Iteration dynamical systems of discrete Laplacians on the plane lattice (II) (The visual impressions given by design-patterns)

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1. INTRODUCTION

This is the second part of the study which is written under the same title. The present study was designed to make clear the underlying factors determining the visual impressions of design-patterns produced by the dynamical systems defined by iterations of discrete Laplacians on the plane lattice. Those patterns were available to stimuli of psychological experiments because they were not only complex, but also defined mathematically ([1]). As for the notations we refer to the first part. We notice that the same experiments with simple designs or with high symmetry properties have been reported in many places. But the complicated designs have not been treated. Here we have a nice opportunity to use our software.

2. EXPERIMENT

Participants: 21 graduate and undergraduate students including 10males and 11females were recruited as participants in the experiment. All of them had normal or corrected-to-normal vision.

Materials: 102 kinds of design-patterns produced by the dynamical system above mentioned were used in the experiment. Those were produced by our software Designer KENTAURUS 2005 which was written by JAVA and analyzed by EXCEL ([2]; samples are shown in Figure

1). Those design-patterns were controlled by three mathematical variables systematically; the number of neighborhood, symmetry of neighborhood, and steps of iterations ([1]).

Procedure: The experiment was situated in an experimental room. The light source of the room was the standardized illumination D65. The 102 design-patterns were presented simultaneously on the work-desk in a random order. Participants were asked to classify those patterns into several groups by the similarities of visual impressions.

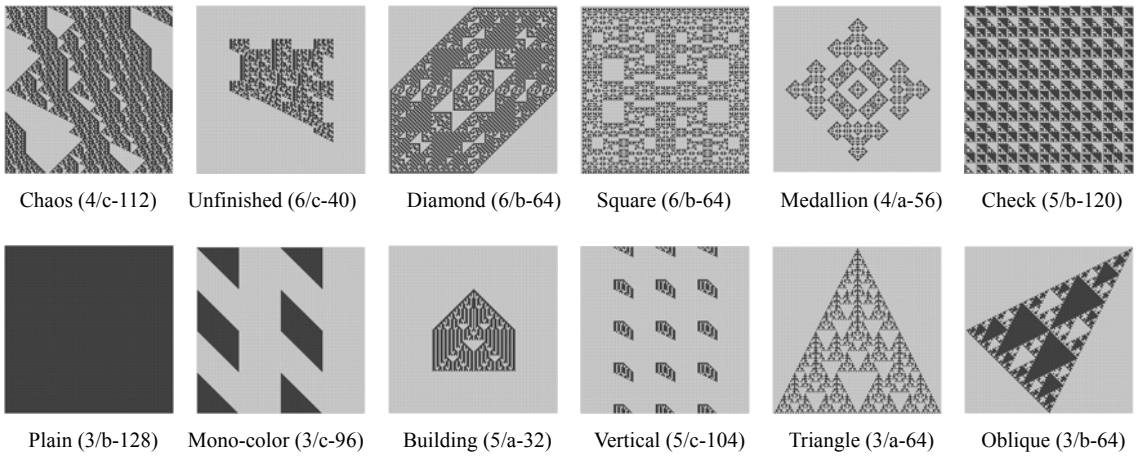

Figure 1 Examples of design-pattern included each category.

The numbers underlying each category name indicate the mathematical variables of pattern (the number of neighborhood / the kind of symmetry of neighborhood - steps of iterations).

Alphabets used in the kind of symmetry of neighborhood mean; a: symmetry against the vertical, b: symmetry against a diagonal, c: asymmetry.

3. RESULTS & DISCUSSION

The degree of similarity was calculated for each pairs of design-patterns, from the frequency of belonging same groups. Those 102 patterns were classified into 12 categories by the degree of similarity using the cluster analysis, one of numerical mathematical method (see Figure 1, Figure 2, & Table 1). The results showed that regularity of pattern defined by the symmetries of neighborhood was a most efficient factor for determining visual impressions of design-pattern. Satoshi Watanabe, a Japanese mathematician, proposed “the theorem of the ugly duckling” and accounted that the similarity of visual impression were reflected the evaluation structure of human nature ([3]). Findings of the present study imply the regularity of pattern was one of most important factor not only for visual impressions, but also for consisting of visual perception and object cognition of human nature.

The results also showed there were some correspondence between visual impressions and mathematical variables of design-pattern. Especially, the visual impressions were influenced greatly by the neighborhood, and less influenced by steps of iterations.

