Towards ground truth in geometric textures

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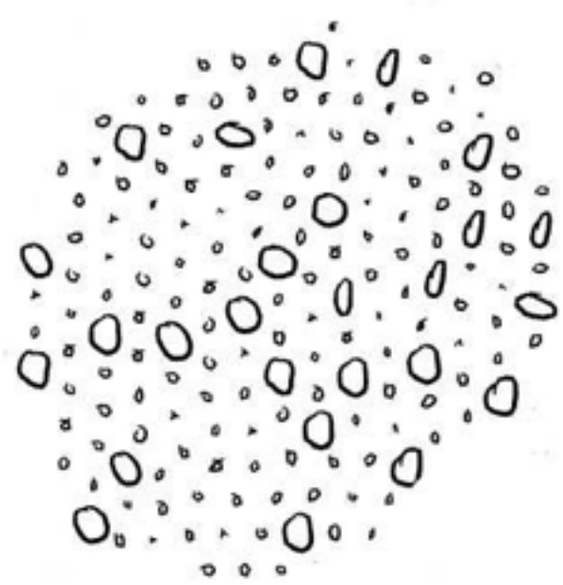
Texture synthesis

Image-based textures

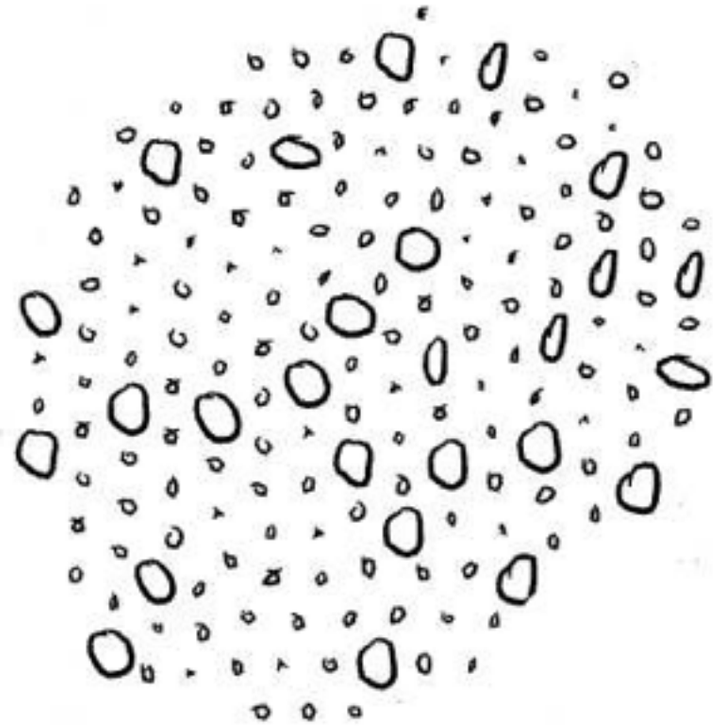
Geometric textures



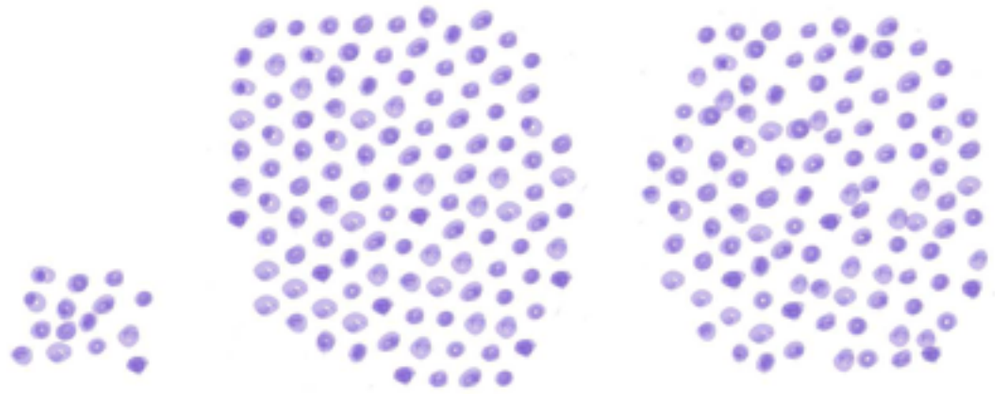
Geometric Texture Synthesis (GTS)

