

- Nomi, Japan
- Dalian, China

Impact of Visual Topological Features on Priority Attention for Product Shapes

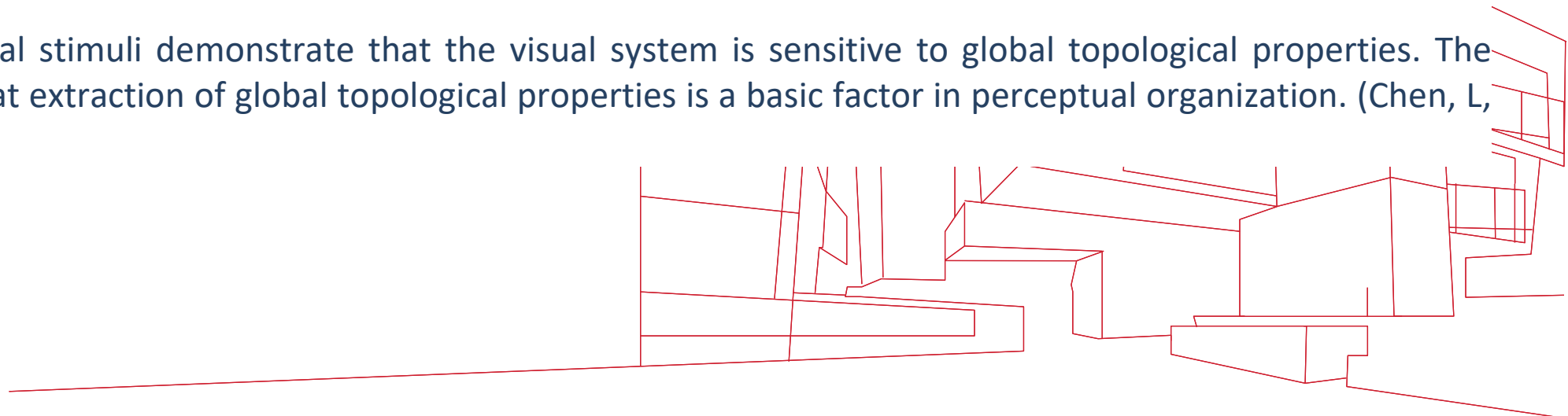
FEI, FEI

- Japan Advanced Instituted Science and
Technology
- Dalian Polytechnic University

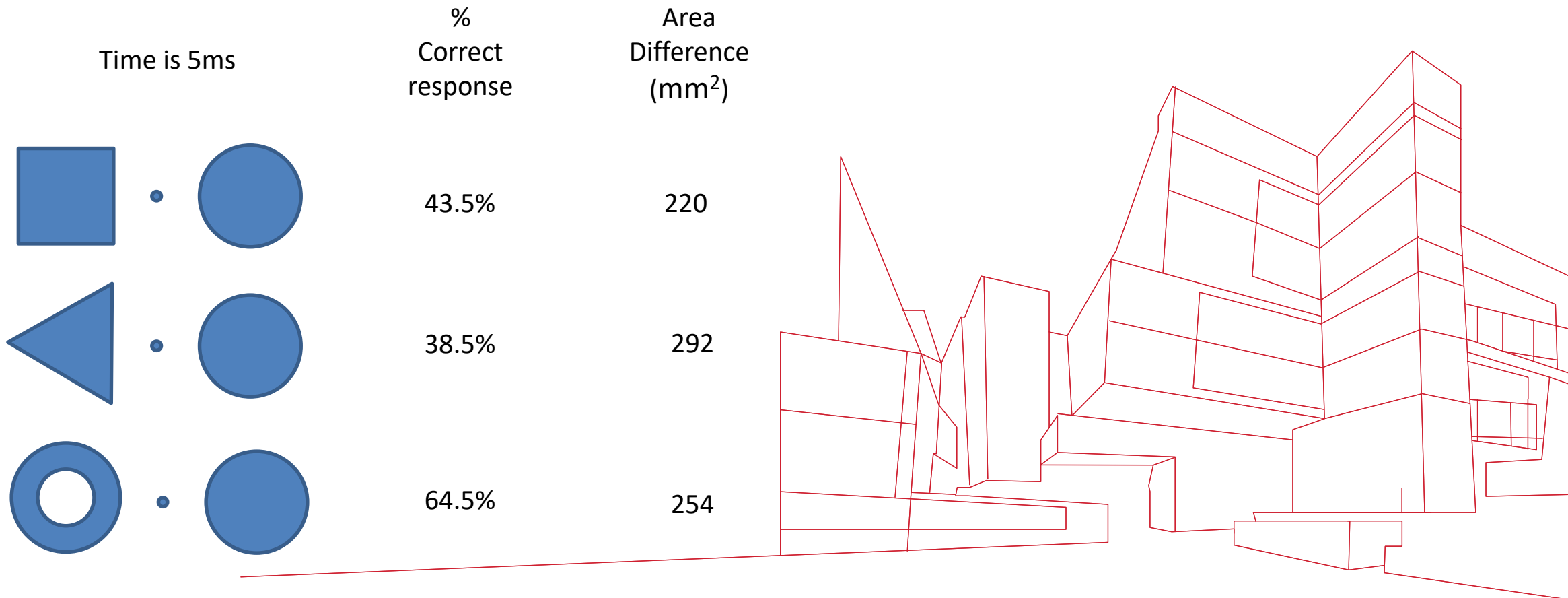


Background

- As products in the same product category should be explicitly distinct from competing products, a product's shape is often the first consideration in distinguishing it from other products in the market (Underhill, P, 2000).
- Under normal circumstances, the relationship between a person and a product begins with the visual appearance of the product. Customers tend to identify the features of a product through its visual form, including aesthetic impression, semantic interpretation, and symbolic association (Nathan Crilly et al., 2004).
- Perception of visual stimuli demonstrate that the visual system is sensitive to global topological properties. The results indicate that extraction of global topological properties is a basic factor in perceptual organization. (Chen, L, 1982)



- A primitive and general function of the visual system may be the perception of global topological properties. (Chen, L, 1982)



- Experiment showed, **bees' brain** are small, but they can percept the difference of topological prosperity between figures. (Chen, L., Zhang, S., & Srinivasan, M. V. 2003)

