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시각의 환원 원리를 적용한 인공지능으로 아름다움 재현하는 구조에 관한 연구

Research on the Structure of Artificial Intelligence Reappearing Beauty by Using Visual Restoration Principle

주 저 자 : 유 욱 (Liu,Xu) 홍익대학교 대학원 공간디자인전공 박사수료

교 신 저 자 : 조택연 (Cho, Taig Youn) 홍익대학교 미술대학 산업디자인학과 교수 / 공학박사
taigyoun@empal.com

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Abstract

The beauty of visual stimuli is a complex whole composed of many factors. These wholes can be divided into individual cognitive elements, and the brain can process information in this mechanism. We only perceive beauty as a whole without knowing what the components and structures are, and as a result, it is challenging to reproduce beauty through these. But the brain has evolved over a long period to have the intelligence to reduce the whole to multiple levels, and neuroscience has shown the process well. In addition, recently, active artificial intelligence has imitated it and succeeded in reproducing beauty.

In this study, visual stimuli were reduced and organized into six levels of intelligence through prior research in cognitive neuroscience. First, the retina converts light into electrical pixel data, which is transmitted to the Lateral Geniculate Nucleus (LGN). Information arriving from the Lateral Geniculate Nucleus to the V1 area is rapidly transferred to the cognitive areas of the brain through the IFOF channel, causing visual attention. In order to respond quickly to the state of the world, a map of spatial visual coordinates is formed in the sensory and perceptual states as a mechanism for attending to objects. Second, primary visual processing reduced the attended visual stimuli to Feature, and the secondary visual cortex was reduced by processing visual information in Element, Shape, and From. Next, the structure of the connections between the visually reduced elements and the affective domain was examined, and it was found that the domain processing the From had a higher density of opioid receptors that elicited positive affect. Then, these visually reductive elements are converted into vocabularies, and a proposition is generated to translate them into Modellings. The generated vocabulary and propositions are used to create a beautiful design using the artificial intelligence Midjourney. Finally, the research on the goodwill of the beautiful shape is carried out, which further verifies the feasibility of this study.

This study is based on cognitive neuroscience, which reduces beauty as a whole to visual stimuli. The possibility of recognizing the design is verified by the beautiful reproduction of artificial intelligence. That is, an attempt is made to transfer the process of understanding and to reproduce the structure of beauty from the feeling of beauty to the category of recognition and to solve the difficulties encountered in producing beauty.

Keyword

Cognitive Neuroscience, Visual Processing, Visual Restoration, Artificial Intelligence, Midjourney

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요약

눈으로 바라보는 시각 자극의 아름다움은 매우 많은 요소로 이루어진 복잡한 전체이다. 이러한 전체는 각각의 인지 요소들로 작게 나눌 수 있고, 두뇌 또한 이 구조로 정보를 처리한다. 우리는 이러한 전체에서 아름다움을 느낄 뿐, 이를 구성하는 요소와 구조가 무엇인지 알지 못하며, 그 결과 이를 통해 아름다움을 재현하는 것이 어렵다. 하지만 두뇌는 오랜 진화에서 전체를 여러 계층으로 환원 처리하는 지능을 가지게 되었으며, 신경 과학은 그 과정을 잘 보여 주고 있다. 또한 최근 활성화되는 인공지능 역시 이를 모방해 아름다움을 성공적으로 재현하고 있다.

본 연구는 인지 신경과학의 선행연구를 통해 시각 자극 환원해 6가지 지능 층위로 정리를 한다. 먼저 망막은 빛을 전기적 픽셀 데이터(Pixel data)로 변환해 외측 슬상핵 (Lateral Geniculate Nucleus)으로 전송한다. 슬상핵 에서 V1영역으로 도달한 정보는 IFOF 통로로 인식 영역으로 빠르게 전달되어 시각적 주목을 이끈다. 세상의 상태에 빠르게 대응

하기 위해, 감각과 지각 상태에서 공간 시각 좌표 지도를 형성해 대상을 주목하기 위한 구조이다. 이어서, 1차 시각 처리는 주목하고 있는 시각 자극을 특징(Feature)으로 환원하고, 2차 시각 피질이 시각 정보의 형편(Element), 형태(Shape), 형상(From)을 처리해 환원한다. 다음으로 시각 환원 요소와 감정 영역의 연결 구조를 살펴보고, 형상 요소를 처리하는 영역에 긍정적 감정을 불러일으키는 아편 수용체(Opioid Receptors)의 밀도가 더 높은 것을 발견했다. 다음은 이러한 시각적 환원 요소를 어휘로 변환하고 이를 조형으로 생산하기 위한 명제를 생성한다. 이렇게 생성된 어휘와 명제로 인공지능 Midjourney를 사용하여 아름다운 디자인을 시도한다. 마지막으로 재현된 아름다운 조형물에 대한 호감도 조사를 실시하여 본 연구의 타당성을 더욱 검증하였다.