1. Capture element spatial relationships

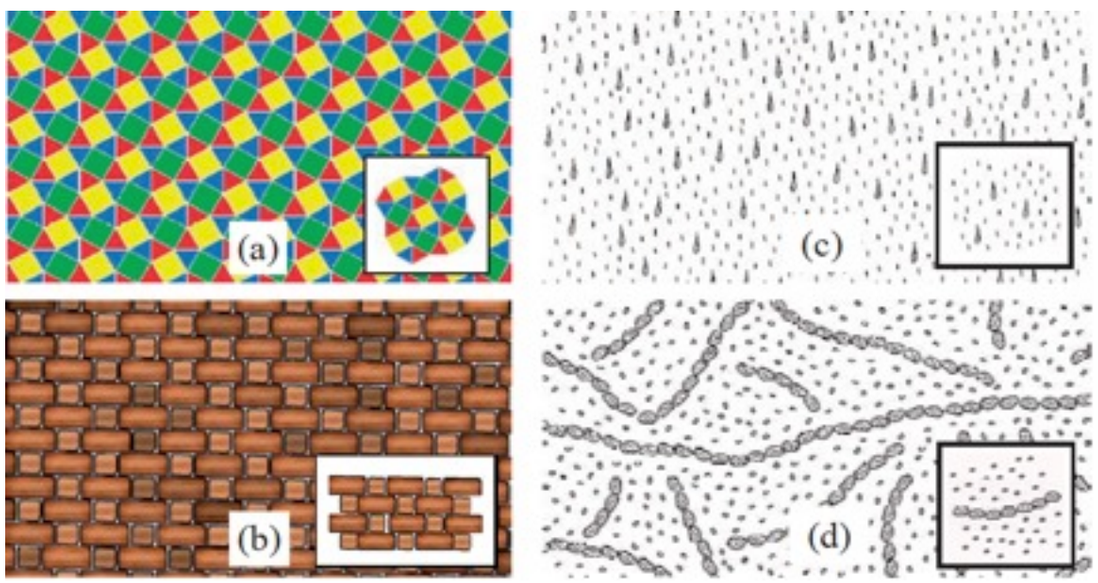
2. Synthesize a new patch of texture



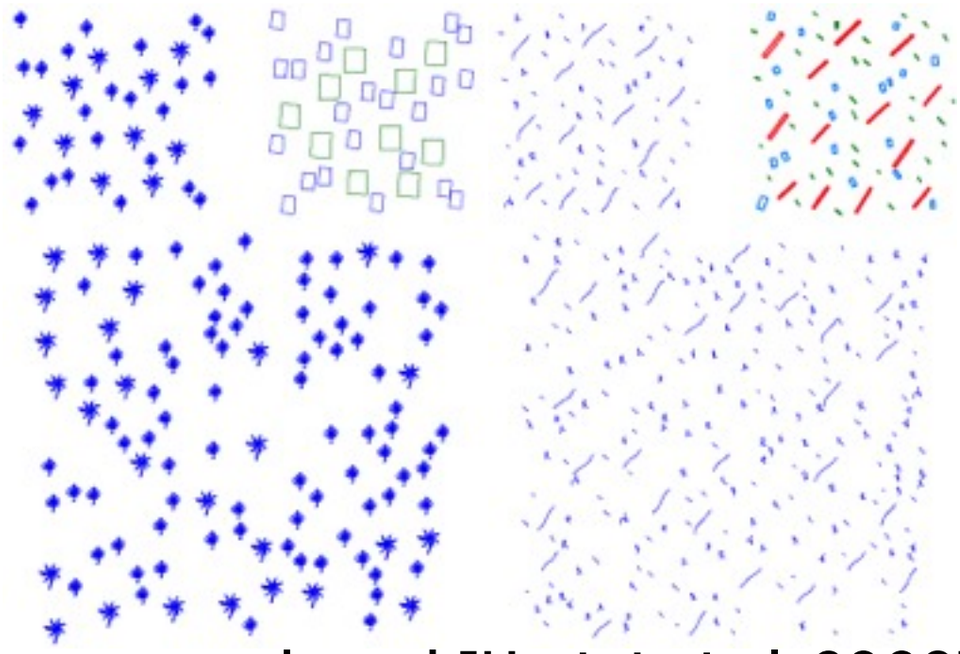
GTS example-based techniques



Statistical [Barla et al. 2006]



Procedural [Ijiri et al. 2008]

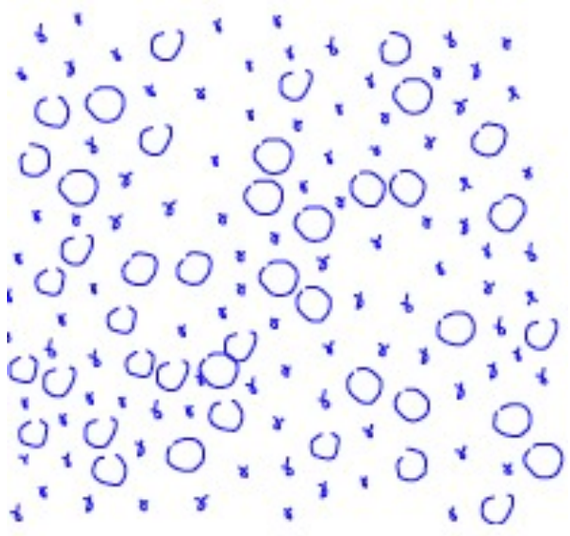


Appearance-based [Hurtut et al. 2009]

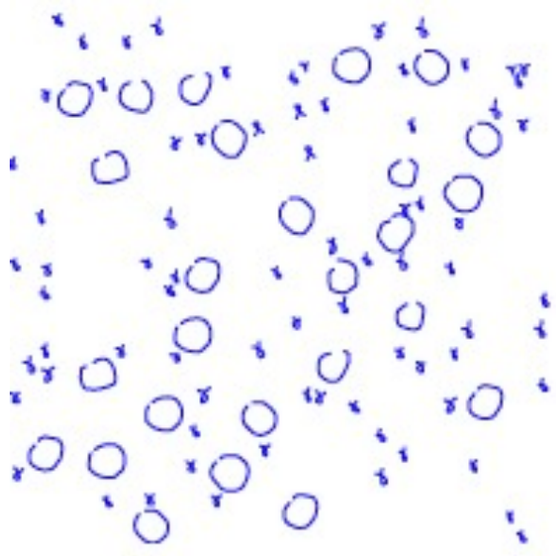
Visually similar?

Given this →

Which of these is more similar?



(1)
[Barla et al. 2006]



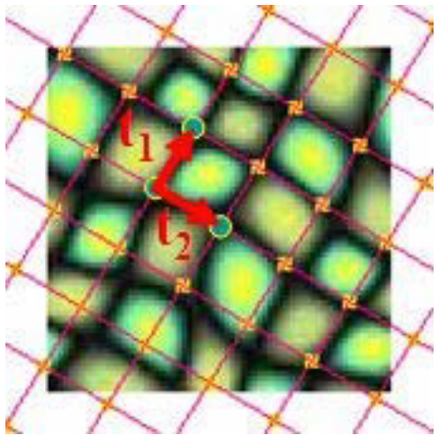
(2)
[Hurtut et al. 2009]

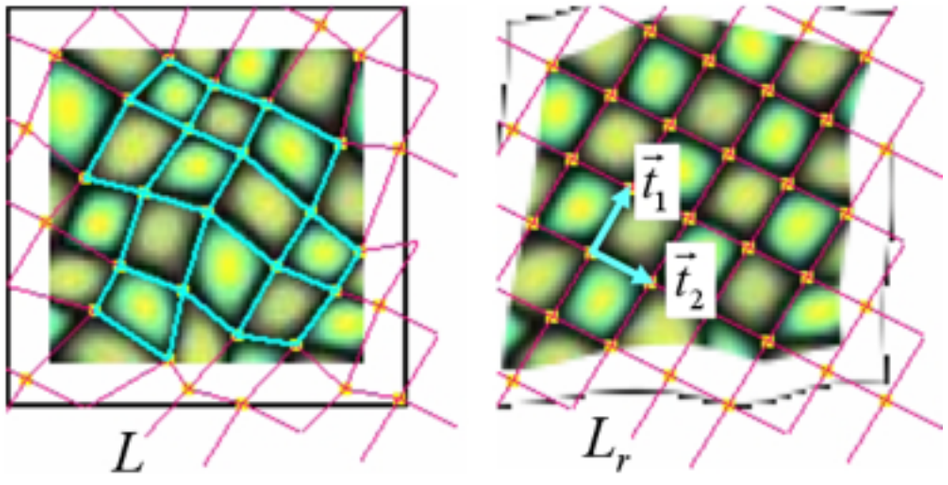
Goal

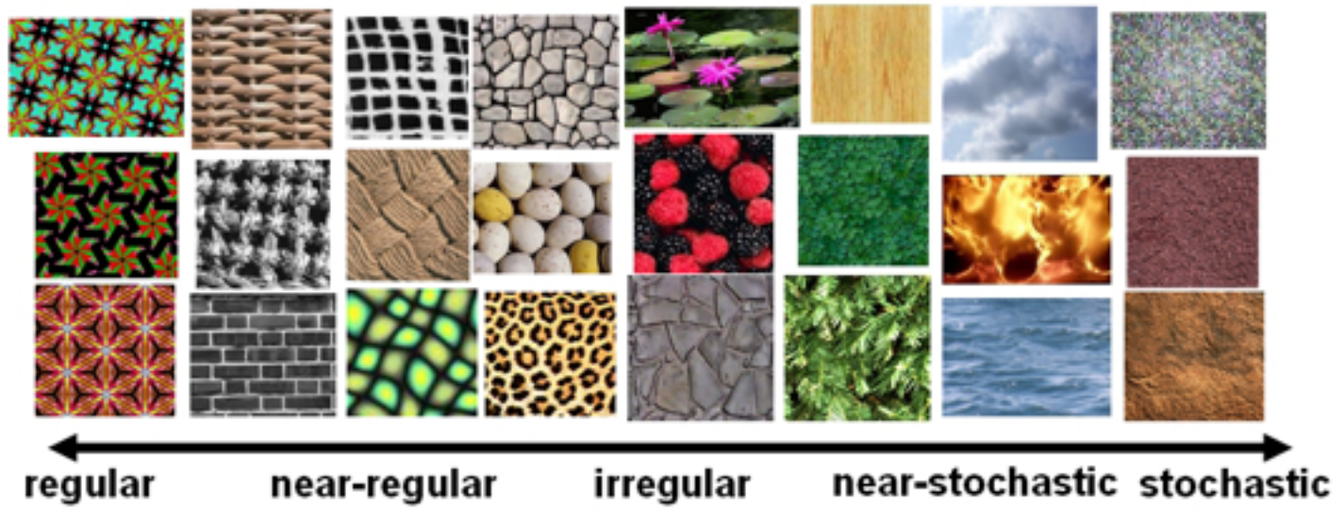
- Measure the success of GTS algorithms
- Perceptual principles for comparing GT arrangements.
  - Qualitative (e.g., descriptions)
  - Quantitative (e.g., p-values)

