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Dance Syntax and Possibility: Moving Beyond Structural Analysis

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ABSTRACT

In this work we contend that studying dance syntax systematically is essential to gain a deeper understanding of dance practices. The reason is that syntax has to do with an essential aspect of dance, music and action in general, namely *possibility*. To the best of our knowledge, the efforts towards a systematic method to study dance syntax are scarce. Therefore, this work proposes the method of Finite-State Automata, borrowed from computer science, and presents three case studies of progressive complexity were the method is applied: (1) learning the basics of salsa, (2) diachronically comparing hip-pushing action in Afro-Ecuadorian Bomba del Chota, and (3) characterizing improvisation in Afro-Peruvian zapateo. While the first case is didactic and introduces the method progressively, the second and third cases are based on several years of fieldwork conducted by the authors with the Afro-Ecuadorian and Afro-Peruvian communities. The precondition for the application of the method we propose is structural analysis itself; that is, that the dance can be analyzed into small movement units that are combined progressively into more complex units. In regards to syntax, however, structural analysis is only the first step. The goal is a synthesis that brings forward the possibilities that arise from structural analysis; that is, the possibilities that are available to dancers and agents in a dance event. We trust that the approach to syntax this work presents will stimulate a renewed interest for researchers in dance, music and movement in general.

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KEYWORDS

generative grammar, movement analysis, finite-state automata, computer science, ethnochoreology, dance anthropology

INTRODUCTION

Imagine a researcher trying to reconstruct how a dance was performed in a remote community decades ago. From interviews she knows that first, the community must chant and then the shaman enters, sings and dances. But her fellow researcher asks: is it possible that the shaman dances before the community chant? She did not consider that possibility. In this imaginary but realistic scenario, a method to systematize the possibilities of interaction between agents in the dance event would have helped. Consider another situation. As a researcher you have taken 100 recordings and notations of many of the most skilled dancers of an improvisational traditional form. How could you characterize the dynamics of improvisation of this dance form given the material you recollected? Let us envision a third scenario. The researcher is studying dance transmission, and identifies a set of basic movements that when combined yield more complex movements. She then wonders: what are the principles governing which basic movements can or cannot be combined in order to form more complex movements?

All of these questions relate to *syntax*. The effort of this work is directed towards presenting syntax as a relevant and necessary concept in dance scholarship today, and advancing a method that will allow dance researchers to take structural analysis as a departure point to understand the possibilities (and impossibilities) that lay before any agent partaking in a dance event—e.g., a dancer, a musician, a member of the audience. Syntax is not an extravagant concept we recur to in a nostalgia for structuralism. Syntax, we claim, is fundamental to understanding how dancers may jointly or individually act in specific settings, and more generally, how situated action takes place. A syntactic description allows us researchers to understand the possibilities at hand for an agent or group of agents, and how these possibilities of combination will also yield new more complex units that in turn can be combined with others. At the heart of syntax lie two concepts: *possibility* and *combination*.

Although in this work we focus entirely on the application of syntax to dance, in virtue of syntax being a capacity that agents possess (Asano – Boeckx 2015), both the conceptual framework and method we present can be extrapolated to music research. Our understanding of syntax does not stem from linguistics, but rather from its development in the fields of computer science (Linz – Rodger 2022; Hopcroft et al. 2001), music (Rohrmeier 2020; Rohrmeir – Pearce 2018), dance (Reynolds 1989, 1994; Dinzel 2011) and action (Lashley 1951; Asano – Boeck 2015). Syntax, therefore, should not be understood as related to dance, music nor language exclusively, but to possibilities of action in general. By means of case studies we shall explain how syntactic description expresses the possibilities of movement or action that agents have when partaking in a dance event (who can do what, and when), as well as the action/movements that are available for a dancer depending on where they are at in their performance—i.e., what the dancer can or cannot do often depends on what they did previously, and/or in what others did.

The reader might wonder to what extent syntax has been addressed in previous works given that it is such an important concept. The literature that deals with syntax in dance is rather scarce. One of the most prominent syntactic studies applied to specifically to tango was

conducted by Dinzel (2011) to systematize their pedagogical approach to improvisation in tango. A similar, although less comprehensive effort, was conducted by Green (2014) to analyze the southeast European dance Brâul bătrân and study possible variations in the dance. In our view, the most comprehensive study of syntax was accomplished by William Reynolds (1989, 1994), since he delves into the notion of generative grammar and proposes a form of syntactic notation that can be combined with Labanotation to describe improvisation possibilities within a dance. Reynolds applied mathematical game theory to arrive at his method, but as will become clear in the course of this work, the method of Finite-State Automata we propose, applied from computer science, has the advantage of including the notion of *state*, which allows for a better understanding of action and movement processes. Besides, we construe syntax as a concept that not only applies to dance improvisation (Section "Case study: Improvisation in Afro-Peruvian zapateo"), as our case studies illustrate, but also to dance pedagogy (Section "Finite-state automata applied to learning salsa") and to diachronic descriptions of dance events (Section "Case study: Hip-pushing in Afro-Ecuadorian Bomba del Chota").

Summarizing, our main goal is to show that syntax is an indispensable notion to a dance researcher today. Hence, we start by presenting a definition of syntax, placing syntax in relation to structural movement analysis. Next, we introduce a method that we trust will appeal to dance researchers—i.e., Finite-State Automata (FSA). The method is explained and developed with examples of progressive complexity taking as a case study a series of salsa lessons. Section "Case study: Hip-pushing in Afro-Ecuadorian Bomba del Chota" discusses the dynamics of the Afro-Ecuadorian *Bomba del Chota* dance deploying FSA, focusing on how FSA allows us to compare diachronically different ways in which the same dance event may take place. The *contrapunto* or "battle" in Afro-Peruvian zapateo is developed as a third case study in Section "Case study: Improvisation in Afro-Peruvian zapateo" where FSA is applied both to characterize how the dancers can take turns to challenge each other, and how the basic movement sequences they use are structured. Our work concludes with a discussion of why and how syntax can become evermore relevant to dance researchers.

SYNTAX AND STRUCTURAL ANALYSIS

Imagine a child playing with legos. Maybe in their lego set they have three different blocks. Mounting the smallest blocks one over the other allows the child to form columns. Columns can be combined to build walls, and brading the legos they discover they can build perpendicular walls and therefore rooms or other more complicated structures. Take another example. In written English, the alphabet consists of characters that combine into syllables, syllables combine into words, words into sentences, and sentences into larger text units. Note that some combinations are possible, while others are impossible—random combinations of letters may form words that do not exist in English or that are misspellings of existent words, while inappropriate combinations of words may result in grammatical errors or meaningless sentences. This can be applied to the case of lego as well, since not all combinations between blocks are possible, which leads us to conclude that which combinations are possible and which are impossible is equally important. In the case of dance, a salsa dancer takes movement elements (e.g., step front, step back, turns) and together with their partner they combine these elements to form sequences, and upon joining sequences they create entire performances. All of these examples can be understood taking a suitably general definition of syntax: "'Syntax' can be

defined as a set of principles governing the hierarchical combination of discrete structural elements into larger units… and/or into sequences." (Asano – Boceckx 2015).

