologies. Dance-generation techniques may be broadly divided into three categories: methods based on textual descriptions, visual inputs, and music. Music-driven approaches aim to produce dynamic and engaging movements synchronized with the rhythm and style of an input musical track.

Dance becomes computationally generable only insofar as it is preliminarily segmented into syntactic units corresponding to states, poses, transitions, and local responses. While music provides temporal and dynamic constraints, the body is reformulated as a chain of combinable units. The meaning of the gesture, here, depends on its position within a sequence, its relation to preceding and subsequent elements, and its rhythmic inscription. At this point, however, a critical question emerges. In order to generate dance, the system must fragment the semiotic languages involved into operationally distinguishable units. Such discretisation nevertheless risks interrupting the phenomenological unity of movements, which, within choreographic perception, function as indivisible wholes. If musical meaning is not primarily located in denotative semantics, but rather in a plurality of intentional levels and meaning-making processes extending from prereflective corporeality to intersubjective sharing (Giacosa 2023), the relation between music and dance appears less as a simple conversion between media than as a transduction between two organizations of movement.

Even at its most elementary levels, musical experience is grounded in dynamics of temporality, tension, affectivity, and vitality. Listening to music consequently entails experiencing an articulation of the body within its own internal space-time: a form of movement that has not yet become visible in geometrical space, but is lived as dynamism, force, impulse, suspension, continuity, and release. The aesthetic experience of music articulates the listener's body by generating a sensation of movement and vitality. Musical sounds are themselves perceived as sounds in motion, endowed with an expressive directionality that exceeds their mere acoustic succession and produces an internal co-movement within the subject.

Existing experiments (Gong et al. 2023; Li et al. 2022; Marchellus and Park 2023) have frequently treated dance generation as a matching problem, in which generation is organized through associations between musical inputs and already encoded

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motor units, sometimes collected within a codebook. In doing so, however, these systems reveal substantial limitations arising from the necessary compromise between technical precision and artistic expressivity. A generation system based on a codebook may produce a syntactically coherent succession of movements, but it does not necessarily generate a unified choreographic text. Such a text should articulate relations of expectation, transformation, and contrast that cannot be reduced to the synchronic correspondence between gesture and beat. Nor can the problem be exhausted by rhythmic synchronization, since choreography may establish different relations with melody. Dance generation will consequently tend to reproduce the regularities found within the training corpus, thereby producing stylistic stereotypes and limiting the emergence of unexpected creative forms.

This issue leads to the second case study: *BADM*, the Bidirectional Autoregressive Diffusion Model proposed by Zhang et al. (2024) for music-to-dance generation. Whereas much of the existing literature focuses on translating music into a continuous sequence of human poses, BADM constructs dance progressively by segmenting musical features, beat information, and motion sequences into corresponding temporal slices. The model represents the body as a sequence of articulated poses and generates each segment by jointly considering the relevant musical condition, the rhythmic organization of the beat, and its relation to neighbouring portions of movement.

Once generated, the individual motion slices are concatenated and processed by a local information decoder, which refines the transitions between adjacent frames and contributes to producing a choreographic sequence that is both globally coherent and rhythmically aligned with the music. The value of a movement therefore no longer depends exclusively on its relation to the past, as was the case in conventional unidirectional autoregressive experiments, but also on the position it occupies in relation to what will follow. The gesture becomes part of a broader relational structure, acquiring meaning through anticipation and continuity, both retrospectively and prospectively.

Earlier codebook-based models adopted relatively stable syntagmatic and paradigmatic organizations, since the value of each movement was determined through correspondences established during training. BADM instead introduces a dynamic syntagmatics in which the structure is progressively updated throughout the generative process. Each portion of movement remains partially underspecified until it is related both to previously generated segments and to the prospective distribution of subsequent ones. Incrementality and underspecification thus become constitutive principles of generation rather than deficiencies to be eliminated.

Bidirectionality does more than improve the technical smoothness of the output. Each gesture is determined retrospectively by the presuppositions established by the preceding movements and prospectively by the virtual transformations opened by those that may follow. It modifies the temporal regime through which the movement acquires

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value. The generated gesture becomes a relational unit whose configuration depends upon a field of local expectations. The model therefore attempts to reproduce, at an operational level, a minimal form of choreographic anticipation: each movement is selected according to both the memory of what has occurred and the constraints projected by what may occur next. In this way, a minimal choreographic-semantic competence takes shape, as the model actualizes, at each step, one movement from a field of virtual possibilities defined by memory, anticipation, and the current configuration of the sequence.