Existing measures

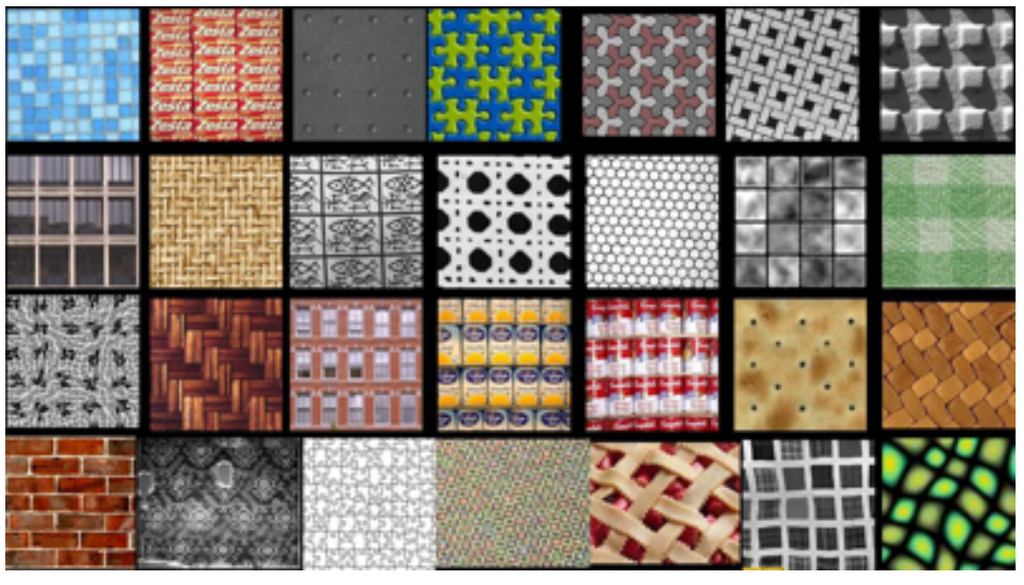
- Evaluation of texture synthesis algorithms: (Lin et al. 2006)







Texture Spectrum



Texture dataset (near regular samples)