본 연구는 인지 신경과학을 기반으로, 아름다움 전체를 시각 자극 요소들로 환원하였다. 인공지능의 아름다움 재현을 통해 인식 디자인의 가능성을 실증하였다. 즉, 아름다움을 느끼는 것에서, 아름다움의 구조를 이해하고 재현하는 과정을 인식 범주로 옮겨, 아름다움의 재현에서 겪는 어려움을 해결하려 시도하였다.

목차

1. Introduction

The concept of reduction can be traced back to Descartes' method of analyzing problems, the process of reduction, which involves breaking down a complex system to the level of the primitives that make it up, abstracting the simplest factors, and then using the nature of the parts to account for the complex. Humans see the world with two eyes precisely, through two visual intelligences or, more precisely, through multiple levels of visual intelligence. In other words, it is a reductionist approach. The beauty of everything we look at every day is equivalent to a complex visual stimulus, we can clearly feel its beauty, but it is very difficult to objectively point out where the beauty lies; therefore, it is necessary to restore the elements that constitute beauty. As early as 1909, German neuroanatomist Brodmann discovered 52 mutually independent brain regions [1)]of the brain In 2016, experts such

1)https://en.wikipedia.org/wiki/Korbinian_Brodmann

as Tianzi Jiang of the Chinese Academy of Sciences used information on brain structure and functional connectivity to draw a new atlas of the human brain network group, including 246[2] fine brain regions, and these subdivisions are highly specialized. Regarding visual brain regions, in the 1970s, and 1980s, biological neuroscientist Semir Zeki explored the functions and connections of visual areas from V1 to V5[3], as well as the status of information pathways. Besides, some researchers summarized the five levels of aesthetic processes[4]. This all provides the basic conditions for visual restoration. The purpose of this study is to use cognitive neuroscience as a medium to restore the elements of beauty that can cause aesthetic feelings and to bring these restored elements into artificial intelligence to reproduce the design of beauty. First, six neural processes in the brain for visual stimulus restoration are organized based on previous studies. Firstly, the retina converts photons into pixel data and sends them to the visual cortex through LGN, next is to focus our eyes on visual objects through the IFOF pathway connecting the occipital and frontal lobes, then, the primary visual area reduces the attention object to Feature, and the secondary visual area further reduces the visual stimulus to Element, Shape, and From.

Finally, we explored the connection between visual reduction components and emotions and found that From is more aesthetically appealing than simple visual reduction components, such as simple lines and shapes. Finally, the visual reduction components are organized into a design code, which is brought into the AI Midjourney to reproduce the beautiful design.

2. Hierarchical composition of the brain's reduction of visual stimuli

2-1. Primary reduction of visual stimuli by the Lateral Geniculate Nucleus

Our visual perception of everything in the world starts when light enters the eye, probably through the following process: first, light is reflected from an object and travels in a straight line to our eye, where it passes through the cornea, enters the pupil and passes through the lens, where the bending (refraction) of the cornea and lens focuses the light on the retina (Figure 1).There are two types of photoreceptors

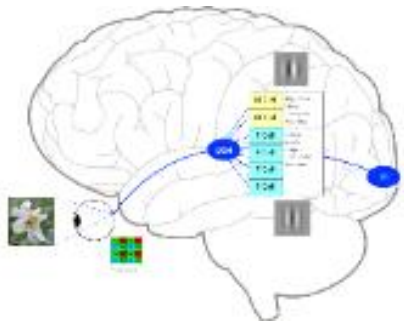


Figure 1 .LGN's Reduction of Pixel Data

in the retina, one is the optic vertebral cell, which is color selective (red, green, blue) and is densely distributed in the fovea. The optic rod cells are sensitive to the intensity of light and play an important role in night vision.In addition, there are three main types of retinal ganglion cells in primates that provide output to LGN and SC. They are Parvocellular (P) cells, Magnocellular (M) cells, and Koniocellular (K) cells, the first two of which have generally been studied more for their cellular properties.The shunt processing of LGN is well defined in all studied primates (Casagrande and Ichida, 2002; Casagrande et al., 2007; Kahn and Krubitzer, 2002; Van Hooser and Nelson, 2006). They consist of two ventral P-cell

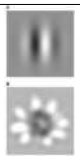
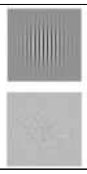
2) Dobs K, Martinez J, Kell A J E, et al. Brain-like functional specialization emerges spontaneously in deep neural networks[J]. Science advances, 2022, Vol.8,No.11,eabl8913.

3) MnegFanjun.A summary of the development of neuroaesthetics abroad[J].Henan Social Sciences,2016,Vol.24,No.05,pp.69-76

4) 류신 & 조택연. Analysis of Shape Generation Methods in Architecture from the Perspective of Cognitive Neuroscience. [J].기초조형학연구, 2019,Vol.20, No.02 ,pp.93-106.

pathways and four dorsal M-cell pathways.PC cells carry fovea visual signals and are sensitive to spatial frequencies above 4 cpd[5] (Table 1), so the PC pathway is dedicated to high spatial frequencies and high contrast. MC cells carry peripheral visual information and are sensitive to spatial frequencies below 4 cpd, so they are dedicated to low spatial frequencies and low contrast. In addition, the two pathways are associated with different aspects of human perception[6]; The MC pathway is associated with the processing of luminance, motion[7], and high-frequency temporal modulation[8], whereas the PC pathway is associated with the processing of color, acuity, and shape[9]. These signals are finally transmitted to V1 visual cortex. This is the first stage of visual reduction.