We can systematize this definition in terms of the following key points:[1]

1. Syntax requires the existence of a set of *discrete elements* (derived from structural analysis).
2. There are *possible and impossible* combinations between these elements.
3. Syntax itself is defined as the set of principles that enunciate which combinations are possible or impossible.
4. The combination of discrete elements results in new elements, which in turn can be combined with each other.
5. This series of combinations results in a hierarchy of levels of combination.

This definition of syntax is consistent with the concept of *structural analysis* of movement proposed by several scholars during the 1970s (Folk Dance Study Group 1974;[2] Kaeppler 1972;[3] Kaeppler – Dunin 2007). Structural analysis means that a dance can be segmented into units, and that these units can be combined hierarchically to form more complex units. This process is repeated to comprise the totality of a dance performance or realization. For example, according to the terminology proposed by the Folk Dance Study Group (1974), a dance can be segmented into a set of "elementary movements" referred to as motif elements, these can combine to form motif cells, which in turn combine to form motifs, and this recombination may go on to form sections, phrases and finally the *totus* (the entire realization of the dance). Figure 1 illustrates the resulting hierarchy for the proposed terminology. The units occupying a higher level in the pyramid (e.g., sections) are more complex and depend on the units on lower levels (e.g., motif elements).

To claim that syntax implies hierarchy does not involve universalizing the model for structural analysis shown in Fig. 1. Some dances may not be suitably characterized by the set of categories listed in Fig. 1 but rather operate with categories of their own, yet the *combination* of units at a given level to form new units one level above in the hierarchy continues to apply. In other words, combination enables hierarchy itself.[4] Furthermore, regarding structural analysis, Fügedi (2020) launched a forceful critique against structural analysis methods based on linguistics such as the method illustrated in Fig. 1. His point of departure to propose categories for movement analysis is "movement content as spatial change", rather than an analysis in terms of

[1]A similar definition in terms of fundamental elements will be arrived at from the perspective of computer science, considering finite-state automata as a departure point in the hierarchy of syntactical models (Linz – Rodgers 2022; Belzer et al. 1975).

[2]The Folk Dance Study Group included several researchers listed in the *Syllabus*, namely Vera Ciortea-Proca, Rosemarie Ehm-Schulz, Anca Giurchescu, Milica Ilijin, Eva Kroschlova, Hannah Laudova, Martin Gyirgy, Ern6 Pesovar, Kurt Petermann.

[3]As Fügedi (2020) points out, there are logical inconsistencies in Kaeppler's hierarchical system based on linguistic structuralism (1972). For example that a pause in movement cannot be a kineme because "kineme" means a unit of movement. Notwithstanding, her work is cited because it was developed somewhat independently from the Folk Dance Study Group (1974) and yet it structures movement in different hierarchical levels.

[4]Note that there may be motif elements that function as motif cells or as motifs. This is analogous to the fact that in the English language a single letter can function as a word. E.g., "*I* am *a* happy person".

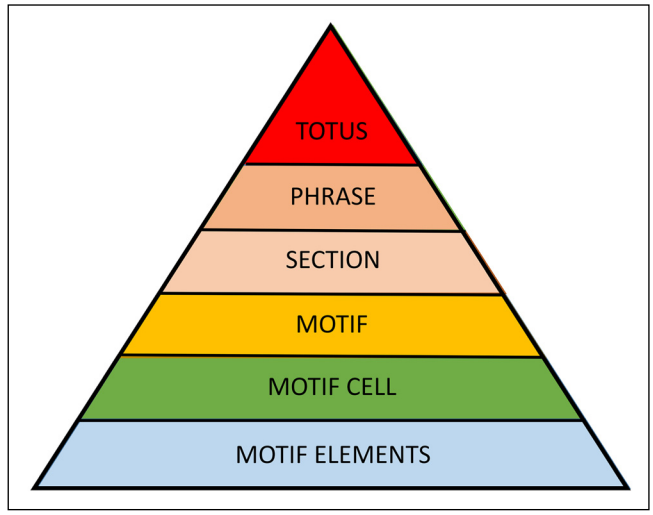

Fig. 1. Typical hierarchical categories for structural analysis (Kaeppler – Dunin 2007; Damsholt 2008). Higher hierarchical levels in the pyramid are composed of elements from the lower levels. Note that the pyramid form does not imply that higher levels have fewer units

units arranged in a temporal order. Hence, Fügedi maintains that a single movement can be comprised of several "movement events" performed simultaneously—e.g., a step forward can also include change in the level of support and rotation of support, a total of three movement events. Therefore, structural analysis ought to consider both the synchronic and diachronic dimensions of movement analysis, i.e., temporal succession and simultaneity. This is all the more explicit in dances practiced by African diasporas where hip movement, feet movement, head movement, shoulder movement, and hand movements can form different lines of movement with independent rhythms, but were the body of the dancer functions as a whole. Although we endorse the validity of Fügedi's critique, this paper does not address the simultaneous dimension of syntax, but rather focuses on temporal movement units. This is done for the saque of simplicity in order to illustrate the method proposed in Section "Finite-state automata applied to learning salsa". Furthermore, Fügedi's critique applies to how movement analysis ought to be performed, but does not in any way question the foundations of our definition of syntax: that movement *can be analyzed* in discrete units that are in turn combined in a variety of ways to form more complex units. How movement ought to be analyzed is out of the scope of this work.

The notion of levels of hierarchy allows us to understand three syntactical operations: (1) *combining* two or more elements of the same level to give rise to an element one level above in the hierarchy, (2) *substituting* an element for another element at the same level of the hierarchy, and (3) *varying* an element to produce another element at the same level of the hierarchy. Substitution enables an economy of movement units, an order of equivalence within a

given level of the hierarchy.[5] Variation points to operations that can be performed on a motif or movement unit that may result in a relationship of difference or of similarity with respect to the original one. Substitution and variation are familiar to us from music theory. For example, a motif can be varied using certain techniques to produce another motif—e.g., via transposition, inversion, augmentation, etc.—. Structural movement analysis also contemplates these possibilities. This work is chiefly concerned with syntax in the sense of possibility arising from combination. Hence, the rest of our discussion, as well as the application of the method of Finite-State Automata, will be oriented to exemplifying and reflecting on this relationship and its application.

