반투명 표피를 사용한 건축에서 느끼는 미의식의 신경 미학적 연구

Research on Aesthetic Consciousness of Translucent-skin Buildings Based on Neuroaesthetics

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접수일자 2022. 5. 25. / 심사완료일자 2022. 6. 12. / 게재확정일자 2022. 6. 25.

Abstract

The functional separation of structure and skins in architecture has emerged in Gothic architecture. The Industrial Revolution accelerated the production of metal and glass, which led to the functional separation of structure from the skins becoming a common architectural design style after the 19th century. The architectural skins is liberated from the structure and assumes the role of expressing beauty. In this context, there are some suggestions on the visual design points of architectural skins and architectural structure given from the perspective of neuro-aesthetics in this paper. This study was conducted in accordance with the following procedure. First, The concept and experimental data related to fluency theory and aesthetic A-HA theory are used to determine human susceptibility to transparency. There is a way found to generate good feelings that is semi-translucent architectural skins. Second, Determine the ideal architectural features through the "Prospect and Refuge" model based on the "Embodiment Theory" and the "Dwelling Theory". Third, Analyze the visual role of semi-translucent architectural skins and building structure based on the "Prospect and Refuge" model from the perspective of symbolism. Fourth, Found the effect of expectation on memory representation in perceptual processing through the comparative analysis of aesthetic model. Fifth, Vitruvius's architectural theory regards utilitas (functionality) , firmitas (strength) , and venustas (aesthetics) as the expected universal values of architecture. Sixth, In terms of memory representation, some suggestions on the visual characteristics of building structures in buildings are proposed with translucent building skins. On this basis, this study puts forward the following suggestions. Buildings with semi-translucent skins are attractive. Semi-translucent building skins should indicate that it is supported by a solid structure. In terms of visual perception, the firmness of the structure on the back of the semi-translucent skins satisfies the universal aesthetic consciousness. The good feelings generated in this automatic cognitive processing process based on unconscious implicit memories can have a positive impact on cognitive outcomes. In terms of visual perception, the stability of the structure projected on the back of the translucent skin satisfies a general aesthetic sense.Therefore, an expression with visual appeal - translucent architectural skins and visually perceived stable building structures are proposed in this study.

Keyword

Neuro-aesthetics(신경 미학), Translucent(반투명), Memory representations(기억 표상)

요약

건축에서 구조와 표피의 기능적 분리는 이미 고딕 건축에서 일어났다. 산업혁명으로 금속과 유리의 생산이 가속되며 구조와 표피의 기능적 분리는 19세기 이후 건축 설계의 보편적 양식이 되었다. 건축 표피가 구조에서 해방되어 아름다움을 표현하는 역할을 맡게 된 것이다. 본 연구는 이러한 맥락에서 신경 미학을 기반으로, 건축 표피와 이에 투영되는 구조가 시각적 디자인 포인트로 제안하기를 희망한다. 본 연구는 우선 유창성 이론과 심미적 A-HA 이론 연구 개념과 데이터를 통해 투명성에 대한 인간의 선호도를 탐구한다. 좋은 느낌을 주는 방법 발견 - 반투명 건물 피부. 두 번째는 “구체화(embodied) 이론”과 “조망과 피신(prospect and refuge) ” 모델을 기반으로 이상적인 건축적 특징을 정하는 것이다. 세 번째는 상징성 관점에서 “조망과 피신 (prospect and refuge) ” 모델을 기반으로 반투명한 건물 외피와 건물 구조의 시각적 역할을 분석한다. 네 번째는 미의식 모델의 비교와 분석을 통해 지각 처리에서 기억 표현에 대한 기대의 영향을 발견하였다. 다섯 번째는 Vitruvius의 건축 이론적인 관점에서 기능성(utilitas), 견고성(firmitas), 심미성(venustas)을 건축이 원하는 가치로 삼고 있다. 여섯 번째는 기억 표현의 관점에서, 반투명 건물 외피를 가진 건물에서 건물 구조의 시각적 특성에 대한 제안이 제공한다. 이를 바탕으로 본 연구는 다음과 같이 제안하였다. 반투명의 표피를 가진 건물은 호감을 느끼게 한다. 또한 반투명한 건물 표피는 견고한 구