Ultimately, however, the dances produced through this methodology retain a predominantly supportive function. They are presented less as autonomous choreographic works than as instruments for assisting creation and assessing whether the proposed techniques outperform previous systems in generating sequences that remain physically plausible, locally coherent, and rhythmically attuned to music. The evaluation of the model consequently continues to privilege the efficacy of music–motion alignment. Although bidirectionality expands the relational structure of the sequence, the question remains as to whether such technical coherence is sufficient to produce a choreographic text endowed with aesthetic unity, internal transformation, and expressive necessity.

3.3. **Natural language-to-dance transduction**

A further form of dance generation based on a transductive process consists in exploiting the expressive and descriptive capacities of natural language to facilitate the production of choreographic forms. The example considered here is *DanceGen*, introduced by Liu and Sra (2024) as a choreography-support system intended for the preparatory stages of choreographic practice, including ideation and early prototyping. Its central process consists in generating choreographic sequences from textual descriptions through a crucial intermediate operation: the transformation of language into a computational representation. DanceGen performs this operation through *CLIP*, a neural model trained to encode textual and visual data within a shared representational space. The user provides a linguistic description of a dance, which may include actions, movement qualities, styles, or affective atmospheres (see Fig. 2). The system does not interpret these expressions through an explicit symbolic grammar. Instead, it converts them into semantic embeddings: numerical vectors that represent the text within a multimodal latent space acquired during training.

Since CLIP is trained on image–text pairs, it produces representations that establish correlations between linguistic and visual content. Within DanceGen, its textual embeddings function as semantic conditioning for a diffusion-based motion-generation model. Although the prompt does not directly specify the movements to be performed, it delineates a semantic field that guides the generation of a sequence of bodily poses. The model consequently produces a temporal series of human postures that constitutes one possible choreographic interpretation of the prompt.

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The generated sequence is not conceived as an automatically completed choreography, but as material for creative ideation. Choreographers may explore its variations, modify individual portions, combine different sequences, or use the resulting movements as compositional stimuli. Natural language therefore provides an initial interface for the generation and subsequent transformation of choreographic material, within a broader system that also allows users to edit, extend, blend, and document the generated sequences. The interaction mediated by CLIP may consequently be understood through a supramodal approach (Gangemi and Nuzzolese 2025), in which the meaning of the units represented within the vector space is determined by the possible syntagmatic and paradigmatic relations they establish with one another. Greater emphasis is thus placed on the cognitive dimension: rather than maintaining a rigid distinction between lexical structure and conceptual organization, the model establishes a continuous interaction between the two.