FINITE-STATE AUTOMATA APPLIED TO LEARNING SALSA

In order to be able to study syntax, we propose the method of Finite-State Automata (FSA). An automaton is a computational method that, when applied to dance, allows us to represent what possible actions we can take depending on what moment of the process we are in.[6]

We begin this section hands-on introducing simple examples to use FSA in salsa.[7] We then proceed to enumerate the components of a FSA and we close pointing out the potentialities of the method. The method is applied to more elaborate case studies in Sections "Case study: Hip-pushing in Afro-Ecuadorian Bomba del Chota" and "Case study: Improvisation in Afro-Peruvian zapateo".

Example 1: your first salsa lesson

You attend your first salsa lesson and learn two basic motifs: the Basic step and the Side step.

After ensuring that you are capable of performing both motifs, the teacher plays the music, and asks you to perform each motif once, starting with the Basic step. In other words, you must perform the Basic step followed by a Side step. This sequence is represented in Table 1.

The information in Table 1 can be represented with the method of Finite-State Automata (FSA) in a compact graphical way as Fig. 3 illustrates. The circles with numbers inside represent the states listed in Table 1. The arrows denote possible transitions from one state to another. Since the sequence you must perform is Basic step and Side step then only the Basic step can enable a transition from State 1 to State 2. The fact that State 1 is your starting point or initial state is denoted by the arrow pointing to the circle of State 1. State 3 is a final state—known in computer science as an *acceptance state.* Final states denote proper ways of ending the dance.

[5]This was noted by Kaeppler (1972) in her concept of *allokine* studying Tongan dance. Regardless of the analytical rigour of her work (Fügedi 2020), the notion of substitution as allokine in Tongan dance refers to practitioners identifying two observably different hand positions as the same within the composition of the dance.

[6]We are aware that there are other methods of greater complexity that can describe any possible syntax from a computer science point of view (i.e., push-down automata or Turing machines). However, the method of finite-state automata has the advantage of combining simplicity with the power to bring forward the fundamental components of a syntax.

[7]The three authors of this work have experience dancing salsa and the salsa motifs chosen to illustrate the use of FSA are very much standard among salsa practitioners. We have referred to illustrative salsa tutorials on YouTube for a more detailed explanation of the motifs.

Table 1. States and possibilities of action for the B–S sequence in Example 1. A video demonstration of these motifs is available on Youtube (2019a) and Youtube (2020), respectively, while Fig. 2 shows the Labanotation scores for both

State	Description	What can the dancer do?	Next state
1	Before the dance starts. (No motif has been executed).	Perform Basic step.	2
2	After executing the Basic step.	Perform Side step.	3
3	The dance finished	No more actions are possible.	–

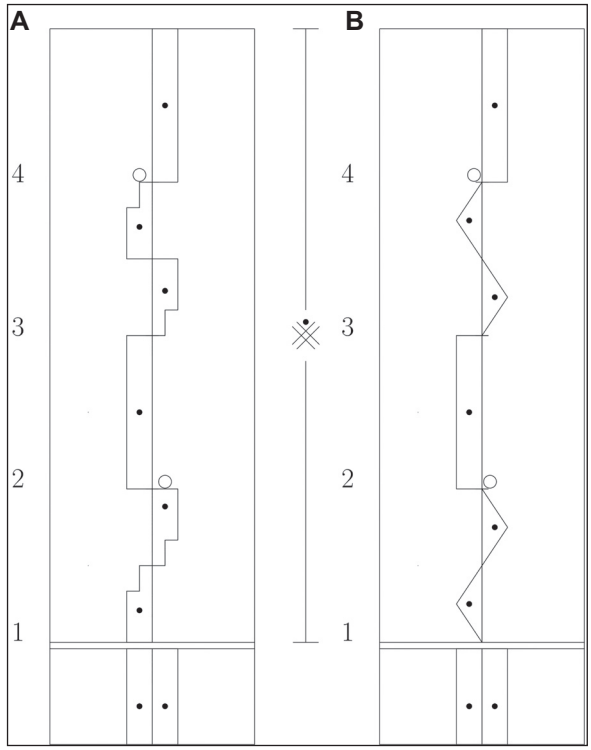

Fig. 2. Labanotation of (a) Basic step, (b) Side step[8]

From this first example we can already identify all the elements that form an automaton:

1. *The set of possible states.* States are transition points from which a set of possibilities of action arise.
2. *The set of possible actions that we can take.* In this case there are two: Basic step and Side step.

[8]The Labanotation scores in Fig. 2 are meant to exemplify how movement notation can be integrated with FSA. Therefore, for the sake of simplicity, certain aspects of movement such as knee flexion or hip movement have been omitted.

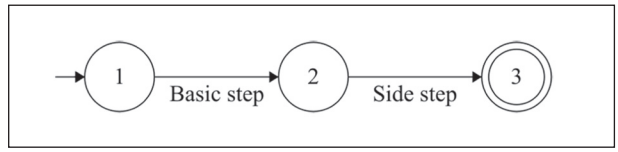

Fig. 3. FSA diagram for the Basic step-Side step salsa sequence

3. *The initial state*, marked by the short arrow that points at it that has no other state before it. In this case our initial state is State 1. In an FSA there can only be one initial state.
4. *The transition functions* denoted by arrows correspond to the actions that we can perform that will take us from one state to another state. For example, the Basic step that takes us from State 1 to State 2 corresponds to a transition function.
5. *The final state(s)* is represented using a double circle; it indicates where the dance ends. An FSA must have at least one final state that indicates when we can stop. Note that it is possible to have more than one final state, and that it is possible to traverse several final states before ending the dance. However, once we decide to end the dance, this must be done arriving (once more) to a final state. In this first example, State 3 is a final state.

Formally defined, a Finite-State Automaton or finite-state machine, "is a mathematical model of computation", "an abstract machine that can be in exactly one of a finite number of *states* at any given time" (Wang 2019). The FSA method is attractive because it allows us to systematically answer the question: given a state, what actions can the dancer take? It does so by connecting circles (states) with arrows (transition functions). It thus represents possibilities by means of connections between states and impossibilities by means of a lack of connection (no arrow). What is possible or impossible for a dancer to do in a dance can be determined by many factors, e.g., by what the dancer's body can afford, by the laws of physics, by cultural conventions set by the practitioners themselves, among other factors.

Example 2: Looping your steps

Performing each motif you have learned only once is not very exciting. Therefore, the teacher encourages you to feel more free, instructing that you can perform the Basic step as many times as you like, and then, when you feel like it, perform the Side step as many times as you like. These instructions are represented in Table 2.