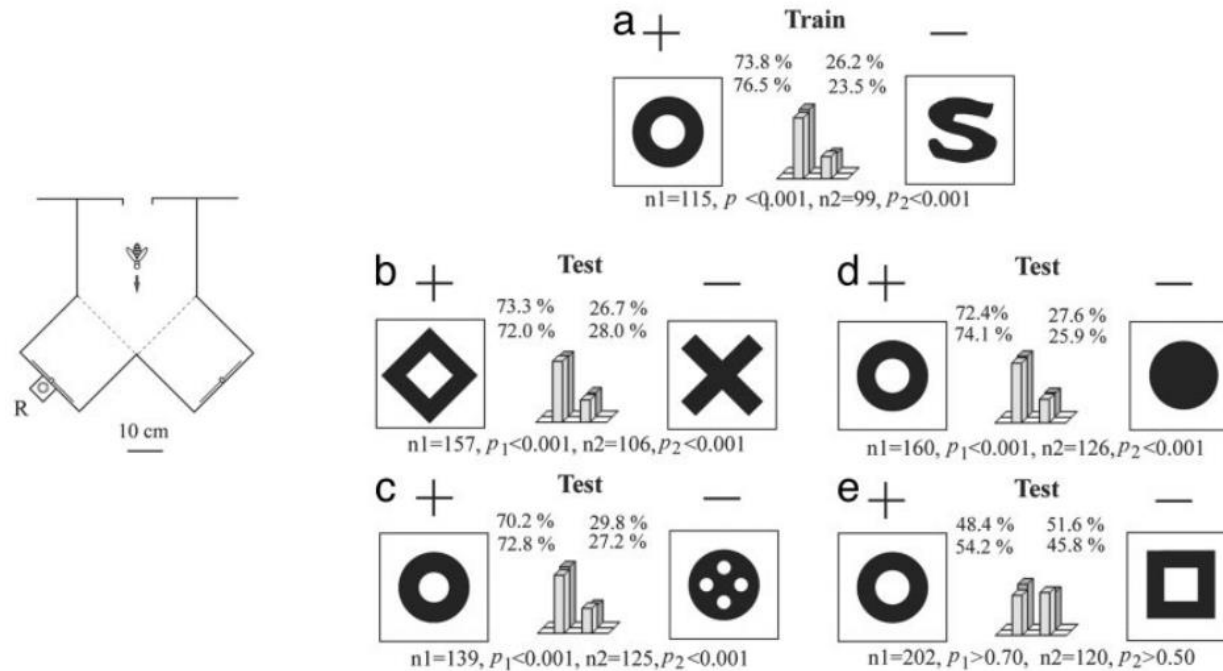
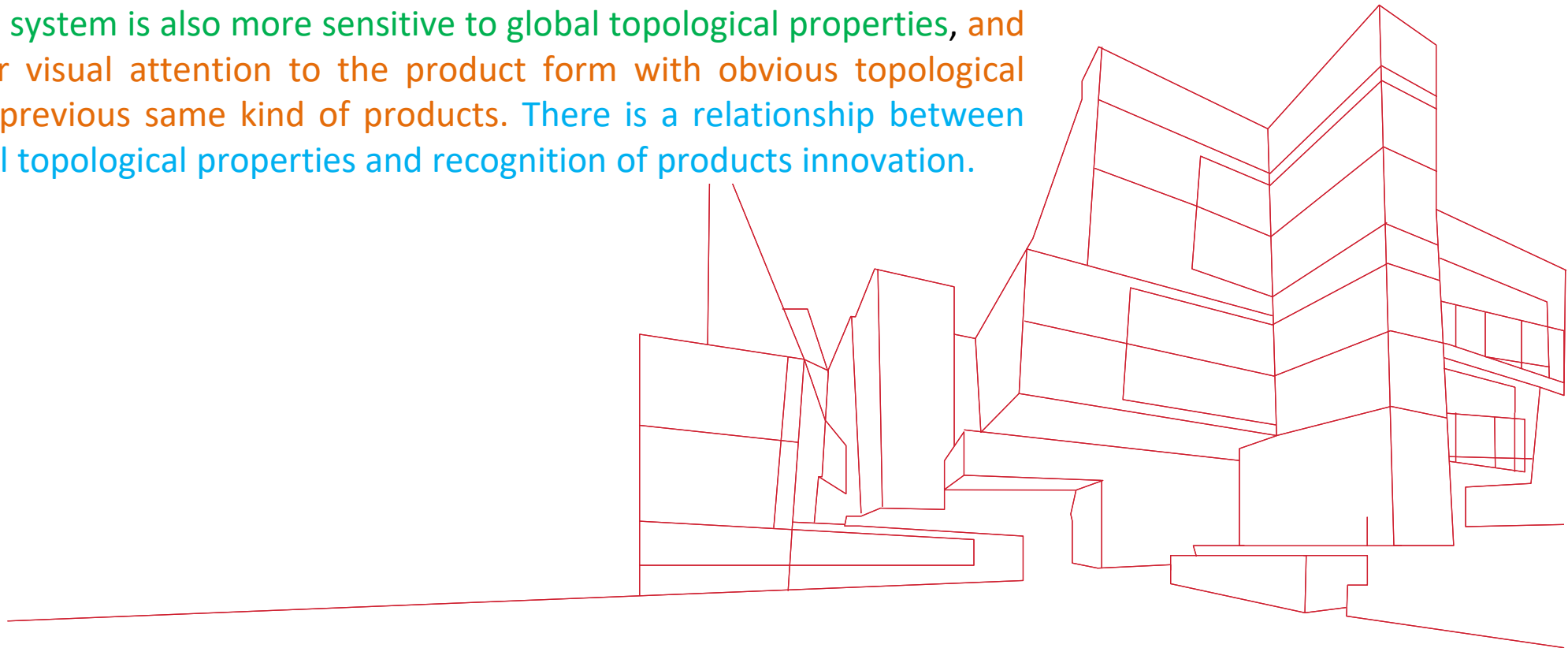


Fig. 1. (Left) Y-maze apparatus for training and testing bees. Scale applies to the apparatus. (Right) Stimuli and results of experiments 1 and 2. (a) Training stimulus pair. (b-f) Test stimulus pairs. Bars and numbers show relative frequencies of choices in favor of the positive (+) and negative (-) stimuli, as measured after training and in various transfer tests. Light and dark bars depict results from experiments 1 and 2, respectively. n_1 and n_2 are the numbers of choices analyzed in experiments 1 and 2, respectively, and p_1 and p_2 are the respective values associated with a χ^2 test for significant difference from random-choice behavior.