조체가 이를 받치고 있음을 잘 보여줘야 한다. 이러한 무의식적 내재 기억에 기반한 자동 인지 처리 과정에서 발생하는 호감은 인지 결과에 긍정적인 영향을 미칠 수 있다. 시각 인지에서 반투명 표피의 배면에 투영되는 구조체의 견고함은 보편적 미의식을 만족시킨다. 따라서 시각적 호감을 얻는 표현인 '반투명한 표피와 이에 비치는 안정된 건축구조'를 제시하고자 한다.

목차

1. Introduction

The relative separation of architectural structure and skins already present in classical architecture is explained in Alberti's "dualism". The theory holds that architecture is first "naked" and then draped in a decorative garb. The development of metal and glass in architectural design in the first half of the 19th century accelerated the separation of skins and structure. In the works of modernist masters such as Wright and Aalto, skins show a constructive meaning that is quite different from structure. As a coat for post-modern architecture to show its style and convey symbolic meaning, the architectural skins do not need to be attached to the structure, but can be freed from the architectural function and play an independent role in presenting the architectural beauty. Under the premise of the dichotomy of architectural skins and architectural structure, how the architectural skins and architectural structure should be visually presented to the perceiver plays an important role.

2. Related concepts

2-1. Building skins and building structures

In the field of architecture, Enclosure, Facade, Interface, Surface, Appearance and skins have similar meanings and can be substituted for each other in many occasions. In this paper, the term "skins" is used for research.

The relative separation of architectural structures and skins already present in classical architecture is explained in Alberti's "Dualism". He considered architecture to be first "naked" and then draped in a decorative garb. This dichotomy of skins and structures is particularly evident in Gothic and Baroque architecture. In the architectural design of the first half of the 19th century, the development of metal components and glass accelerated the separation of skins and structures. In the German Pavilion designed by Mies for the 1929 Barcelona Exposition, the cross-shaped load-bearing steel columns completely free the skins from the structure, thus becoming a spatial interface with its own compositional rules. In the works of modernist masters such as Wright and Aalto, skins show a constructive meaning that is completely different from structure. In addition, Le Corbusier also noticed the independent value of skins and incorporated it into theoretical thinking. In Le Corbusier's Towards a New Architecture, he established surface, mass and plan as the three basic elements of architecture[1]. Modern buildings have individual skins, which are used to fill in various aesthetic contents, while plumbing for structures, equipment, appliances, etc. is covered inside[2]. As a coat for post-modern architecture to show its style and convey symbolic meaning, architectural skins do not need to be attached to the structure, but can be separated from the architectural function and play an independent role in presenting the architectural beauty.

Combined with the discussion in this chapter, this paper defines the architectural structure as the "naked" structure of the building in Albert's "dualism", which is defined as the architectural structure, and the architectural structure exists as the function of the building base. (Table 1)

Table 1. Building Structure and Building Skin

Building Structure and Building Skin Definition			
Architectural prototype	Model	building structure	building skin
			

2-2. Neuroaesthetics

Neuroaesthetics, as an emerging discipline, is the biological basis for the study of aesthetic experience[3]. Aesthetic experience arises when we perceive objects and evaluate them. Aesthetic experience includes the emotions, evaluations, and behaviors produced by these objects, as well as the processes that underlie their interpretation and production. Neuroaesthetics is a combination of empirical aesthetics, evolutionary aesthetics, cognitive and affective neuroscience. It hopes to find the law and basis of aesthetic production from an empirical point of view through the research on perception process and aesthetic judgment mechanism. Neuroaesthetics focuses on the properties and interactions of three nervous systems: sensory-motor, knowledge-meaning, and emotion-valuation systems[4]. (fig. 1)