Table 2. States and possibilities of action for the B–S sequence in Example 1

State	Description	What can the dancer do?	Next state
1	Before the dance starts or once the dance has started but only the Basic step has been executed.	Perform Basic step.	1 or 2
2	After executing the Basic step.	Perform Side step.	2
		Stop dancing (dance finished).	–

The information in Table 2 is represented in the FSA shown in Fig. 4. For the sake of clarity we refer to repeating a movement sequence indefinitely as *looping*. This is graphically illustrated in Fig. 3 with the two loops over State 1 and State 2. In this case, State 1 continues to be our initial state, while State 2 is the final state (we terminate the dance with a Side step after having executed any number of Side steps as shown in Fig. 4).

Example 3: learn the right turn.

In your next salsa lesson you learn how to perform the Right turn, illustrated on Labanotation in Fig. 5 and available as a demonstration on Youtube (2019b).

Using the new motif you just learned, the teacher encourages you to try a new sequence: open with the basic step (perform it only once) then perform the side step any number of times you like, but you can only finish your performance executing the Right turn once. This sequence is represented in Table 3.

The description in Table 3 could be represented in a more friendly manner using the FSA shown in Fig. 6.

Example 4: performing a right turn with your partner

This time you dance with a partner, and the teacher explains how to perform the right turn as demonstrated in this YouTube video (2015). In salsa couple dancing, dancers take on the roles of Leader (L) and Follower (F). Most often salsa couples are heterosexual and men take the role of leaders and women that of followers. The sequence of actions for the right turn are as follows:

1. L and F are framed up in a closed position and are performing the Basic step.
2. L and F perform the "one, two, three" steps together while L raises their left hand thus raising F's right hand.
3. L does a circle with their left hand around F's head thus helping F turn while F performs a turn on "five, six, seven".
4. L and F reconnect into a closed position.
5. L and F go back to the basic step.

This can be expressed in table form in terms of states and actions as shown in Table 4.

These same possibilities of action can be expressed with greater clarity using the FSA shown in Fig. 7. The important point of this example is that FSA can also be used to represent *interaction* between dancers. In the case of salsa this could apply to couple dancing or to a *rueda de casino* where several couples dance coordinately together. More generally, this entails that FSA can be used to model choreographic processes of interaction.

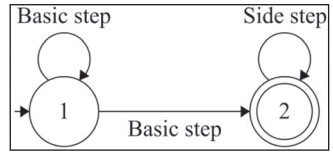

Fig. 4. FSA for looping the Basic step and then looping the Side step

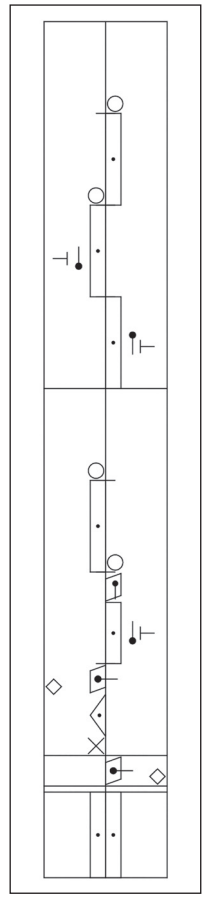

Fig. 5. Labanotation of the right turn in salsa. The notation follows the Szénpal convention for directions. Score revised by expert notator Prof. János Fügedi

Table 3. States and possibilities of action for the salsa performance in Example 3

State	Description	What can the dancer do?	Next state
1	Before the dance starts. (No motif has been executed).	Perform the Basic step.	2
2	After executing the Basic step.	Perform the Side step.	2
		Perform the Finale.	3
3	The Finale has been executed.	The dance is finished.	–

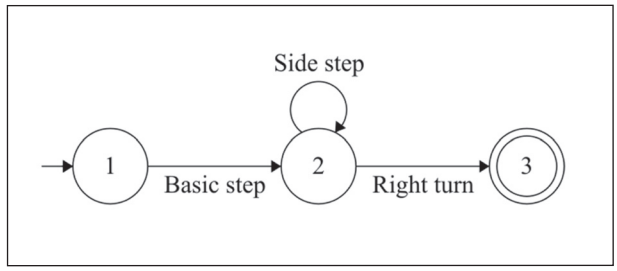

Fig. 6. FSA corresponding to the dance sequence executing the Basic step once, the Side step any number of times and the Right turn once

Table 4. States and possibilities of action for the Right turn

State	Description	What can the dancer do?	Next state
1	Before the dance starts. L and F are framed up in a closed position and are performing the Basic step.	Perform the Basic step.	1
		Perform the Basic step before taking the Right turn.	2
2	After executing the Basic step.	L and F perform the "one, two, three" steps together while L raises their left hand thus raising F's right hand.	3
3	After raising hands.	L does a circle with their left hand around F's head thus helping F turn |F performs a turn on "five, six, seven".	4
4	After having taken the Right turn.	L and F reconnect in a closed position.	1

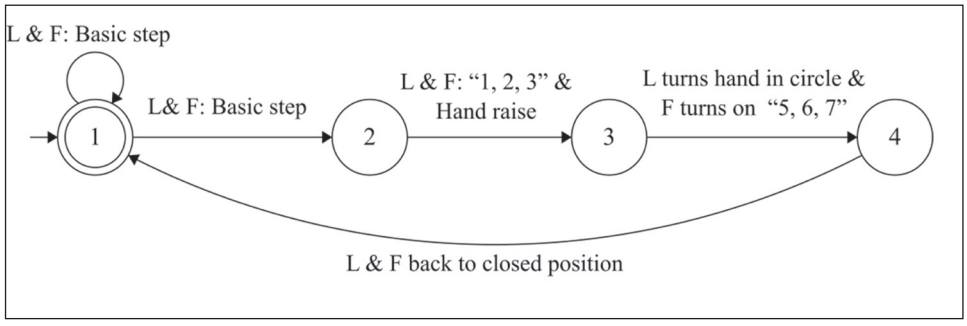

Fig. 7. FSA for the Right turn

Now that you master three salsa motifs (the Basic step, Side step and Right turn) your teacher encourages you and your partner to take greater improvisational freedom. You can use the motifs you have learned in any order you like, but you must always perform the Side step before the Right turn. She adds one constraint: you can only end the dance with a Right turn. This is illustrated in the FSA in Fig. 8. According to the action possibilities the FSA illustrates, we may start dancing with the basic step or the side step, and we can perform any of them as many times as we like (hence the loop around State 1). The FSA also illustrates that before performing the Right turn we have to perform the Side step—i.e., with the Side Step we transition from State 1 to 2, and only when we are in State 2 can we transition to State 3 by performing the Right turn. Since the teacher added the constraint that the dance can only end with a Right turn, the Right turn is the only possible action previous to State 3, which is the only final state. As the FSA shows, the Basic step and the Side step can only lead us back to States 1 and 2, but none of them can lead us to the final state. For example, it is possible that you perform the following combination: Basic step (State 1 to State 1), Side step (State 1 to State 2), Right turn (State 2 to State 3), Side step (State 3 to State 2), and then Right turn (State 2 to State 3), thus ending your performance. This sequence would be consistent with the instructions you received from your salsa teacher.