Hypothesis

For products, the visual system is also more sensitive to global topological properties, and people have the prior visual attention to the product form with obvious topological variant relative to the previous same kind of products. There is a relationship between the perception of global topological properties and recognition of products innovation.



Methodology

Experiment 1

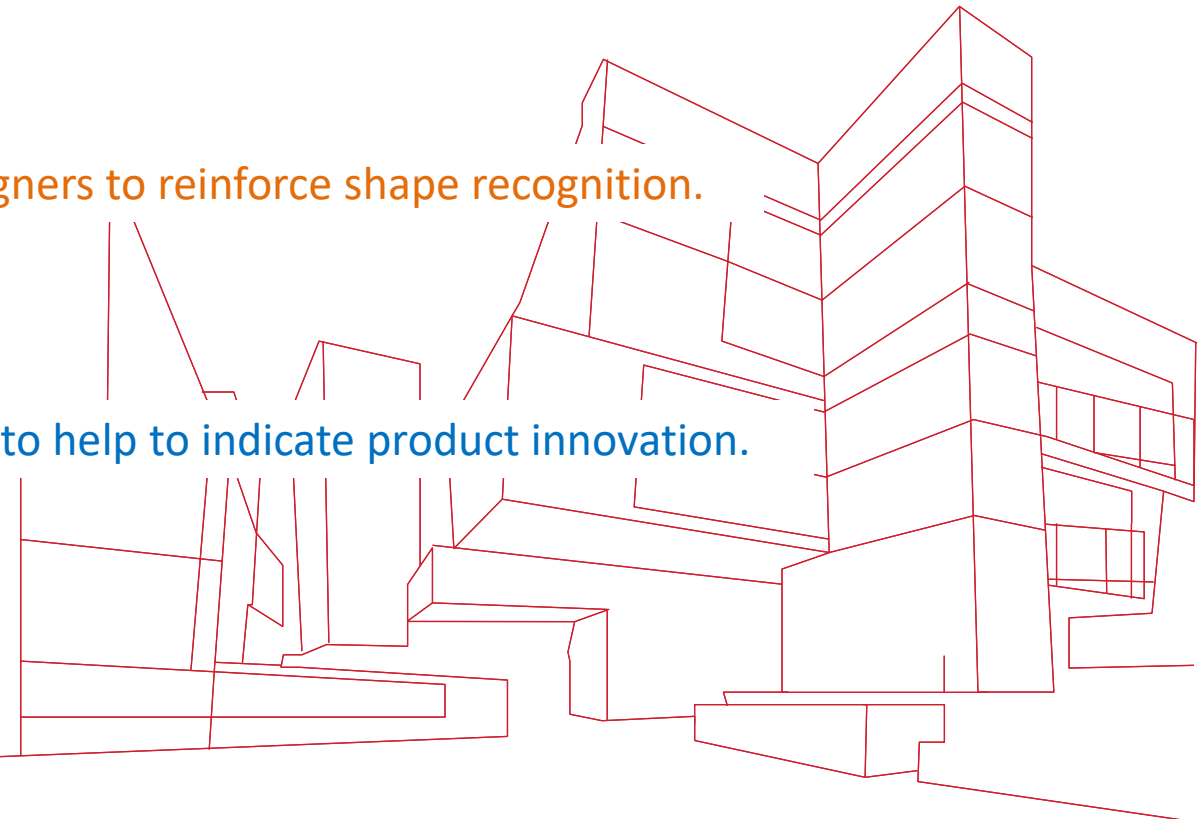
Visual topological structures variants can be recognized quickly in the forms of product.

Experiment 2

Topological structure can used by designers to reinforce shape recognition.

Experiment 3

Topological structure can also be used to help to indicate product innovation.



Experiment 1 Which the displayed bicycle is prior to perception.
Bicycles in each picture are arranged in a different order and randomly displayed before the subject.



C

1 2 3 4 5



B

1 2 3 4 5



A

1 2 3 4 5

When you look at the picture, which picture instantly attracts your attention? Namely, Which is more eye-catching?

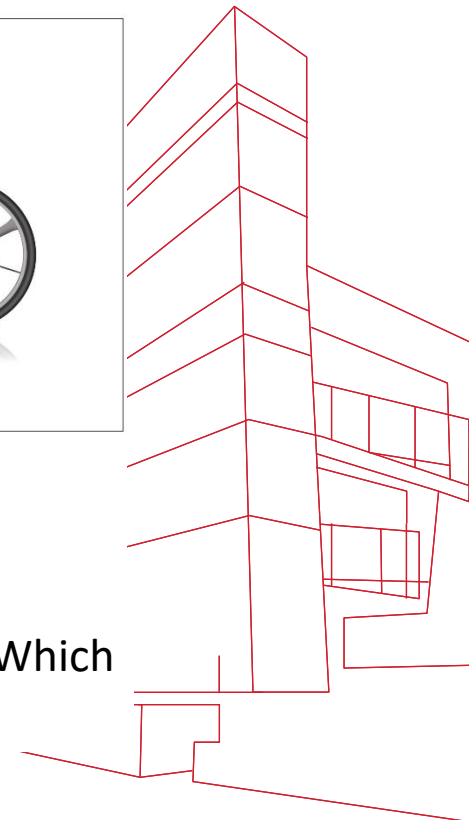


Table 1: Parameters of the experimental objects in Experiment 1

	Score	Average	Number of highest scores	Number of lowest scores
A	208	3.301	19	9
B	157	2.492	15	34
C	235	3.730	29	9



A multiple comparison test for parametric data showed significant differences between bicycles A and B ($p < 0.01$) in terms of average reaction time when rating; similarly, differences were observed between bicycles B and C ($p < 0.01$). The findings further indicated that bicycles A and C received obvious visual attention compared with bicycle B.