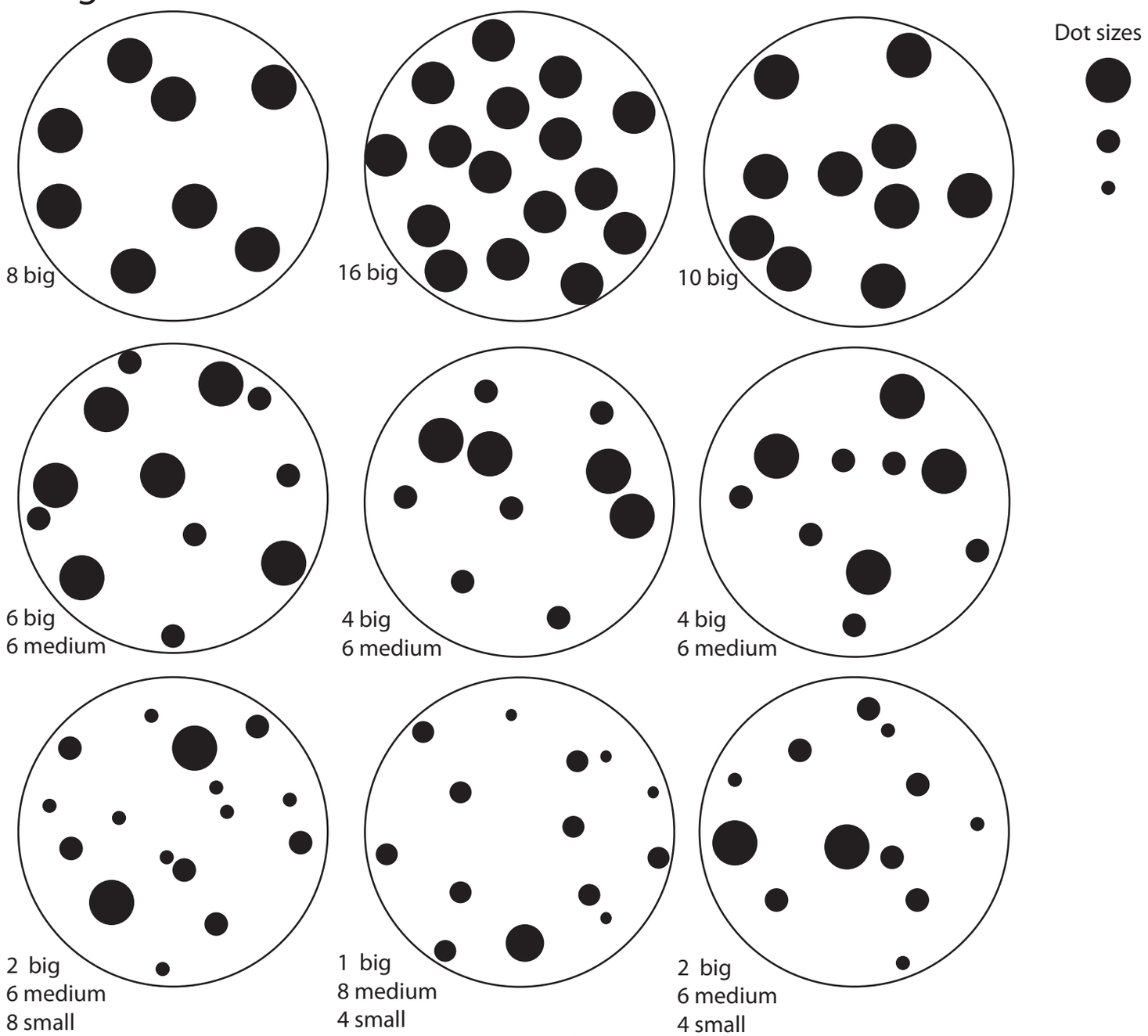
Our studies

1. Analyze and generate 2D geometric textures

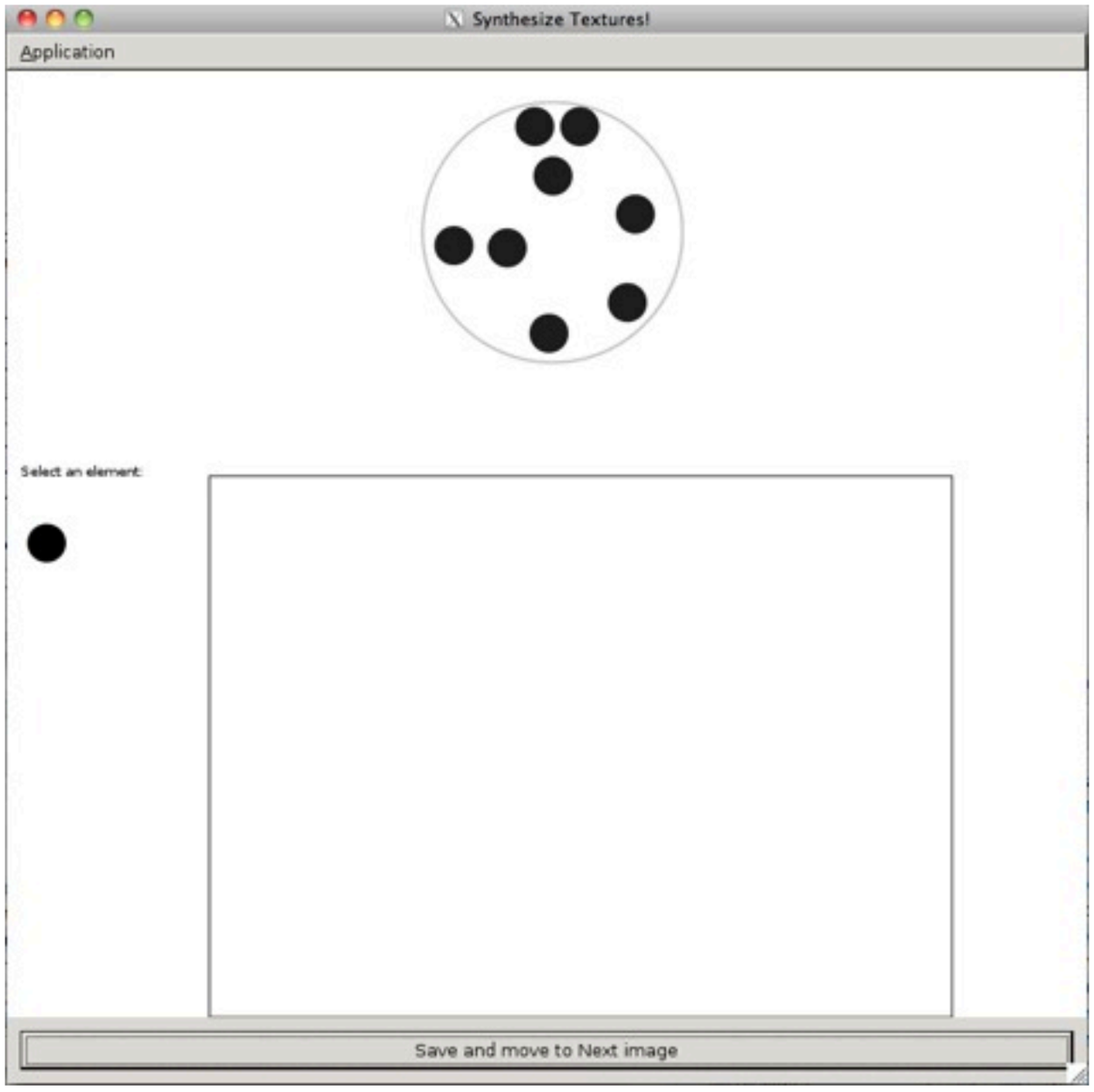
2. Evaluate similarity

Stimuli

Irregular



First phase



1. Generate

"construct a new larger arrangement that appears to have been generated from the same underlying process"

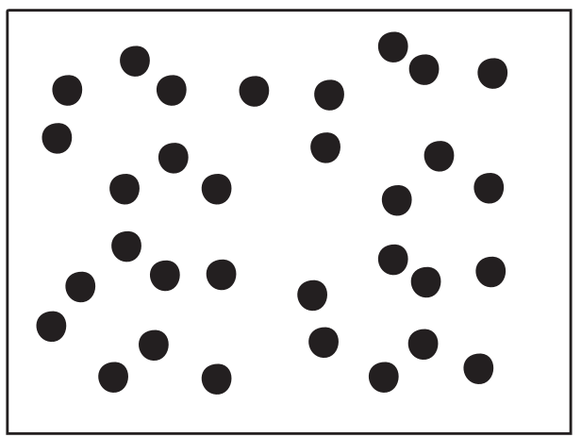
2. Evaluate

Rate how visually similar you believe your generated arrangement is to the sample arrangement.

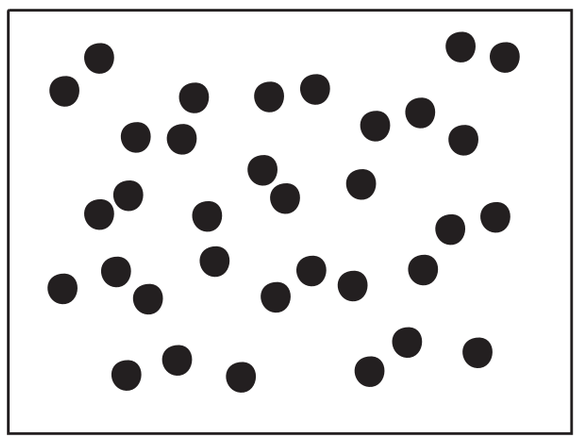
Texture generation

1. Generation strategies

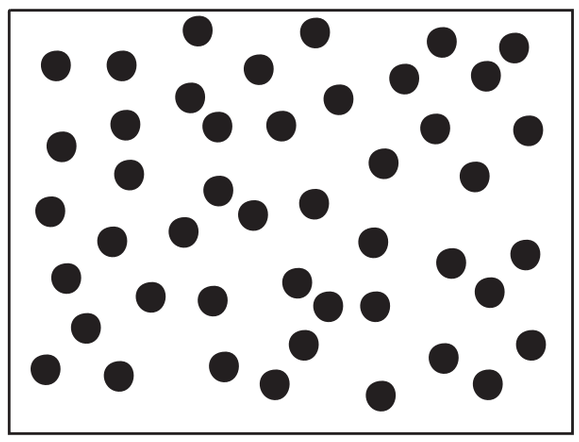
Stimulus 



Tiling approach (P5)



Structured approach (P14)



Random approach (P15)

2. Causal attributes

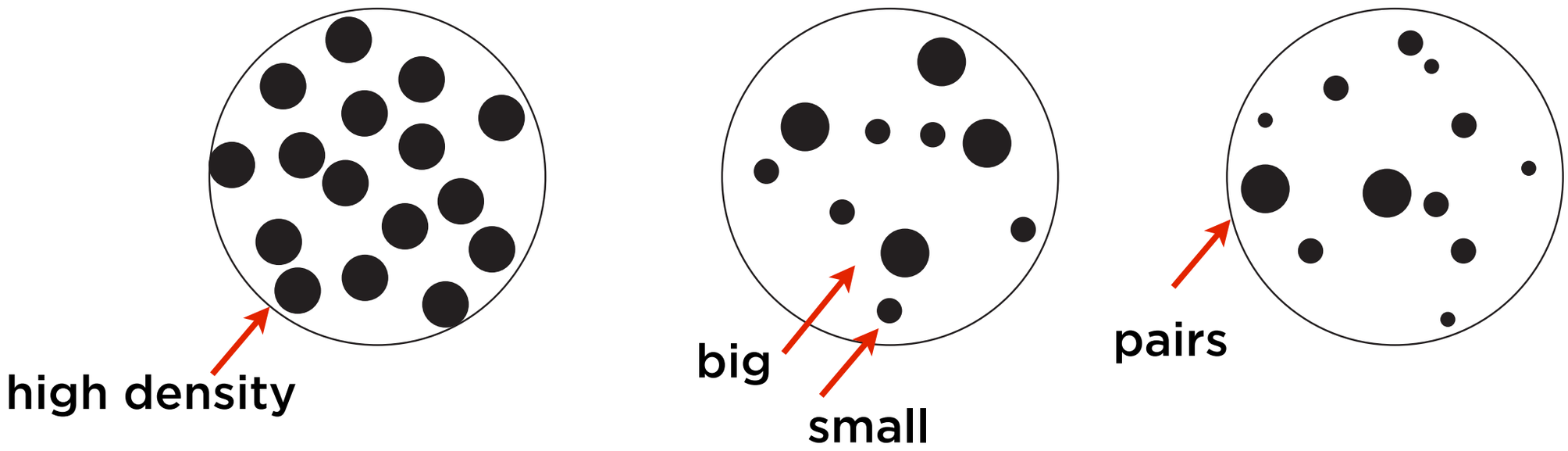
(C.1) Global visual properties perceived