Table 1 Twelve categories of design-patterns based on visual impressions.

GROUP NAME	INCLUDED DESIGN-PATTERNS						
CHAOS PATTERN	4/c-96	4/c-104	4/c-112	4/c-120	4/c-128	6/c-64	6/c-96
	6/c-104	6/c-112	6/c-120	6/c-128			
UNFINISHED FIGURE	4/c-32	4/c-40	4/c-48	4/c-56	4/c-64	6/c-32	6/c-40
	6/c-48	6/c-56					
DIAMOND FIGURE	6/b-32	6/b-40	6/b-48	6/b-56	6/b-64		
SQUARE FIGURE	6/a-32	6/a-40	6/a-48	6/a-56	6/a-64		
MEDALLION	4/a-32	4/a-40	4/a-48	4/a-56	4/a-64	4/b-32	4/b-40
	4/b-48	4/b-56	4/b-64	8/a-32	8/a-40	8/a-48	8/a-56
PLAIN PATTERN	3/b-128	5/a-128	8/a-64				
MONO-COLOR FIGURE	3/c-32	3/c-40	3/c-48	3/c-56	3/c-64	3/c-96	3/c-104
	3/c-112	3/c-120					
BUILDING FIGURE	5/a-32	5/a-64	5/a-96	5/c-32	5/c-48	5/c-64	5/c-96
VERTICAL PATTERN	5/a-40	5/a-48	5/a-56	5/a-104	5/a-112	5/a-120	5/c-40
	5/c-56	5/c-104	5/c-112	5/c-120			
TRIANGLE FIGURE	3/a-32	3/a-40	3/a-48	3/a-56	3/a-64	3/a-96	3/a-104
	3/a-112	3/a-120	3/a-128				
CHECK PATTERN	5/b-64	5/b-96	5/b-104	5/b-112	5/b-120		
OBLIQUE PATTERN	3/b-32	3/b-40	3/b-48	3/b-56	3/b-64	3/b-96	3/b-104
	3/b-112	3/b-120	5/b-32	5/b-40	5/b-48	5/b-56	

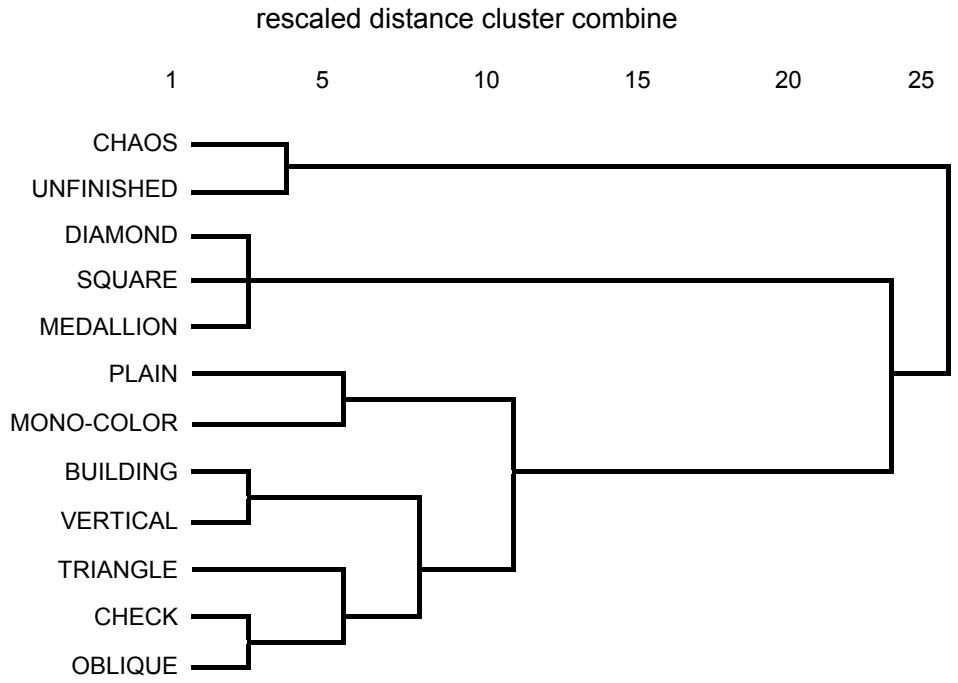

Figure 2 Classification of categories by the similarities of visual impression (by Cluster analysis).

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