3. Theories related to perceived preference

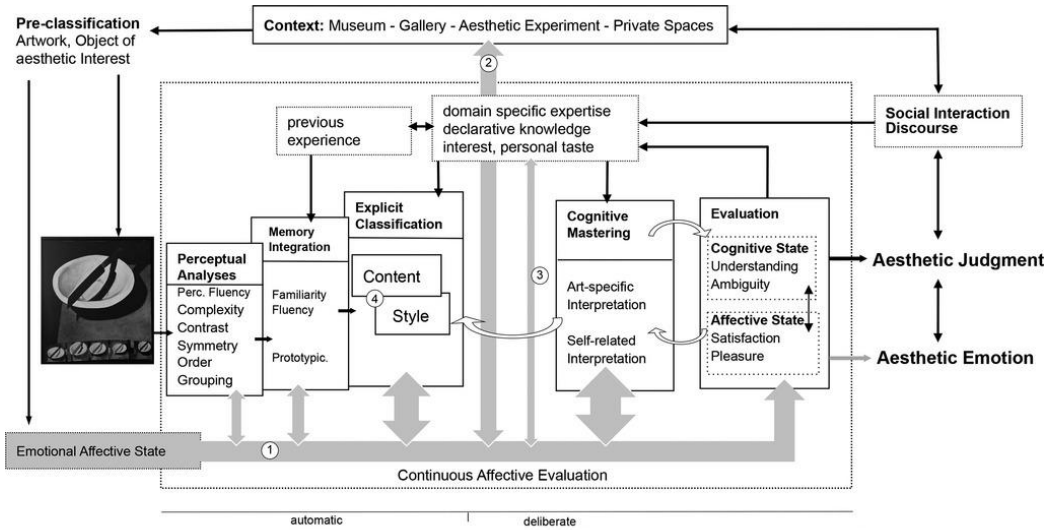
3-1. Related concepts of Embodied simulation and neuro-aesthetic triad

1) Gans, Deborah, and Le Corbusier, 『The Le Corbusier Guide』, Princeton Architectural Press, 2006, p.22.

2) Morley, Jane, R. Gregory Turner, Construction Economics and Building Design: A Historical Approach (Book Review), Technology and Culture, 1989, p.477.

3) Martindale, Colin, and Arnold Berleant, 『Neuroaesthetics』, Eds. Martin Skov, and Oshin Vartanian. Baywood Pub, 2009, p.5.

4) Chatterjee, Anjan, and Oshin Vartanian. Neuroaesthetics, Trends in cognitive sciences Vol.18, No.7, 2014, pp.370-375.



Model of Aesthetic Experiences (adpated from Leder, Belke, Oeberst & Augustin, 2004). Painting by HL.

Fig. 2 Model of Aesthetic Experiences (Leder, 2014)

The activation of the Embodied simulation is a recollection of the background and bodily knowledge we acquire in our actual relationship with inanimate objects and other sentient world s[5]. Among the properties and interactions of the three nervous systems that neuroaesthetics focus on, the Embodied simulation process plays an important role in the affective and motor components[6]. Motor systems are triggered not only by observing their behavior, but also by the elements of our environment. Elements present in the environment have different support for different movement policies. Only by providing fast and effective support to the environment, can a comfortable physical and psychological sense index the brain's judgment of environmental elements. Based on the concept of Embodied simulation and neuroscientific research, this paper proposes Embodied simulation in which architectural design can trigger human behavior and its rich emotions, so that perceivers have a favorable impression of architecture.