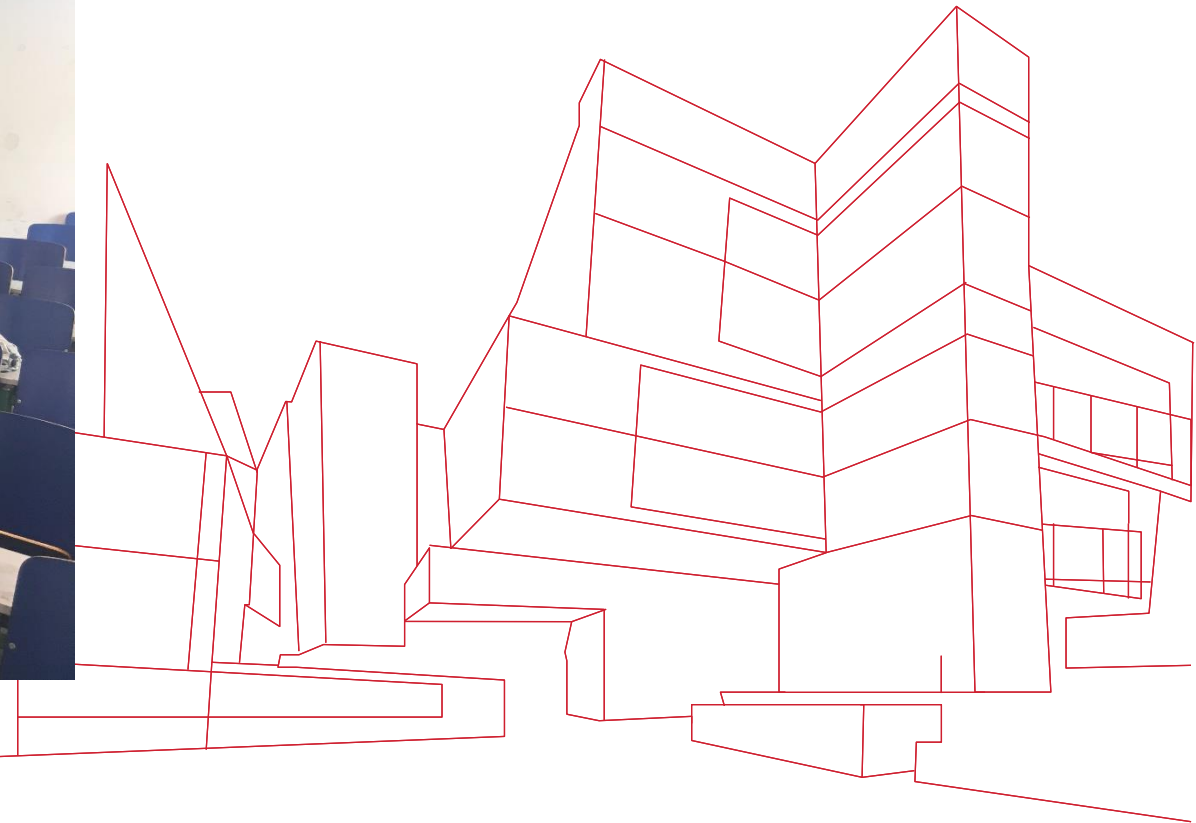
Experiment 2: The same subjects, the first step, the subjects designed novel chairs; the second step, and then to the topological characteristics of the graphic design elements, taking improved design.

Experiment 2-1:





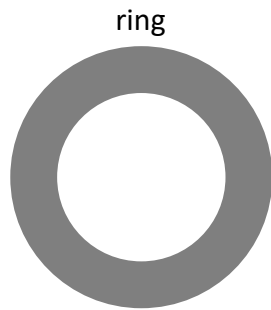
Test scene



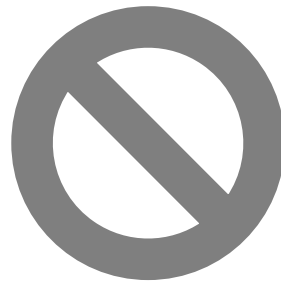
Experiment 2-2:

Classical visual topological structure

Conference 1 :



Disk with two holes



Square ring



Can choose one, but also more election.

Conference 2 :



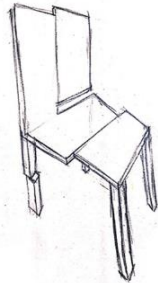
Möbius band

Please design the previous two chairs, according to one of the reference, to improve the design, the reference items into the chair design.(hint: two chairs can use different reference items)
45 degree angle, white background, pencil sketch.