In this section we introduced the method of Finite-State Automata (FSA) to represent and characterize syntax in a systematic fashion emphasizing on possible (and impossible) combinations of movement sequences or actions. FSA relies on the notion of states as moments in the performance that offer certain possibilities of action, and these possibilities depend on the actions you carried out before. In other words, there is a finite set of specific movement sequences or actions. Actions will lead you to transition from one state to another, and being in a state means simply that you have, as an agent, certain possible actions that you can perform (and impossible actions that you should not perform given that state). In the four examples related to salsa lessons we have provided a syntactic description at the level of motifs (through the Basic

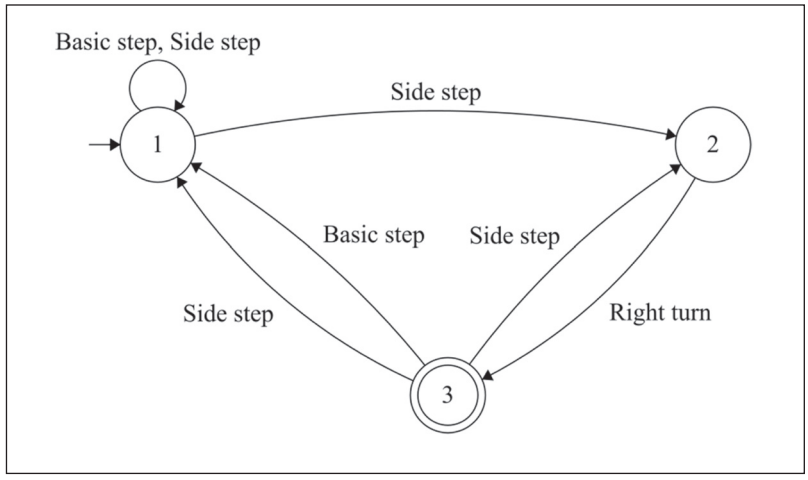

Fig. 8. Improvisational salsa routine that may only finish with a Right turn

step, the Side step and the Right turn). Notwithstanding, a similar characterization using FSA can be conducted at any level of the hierarchy of the dance being studied. In other words, before rushing into a syntactic study of a dance, you need to establish the hierarchy of movement sequences (e.g., from motif element to totus, as shown in Fig. 1). This is the task of structural movement analysis. Next, you choose the level in the hierarchy for which you want to develop a syntactic study. For that level, you enumerate all of the possible actions or movement sequences. Then, you can use FSA to clarify which movement sequences can follow from others as the dance unfolds. In addition, the case of the salsa lessons illustrates the complementary relation between a syntactic approach from FSA with Labanotation. The latter describes the movement sequences, FSA describes how they can be combined. The same applies to video recordings or motion capture. Furthermore, the example of the Right turn points to the fact that FSA can be used to represent interaction between dancers.

CASE STUDY: HIP-PUSHING IN AFRO-ECUADORIAN BOMBA DEL CHOTA

Bomba del Chota is a music- and dance-based event that originated in an Afro-Ecuadorian Valley named Chota-Mira during the period of Atlantic Slavery (16th to 19th centuries). It is mainly Afro-Choteño people who practice Bomba until the present day in both Chota-Mira Valley communities and in specific neighborhoods in Ecuadorian cities like Ibarra or Quito where there is a predominance of Afro-Choteño population. The central movement of Bomba is a sideward hip-movement (Costales – Peñaherrera 1959:192–193, Chalá Cruz 2006:166; López-Yánez 2013, 2022). In this section, we specifically focus on the dancing event of hip-pushing among Bomba dancers that used to be called *Desafío* (challenge) and more recently is referred to as *atacarse* (to attack each other). There are three main descriptions of the action of hip-pushing. The first description was published in 1959 by the renowned Ecuadorian anthropologists Alfredo Costales and Piedad Peñaherrera. Apparently, throughout their long-term research in Chota-Mira, they managed to see at least one Desafío as a hip-pushing event performed by a dancing couple, which is what they described. However, it is also possible that this description was a result of several hip-pushing events. In the second description, José Chalá, an Afro-Choteño anthropologist, and one of the authors of this work (López-Yánez), study a more recent Bomba hip-pushing event also performed in couples. Finally, the third description was developed by López-Yánez, and represents a Bomba's hip-pushing event she witnessed repeatedly during her fieldwork in night clubs in Ibarra (a city nearby Chota-Mira) and Chota Mira.

Here, we focus on the similarities among these descriptions as a way to demonstrate that this dancing event has survived until the present day. As you can see in the chart, there are important similarities. For instance, for a Desafío event, or for Bomba dancers to begin to "attack each other", the event of Bomba del Chota must be at its peak. That is, the Desafío or the Atacarse begins in the midst of the celebration, when Bomba music is played. Therefore, the initial state is the peak of a Bomba set or celebration. In State 1, a female or male dancer initiates the Caderazo or Desafío through hip-pushing his/her partner or partners. This action allows the game to pass to its second stage. In the second stage, dancers will keep pushing each other until a dancer or dancers manage to throw to the floor or throw away either his/her dancing partner or the rest of the dancers. This action will allow the dancing event to pass into its third stage which is when the action of hip pushing stops. From that point onwards, dancers have the choice to

either finish the dance as a whole, go back to dancing Bomba without hip-pushing or beginning another caderazo or desafío event.

In Fig. 9 we present the FSA for this case study. As you can see, the initial state is state number one. In this state, dancers are at the peak of a Bomba event, which, as mentioned before, is an essential characteristic for the possibility of the Desafío or Caderazo to arise. In this state, dancers have two possibilities. First, they can either keep dancing Bomba with no hip-pushing until they reach the final state, that is, until the celebration ends. This option is represented by means of a double circle. Second, one or more dancers can make the decision to enact the first hip push. If they choose this last option, they end up in State 2, which is the dancing game of Desafío or Caderazo. At this point new possibilities arise. They can either keep hip pushing each other, or one or more dancers can manage to hip push the other dancer(s) to the floor or push them away. If the second possibility is enacted, the dancer or dancers will reach State 3. Finally, in State 3, which is when the Desafío or Caderazo ends, three possibilities arise. First, the dancers can stop dancing, so the dance event of Bomba comes to an end, thus reaching the acceptance or final state. Second, dancers can choose to enact again a first hip push, which would lead them to the second stage of Desafío or Caderazo again. And third, they could go back to dancing Bomba without hip pushing each other.