(C.2) Local themes identified by participants

(C.3) Recognition of large spatial structures

2. Causal attributes

(C.1) Global visual properties perceived



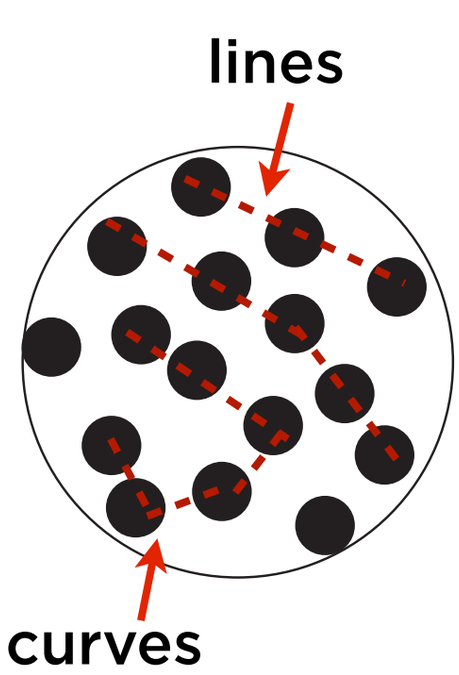
Density

Spacing and distribution style

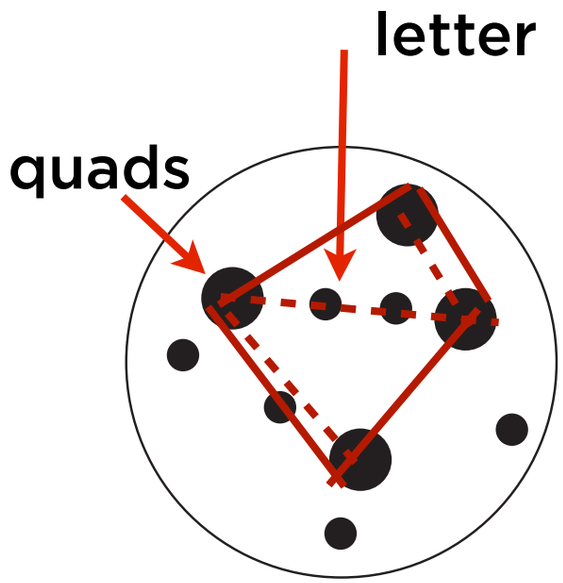
Focal points

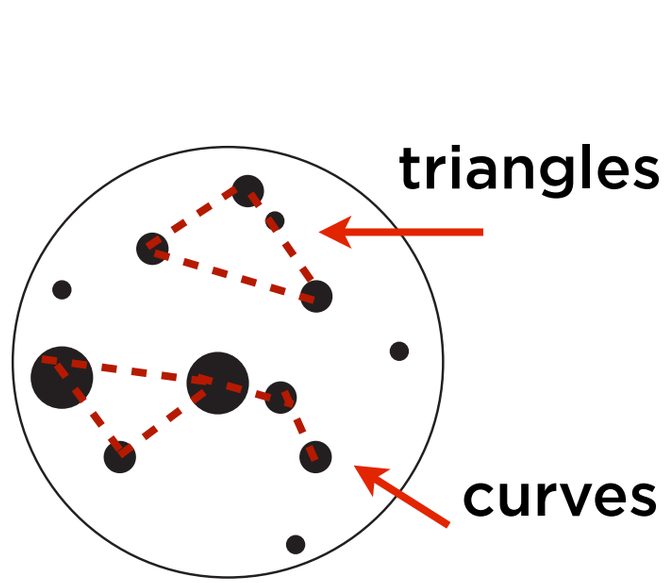
2. Causal attributes

(C.2) Identified local themes



Lines and curves

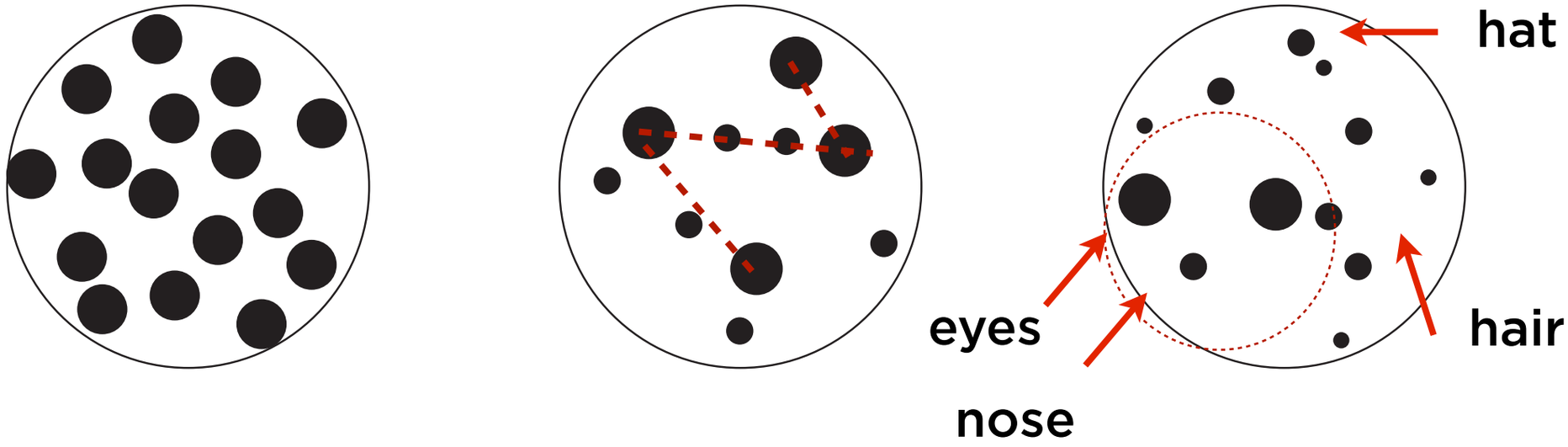




Letters, rectangles, triangles and quads

2. Causal attributes

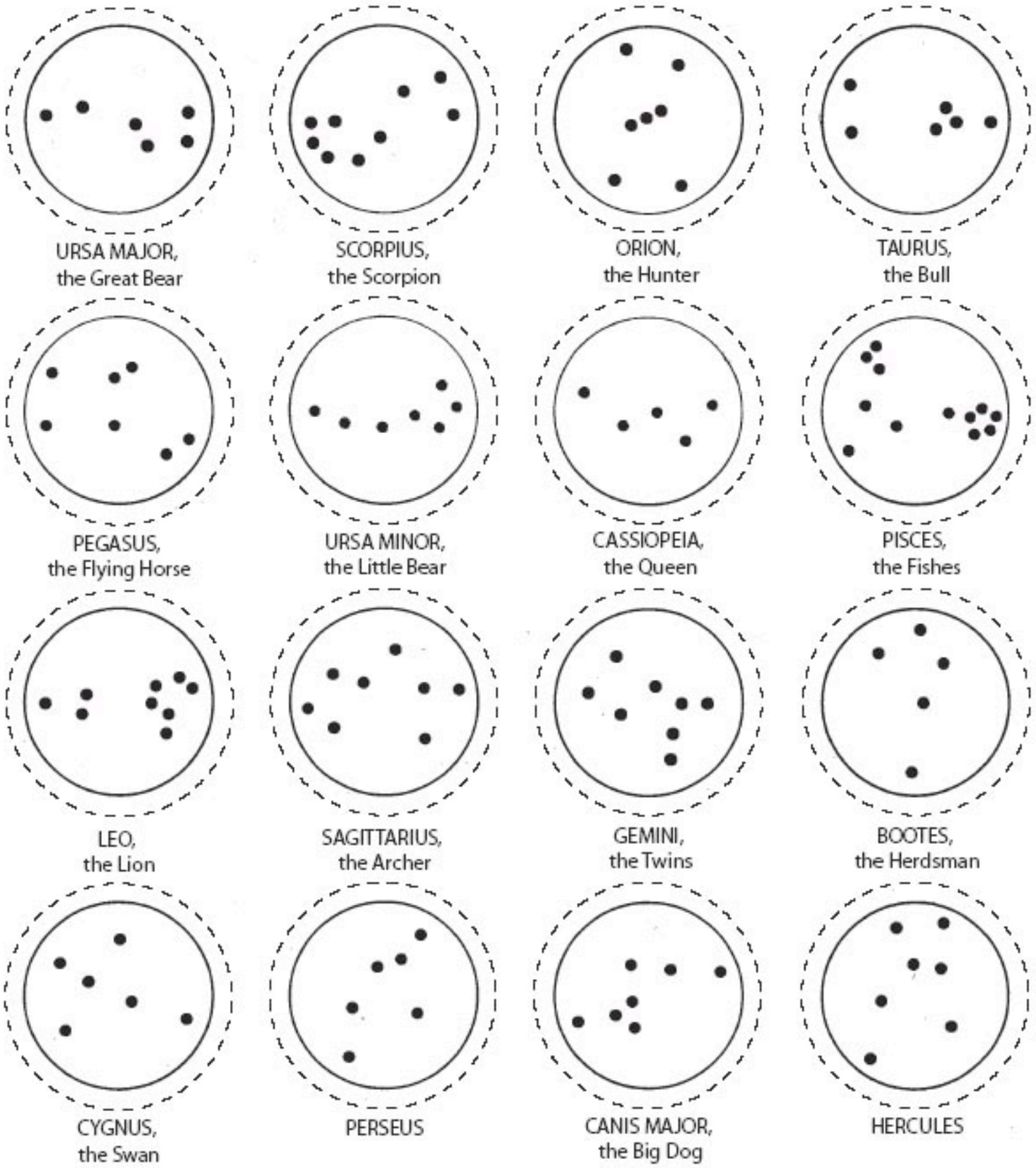
(C.3) Recognition of large spatial structures



Networks and microscopic organisms

Repeated zigzag patterns, faces, animals and objects

Pareidolia


URSA MAJOR, the Great Bear