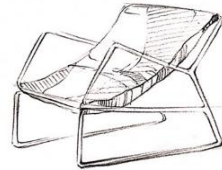
step1



1



2



3



4



5



6

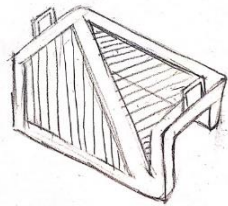


7



8

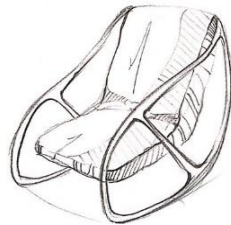
step2



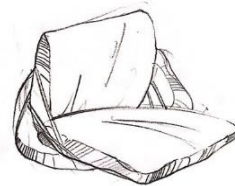
A



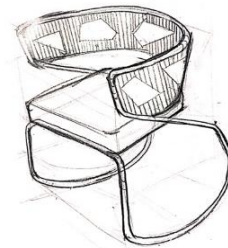
B



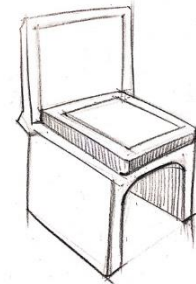
C



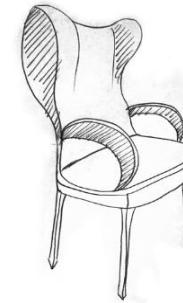
D



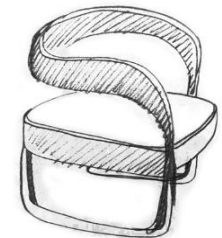
E



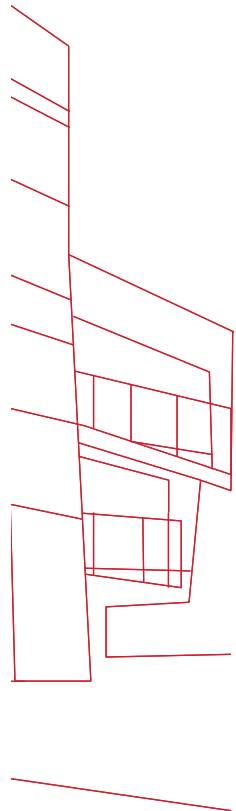
F

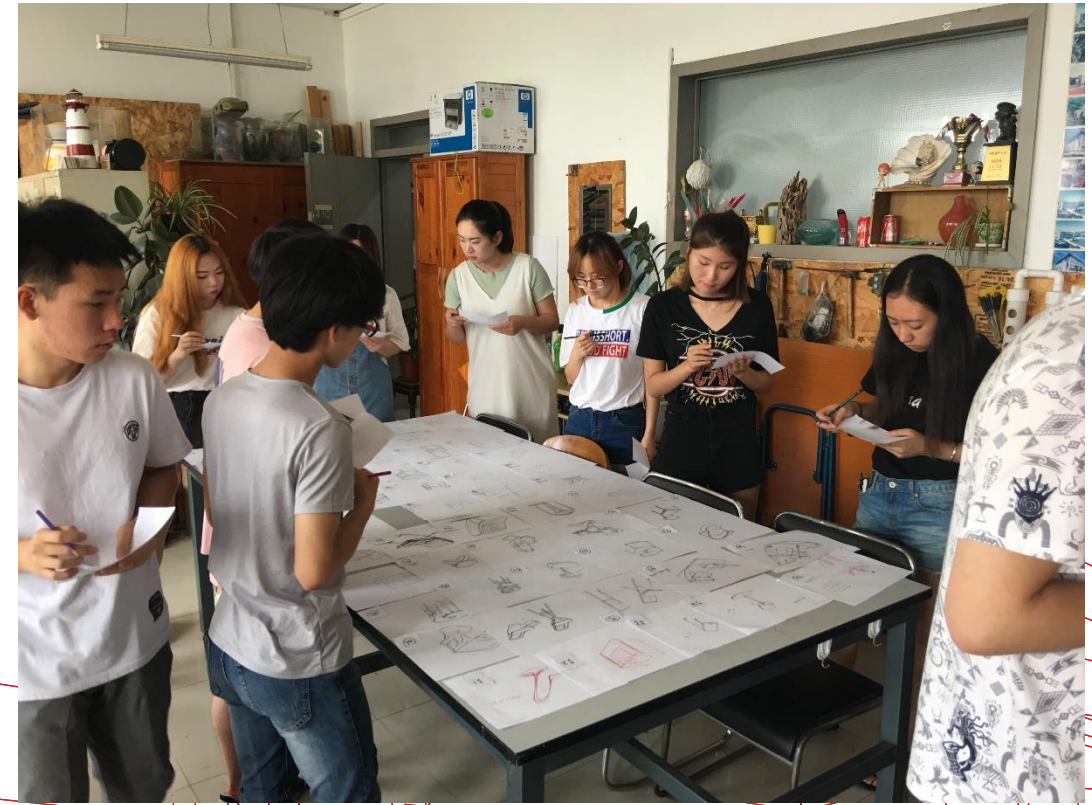


G



H





Test scene 20 design
non-expert users

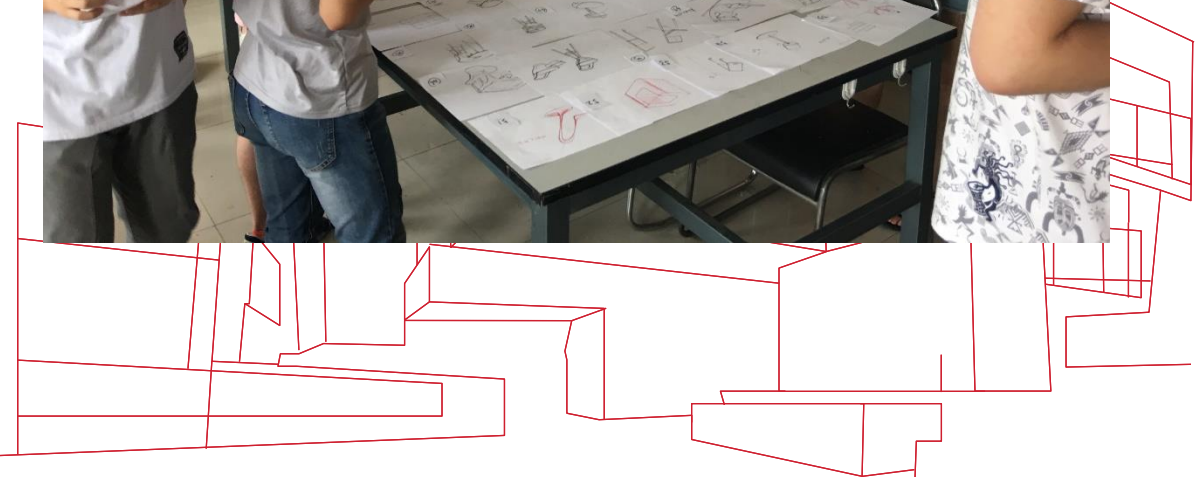


Table 2: Parameters of the experimental objects in Experiment 2

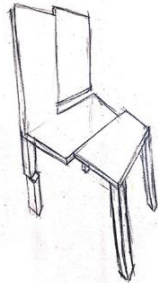
	Step 1								Step 2							
	1	2	3	4	5	6	7	8	A	B	C	D	E	F	G	H
Score	24	46	60	57	45	24	67	57	38	30	88	68	86	44	48	67
Average	1.2	2.3	3	2.85	2.25	1.2	3.35	2.85	1.9	1.5	4.4	3.4	4.3	2.2	2.4	3.35
Number of 5	0	0	0	0	0	0	2	0	0	0	10	1	8	0	0	0
Number of 1	16	1	0	0	0	16	0	0	5	12	0	1	0	2	1	0

The results showed significant differences in average reaction time between the two groups of chairs ($p < 0.01$). The improved scheme of adopting visual topological features in the design shape gained obvious visual attention. In particular, C and E were scored the highest. The shape of C and E had more obvious visual topological features: holes and connectivity.