By means of this FSA, we have highlighted the similarities of all of the descriptions of Desafío or Caderazo to clearly illustrate a pattern of choices or possibilities that has survived through the centuries. In this way it becomes clear that the main structure of the event of hip-pushing in Bomba del Chota, and thus its knowledge system, continues to be practiced until today.

CASE STUDY: IMPROVISATION IN AFRO-PERUVIAN ZAPATEO

Zapateo refers to "using the shoes" to make rhythmic percussive patterns by stomping the feet against the floor. Dancers also deploy the movements of the hand beating the legs, the floor or the

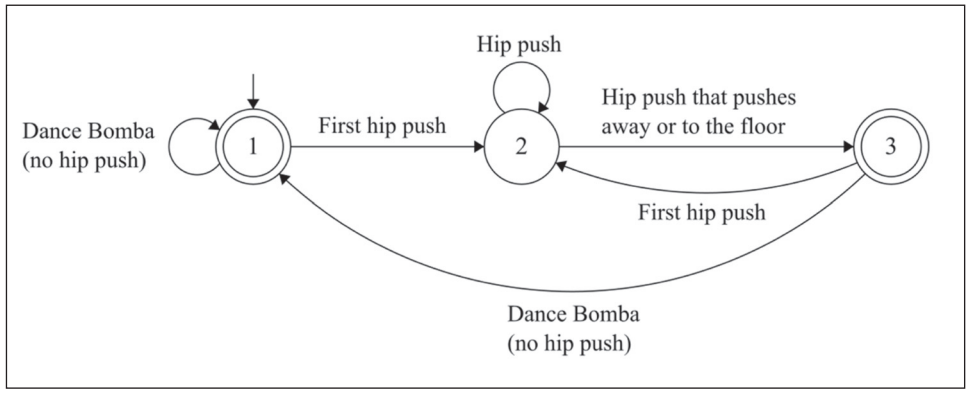

Fig. 9. FSA summarizing the diachronic comparison of the Bomba del Chota dance event presented in Table 5. Description of states: (1) Peak of Bomba event, (2) Desafío or Caderazo, (3) Desafío or Caderazo ends

Table 5. Diachronic comparison of dance events of Bomba del Chota

Current state	Action			Next state
	Costales – Peñaherrera (1959, p. 192)	Chalá (2006)/López-Yánez (2013)	López-Yánez (2013)	
	The celebration that includes Bomba del Chota is at its peak			
	Dancing couple		Dancing group	
1	A man or a woman initiates the *desafío* or the *atacarse* (hip-pushing action)			2
	The woman initiates the desafío	A man or a woman begins to atacarse	Men or women begins to atacarse	
2	A man or a woman manages to hip-push her or his dancing partner/s			3
	The woman manages to hip-push her male partner, making him fall to the ground	A man or a woman manages to hip-push her/his dancing partner not to the floor but just slightly away and far away from her.	One or more male or female dancers fall to the ground.	
3	The action of hip-pushing stops			
	The action of hip-pushing begins again			
	The woman invites another man to hip-push	The same couple begins to hip-push again	The group of dancers stand up and continue hip-pushing	
	The dance of Bomba finishes, dancers continue dancing Bomba without hip-pushing or dancers initiate another Desafío or Caderazo event			

body within these rhythmic-movement sequences known as *pasadas* (Miranda Medina – Cervantes 2021). *Contrapunto* refers to the fact that there is a battle, or speaking more properly, a *challenge* between the dancers. The contrapunto was originally a contest (Acosta Ojeda 2015; Tompkins 2011), but today it is mostly practiced on stage (Miranda Medina 2021). So even if there is no judge to declare a winner, the challenge remains: dancers perform so as to engage the audience in their favor.

The extensive research of one of the authors (Miranda Medina) with the Afro-Peruvian community, as well as his experience as a zapateo dancer, allow us to postulate the following levels in the hierarchy of movement structure for zapateo (from higher to lower order):

1. *Turn-taking* between the dancers to form a contrapunto.
2. The *turn* of an individual dancer (combining *pasadas*).
3. The *pasada.*
4. The *figures* that compose the pasada.
5. The *morphokines* that form the figures.
6. The *movement elements* that form the morphokines.

To demonstrate the usefulness of FSA to study the syntax of zapateo, we address levels 1 (turn-taking) and 3 (the pasada).

The syntax of turn-taking in zapateo

A *contrapunto de zapateo* is a dance challenge where dancers take turns. The dancer is expected to outdo their partner as the contrapunto progresses. To become acquainted with the dance, we recommend this video (Youtube 2009) of Caitro Soto in contrapunto with Pititi, or this one (Youtube 2015) of Lalo Izquierdo with Huevito Lobatón, both of them performed by dancers renowned for their zapateo skills. Although there are some contrapuntos that involve more than two dancers, two is the most common case, and is therefore the case that is addressed in what follows.

A staged contrapunto may be structured in different ways, but in general it has three moments: a joint opening, the contrapunto itself (challenge) and the closing common choreography. If we call our two dancers A and B, it might be that there is a joint opening where A and B enter the stage dancing, each from an opposite side of the stage. Else, it might be that there is no joint opening and that one of the dancers, A or B, enters the stage and takes a round. The rule is that dancers must alternate (i.e., the same dancer can not take two consecutive solo rounds). Thus, if A danced first, then it is B's turn. If B danced first, it would then be A's turn. The staged contrapunto then closes with a common choreography where both dancers perform the same sequence.

The rules for the structure of the contrapunto can be summarized as follows:

1. There may or may not be a joint opening (AB).
2. One of the dancers takes a round, and the next round it will be the other dancer's turn.
3. This can be repeated any number of times.
4. The number of turns for A and B before the common choreography must be equal (a typical number of rounds per dancer is two or three).
5. The contrapunto closes with a common choreography (AB2).

It is important to note that the sequence (AB),A,(AB2) is impossible. That is to say, if A dances a solo round once, then B must also take one solo round once, for the number of solo rounds must be equal for A and B.

Using FSA, however, this can be compactly represented in the automata shown in Fig. 10. Note that the automata only allows the combinations that comply with the rules stated above, and excludes invalid combinations such as B,B,A,B,(AB2). The automata in Fig. 10 uses the convention that A refers to the dancer that starts the contrapunto, and B to the dancer that follows, making it clear that if Mary and Peter dance the contrapunto, in a given realization A could refer to Mary or Peter, depending on who starts.

