xCoAx 2022 10th Conference on
Computation, Communication, Aesthetics & X
2022.xCoAx.org
Coimbra, Portugal

Generative Dance as a Self-Organizing Dynamic System: A Study on Choreographic Emergence and the Phenomenon of Togetherness

Ana Leitão
ana-leitao1@campus.ul.pt
Universidade de Lisboa, Faculdade de Motricidade Humana. INET-md, Instituto de Etnomusicologia - Centro de Estudos em Música e Dança, polo FMH. CIPER - Centro Interdisciplinar de Performance Humana. CMAT - Centro de Matemática

In this transformative exploratory study, we propose to contribute to the definition of the concept of Generative Dance based on the theory of self-organized dynamic systems, in order to: 1) Describe the concepts of Emergent Choreography and Generative Dance (by approximation to the Generative Art concept); 2) Computationally model generative dance and study the emergence of spatio-temporal patterns - using Agent-based model theory and genetic algorithms; 3) Explore collective improvisation, following the cycle Practice-led Research and Research-led Practice (Smith and Dean 2009), integrating the relationship principles observed in the emergent modeling behavior; 4) Know the subjective experience of space-time sharing - togetherness phenomenon - experienced in generative dance.

Keywords Generative Art, Self-organized system, Collective composition, Collective improvisation, Collective dance, Togetherness

DOI 10.24840/xCoAx_2022_84

1. Introduction

Nowadays, it is essential to reflect how we corporeally relate to each other and how we can create a collective universe ("togetherness"). Observing the movement of fish, birds, flocks, traffic and human crowds, we can see that they exhibit complex and coordinated spatio-temporal patterns (Couzin and Krause 2003), which are explained by Self-Organization Theory. According to this, the global displacement of a group emerges, without the need for an external regulating agent, due to the numerous intra-element interactions of the system (Camazine et al. 2003). Currently, Self-Organization Theory is applied to slime mold aggregation processes, players behavior in team sports (Araújo, Correia and Davids 2012), study in motor control (Camerino, Castañer, and Anguera 2012), contact-improvisation (Torrents, Castañer and Anguera 2011) and collective improvisations (Leonard et al. 2012).

For Hagendoorn (2012), a choreography is constituted as a set of instructions for the organization and reconfiguration of one or several bodies in space-time, where the choreographer defines how the dancers move and what their spatial organization is. This function seems to be reduced to a set of rules that interrelate the dancers. When we want to produce generative choreographies, is it enough to play with these rules?

The concept of generative art, according to Galanter (2003), is associated with artistic practice in which the artistic result comes from the use, by the artist, of a set of rules that constitute a system. Transposing this concept to a generative dance, we can consider that the choreographer creates and defines the functioning of a system of dancers, where the choreographic result emerges from the set of inter-dancers relationships. Assuming a model of composition in contemporary dance based on the choreographers' privilege in the development of organizing principles - logic that engenders a choreographic organization that: superimposes the logic of chaining movements and steps ; and makes it possible to establish contingent relationships between the elements (Leste 2010) - the concept of generative dance and emergent choreography is based on the composition by "Organizing Principles". The Organizing Principles, "recursively co-constitute themselves in the multiple interrelations (...) from which will emerge movement patterns that had only their parameters pre-defined and not their final formatting" (Leste 2010, 33). In this way, the choreographer proposes simple rules of interaction, potentially generating emergent collective behaviors. But how is it felt, this emergent collective behavior between dancers? Considering the intra-dancer relationships, is there an amplification of the perception of the togetherness phenomenon?

Hart (2014), discovered that when improvisation happens co-confidently between performers, it achieves a smooth and symmetrical universal movement, but not periodic and simple. However, in dance, 'togetherness' is associated

with the sense of the agency of the other (Himberg et al. 2018) and not exclusively only with synchrony, once we can move together without feeling together. Therefore, how will the phenomenon of togetherness be felt from the intra-dancer perspective, when the rules of relation are already pre-established as in generative dance?

