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Order-fractal transitions in abstract paintings

E.M. de la Calleja [a,*,1], F. Cervantes [b], J. de la Calleja [c]

[a] Instituto de Física, Universidade Federal do Rio Grande do Sul, Caixa Postal 15051, 91501-970, Porto Alegre, RS, Brazil

[b] Department of Applied Physics, CINVESTAV-IPN, Carr. Antigua a Progreso km.6, Cordemex, C.P.97310, Mérida, Yucatán, Mexico

[c] Department of Informatics, Universidad Politécnica de Puebla, 72640, Mexico

HIGHLIGHTS

- We determined the degree of order in Jackson Pollock paintings using the Hausdorff–Besicovitch dimension.
- We detected a fractal-order transition from Pollock's paintings between 1947 and 1951.
- We suggest that Jackson Pollock could have painted *Teri's Find*.

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ABSTRACT

In this study, we determined the degree of order for 22 Jackson Pollock paintings using the *Hausdorff–Besicovitch fractal dimension*. Based on the maximum value of each multi-fractal spectrum, the artworks were classified according to the year in which they were painted. It has been reported that Pollock's paintings are fractal and that this feature was more evident in his later works. However, our results show that the fractal dimension of these paintings ranges among values close to two. We characterize this behavior as a fractal-order transition. Based on the study of disorder-order transition in physical systems, we interpreted the fractal-order transition via the dark paint strokes in Pollock's paintings as structured lines that follow a power law measured by the fractal dimension. We determined self-similarity in specific paintings, thereby demonstrating an important dependence on the scale of observations. We also characterized the fractal spectrum for the painting entitled *Teri's Find*. We obtained similar spectra for *Teri's Find* and *Number* 5, thereby suggesting that the fractal dimension

* Corresponding author.
E-mail address: elsama79@gmail.com (E.M. de la Calleja).

[1] E.M.D.C. Bolsista do CNPq, Brazil.

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cannot be rejected completely as a quantitative parameter for authenticating these artworks.

1. Introduction

Fractality is present in many objects in nature, structures generated by mathematical algorithms, spatial interactions among populations, the distributions of particles in amorphous solids, and in particle configurations created by computer simulations [1–5]. Thus, we can measure the fractal characteristics in a wide variety of two-dimensional digital images. From the viewpoint of analyzing physical systems, it is possible to identify fractal characteristics in Jackson Pollock's paintings [6,7].

Since Taylor et al. first indicated that all Jackson Pollock paintings are fractals [6], many studies have either confirmed or questioned the fractal characteristics of abstract artworks [8–13].

Based on the fractal dimension, Taylor presented five criteria to describe the processes involved in the construction of the colored layers on Pollock's canvases [14]. He also concluded that it is possible to authenticate these paintings using the fractal dimension [6,14,15]. Taylor's criteria have been tested with different methods and many studies have concluded that using the fractal dimension is not sufficient for authenticating any drip paintings [10–13,16,17].

However, the objections raised in these studies have been addressed by others [18,19], thereby leaving the fractal dimension as a rigorous measure for characterizing Jackson Pollock's paintings, so it can be used as an important parameter during the authentication process as well as being useful for improving the analysis of complex abstract art [10,16].

Pollock's paintings were created by dripping, pouring, splashing, or peeling layers of paint in different colors on a canvas placed on the floor. Paint strokes were painted above each other until the canvas was totally covered, or at least most of it. Pollock argued that he had control of the paint splattering or dripping and denied that they were accidental paintings [20,21]. This argument suggests that he was aware of his actions and the movements required to control the paint strokes, the flow of paint, the velocity, and the rhythm of his creative processes. This is surprising to many researchers considering the apparent complexity of the strokes.

The visual complexity of the linked paint strokes produced by the method described above results in a high apparent degree of complexity, which is directly proportional to the large number of linked and superimposed lines. However, we found that this is not completely true in the case of Pollock's paintings. If Pollock added paint lines by spilling them one by one in a particular way that only the artist knew, then we can determine whether the process is not completely random. Clearly, the creative process is unique, complex, and unrepeatable, especially in the case of Pollock.

In this study, we compared the physical complexity present in two-dimensional images based on experimental phenomena and we used the same method to quantify the degree of order in physical structures. The distribution of paint strokes in Pollock's paintings has been compared to natural objects, but we relate them to fibrillar aggregation [22] and particle aggregation processes [23–26]. The distribution of paint strokes reflects some degree of disorder, but we assumed that there would be a high degree of order if the fractal dimension is close to two. According to previous studies of physical images that described the evolution of order in systems of supercooled liquids [23], granular materials [26], and magnetic properties [27], we consider that structures formed by paint strokes would possess a high degree or order.

Our results suggest that there is an increase in the order of the paint stroke distributions in a particular series of Pollock's paintings (see Table 1), and our results also indicate that the fractal property of Pollock's paintings lies within a specific range of values. It has been suggested that fractal dimension cannot be used as a quantitative parameter to authenticate abstract art. However, we consider the complex process of authenticating artworks based on the example of *Teri's Find*, which is a well-known case that has been discussed with respect to the authentication process according