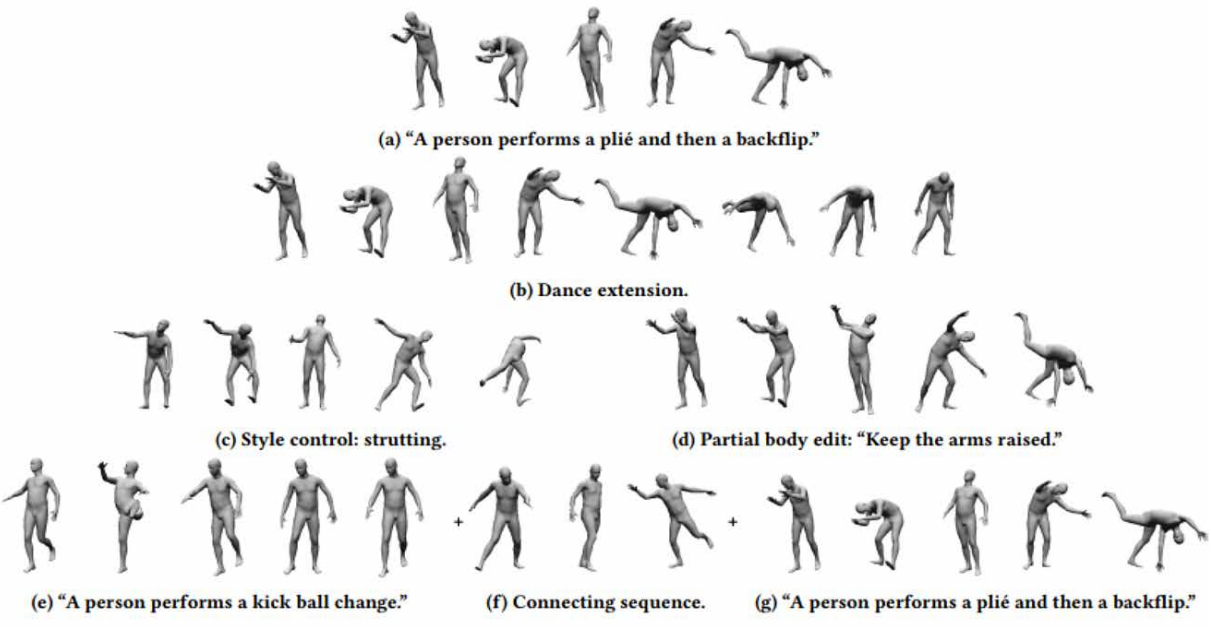


Figure 2. Examples of dance generation through linguistic prompts. Reproduced from Liu and Sra (2024, Fig. 5), © 2024 the authors, licensed under CC BY 4.0.

In this case, however, annotation passes through a computational mediation operating directly within the model's multimodal semantic space, rather than through the adoption of an explicit symbolic notation system, as occurs in traditional choreographic writing. Dance as a practice remains intrinsically embodied, since its meaning emerges from the articulation of the body in space, from rhythm and movement quality, and from the relations established with the environment and with other bodies.

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Traditional choreographic notation constitutes a particular form of translation. Movement is first translated into written symbols capable of recording the choreography; these symbols subsequently become the source text from which movement is reconstructed in performance. This double passage inevitably introduces margins of interpretation and makes notation a privileged site from which to observe the performative and embodied nature of translation.

In DanceGen, by contrast, one is not confronted with notation in the strict sense. The system generates movement directly from a latent semantic representation of language. The translational process therefore does not occur between two stabilized symbolic systems – text and choreographic notation—but through a mediation that relates language, vision, and movement within a shared vector space. The textual prompt activates a particular region of this semantic space, from which the model generates a possible bodily interpretation.

The relation established between prompt and movement does not therefore amount to the attribution of a fixed motor equivalent to each linguistic unit. Rather, the embedding condenses a network of semantic proximities that provides the generative model with a field of constraints. Transduction no longer consists in replacing words with movements according to a predetermined code, but in passing from a linguistic configuration to a probabilistic distribution of possible bodily forms. What is preserved throughout this process is not the identity of individual units, but a relational organization that the system reconstructs through another expressive substance.

It remains to be asked whether natural language can constitute both the point of departure and the primary mediating device for the generation of choreographic forms. In doing so, dance would be defined in relation to a codified system, or at least to one interpreted as such by a computational system. As Judith Hanna observes, just as dance conveys to its audience a multiplicity of meanings, including unpredictable elements, references to what is not immediately present, and components shaped by cultural transmission, it is also articulated through a plurality of channels, including motor, auditory, olfactory, and proxemic ones (Hanna 1977). Reducing the multiple points of access to dance to natural language therefore risks limiting the expressive potential of movement and excluding the meaningful interpretative variations inherent in it.

Ultimately, the system's potential lies in using language as a generative constraint: ideally accelerating prototyping and introducing variations that might not emerge through conventional compositional procedures. In this sense, DanceGen attempts to turn language into movement by translating a semantic organization that can be articulated linguistically into a bodily form that may already take shape, even if we do not yet know how to describe or formalize it with the same precision.

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4. Conclusion: perspectives and possibilities of dance technology

According to McFee, 'danceworks depend on the specific physicality of the dancers'; indeed, dancers do not cause the dance; rather, they are the dance – their movements instantiate it' (2013:28). Dance may therefore be understood as a radical form of embodiment, one that depends upon the particular characteristics and capacities of the dancer's physical body. This becomes especially evident in improvisational practices and in the acquisition of unusual or non-habitual movement patterns, both of which require dancers to reconsider their relation to their own bodies in motion. Improvisational exercises also enable choreographers to explore possible developments of a choreography by asking the bodies already engaged in action to prolong, repeat, or transform their movements in response to specific instructions.