2. Description of the Proposal Approach

Our transformative exploratory study combines implicit quantitative study procedures with an explicit qualitative approach to data interpretation. For the quantitative study, we have created a set of choreographic objects based on Agent - based - models for the plan, that simulate self-organized systems of dancers. For the qualitative study, by approximation to a case study, we use samples of convenience, where the participants will be selected by curriculum, motivation letter or audition. To achieve the project main goals, this project was divided in three stages:

Stage_I - Construction of Mathematical models of self-organized systems in the plane - by approximation to Forsythe's (2012) choreographic objects - defined as a model of potential transition from one state to another in any imaginable space - based on the theory of Agent-based models. The creation of these models allow us to study generative dance as a self-organized dynamic system and perceive: the collective spatial behavior of the virtual dancers; the emergent spatio-temporal patterns; the system's attractors and transients; the spatio-temporal variations for random initial conditions and the resilience to error. Using Wolfram Language - Mathematica, data is being collected through systematic direct observation by two experts and the chosen results compiled by recording images in JPEG and GIF format.

Stage_II - Creation of generative dances (Flasmob of 20-60 dancers and Collective Improvisation for a group of 10 dancers) based on the previous study of choreographic objects. With them, we intend to substantiate the concepts of generative dance and choreographic emergence and contrast results on stage with modeled results obtained. For this, Flasmobs will be recorded in video format with subsequent analysis by two expert observers, using an instrument based on criteria of time shift, interaction and spatial design in order to create an - exhaustive and mutually exclusive - system of categories (Torrents, Castañer and Anguera 2011). On the other side, collective improvisation for 10 dancers - inserted in the cycle of Practice-led Research and Research-led Practice (Smith and Dean 2009) - will include: 1) Direct observation by the researcher with daily field notes; 2) Individual Logbook for each participant, with regular recording of sensations, words, images and ideas; 3) Daily group discussions (30') at the end of each work session, to collectively share thoughts, concepts and ideas regarding the project and individual conclusions.

Stage_III - Parallel to stage_II, we seek to understand how generative dance influences the feeling of "togetheness" between dancer. For that, we will conduct In-Depth Interviews (Roller and Lavrakas 2015) and apply the Focus Group technique (Onwuegbuzie et al. 2009) in order to deepen the concepts of own space, shareable space and group feeling, based on the perception of relational dynamics, allowing a better understanding of the Togetherness phenomenon. The individual in-depth interviews will be applied during the residency (collective improvisation) and are based on the principles of the explicitness method (Vermersch 2010), to characterize the subjective experience of the dancer.

3. Expected Contributions

A system corresponds to a relationship between unified parts for which new qualities and properties emerge (Morin 2008), as exemplified by the spatio-temporal emergence patterns detected in self-organized systems. With regard to individual experience, this "is experienced as a joint movement where the subject is a collective and not a sum of individuals" (Himberg et al. 2018, 4). From the complementarity of these assumptions, we question: 1) the possibility of creating dance as a self-organized dynamic system for a group of dancers (generative dance) with emergent choreography; 2) the set of rules for which emergent dynamic patterns are produced; 3) how does generative dance influence the feeling of "togetherness" between dancers.

In sequence of these main questions we expect to contribute to understanding of the phenomenon of choreographic emergence and the relations between the organizational principles in contemporary collective dance, through practical artistic research based on rules resulting from computational modeling, capable of generating emerging collective behavior patterns. For that we will: 1) Explore the emergent behavior patterns, by computational modeling, that may confer to generative dance a component of autonomy and a coherence beyond the expected behavior - "a life of its own" (Monro 2009, 2) Propose a definition of generative dance and emergent choreography, based on the established concepts of Generative-Art and Generative-Art Emergence (Cook and Brown 1999; Gomes 2010), applied to contemporary dance, as of organizational principles of collective composition and improvisation; 3) Explore Emergent Phenomena in Dance based on the definition of autonomy component, connected with the idea of "going beyond" or transcendence of origins, of Monro(2009); 4) Understand the Togetherness phenomenon, verifying the influence of Generative Dance on collective choreographic creation, via listening the subjective experience of the dancers (perspective between dancers) for the construction of the concepts of own space, shareable space and group feeling.