SCORPIUS, the Scorpion
ORION, the Hunter
TAURUS, the Bull
PEGASUS, the Flying Horse
URSA MINOR, the Little Bear
CASSIOPEIA, the Queen
PISCES, the Fishes
LEO, the Lion
SAGITTARIUS, the Archer
GEMINI, the Twins
BOOTES, the Herdsman
CYGNUS, the Swan
PERSEUS
CANIS MAJOR, the Big Dog
HERCULES

3. Evaluation strategies

(E.1) Sampled the generated image for the stimulus

(E.2) Looked for similar parts or discrete patterns like in the sample

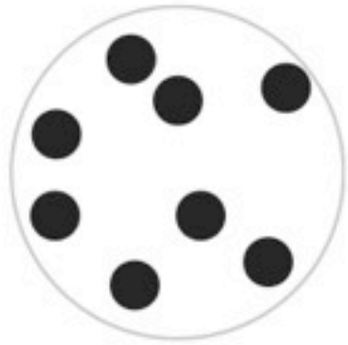
(E.3) Compared the overall aggregate to the stimulus

(E.4) Other influencing factors

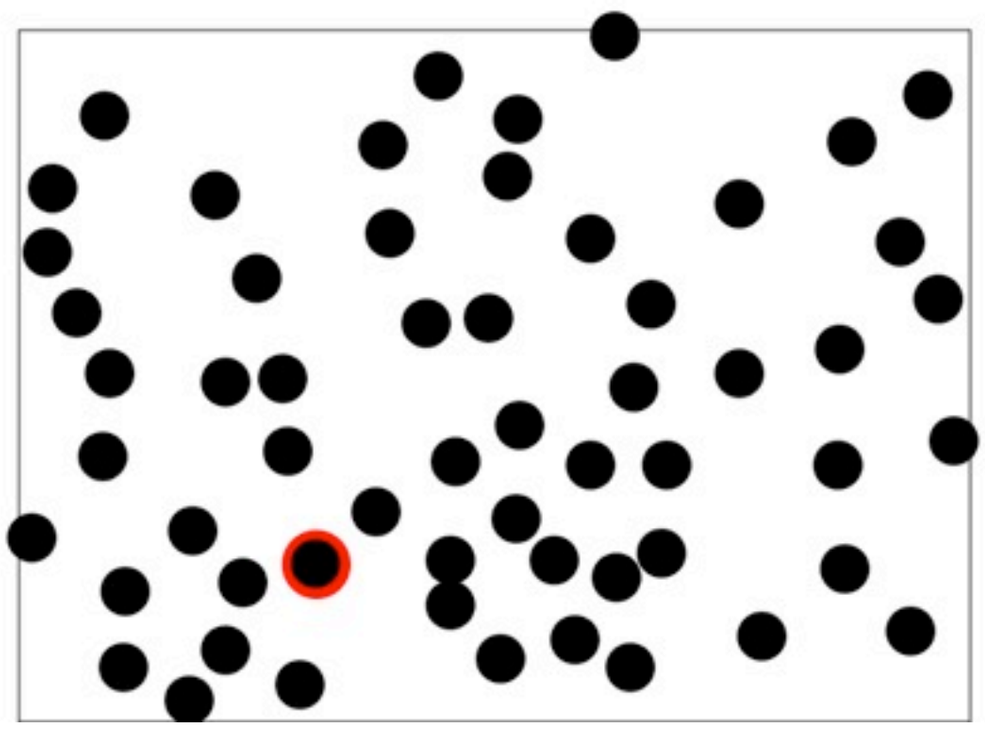
3. Evaluation strategies

(E.1) Sample the generated image for the stimulus

Texture by
participant no. 3:



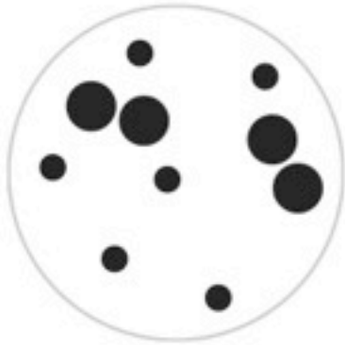
Select an element:

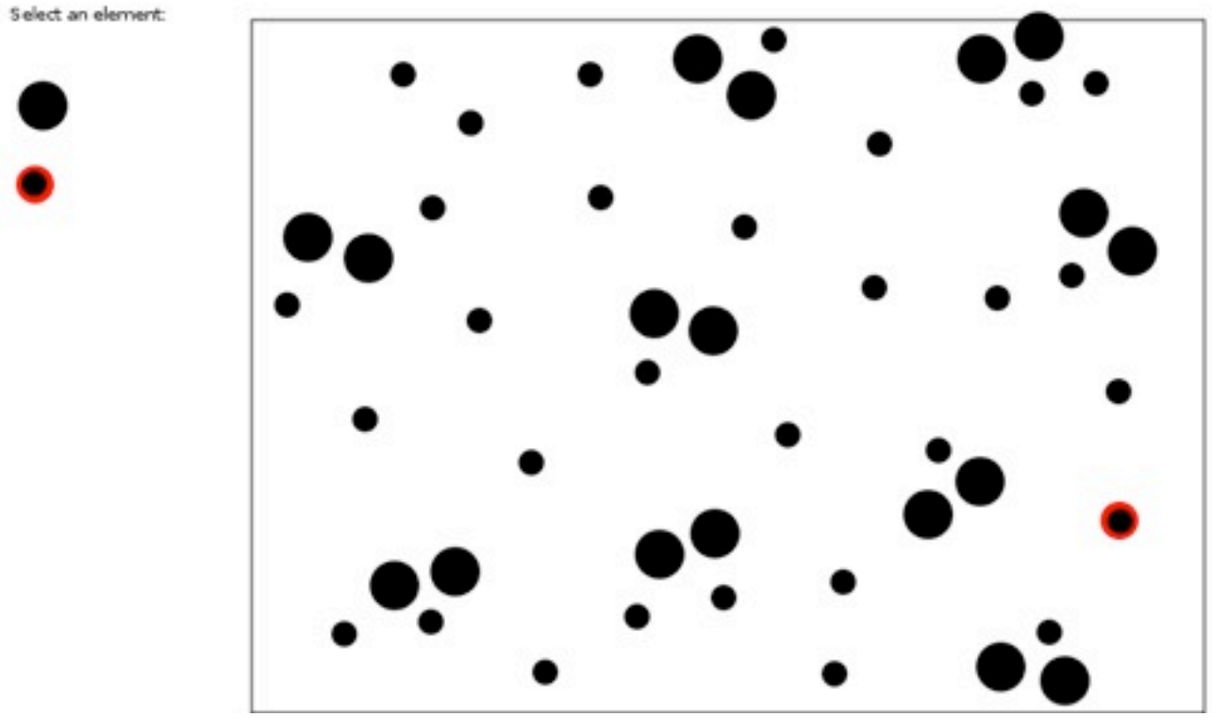


3. Evaluation strategies

(E.2) Looked for discrete patterns

Texture by
participant no. 14:

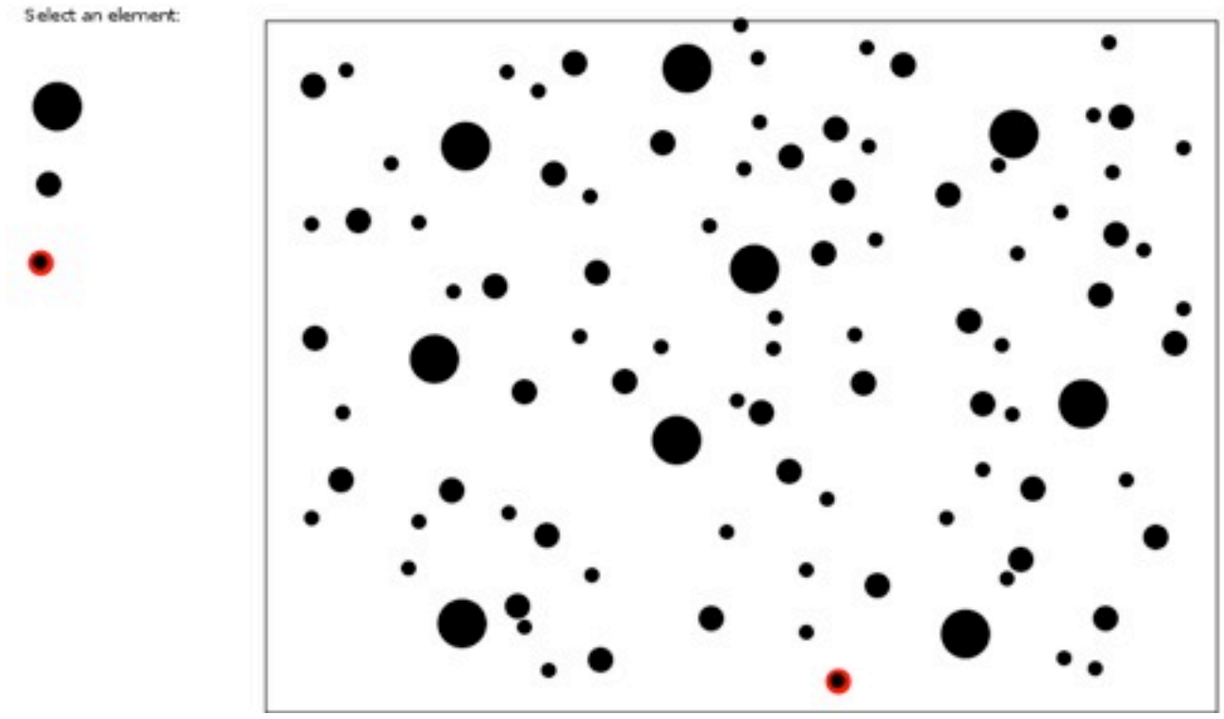




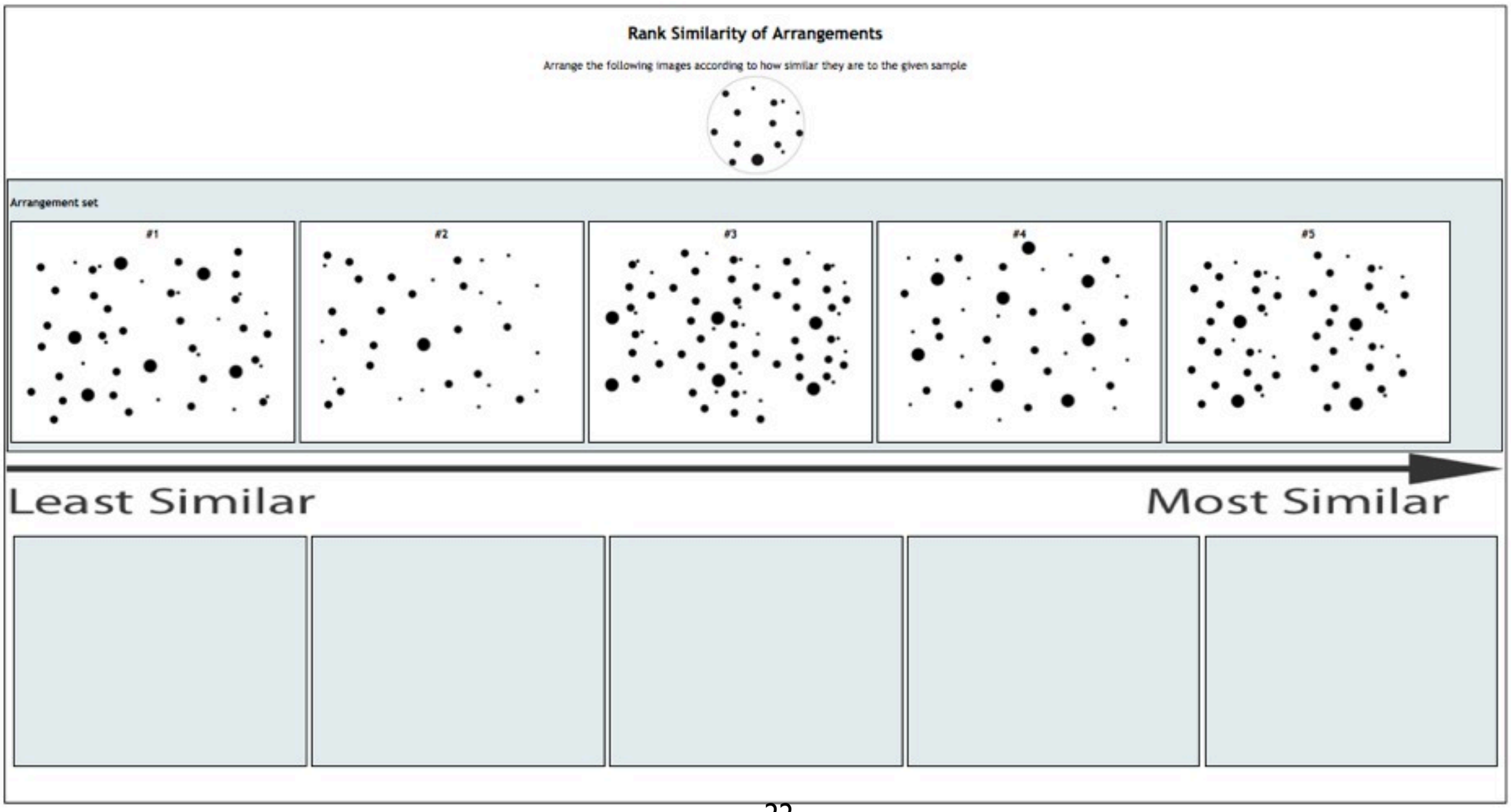
3. Evaluation strategies

(E.3) Compared the overall aggregate to the stimulus

Texture by
participant no. 13:



Second phase



Ranking task

Important Visual Factors

- Distances, sizes, white space
- Density
- Shape(s)

Also: clustering, sizes, pattern, copied samples, sampling and symmetry.

Discussion

- The language used for similarity studies
- Image presentation styles
  - Psychophysical studies by Benjamin Balas.

Discussion

- ‘Similarity only’ or a ‘balance of similarity and aesthetics’?
  - Neil Dodgson’s inquiry into Op art.

Conclusion

- Our research provides perceptual grounds which we hope will motivate and guide future researchers to develop and subsequently assess the success of their new algorithms.
- In this work we identify:
  - Visual factors
  - generation strategies

Future work

- Develop benchmark samples for evaluating the effectiveness of new synthesis algorithms.
- Evaluate the effectiveness of existing Geometric texture synthesis algorithms (i.e., Barla et al., Ijiri et al., and Hurtut et al.).
- Extend synthesis algorithms to reproduce a complete range of texture styles, from regular to irregular textures.

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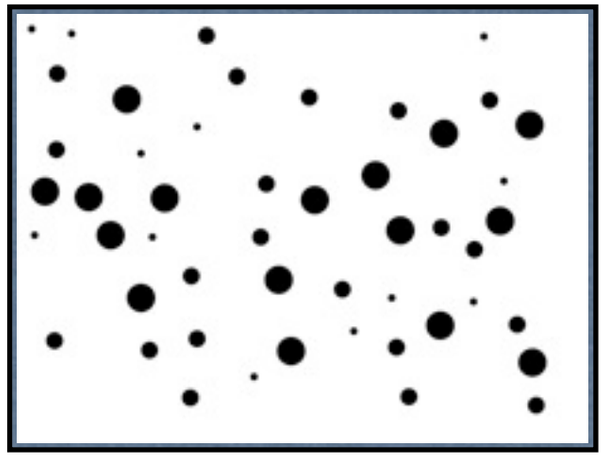
Thank you and to all who made this work happen!

Image retrieval:

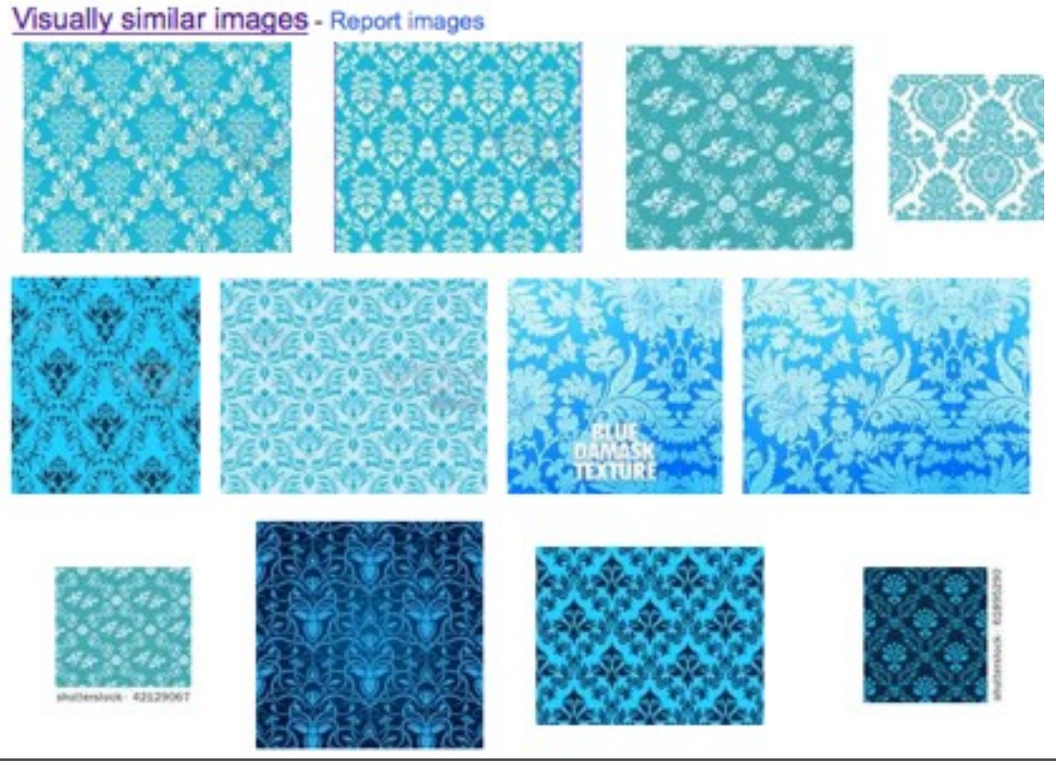
Google's "search-by-image"

Raster image

Vector image



Results



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