Table 1 M-Cell and P-Cell Vision Processing Tasks

Characteristics	MCell pathway	Pcell pathway
The size of the ganglion cell body	large	small
Size of the receptive field of ganglion cell	large	small
Speed of a nerve impulse transmission	fast	slow
Number of axons in optic nerve and tract	small	large
Color differentiation	no	yes
Contrast sensitivity	small	large
Spatial resolution	small	large
Time resolution and movement sensitivity	large	small
Sensitivity to differentiation of brightness of planes lying next to each other	large	small
Source / Type of Information	Rods; necessary for the perception of movement, depth, and small differences in brightness	Cones; long- and medium-wavelength ("red" and "green" cones); necessary for the perception of color and form (fine details).
Location	Layers 1 and 2	Layers 3, 4, 5,6
Response	rapid and transient	slow and sustained
Image		

2-2. IFOF pathway conducts images and directs visual attention

The impact of visual information processing on human existence can be seen in the fact that one third of the cerebral cortex is involved in the process of visual processing. Human visual intelligence can be divided into two processes, the first of which is the visual intelligence of

5) Leonova A, Pokorny J, Smith V C. Spatial frequency processing in inferred PC-and MC-pathways[J]. Vision research, 2003, Vol.43,No.20,pp.2133-2139.

6) Livingstone MS, Hubel DH. Psychophysical evidence for separate channels for the perception of form color, motion and depth. J Neurosci. 1987,Vol.7,pp.3416-3468.

7) Ibid.

8) Lee BB, et al. Luminance and chromatic modulation sensitivity of macaque ganglion cells and human observers. J Opt Soc Am A. 1990,Vol,7,pp.2223-2236.

9) Livingstone MS, Hubel DH. Psychophysical evidence for separate channels for the perception of form color, motion and depth. J Neurosci. 1987; 7: 3416-3468.

observing the world through images reflected in the eye. Although we know we are looking, so far we cannot see the shape and meaning of the object, but only illusively perceive the appearance of the object that the retina converts into neural signals to convey.The birth of this intelligence may have been accompanied by an evolutionary process of quickly looking for objects in the environment that are worthy of attention, such as something familiar at close range that suddenly moves, like red or blue with high saturation. Something that suddenly moves at close range is likely to be the result of a dangerous predator. Red or green etc. are likely to be valuable food resources like flowers or fruits. Familiarity is what helps to quickly identify survival collaborators and safe survival environments. Movement, color, and familiarity are the most perceptible and easily distinguishable visual characteristics. If one can see and react without thinking, one can respond to threats or access resources more quickly. The brain has gradually evolved a fiber bundle to achieve this goal, the inferior frontal-occipital fasciculus (IFOF), also mentioned earlier, was one of the first significant fiber bundles to be identified and depicted (Schmahmann and Pandya, 2007). The IFOF is a large white matter bundle that originates in the occipital and parietal lobes and terminates in the inferior frontal lob e[10]. (Figure 2) Some of these IFOF branches connect BA8 (frontal eye field, FEF) and BA9 (Dorsolateral and Medial prefrontal cortex.) with Striate cortex V1and Extrastriate cortexV2, V3, V3a connections ; the significance is that it plays an important role in reading, attention, goal orientation, and visual processing (Catani and Thiebaut de Schotten, 2008). At the same time, it connects the early visual cortex with OFC[11] (Orbitofrontal Cortex), which means that emotional judgment is involved in addition to quick visual attention. Because of IFOF, we can clearly realize that we are looking at the world unfolding before us[12]. Our brain is a careful calculation machine, which does not process unimportant information, but selectively processes it. Therefore, the visual intelligence described above first allows the brain to choose the object of attention and then interpret its structure and meaning. This is the second stage of the visual restoration process.

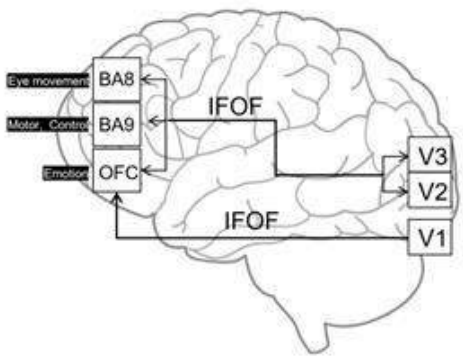


Figure 2 IFOF connects primary visual cortex with frontal cortex to trigger visual attention

2-3. Feature reduction of visual stimuli by primary visual cortex

To read the structure and meaning of an object from the image seen, it is necessary to reduce complex visual things into computable quantities. That is, the idea is quantified into specific elements that can be computed, i.e., feature vectors. This work is done by the visual hub V1, which extracts the light signal[13] from

10) vickström P, et al. Selective frontal neurodegeneration of the inferior fronto-occipital fasciculus in progressive supranuclear palsy (PSP) demonstrated by diffusion tensor tractography. BMC Neurol. 2011,Vol.11,No.1,p.13.