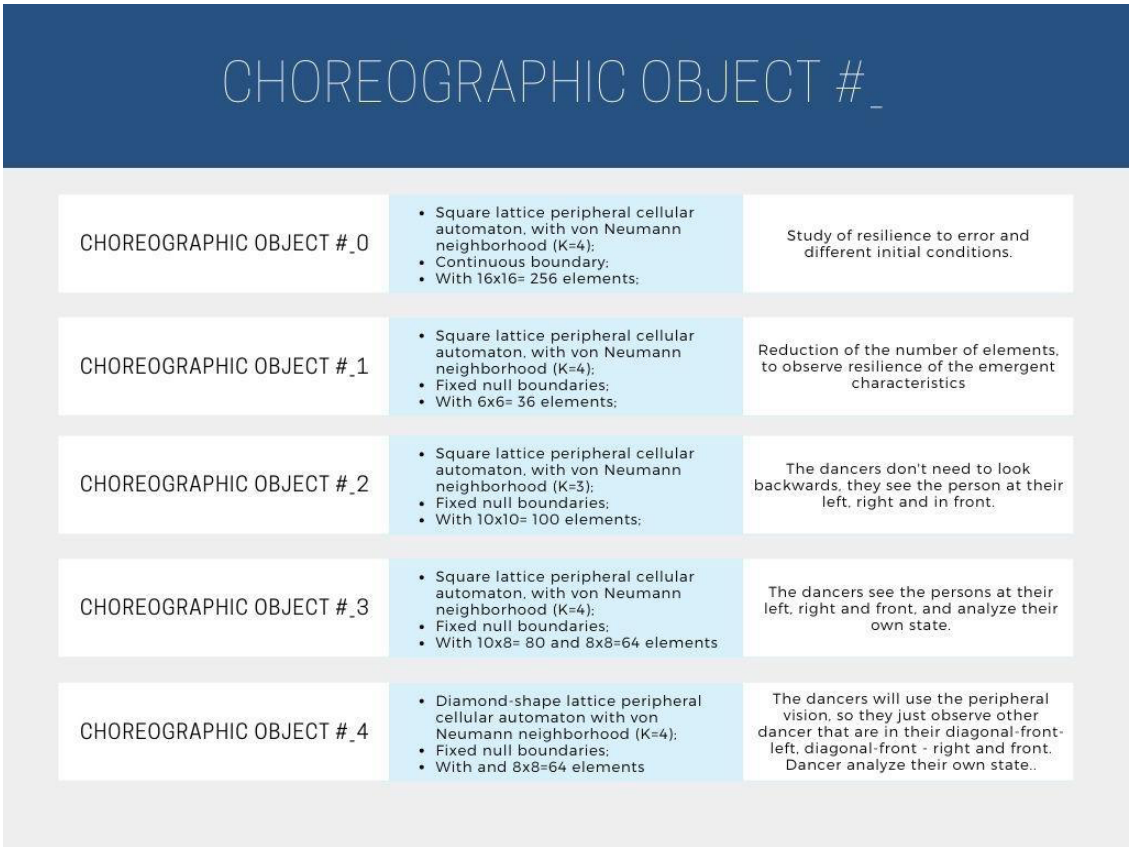
4. Progress Towards Goals

Classically, one would guess that systems with numerous small parts that interact with similar nearby parts in a very simple way (and the word simple is the key here), could not show a collective behavior rather than a simple one. The study of elementary cellular automata came to show that, for some interaction of simple rules, the collective behavior of the systems is anything but simple. As John Conway showed, with his Game of Life, 2D cellular automata, some of these non-simple collective behaviors can exhibit both order and disorder/unpredictable features. Stephen Wolfram suggested that this kind of dynamic should be called as complex behavior. In the 1980s, Stephen Wolfram identified the elementary cellular automata that would be able to show complex behavior. Since then, it remains an open question to know if different cellular automata can show different order and disorder/unpredictable features. Still also to answer how different from that identified by Wolfram, can an order and disorder/unpredictable collective behavior be.