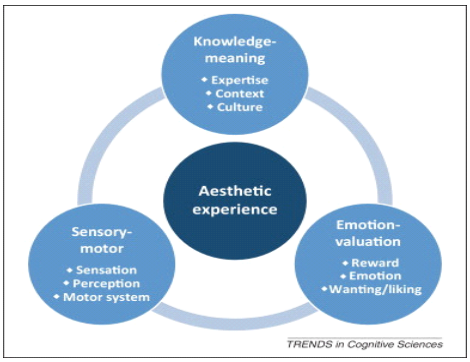


Fig.1 The three systems of neuroaesthetics (Anjan Chatterjee, 2014)

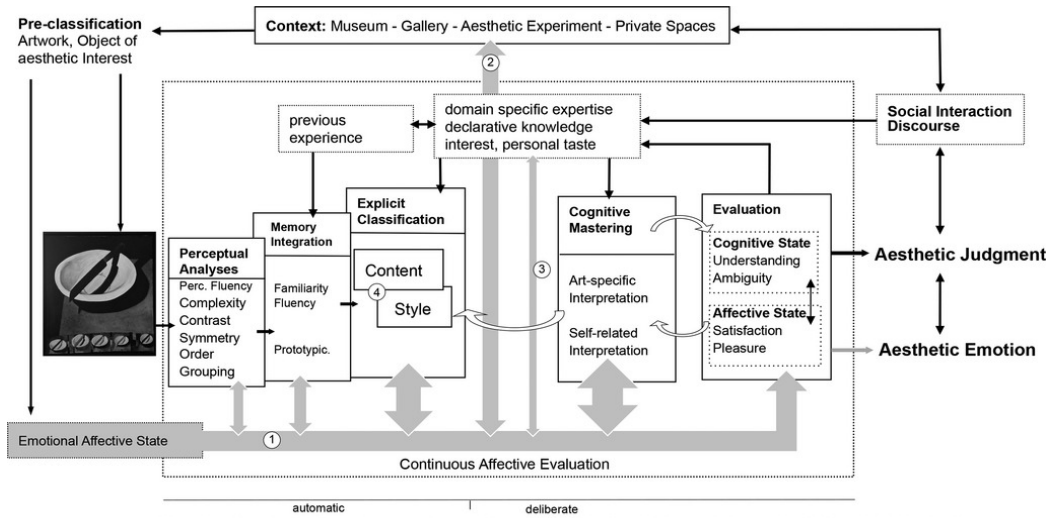
3-2. Habitat Theory and prospect-refuge theory

The core point of evolutionary aesthetics comes from a point put forward in Darwin's theory of evolution: "Human aesthetic preferences may be the result of human evolutionary history." Habitat Theory is a preference analysis from the perspective of evolution. Appleton's (1975) Habitat Theory proposes that we have an innate ability to assess

5) Gallese, Vittorio., Embodied simulation. Its bearing on aesthetic experience and the dialogue between neuroscience and the humanities, Gestalt Theory, Vol.41, No.2, 2019, pp.113-128.

6) Di Dio, Cinzia, and Vittorio Gallese, Moving Toward Emotions in the Aesthetic Experience, Brain, Beauty, and Art: Essays Bringing Neuroaesthetics Into Focus Vol.19, 2021, p.22.

whether the environment can meet our basic biological needs for survival. If the environment is perceived as conducive to survival, we experience positive emotional responses. If we perceive environmental conditions that are not suitable for survival, we will have negative emotions of anxiety or unease. People who are sensitive to this environmental preference can find habitats that are more conducive to human survival and pass this environmental preference to the next generation.



Model of Aesthetic Experiences (adpated from Leder, Belke, Oeberst & Augustin, 2004). Painting by HL.

Fig. 2 Model of Aesthetic Experiences (Leder, 2014)

If environmental conditions are considered favorable for survival, we experience positive emotional responses. If conditions are deemed inappropriate, we experience anxious or restless responses. Habitat Theory argues that this response motivates humans to seek an environment conducive to survival. This process enables people who are sensitive to these factors to live long enough to be fertile to pass on this environmental preference to their offspring. Conversely, people living in harsh environments may be exposed to hazards and ultimately eliminated from the population through natural selection. The prospect-refuge model is an ideal living environment proposed by Appleton from Habitat Theory. The core idea of this model is " could have been seen but not seen"[7]. The environmental attributes of prospect should be able to locate distant resources and find the way to resources and possible dangers, while the attributes of refuge should be able to hide and avoid danger. Although prospect-refuge theory is an environmental preference model for landscape preference, it is also widely used in architectural design. In 1991, Hildebrand discovered that elements of Wright's buildings had a strong prospect-refuge symbol, which may have been a factor in the success of Wright's buildings. At present, a large number of relevant empirical studies based on the prospect-refuge model continue to confirm that this model should be considered in architectural design to a large extent[8].