11) Rudrauf D, David O, Lachaux J P, et al. Rapid interactions between the ventral visual stream and emotion-related structures rely on a two-pathway architecture[J]. Journal of Neuroscience, 2008, Vol.28,No.11,PP. 2793-2803.

12) Wu Y, Sun D, Wang Y, et al. Subcomponents and connectivity of the inferior fronto-occipital fasciculus revealed by diffusion spectrum imaging fiber tracking[J]. Frontiers in neuroanatomy, 2016, Vol.10,No.88

13) Roelfsema P R, Tolboom M, Khayat P S. Different processing phases for features,

the image sent by the retina and converts it into computable features.For example, when we see a visual object, the optical signal from the retina is sent to the prefrontal lobe at the same time as it reaches V1, drawing attention to it, but in order to read the more important information, i.e., the structure and meaning of the visual object, it needs to go through an arithmetic process. V1 is the starting point for visual arithmetic, and it consists of six neural layers (Figure 3)[14].It receives Hsf visual information from the P cell layer of LGN and LSF visual information input from the M cell (Ferrera et al., 1992, 1994). Each layer of V1 is sensitive to different feature vectors. For example, the features that can be restored and extracted from the image are the position of the point, the angle and length direction of the line, the proportion, the depth,

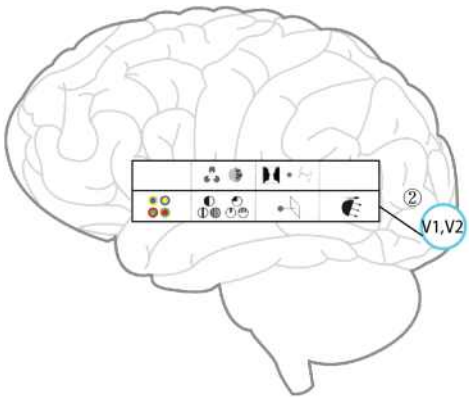


Fig. 3 primary visual processing is the reduction and conversion of visual images into feature vectors

the movement,[15] the difference of the nearby tone, the RGB color, the flicker in the time plane and the position change. After that, V1 acts like a post office, distributing different signals to different destinations. For example, the visual memory of the V2 region has not reached the modeling state but only stays at the level of the feature set, providing the information of motion and contour boundary for the next stage. To sum up, the primary visual processing is to restore and convert optical images into feature vectors. This is the third stage of graphic restoration.

2-4. Appearance reduction of visual stimuli by Secondary visual cortex

The edge curve information that is converted into a function continues backward from the primary visual cortex to V3, V3a, VP, and V4, further stringing together the initial fragmented feature vectors to form a curvature that conserves brain resources. In nature, where our visual system has probably evolved a lot, perfectly flat surfaces are rare, and even the flattest natural features (e.g., oceans, and beaches) are often curved to some degree due to wind, water movement, and even the curvature of the Eart h[16].Among them, V3, V3a is more sensitive to LSF information, which is extracted from the image uploaded to V1 from the retina as interval pixel relationships with slow changes in light and darkness, like the intensity in an ink painting, and perceives 2.5-dimensional surfaces through changes in power. At the same time, Vp is sensitive to HSF information, which is generated like a boundary line distinguishing the background from the object, along the vicinity of pixels with sharp changes in light and darkness, i.e., the contour of an object, This step is the fourth stage of visual reduction and constitutes the components of shape.

It has been shown that LOC(Lateral Occipital Cortex) is the neural substrate of volume perception and that in LOC , the VP curve closes into a 2D shape, forming a closed surface with V3, V3a soft tonal order (figure illustration).

figures, and selective attention in the primary visual cortex[J]. Neuron, 2007, Vol.56,No.5,pp. 785-792.

14)Principles of neural science[M]. New York: McGraw-hill, 2000.pp.571-572

15)Li Z. A saliency map in primary visual cortex[J]. Trends in cognitive sciences, 2002, Vol.6,Nol.1,pp.9-16.

16)Curvature-processing network in macaque visual cortex XiaominYue.August 4, 2014 Vol.111,No.33,pp.E3467-E3475

Reaching the 2.5-dimensional diversity, which constitutes the smallest unit of Shape, this step allows us to distinguish the object from the background. In addition to this, the presence of

Table.2 Froms in nature

Image	From	
	Fibonacci Diagram	
	Voronoi Diagram	
	Spiral Rate	
	Bifurcation Diagram	
	Central symmetry	Symmetry
	Self-similar symmetry	
	Chaos symmetry	
	Equal specific radiation	Superposition
	Equal ratio arrangement	
	Central radiation	

the V3B/KO region near V3 has a significant activation of glossiness[17], so I guess that the evolutionary process of quickly locating the glossiness reflected by water resources has a very important value for the survival of life. Visual information continues to be conveyed backward, and V4 imparts morphology to a multiplicity of colors. In turn, the visual characteristics, such as transparency, glossiness, and backlight transmission of the perceived composite order tones. This step is the fifth stage of visual reduction, a stage where we are able to perceive the Shape and material properties of a thing.