Approaching the collective dance behaviors to a choreographic object led us to study 2D cellular automata. Our interest is to see if the dynamics shown by these cellular automata have characteristics one could describe as order and disorder/unpredictable, and consequence recognizable patterns that we could define as emergent choreographies.

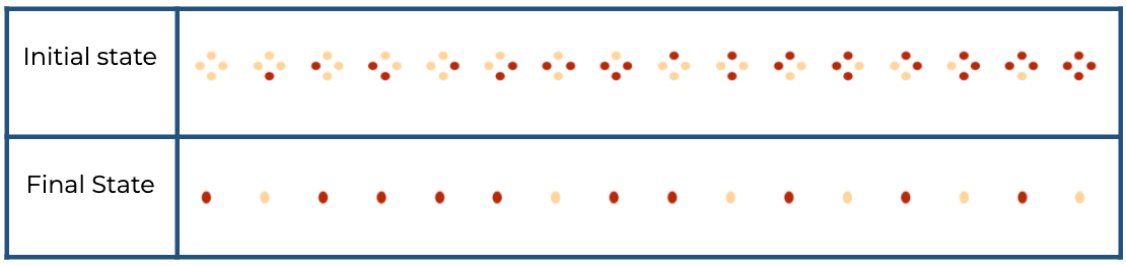
After, the systematic study of choreographic objects (Agent based models - 2D cellular automata) (Fig.1.), we have identified: 1) A different complex behavior for a square lattice peripheral cellular automaton, with von Neumann neighborhood and fixed null boundary conditions, which due to its characteristics, we are calling such order and disorder/unpredictable collective behavior as flow; 2) A singular cellular automaton capable of displaying self-organizing collective behavior with the system showing unexpected symmetries, after other families of cellular automata, diamond-shape lattice cellular automaton, with 4-neighbors (front & front left & front right & self), with fixed null boundary conditions.

Fig. 1. Systematization of choreographic objects.



We have found a specific rule of correlation (Fig.2) in the choreographic object (Agent Based Model - diamond-shape lattice cellular automata, with 4-neighbors (front & front left & front right & self) with fixed null boundary conditions) for which we could observe the emergence of a concentric flux associated with a non-regular geometric pattern. With that, we have decided to use the same rule as a choreographic dispositive for our first Flashmobs, translating it to a set of scores (Table.1) that will be given to the participants.

Fig. 2. Singular cellular automaton capable of displaying self-organizing collective behavior, with the system showing unexpected symmetries.



The practice of Flasmobs, corresponds to the final presentation of dance workshops that we are collaboratively producing with different institutions (All Dance Portugal Festival; Center of Mathematics of University of Minho, etc.). As first workshops, they will serve as trials for the next investigations, nevertheless all of them will be followed by focus groups towards the phenomenon of togetherness (own space, shareable space and group feeling).

Table 1. Translation of automaton - diamond-shape lattice cellular automata, with 4-neighbors, with fixed null boundary conditions into a set of scores.