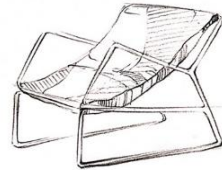
step1



1



2



3



4



5



6

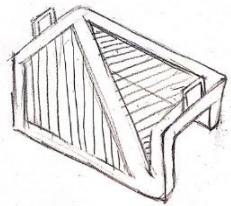


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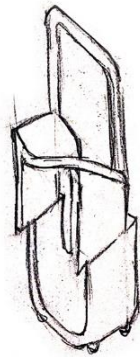


8

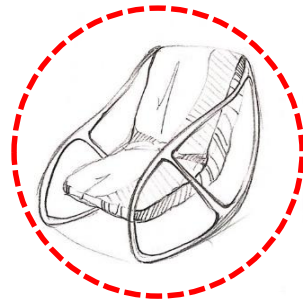
step2



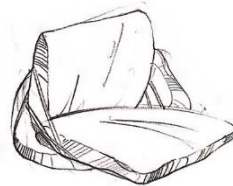
A



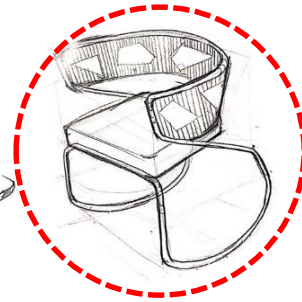
B



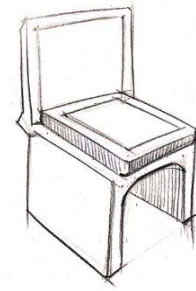
C



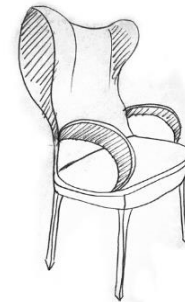
D



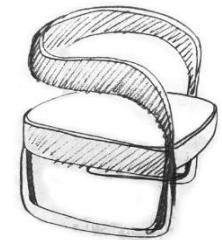
E



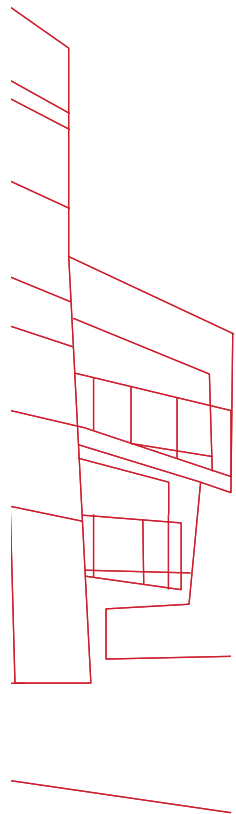
F



G



H



Experiment 3

Select the first note from the displayed cup by picture or screen
 Subjects were randomized to see the picture.



Prototype



A

1 2 3 4 5



B

1 2 3 4 5



C

1 2 3 4 5

When you look at the picture, which picture instantly attracts your attention? Namely, Which is more eye-catching?

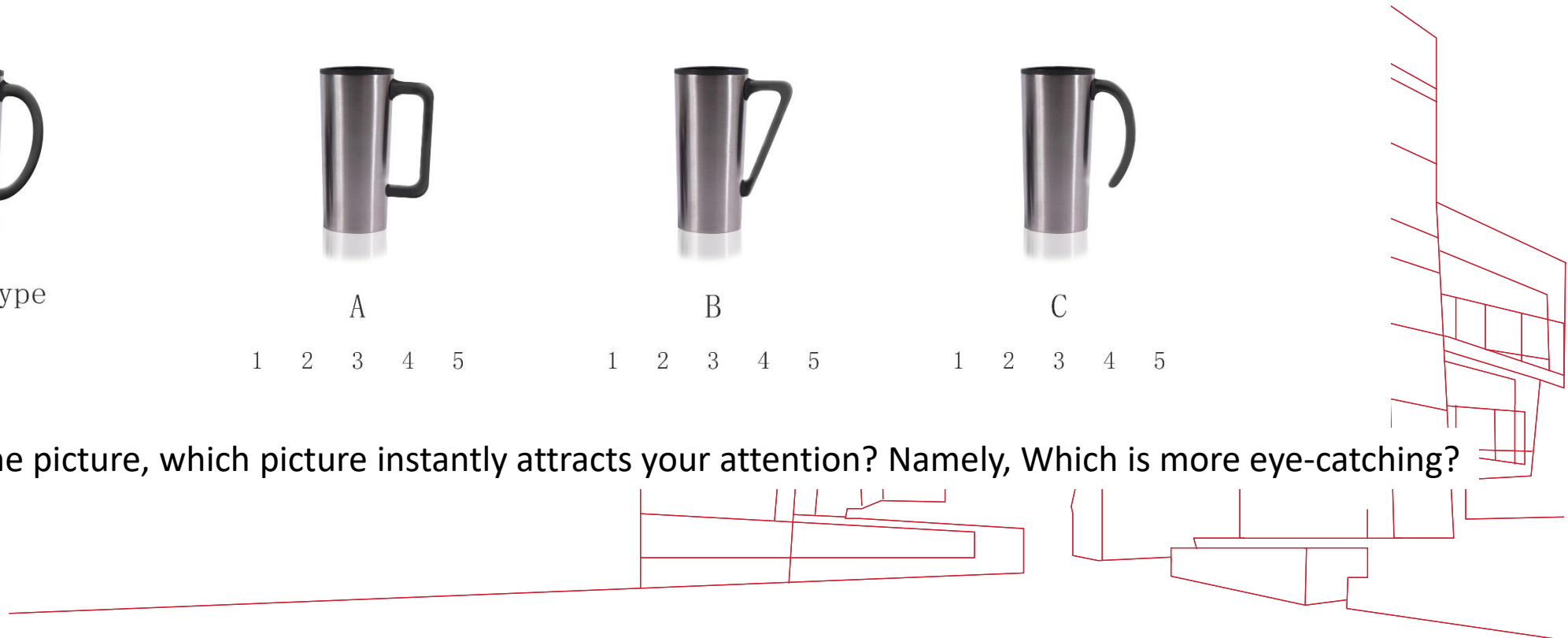
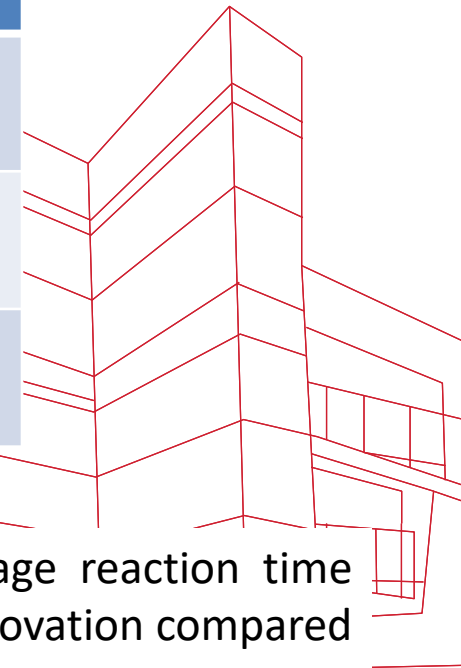