However, most of the living organisms in nature do not appear in individual shapes, except for the fact that they are mainly composed of curves, because the life that constitutes our ecosystem is generated from genes, and the life shapes of plant growth, flowering, and branch forking are generated by repeated orderly rows (Table 2). This is the structure of life shapes that has the most significant impact on human survival. For example, we are familiar with the fractal structure, Tyson polygon structure, Fibonacci series, etc. The minimal information that the brain perceives most effectively as a resource is the generative structure of living shapes (Order forms). The human brain, with its vastly complex visual intelligence, understands this repetitive order form very well. Studies have shown that the intelligent region that processes the structure of repeated order shapes is located in the Fusiform Gyrus (FG) at the base of the temporal lobe(YeongJi Huang,Taigyoun Cho, 2018). It is conveyed through the Inferior Longitudinal Fasciculus (ILF) pathway, and at the same time, the above-mentioned properties of light, color gradient, glossiness, transparency and other objects are conveyed through the Superior Longitudinal Fasciculus (SLF) pathway and the combination of the two can be transformed into the survival meaning with rich nutritional value that the brain can predict.This stage is the sixth stage of visual restoration, the stage where we can perceive the presence of order.(Figure 4).

17)Sun H C, Ban H, Di Luca M, et al. fMRI evidence for areas that process surface gloss in the human visual cortex[J]. Vision research, 2015, Vol.109, pp.149-157.

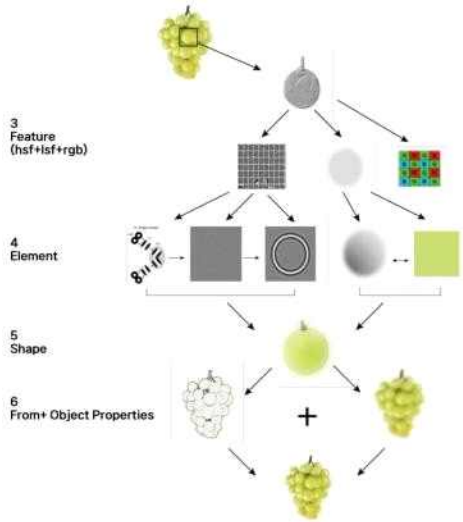


Figure 4 The brain's reduction process to visual stimuli

3. Emotion in the process of visual restorationl

3-1. Visual restoration and pleasure increment mechanism

The world's complex visual stimuli are reduced by the brain's cascading processing into individual elements that are easy to process. Research has shown that different levels of good feelings are triggered during the reduction of visual stimuli. An interesting study showed that there is a reward network in the brain that relies on the brain's own production of natural Opioids[18]. Thousands of years of experiments have demonstrated that Opioids alter brain activity, but it wasn't until the early 1970s that scientists figured out why. In 1972, researchers discovered that Opioid drugs could target certain molecules on the surface of brain cells receptors on the surface of brain cells. They made people feel "happy." This is why tens of thousands of people fall into the trap of artificial Opioids drugs. In this experiment, the researchers found that there were targets in the ventral visual processing areas of the brain that were capable of receiving Opioid drugs, and the number of targets increased in a gradient; as can be seen in the figure, the lower visual stimulus reduction stages V1, V2, and V3/VP areas, where it is clear that the targets of Opioid drugs (black dots) are sparse(Figure 5), which means that when we only As visual processing proceeds backward, the target sites (black dots) of Opioid drugs become more and more numerous, with the FG regions dealing with formal features being very dense, i.e., if there is an orderly, organized formal feature of the visual object itself, from an evolutionary aesthetic point of view, it is a potential survival resource generated by genetic inheritance.

Genetically generated life, whether plant or animal, contains substances that are essential for survival. Thus, the brain first perceives form and then perceives organized, recurring forms of order from the information thus transmitted, yet through tens of millions of years of evolution, our visual processing and emotional mechanisms have become intimately linked. In the field of art, the abstract painter Mondrian seems to have discovered the beauty of orderliness and experimented with it in his paintings for 20 years before his death.

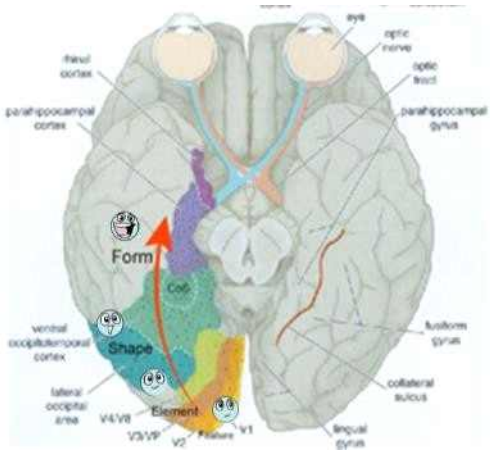


Figure 5 Form will lead to more good feelings.