SET OF SCORES

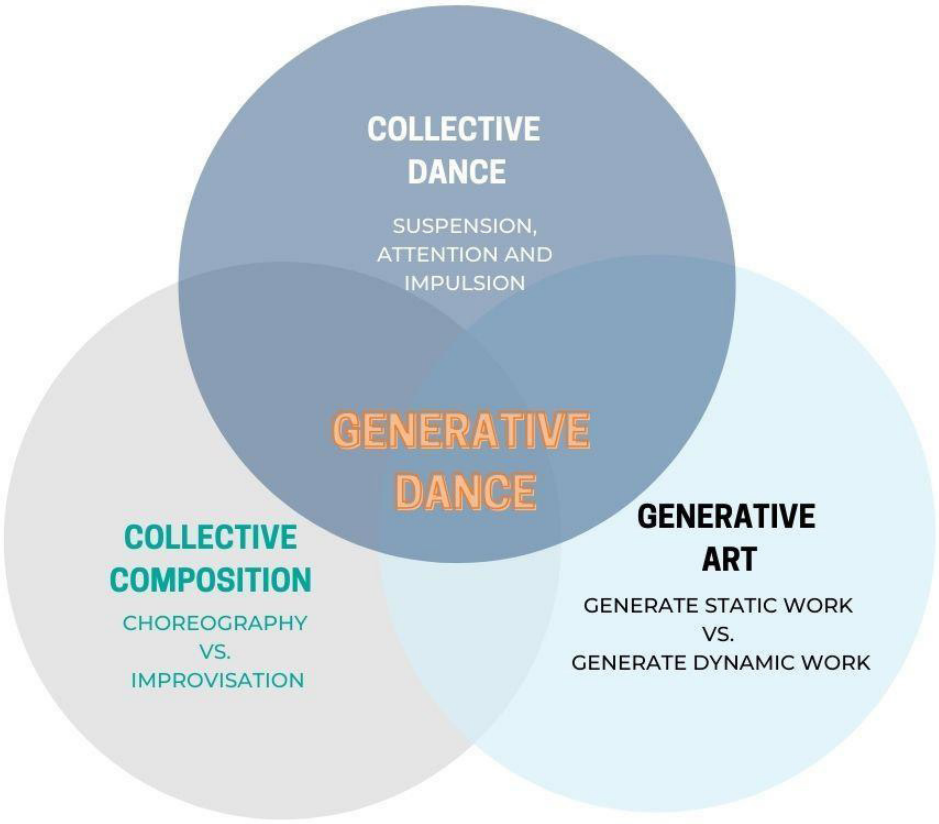
ASSUMING THE NOMENCLATURE:

L- THE STATE OF THE PERSON AT MY DIAGONAL - FRONT - LEFT
R- THE STATE OF THE PERSON AT MY DIAGONAL - FRONT - RIGHT
F- THE STATE OF THE PERSON IN FRONT OF ME

INITIAL SITUATION	MY CHOICE
If everybody is paused	I move
If L, F, R are paused, and I'm moving	I paused
If L is moving and F, R and me are paused	I move
If L and me are moving and F, R are paused	I move
If L, F and me are paused and R is moving	I move
If L, F are paused and R and me are moving	I move
If L, R are moving and F and me are paused	I pause
If L, R and me are moving and F is paused	I move
If L, R and me are paused and F is moving	I move
If L, R are paused and F and me are moving	I pause
If L, F are moving and R and me are paused	I move
If L, F and me are moving and R is paused	I pause
If L and me are paused and F, R are moving	I move
If L is paused and F, R and me are moving	I pause
If L, F, R are moving, and I'm paused	I move
If everybody is moving	I pause

On the other side, at this moment, we are writing an article with the provisional title - “An essay about the dimensions of a generative dance”- in which we propose a mapping and systematization of some concepts (Collective Dance - suspension, attention and impulsion; Collective Composition - Choreography vs. improvisation ; Generative Art - Generate Static Work vs. Generate Dynamic Work) that bound the concept of Generative Dance (Fig.3.).

Fig. 3. Main concepts that bound Generative Dance.



References

Araújo, Duarte, Vanda Correia, and Keith Davids. 2012. "Sports Teams as Superorganisms: Implications of Sociobiological Models of Behaviour for Research and Practice in Team Sports Performance Analysis." *Sports Medicine* 42 (8): 633–42. https://doi.org/10.2165/11632450-000000000-00000

Camazine, Scott, Jean-Louis Deneubourg, Nigel R. Franks, James Sneyd, Guy Theraula, and Eric Bonabeau. 2001. *Self-Organization in Biological Systems.* Princeton University Press.