7) Appleton J. The experience of landscape[M]. Chichester: Wiley, 1996

8) Dosen, Annemarie S., and Michael J. Ostwald, Evidence for prospect-refuge theory: a meta-analysis of the findings of environmental preference research, City, territory and architecture, Vol.3, No.1, 2016, pp.1-14.

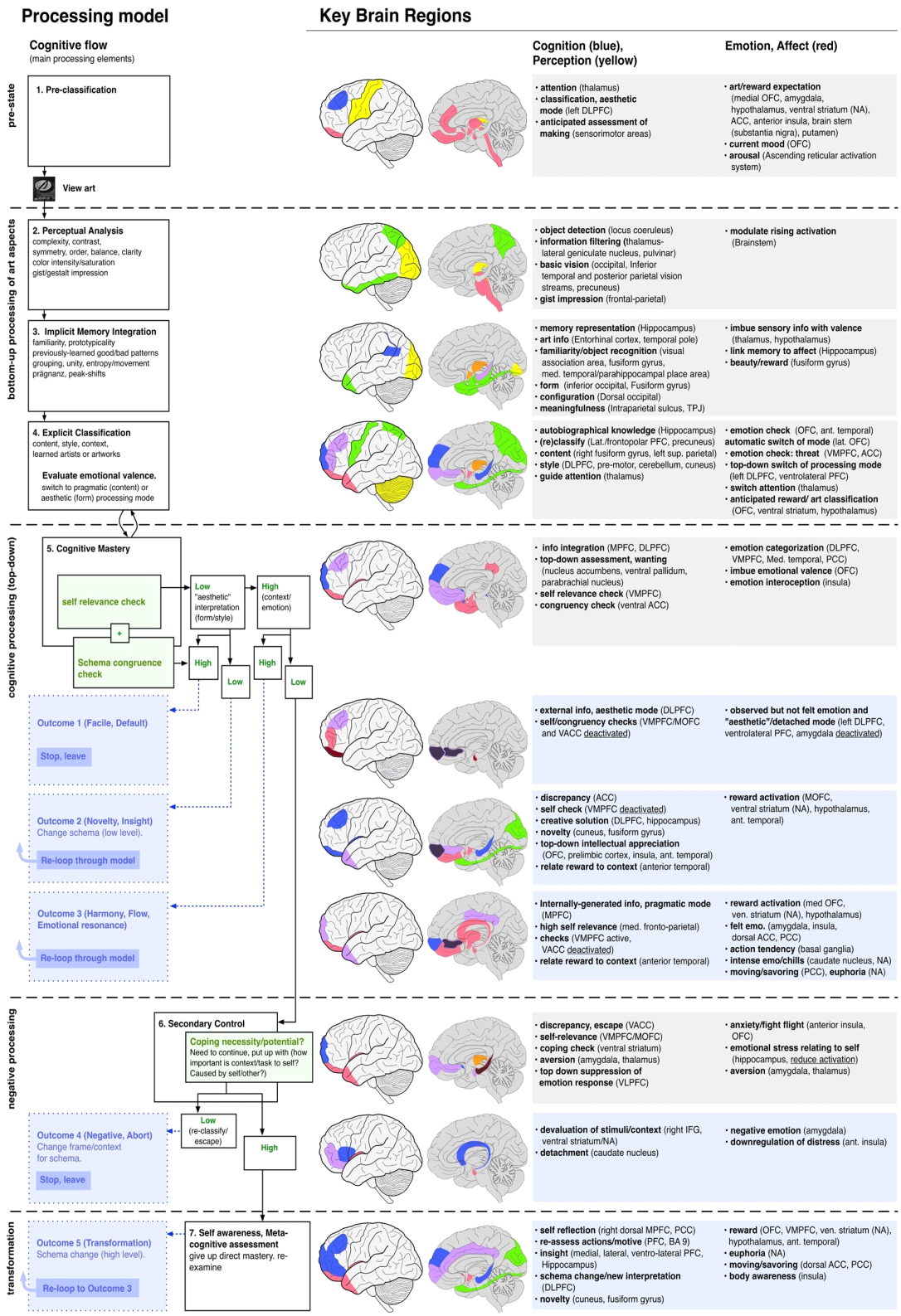


Fig. 3 VIMAP (MatthewPelowski, 2017)

3-3. Aesthetic cognitive process

Perception is not a simple "bottom-up" mechanism the progressive processing of sensory input. Instead, sensation is only made possible by processing sensory information in the context of information spanning multiple cortical levels. In 2004 the British Journal of Psychology published a paper describing a new mode of aesthetic experience in art[9] (fig2). (Leder, Belke, Oeberst, & Augustin, 2004). The model provides a comprehensive framework for empirical research and theoretical development. The model is designed as an information processing box model and summarizes various findings related to the ways in which factors such as perception, knowledge, familiarity, expertise, style and content influence the aesthetic experience of art. Specifically, the model includes five main processing stages, namely perception, implicit memory integration, explicit classification, cognitive mastery and evaluation, and ongoing emotional evaluation. This model, and the VIMAP[10] model (fig. 3) proposed by Matthew Pelowski in 2017 on top of this model, continues to be confirmed in empirical research on neuroaesthetics. Equally exciting is that these two