The syntax of a pasada with hands

Zapateo is a highly structured dance. Its elementary meaningful sequences, the *pasadas*, which are the basis for improvisation, are composed of smaller units (morphokines, in Kaeppler's sense) that can be substituted for each other in order to give the same pasada a number of variations.

Let us take the case of one of the most basic pasadas in zapateo, namely a "hand" pasada (*pasada de mano* in Spanish). The core of this pasada consists of the dancer stomping twice and then touching the inside of the right foot with the right hand, stomping twice again, and then touching the outside of the right foot with the right hand. The hand pasada knows several

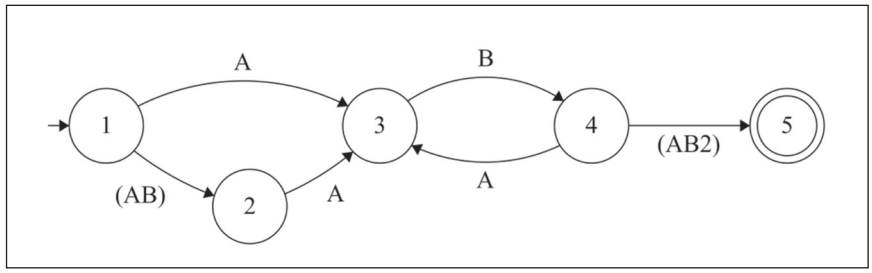

Fig. 10. Syntactic structure of turn-taking in a contrapunto de zapateo using FSA. The dancers can perform the joint opening sequence (AB) to start the contrapunto (transition from States 1–2) and then dancer A starts the dance (transition from State 2–3). However, an alternative opening is possible: A can perform first thus starting the contrapunto (transition from States 1–3). A's performance will be necessarily followed by the performance of B (transition from State 3–4). However, the transition between States 4 and 3 with a new performance of A enables a loop that must be followed by a new performance of B. After dancers A and B have exchanged enough turns, they end the dance by performing together (AB2), thus transitioning from State 4 to State 5

variations. A recording of its simplest and most common form performed by "Lalo" Izquierdo is available on YouTube (2013). This demonstration exemplifies as well one of the most common schemas of repetition in zapateo that applies to a large number of pasadas. This schema, known by some practitioners as "short-short-long" (*chiquito-chiquito-largo* in Spanish), has the form AAA'. In this schema, a basic *figure* (A) is repeated identically once or more, but repeated with a prolongation (A′) to close the pasada. Figure 11 shows the Labanotation of the basic figure of the hands pasada in its simplest form.

The pasada performed by Lalo Izquierdo (variation 1, v1) can be written in terms of its morphokines in the following formula:

$$\text{v1}: \ [\text{H},\ \text{S},\ \text{B}],\ [\text{H},\ \text{S},\ \text{B}],\ [\text{H},\ \text{H},\ \text{H},\ \text{S},\ \text{B}] = \text{A}_1\text{A}_1\text{A}_{1\text{P}}$$

where H corresponds to the morphokine shown in Fig. 10. S is the morphokine that consists of three alternating steps in place starting with the right foot, and B consists of two inward brushing movements starting with the right foot. The brackets group the morphokines into figures. In this case the prolongation structure AAA' takes the form $A_1A_1A_{1P}$. Note how using repetition and prolongation (i.e., repeating H several times in A_{1P}) a rather long sequence can be formed deploying only a few short movement sequences (i.e., H, S and B).

A second variation (v2) demonstrated by master Marcos Napa is available on YouTube (Robin Estela 2015). This variation is once again based on morphokine H, but this time H is complemented with morphokine K instead of SB. K consists of three steps in place followed by a kick with the left foot and two steps in place. The sequence Marco performs can then be written as:

$$\text{v2}: \ [\text{H},\ \text{K}],\ [\text{H},\ \text{K}],\ [\text{H},\ \text{K}],\ [\text{H},\ \text{H},\ \text{H},\ \text{H},\ \text{H},\ \text{H},\ \text{H},\ \text{S}] = \text{A}_2\text{A}_2\text{A}_2\text{A}_{2\text{P}}$$

As a final reference, a third variation (v3) performed by Afro-Peruvian master Carlos "Caitro" Soto is available on YouTube (AcuarelaCriolla 2009). This variation combines morphokine H

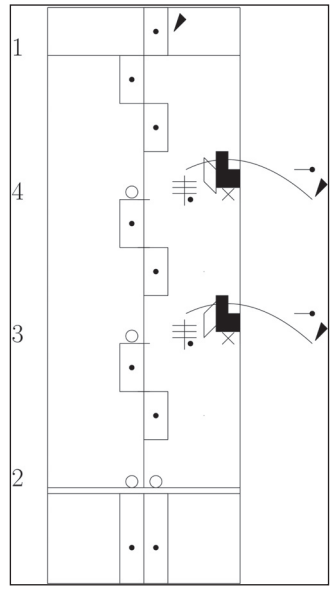

Fig. 11. Labanotation of the core figure of the "hands pasada" in its simplest form (Miranda Medina 2017)

with a sequence Z where he touches the heel of the left foot with his right hand and then kicks the floor with the left foot. The variation can be written in terms of its morphokines as:

$$\text{v3}: \ [\text{H},\ \text{Z}],\ [\text{H},\ \text{Z}],\ [\text{H},\ \text{Z}],\ [\text{H},\ \text{Z},\ \text{Z},\ \text{Z}],\ \text{new pasada} = \text{A}_3\text{A}_3\text{A}_3\text{A}_{3\text{P}}\text{B}.$$

An interesting difference between v3 and the two previous variations is that the prolonged figure A_{3P} consists of repeating morphokine Z, rather than H. Yet, as we can see, all three variations share a common pattern: repeat a figure A a number of times that includes H and close the pasada performing a prolonged version of A, where either H or another of its constituent morphokines is repeated. Is it possible to represent the possibilities that these three realizations have opened in a single representation system? Our answer is affirmative. That is one of the strengths of the FSA method. The FSA for all three variations is shown in Fig. 12. States 1, 2, 3 and 4 are traversed by variations 1 and 2, which are structurally very similar. Variation 3 is different in that, as pointed out previously, it requires the repetition of Z rather than H before closing. Nevertheless, the FSA shows the structural similarity of having a core figure that is repeated (loops in States 1–2 and 1–2B), and of having a prolonged figure based on repeating a morphokine (loops around States 3 and 3B).