Camerino, Oleguer, Marta Castañer, and M. Teresa Anguera. 2012. *Mixed Methods Research in the Movement Sciences: Case Studies in Sport, Physical Education and Dance.* Routledge. https://doi.org/10.4324/9780203132326

Cook, Scott D.N., and John Seely Brown. 1999. "Bridging Epistemologies: The Generative Dance between Organizational Knowledge and Organizational Knowing." *Organization Science* 10 (4): 381–400. https://doi.org/10.1287/orsc.10.4.381

Couzin, Iain D, and Jens Krause. 2003. "Self-Organization and Collective Behavior in Vertebrates." *Advances in the Study of Behavior* 32: 1–75. https://doi.org/10.1016/S0065-3454(03)01001-5

Forsythe, William. 2012. "William Forsythe Choreographic Objects : Essay." https://www.williamforsythe.com/essay.html

Galanter, Philip. 2003. "What Is Generative Art? Complexity Theory as a Context for Art Theory." In *GA2003–6th Generative Art Conference*, 1–21. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.90.2634

Gomes, Joana Fernandes. 2010. "Untitled* Interactive Generative Installation for Visual Composition." *Journal of Science and Technology of the Arts* 2 (1): 15–21. https://doi.org/10.7559/citarj.v2i1.15

Hagendoorn, Ivar. 2012. "Inscribing the Body, Exscribing Space." *Phenomenology and the Cognitive Sciences.* Springer. https://doi.org/10.1007/s11097-011-9238-7

Hart, Yuval, Lior Noy, Rinat Feniger-Schaal, Avraham E. Mayo, and Uri Alon. 2014. "Individuality and Togetherness in Joint Improvised Motion." *PLoS ONE* 9 (2): e87213. https://doi.org/10.1371/journal.pone.0087213

Himberg, Tommi, Julien Laroche, Romain Bigé, Megan Buchkowski, and Asaf Bachrach. 2018. "Coordinated Interpersonal Behaviour in Collective Dance Improvisation: The Aesthetics of Kinaesthetic Togetherness." *Behavioral Sciences* 8 (2): 23. https://doi.org/10.3390/bs8020023

Leonard, Naomi E., George Young, Kelsey Hochgraf, Daniel Swain, Aaron Trippe, Willa Chen, and Susan Marshall. 2012. "In the Dance Studio: Analysis of Human Flocking." *Proceedings of the American Control Conference*, 1–6. https://doi.org/10.1109/acc.2012.6315402

Leste, Thembi Rosa. 2010. *Dança: Modos De Estar Princípios Organizativos Em Dança Contemporânea.* Universidade Federal da Bahia. http://www.repositorio.ufba.br/ri/handle/ri/8076

Monro, Gordon. 2009. "Emergence and Generative Art.". Leonardo 42 (5): 476–477. https://doi.org/10.1162/leon.2009.42.5.476

Morin, Edgar. 2007. "Restricted complexity, general complexity." In *Worldviews, science, and us: Philosophy and complexity.* 5–29. New York: World Scientific Publishing Company.

Onwuegbuzie, Anthony J, Wendy B Dickinson, Nancy L Leech, and Annmarie G Zoran. 2009. "A Qualitative Framework for Collecting and Analyzing Data in Focus Group Research." *International Journal of Qualitative Methods* 8 (3): 1–21. https://doi.org/10.1177/160940690900800301

Roller, Margaret R. and Paul J. Lavrakas. 2015. *Applied Qualitative Research Design: A Total Quality Framework Approach.* New York: The Guilford Press.

Smith, Hazel, and Roger T Dean. 2009. *Practice-Led Research, Research-Led Practice in the Creative Arts.* Edinburgh: Edinburgh University Press. http://www.jstor.org/stable/10.3366/j.ctt1g0b594

Torrents, Carlota, Marta Castañer, and Maria T. Anguera. 2011. "Dancing with Complexity: Observation of Emergent Patterns in Dance Improvisation." *Education, Physical Training, Sport* 80 (1): 76–81. https://doi.org/10.33607/bjshs.v1i80.344

Vermersch, Pierre. 2010. *L'entretien d'explicitation.* Issy-les-Moulineaux: ESF.