Reflecting on the relation between dance and embodied cognition, Carmona observes that dancers cannot memorise movements by relying upon perfectly defined mental images or upon a pre-existing conceptual organization of the world. They must instead exaggerate certain movements until 'the body remembers how to proceed' (2018: 41). Choreographic memory is therefore not simply the retrieval of a previously stored representation, but a practical reactivation of bodily dispositions through movement itself.

Within performance, embodiment concerns both bodily awareness and the subject's lived sense of their own body. Performative embodiment can consequently be conceived as a form of incorporated practical knowledge. As Dreyfus (1996) argues, drawing on Merleau-Ponty, the acquisition of a skill progressively transforms the relation between perception and action. The expert body does not proceed by applying explicit representations or rules but responds directly to the solicitations offered by the situation. Dance improvisation displays precisely this form of skillful coping, in which movement emerges from the dynamic interaction between body, accumulated experience, and environment.

This leads to a necessary qualification concerning both the experiments examined above and the broader potential of dance technology. The available software and computational instruments should primarily be understood as creativity support tools: devices capable of orienting and sustaining the choreographer's work with dancers, but not, at present, of replacing it. Since meaning is grounded in the situated experience of the individual, transductive processes of this kind tend to fall short whenever they claim to represent the full value of the languages they decompose.

This limitation concerns the absence of embodied experience, as well as the manner in which each of the systems analyzed here selects and reorganizes movement. After all, these models operate primarily upon the plane of expression of discourse. The semiotic systems upon which they intervene, however, already determine meaning through their own networks of relations. The syntacticisation of movement is itself situated within

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– and anticipated by – a system that establishes general relations of dependency between input and output in advance. Computational production therefore reaches textual outcomes through procedures that differ from the situated semiotic processes through which human subjects construct meaning (Haapaniemi et al. 2024).

At this point, semiotics becomes relevant insofar as it makes it possible to describe the regime of intelligibility established by the computational procedure: that is, the manner in which the continuity of gesture is reformulated as something segmentable, analyzable, and comparable. What emerges is not the reproduction of dance as such, but the construction of a new semiotic system.

The lack of equivalence with embodied dance does not, however, imply the absence of productive potential. If, as Lotman observed, every semiotic system constitutes a mechanism for the generation of new information (1985), the systems examined here can be understood as devices capable of producing a different version of dance: one that can be manipulated, compared, recombined, and generated through computational procedures. Their value does not therefore lie in preserving the identity of dance across the transductive process, but in constructing a new field of relations through which dance becomes technically operable. Similarly, as Ludskanov observes (as cited in Osimo 2010), whenever an intermediate language is introduced, a third semiotic system emerges, capable of relating the means and structures of the two languages between which it mediates. From this perspective, meaning within a computational system concerns precisely the actualization of translations among multiple signs. The intermediate language does not remain external to the systems it connects: by selecting correspondences, establishing dependencies, and determining the pertinent features of each input, it actively participates in the production of the resulting text.

Although such an artificial language is founded upon convention, the dimensionality of the system tends to expand exponentially through training on large-scale datasets. Algorithms and trained models can consequently make potential values, virtual social norms, actual intersubjective uses, and realized utterances simultaneously available within the same computational architecture (Paolucci 2021). As the code expands through its structural variability and approaches a potentially indefinite number of combinations, transductive operations become possible even for complex and weakly codified systems such as dance. This expansion, however, should not be confused with the acquisition of embodied experience. The multiplication of parameters increases the system's capacity to differentiate and recombine forms, but it does not transform the computational model into a situated dancing subject.

In conclusion, we hope to have shown how dance technologies operate by constructing intermediate semiotic transductions through which choreographic movement is selected, segmented, and reorganized. These systems neither faithfully reproduce the living body that makes dance possible nor possess the embodied and creative capacities required to generate new choreographic forms autonomously. Rather, at least for the

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time being, they should be understood primarily in terms of their supportive function and its potential, when interacting with human agents, to foster innovation in both educational and creative contexts. However, whereas such technologies were once largely confined to the construction of annotation systems, they now increasingly aim to achieve the most faithful possible representation of the human body in virtual environments. Although this objective has not yet been fully attained, current developments suggest that significant progress is being made in this direction.

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