18) Biederman I, Vessel E A. A novel theory explains why the brain craves information and seeks it through the senses[J]. Am. Sci, 2006, Vol.94,pp.249-255.

3-2. Pleasure enhancement mechanism of From

Human visual attention is often modulated by emotions, adjusting visual attention by quickly extracting relevant information present in the stimulus prior to mature visual processing (Anderson, 2005; Vuilleumier, 2005). Our brain has an "Anterior Affective System" [19](AAS) composed of the amygdala, temporal pole, and orbitofrontal cortex, and the AAS is critical for emotional processing and receiving. The AAS also exhibits early responses to visual stimuli that are modulated by the emotional meaning of the stimuli (Kawasaki et al., 2004). (Kawasaki et al., 2001; Eimer and Holmes, 2002). Also, studies have shown that the amygdala, temporal pole, and orbitofrontal cortex are all associated with positive emotions.[20] Interestingly, the brain network set of Brainnetome Atlas developed by the Chinese Academy of Sciences shows that the FG region(Figure 6), which processes formal features, is tightly connected to these three regions, and in addition to these three emotional regions, a connection to the Anterior cingulate gyrus is also seen. Activation of the Anterior cingulate gyrus leads to feelings of pleasure. In other words, the element of visual restoration with organization, and repetitive order, stimulates positive pleasure, and our feeling for such forms is initially derived from the perception of living resources and the environment and is then gradually projected into the field of design.

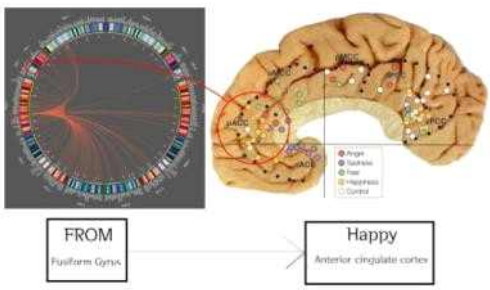


Figure 6 From activates the brain ACC to trigger pleasure

4. Design practices of transforming visual restoration Components into propositions

4-1. Design vocabulary coding for visually restored components

The previous content can grasp the basic reduction process of objects in the brain's visual processing, which is divided into six levels, the first level is the pixel data collection stage; the second level is the visual image fast perception stage; the third level is the image dissociation into features stage; this stage is able to perceive points, straight lines, directions, changes in intensity, etc., and the fourth level is the features collection into components stage, this step is able to identify curves, surfaces, The fifth level is the intelligence collection of components in closed curves to form independent shapes, spheres, squares, etc. The sixth level is that the shapes are composed of forms with a certain spatial order and the materiality of the object, including Fractal, Voronoi, Fibonacci, Bifurcation, etc., and the materiality includes transparency, translucency, reflection, etc.

The coding is used to connect the reduction hierarchy with the corresponding visual reduction components for more efficient use in the design of artificial intelligence. In the encoding, the number represents the visual reduction level, the first capital letter represents the name of the level, and the subsequent letters represent the specific names of the reduction elements. For example, 6F-S-V, 6 represents the sixth level, F represents From, S represents Structure, and V

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Table 3 Visual Restoration Hierarchy and Design Vocabulary(Code)

NO.	Levels	Brain Area	Visual Restoration Process								Visual Restoration Diagram
1	PixelData	Retina	빛이 만들어내는 이미지(images)를 전기신호(electrical impulses)로 변환해 LGN를 거쳐 시각피질로 보낸다. (V1)								
2	Image	V1、V2、V3〉(B9) IFOF	망막에 맺힌 픽셀 상태의 광학 데이터가 IFOF로 의식 영역에 전달 영상으로 자각								
3	Feature	V1、V2	이상 특징 정보들을 멋대, 변화를 포함하는 형편 정보로 변환하는 지능 층위								
			MCeLL LSF		PCell HSF		primary colours	Visual disparity	Time element Changing light pattern	Direction	Quantization of data into numerical values
			Gradation	Blurred	Straight	Point	Red, Green Blue	Parallax	Flash	Direction	
		Code	3F-G	3F-Bl	3F-Sl	3F-P	3F-R 3F-G 3F-B	3F-P	3F-F	3F-D	
4	Element	V1、V2、V3 V3a、V3B/KO、VP、V4	2개 이상 특징 정보들을 멋대, 변화를 포함하는 형편 정보로 변환하는 지능 층위								
			Boundary line (point+component)		Grayscale Single gray scale Compound gray scale		Color change color+gray scale	light	Occurrence of motion	Depth of field	
			Curve		Curved Surface	Texture	Intermediate Color	Light	Movement	Depth	
		Code	4E-C		4E-CS	4E-T	4E-IC	4E-L	4E-M	4E-D	
5	Shape	LOC	형편 정보를 폐곡선 안에 더해 이를 독립된 객체로서 형태로 인지하는 지능층위								
			2D Shape				3D Shape				
			Triangle	Circular	Square		Triangular pyramid	Globosity	Cube	cylinder	
		Code	5S-2D-T	5S-2D-C	5S-2D-S		5S-3D-T	5S-3D-G	5S-3D-C	5S-3D-Cy	
6	Form	FFA/Parietal lobe	형태들 사이 공간 관계에서 질서를 읽어 이를 형상 가치로 인지하는 층위의 지능								
			Structure						Object Properties		
			Fractal	Voronoi	Fibonacci	Bifurcation	Chaos	Symmetry	Spiral	Transparency	Translucence	Glossiness	Nonopaque	Refract
		Code	6F-S-Fr	6F-S-V	6F-S-Fi	6F-S-B	6F-S-C	6F-S-Sy	6F-S-Sp	6F-OP-T	6F-OP-T2	6F-OP-G	6F-OP-N	6F-OP-R

represents Voronoi. (Table 3)