Table 3: Parameters of the experimental objects in Experiment 3

	Score	Average	Number of highest scores	Number of lowest scores
A	212	3.028	17	22
B	223	3.185	18	15
C	253	3.614	32	10



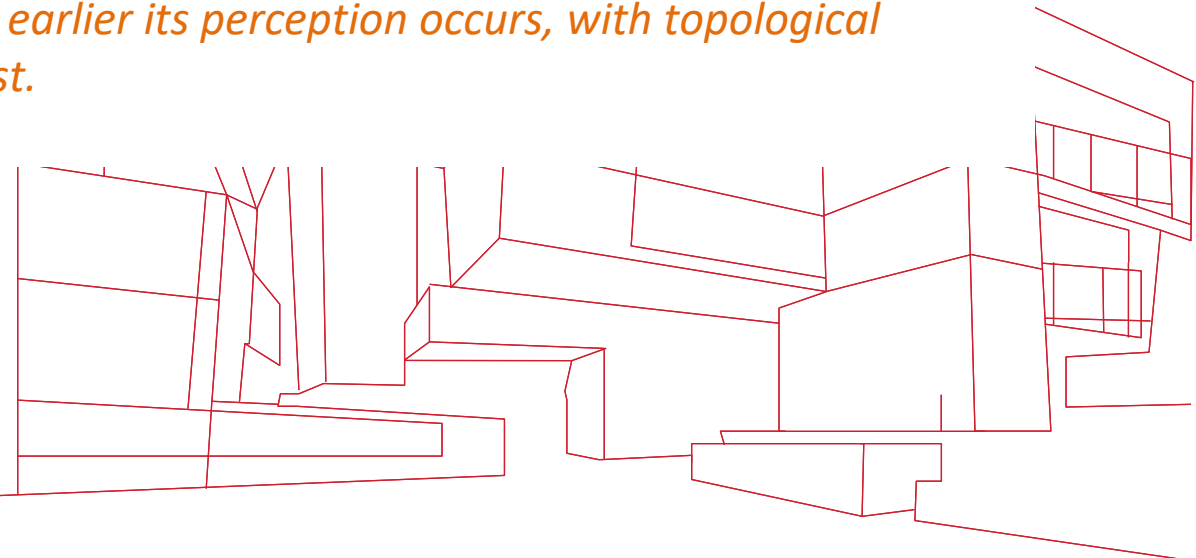
A multiple comparison test for parametric data revealed significant differences in the average reaction time between cups A and C ($p < 0.05$) and between cups B and C ($p < 0.05$). Cup C had obvious shape innovation compared with cups A and B.



Discussion

Vision: In the study, put topological structure in visual perception into the forms of products. The forms of products are more complicated relative to the typical geometric shape (disk, triangle, rectangle, ring). Therefore, at the level of visual perception of product, the topological structure of product is not rigorous enough.

Globe: the framework of the topological structure and functional hierarchy highlights a fundamental empirical prediction, namely a time dependence of perceiving form properties, in which visual processing is from global to local: *the more global a form invariant is the earlier its perception occurs, with topological perception being the most global and occurring earliest.*