Afro-Peruvian zapateo is a dance with a very complex syntax and many possible variations that stem from the flexible use of some key morphokines. This section has illustrated how several realizations can be conjoined into a single graph highlighting the different possibilities available to perform a pasada.

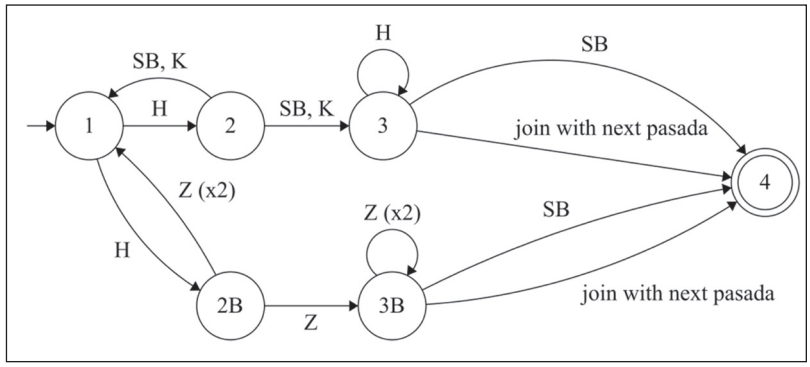

Fig. 12. FSA for variations 1, 2 and 3 of the hands pasada

DISCUSSION AND FUTURE OUTLOOK

Dancing allows dancers to realize specific actions or movements from a myriad of possibilities. We believe that a proper and methodological approach to the concept of syntax is key to characterizing these possibilities systematically.

Our literature review indicates that while some researchers have studied the syntax of specific dances, syntax as a concept is scarcely used, and until today no standard methodology has been proposed to study syntax in different dance practices. In light of these facts, we introduced an operational definition of syntax that applies to other practices—such as music and language—that can be understood as follows: asserting that a practice has a syntax is asserting that there are principles that rule combinations of units into more complex units. This entails that the combination of certain units is possible while the combination of others is impossible. A profound discussion about the principles allowing or ruling out combinations is the subject of future work, but for our purpose it suffices to say that they can be based on (1) logical possibility, on (2) what is physically possible, and (3) what a given culture prescribes as possible and impossible in a practice (i.e., desirable, accepted, proper, or uncommon and undesirable). As ethnochoreologists we have focused on the third kind of principle that is derived from fieldwork, i.e., from what we as researchers can gather about what practitioners do and prefer to do.

But when we speak about "units", what are we referring to? First, the notion of *unit* can refer to a sequence of movements, to a single movement, or even to the conjunction of events that simultaneously compose a single movement (Fügedi 2020). An important consequence of the definition of syntax we endorse is that the combination, whether simultaneous or successive, of units into evermore complex units results in a hierarchy: at the bottom of the hierarchy we find the most elementary units (e.g., motif elements, or movement events) while at the top we have the totus or totality of a realization of the dance. Each level in the hierarchy will require a different syntactic characterization to understand how combinations at that level operate. Second, "unit" can refer to parts of the body of a dancer that operate in conjunction with each other to produce movement (e.g., we can speak of the syntax comprising the combination of head movements, with shoulder action, hip movement and feet movement for a given dance). Third, "units" can

refer to different dancers interacting with each other. Therefore, we can study the joint syntax of several dancers that together form a totus, i.e., a choreography in the general sense.

In this work we have presented syntax from two different standpoints. First, from an objective (third-person) standpoint, approaching syntax as something one studies. From this perspective, the researcher can define, model or characterize what the principles of combination for a dance practice are. Second, from a subjective standpoint, that is, considering syntax as something one does. As a dancer you use the salsa motifs that you know, you perform them in different order, vary them, or even integrate them with motifs from other dances in order to produce new realizations of the dance. As a zapateo dancer one can rearrange and create new morphokines that give rise to different pasadas in order to hold a contrapunto/battle with other dancers.

The two standpoints from which to approach syntax are of course deeply connected. In order to understand both of them we have introduced the method of Finite-State Automata (FSA) from computer science. This method allows us to characterize and understand syntax relying on the notion of *states* and *transitions* between states. In the case studies we presented (salsa, Bomba and zapateo), *action* enables the transition between states. The application of Finite-State Automata, however, could be extended to include events—things that happen to agents but that are not caused by them, for example actions that other agents perform—. The notion of state points to the fact that, at a given point of a dance realization, after a sequence of actions is performed, only certain actions remain available as possibilities for the agent.

How can a researcher characterize the syntax of a dance? We recommend the following:

1. Choose a methodological approach from which to study the dance. Such an approach can include the study of a collection of recorded realizations, a recollection of your own experience as a fluent practitioner in the dance, or a combination of both.
2. Using structural movement analysis, define the different levels that form the hierarchy for the dance practice in question.
3. Choose a level in the hierarchy to study its syntax.
4. Compile a dictionary, that is, list all possible actions/movement sequences at the hierarchy level chosen in Step 3.
5. Based on your empirical material (Step 1), define which transitions between them are possible or impossible and ask yourself which of the actions in the dictionary make these transitions happen.

From Step 2 we see that the study of syntax integrates with structural movement analysis and relies on it; neither is reducible to the other. As the case study of salsa exemplified, movement notation can aid in describing the different movement elements that form the dance, and syntax can explain how these elements are combined. Thus, syntax is complementary with notation, it does not compete with it. Step 1 makes clear that there are different epistemic positions from which to approach syntax. The researcher can take a single realization with several dancers that may have been video recorded, can take movement notations of a collection of motifs, can also rely on motion capture of several realizations of the dance. If we understand "recording" as a general category that encompasses audiovisual material, motion capture, movement notation or anything of the sort, syntax can integrate a collection of recordings into a coherent description of the possibilities available within the dance.

On the other hand, insofar syntax is connected to actions performed by agents in a dance event, syntax mediates between the dance concept and the dance realization (Bakka – Karoblis

2010). While the *dance concept* corresponds to the systemic level, the *dance realization* actualizes and enacts the rules or principles of the system to form dance sequences that are regarded as valid or acceptable by a community. Moreover, a question that begs for an extended answer in future publications is what is the precise relation between the dance concept, the dance realization and syntax. Nevertheless, in agreement with Bakka and Karoblis, because the dance concept influences every realization and every realization influences the concept, we believe syntax is speculative, iterative, and changing with each realization of the dance. This does not mean, however, that in its flexibility syntax cannot be studied systematically.

Finally, we trust this work will awaken the interest of dancers and dance researchers, for it applies to the study of heritage as living and spontaneous, to improvisation as enacting possibilities, to the study of dance events as the case of Bomba shows, and surely to the study of new aspects of dance that our colleagues in the field will discover in their own efforts to approach syntax.

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