4-2. Design practices of using Midjourney

To further verify the feasibility of converting reduced elements into design propositions, this study attempts to use a popular AI tool for empirical evidence. The selected AI tool is a mapping software called Midjourney(Figure 7), an AI thatproduces unexpected results by simply typing in the collated English pronouns. However,

Figure 7 Midjourney Operating Interface

Source :https://midjourney.com

it is crucial for designers to represent the blueprint in their heads as accurately as possible, which requires a basic cognitive agreement with the artificial system. If the input words are emotionally oriented adjectives, the result is often uncontrollable and may not be the same as what one expected. However, the above codes, which are organized according to the brain's visual reduction processing, are more direct and clear and will generate predictable designs if one organizes the shapes in one's mind with these codes. Therefore, this section uses artificial intelligence to practice furniture design, utility design, architectural design, and art creation (Table 4), (Table 5), (Table 6), (Table 7)

Table.4 Furniture Design Based on Visual Reduction Vocabulary

AI Furniture Design			
No	Code	Corpus	Image
A	This is a comfortable seat +(6F-OP-T)+(4B-IC) +(4E-CS)+(4E-C)	This is a comfortable seat, transparent, curved, blue-purple, fluorescent, curved and soft	
B	A comfortable seat +(7)+(6F-OP-R)+(7) +(6F-S-V) +(4E-C)	A comfortable seat, mirror reflection, metal, Voronoi diagram, curves	
C	Furniture that can sit +(6F-S-B) +(6F-OP-T2)+(4E-IC) +(6)+(4E-B)	Furniture that can sit, Bifurcated,Translucent. Pink Orderly ,Curved.	

Table.5 Public Facilities Design Based on Visual Reduction Vocabulary

AI Public facilities design			
No	Code	Corpus	Image
D	A bus stop+(4E-CS)+(4E-C)+(4E-IC)+(6F-OP-T2)	A bus stop, curved surface, curve, blue-purple, translucent material. Real environment, 4k	
E	A bus stop+(6F-S-V) + (6F-OP-T) + (4E-IC) +Real environment+4K	A bus stop in the metropolis. voronoi. transparent material. Bus stop is gradient pink. Real environment, 4K	
F	A bus stop+people sitting inside+(6F-S-C) + (6F-S-Fr) + (6F-OP-T2) + (4E-IC) + Real environment+4K	A bus stop, people sitting inside, Chaos change, Fractal paradigm, translucent,blue-purple epidermis. Real environment, 4K	

Table.6 Architectural Design Based on Visual Reduction Vocabulary

AI Architectural Design			
No	Code	Corpus	Image
G	A skyscraper +(6F-S-V) +(6F-S-S1)+(6F-OP-R)	A skyscraper. voronoi diagram. Spiral twist. Reflection. Metal. High	
H	An independent skyscraper +(6F-OP-T)+(6F-OP-N)	An independent skyscraper, translucent,nonopaque, frosted, spiral paradigm, sleek. glass	
I	This is a skyscraper +(6F-OP-T)+[(4E-IC)(4E-L)]+(6F-S-Sp)+True, 4k.	This is a skyscraper with translucent frosted glass and yellow light, and there are spiral structure inside. True, 4k.	

Table.7 Artistic Creation Based on Visual Reduction Vocabulary

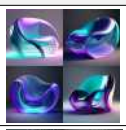
AI Artistic Creation			
No	Code	Corpus	Image
J	It is a painting+(3F-SI)+(3F-SI)+[(3F-R)(5S-2D-S)]+[(3F-B)(5S-2D-S)]+[(4E-IC)5S-2D-S]+[(5S-2D-S)]	It is a painting with black horizontal straight line black vertical straight line, red square color block ,blue square color block, yellow rectangle color block, and white rectangle color block.	
K	This is a watercolor painting+2D+(3F-SI)+(3F-SI)+[(3F-R)+(5S-2D-T)]+[(4E-IC)+(5S-2D-C)]+(4E-C)+[(4E-IC)+(3F-P)]+[(3F-B)+(5S-2D-S)]	This is a watercolor painting, 2D, with black straight lines, black diagonal lines, red triangles, yellow circles, wavy lines, black dots and blue rectangles.	
L	This is an oil painting+small lotus flowers+(4E-IC)+(3F-G)+(3F-SI)	This is an oil painting. There are several small lotus flowers in the water in the distance, with a blue-purple tone and a blurred picture, which is composed of short strokes.	