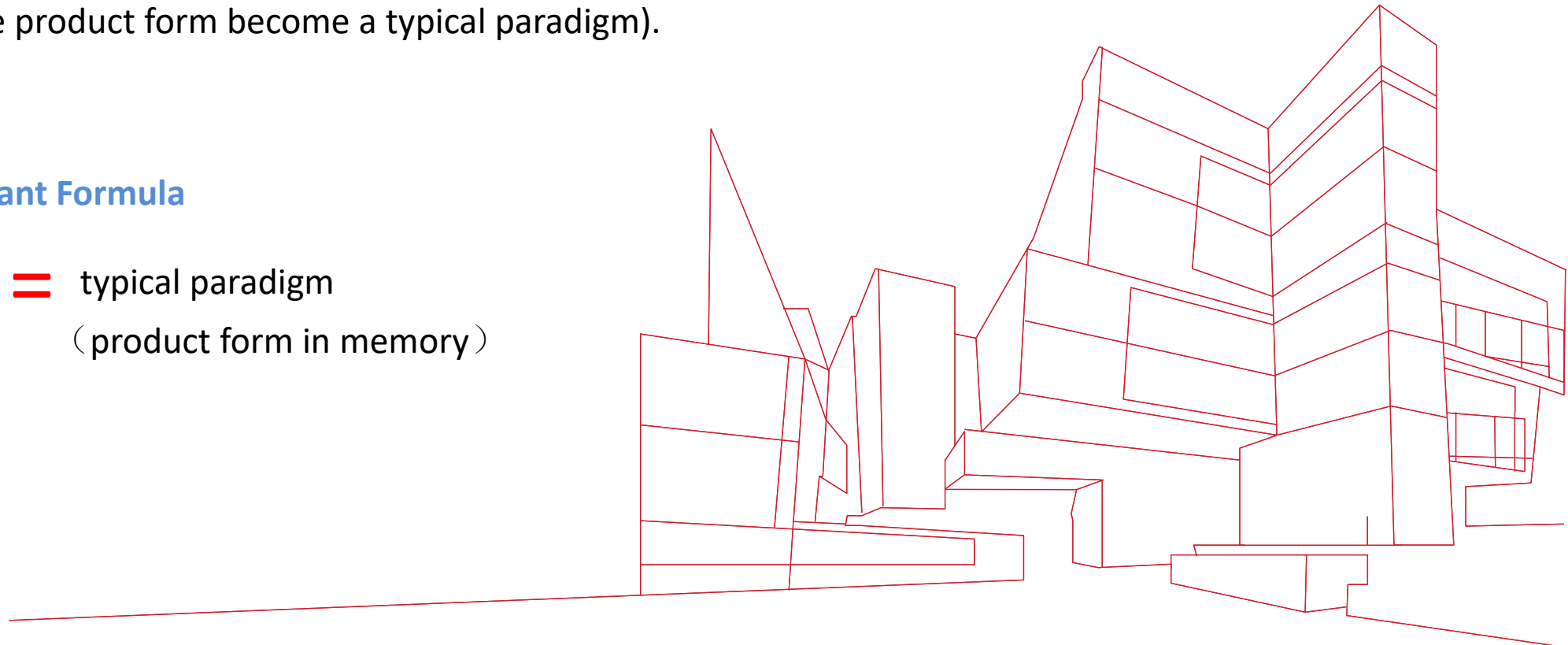


Discussion

Memory: As soon as the perception of global topological properties are introduced into product form, people make a comparison between the current products and the ones in memory (in memory, the product form become a typical paradigm).

Important Formula

Reward = typical paradigm
 (sugar water) (product form in memory)



Topological Variant—the numbers of Holes



Dyson fans

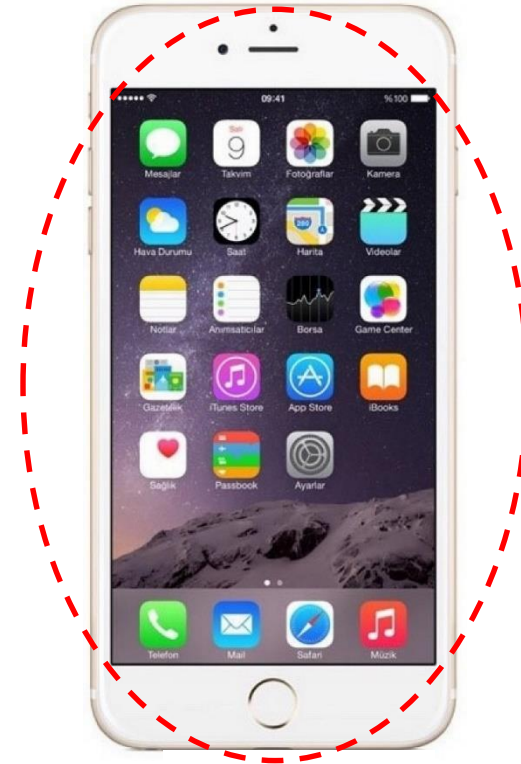
Topological Variant—connection



Topological Variant— Inside or Outside



NOKIA 3210

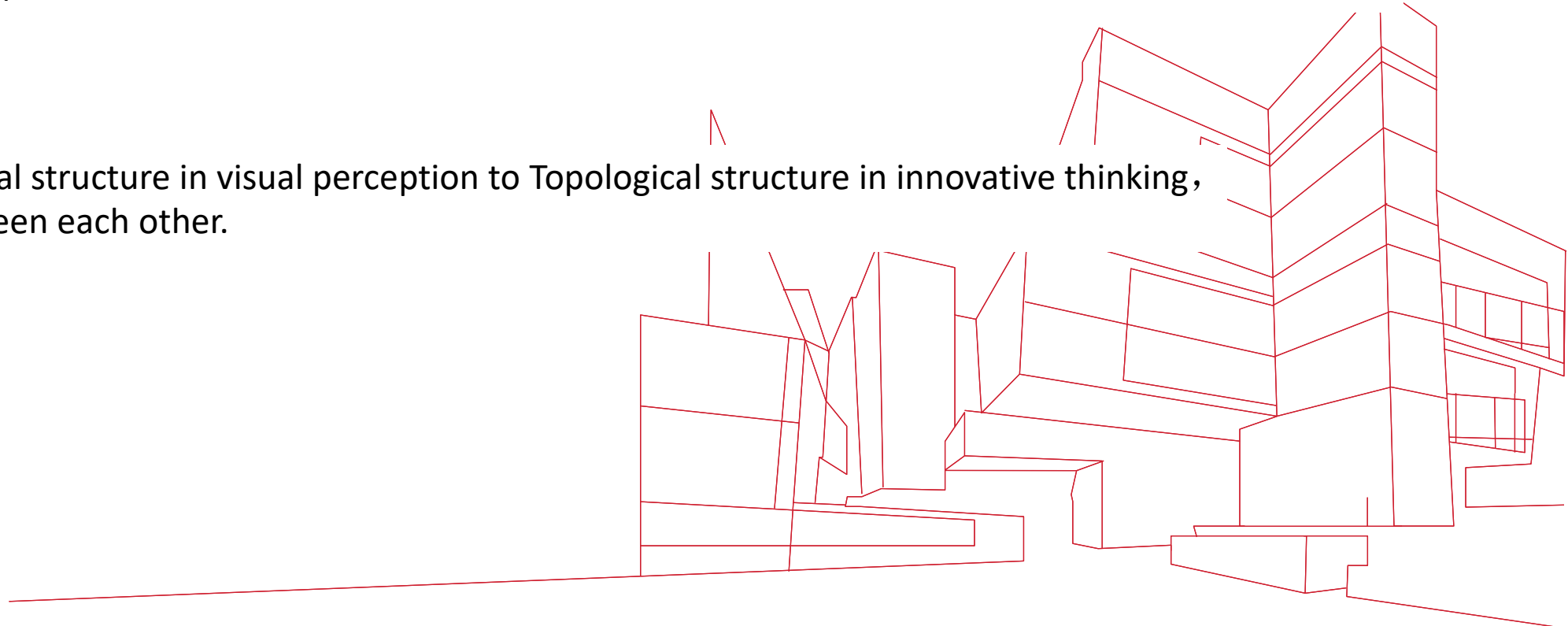


iPhone 6

The Next stage of research

1. The next stage of the topological structure of visual perception experiment through the use of eye tracking and product physical photos.

2. Transfer Topological structure in visual perception to Topological structure in innovative thinking, to find the link between each other.



Thank you for your attention!

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