What are the features of shapes easy to remember in the visual search?

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The question

Can we use an agnostic method to study the characteristics of images that improve reaction times in a visual search experiment? We tried to answer this using a Genetic Algorithm that generates random radial shapes. The algorithm was trained to modify images randomly in order to reduce reaction times.

Summary

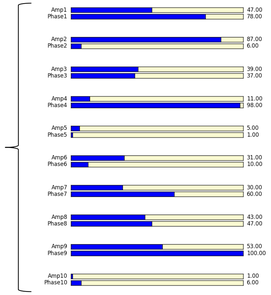
We used a Genetic Algorithm (GA) to generate radial random patterns that evolve to easy-to-remember shapes.

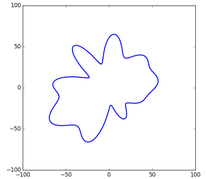
Firstly, a random target is displayed and the subject is asked to memorize it. The presentation time is 300ms or 600ms. After the target disappears, a panel is shown with the target and various random distractors. The number of them can be 15 or 23, for a total of four different trial combinations. Initially, we have 8 targets that make the “first generation” of 32 trials. The GA calculates the average reaction time (RT) for each of them. The worst five shapes (those that took longer RTs) are eliminated, the best two preserved and three new “children” targets are generated mixing parameters of the survived images.

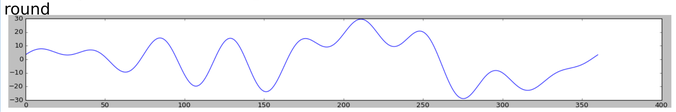
◆ How to make a Target

It has the amplitude and a phase parameter each frequency. The feature of shape is formed by these parameters like **DNA**.

Frequency “1” per one round
Frequency “2” per one round
Frequency “10” per one round

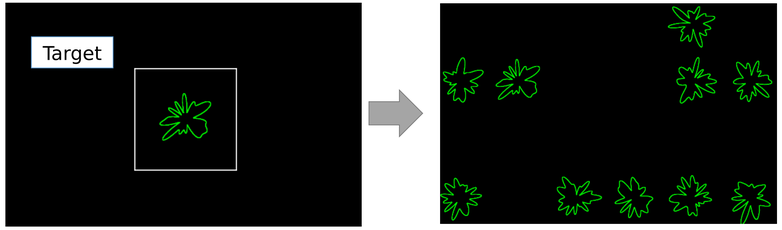






Search experiment method

◆ Visual Search Tasks



Memorization phase　　Search phase

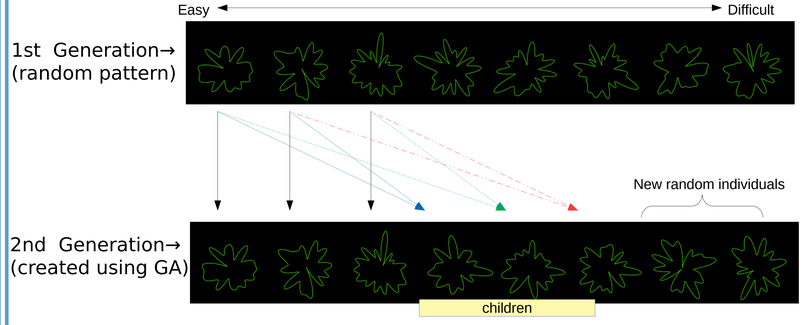
Step1) A target is displayed (Memorization phase) for 300 or 600 msecs.
Step2) A panel (Search phase) is shown with the target and some distractors.
Step3) The subject clicks the target, reaction time is measured.

∗Initially, we have 8 targets .
∗The presentation time is 300ms or 600ms.
∗The number of distractors can be 15 or 23.

→For a total of four different trial combinations, there are 32 trials in one generation.

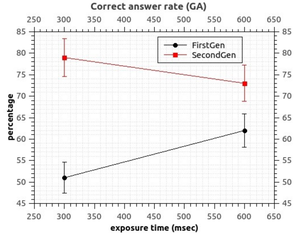
◆ Genetic Algorithm(GA)

The second generation is generated by the first generation result using GA.

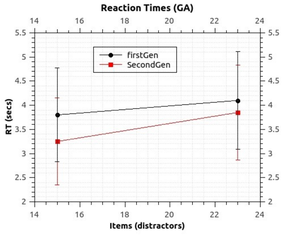


Results

Results on 7 subjects、64 trials per subject。



Target recognition accuracy in function of memorization time

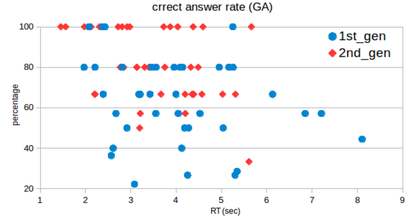


Reaction time in function of number of items

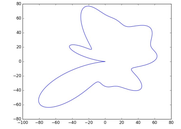
In the first generation we observe a correct answers rate of about 50-60%, in the second generation the rate increases to over 70%.

After the Genetic Algorithm kicks in, the effect of memorization time is lost. This suggests that the shape changes have a stronger effect than the memorization time.

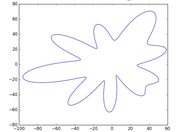
It is evident also the effect of the GA on reaction time that drops noticeably in the second generation. This confirms that images are easier to remember.



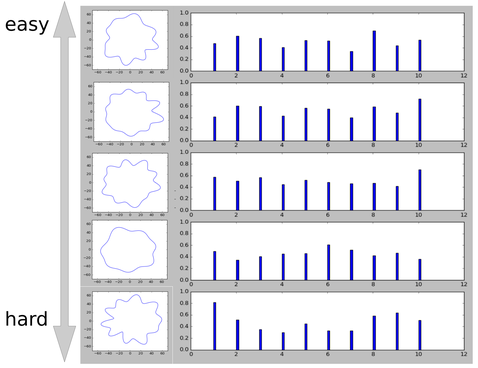
The variation of response time in function of the correct answer rate. We notice that in the second generation the correct answer rate is better and in short RT ranges.



Easier (example)



Harder (example)



Shapes easy and hard to remember. The images are averaged and sorted in order of correct answer rates. On the right are the frequencies used for generating these images.
On the left there are two typical examples of an easy to remember image and a hard one.

Conclusion

∗ The Genetic Algorithm produces shapes more easy to remember. The correct answer rate increases more than 40% in the second generation for a memorization time of 300ms. The improvement is also visible for exposition of 600ms. The images generated in an agnostic way by the genetic algorithm suggests that symmetry plays a role in the memorization process.