5. Design practice and evaluation investigation

5-1. Questionnaire design

In order to further verify the feasibility of design products based on the visual restoration structure, the above design results were numbered in alphabetical order (A, B, C, D.....) and a visual favorability survey was conducted, and the question "How do you feel about the visual favorability of the design? " was asked. The survey was conducted using the online research tool, the Likert scale to set five levels of individual choices, namely "very ugly", "not good", "average ", "good looking", and "very nice". The research form is shown in the figure (Table 8).

Table 8 Questionnaire design

How do you feel about the visual appeal of the design work?		
What is your gender?	Male / Female	
What is your profession?		
NO.	Visual stimulation	Options
A		1."Very ugly" 2."Not good .looking" 3."Average" 4.."Good-looking" 5."Very nice"
B		
.....		
L		

5-2. Analysis of results

In order to exclude the influence of art theory on the results, the research was conducted for non-art college students, and 110 research questionnaires were distributed, with 104 valid responses returned. Among them, there were 59 male students and 45 female students, including 9 majors in philosophy, 13 majors in economics, 9 majors in law, 12 majors in education, 5 majors in literature, 13 majors in history, 7 majors in science, 7 majors in engineering, 11 majors in agriculture, 10 majors in medicine, and 8 majors in management. (Table 9)

Table 9 Analysis of results

No.	Very Ugly	Not Good	Average	Good-looki	Very Nice	

		Looking		ng		
A	0	0	14	34	56	Furniture design
B	0	0	15	45	44	
C	0	0	19	46	39	
D	0	0	15	53	36	Public Facilities Design
E	0	2	19	53	30	
F	0	0	23	34	47	
G	0	1	16	51	36	Architectural Design
H	0	1	24	40	39	
I	0	1	34	30	39	
J	0	0	16	40	48	Artistic Creation
K	0	0	16	47	41	
L	0	0	22	38	44	
Total	104					

From the overall results, the subjects generally have a strong affection for artificial design, among which Group A in furniture design has the highest praise. In the design process, the author consciously uses the unfamiliar blue-purple color in daily life, the transparent texture with pleasure and the code generation of familiar chair shapes, forming a strange and familiar shape, which may be the reason for the subjects' high evaluation. However, in the painting group, there is an option of "not looking good". The author thinks that it may be because the subjects are more inclined to figurative painting and expect to find meaning in painting, which leads to negative emotions after failure. Generally speaking, the use of visual reduction elements into design vocabulary can realize the reproduction of beauty.

6. Conclusion

We intuitively sense that the overall impression of a visual object is regarded as beautiful, such as a beautiful flower, a beautiful tree, etc. However, neurological studies have shown that the brain is unable to create such a complex whole but rather needs to reduce the complex visual whole into individual visual elements, which it can be further used in design and art.

In this study, theoretical studies from cognitive neuroscience firstly sort out the six processes of visual stimulus reduction, i.e., firstly, the retina converts photons into Pixel data through the geniculate body, and then these pixel sets-visual images are transmitted to the frontal lobe by the IFOF pathway, which triggers visual attention. Subsequently, the primary visual processing starts to process the vector Feature of the object, followed by secondary ventral visual processing to

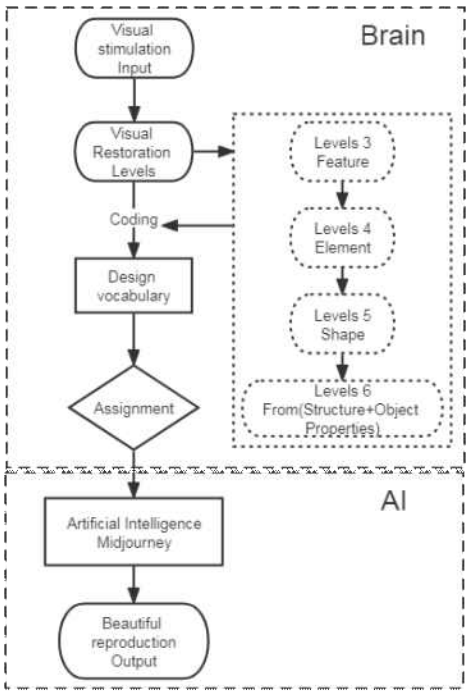


Figure 8 Research flow chart

restore the Element, Shape, and From of the visual stimulus. The connection structure between the restored elements and emotion is then explored, and it is found that the high-level visually restored elements trigger more pleasurable emotions than the low-level visually restored elements, which in turn trigger the perception of beauty. Next, these restored elements were edited into design codes and brought into the AI Midjourney to reproduce the beautiful design. Finally, the design results are investigated for the goodness of feeling to further empirically prove the feasibility of this study(Figure 8).

Based on cognitive neuroscience, this study deconstructs and reduces the complex whole that constitutes beauty and discovers the corresponding emotional relationships, solving the difficulties experienced in reproducing beauty with a scientific approach and providing a way to recognize beauty from perceiving it to cognizing it to creating it.

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