aesthetic models are also being applied to art-related topics such as design. Likewise, the relevant demonstrations and applications of architectural skins and architectural structures, which are the subject of this paper, will be guided by the perceptual processes proposed by these two aesthetic models. (see 4-2)

9) Leder, Helmut, et al., A model of aesthetic appreciation and aesthetic judgments, British journal of psychology, Vol.95, No.4, 2004, pp.489-508.

10) Pelowski, Matthew, et al. "Move me, astonish me… delight my eyes and brain: The Vienna integrated model of top-down and bottom-up processes in art perception (VIMAP) and corresponding affective, evaluative, and neurophysiological correlates." Physics of Life Reviews, Vol.21, 2017, pp.80-125.

4. Visual characteristics analysis of architectural skins and architectural structures

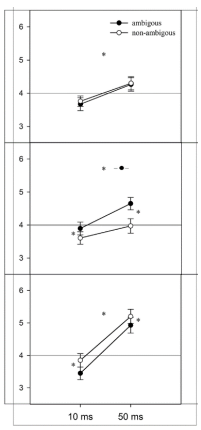
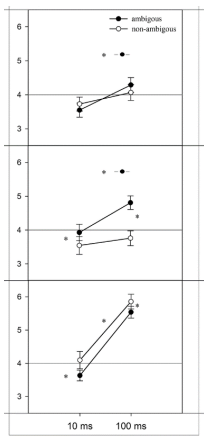
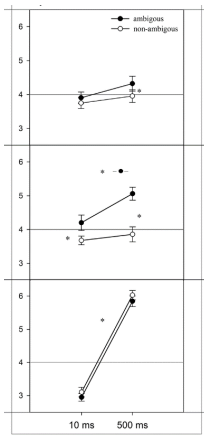
4-1. Evidence for favorability of translucency in cognitive processes

Fluency theory assumes that the smoother the processing, the higher the appreciation (Reber et al., 2004). Empirical studies on this theory mainly include:

1. Repeated stimuli and unreinforced exposures increase preference for the "mere exposure effect"
2. Preference for archetypes (Winkielman, Halberstadt, Fazendeiro, & Catty, 2006)
3. Preference for symmetrical stimuli (Reber, 2002)

However, these classic findings conflict with those that associate novelty or innovation with high rewards and liking (Blijlevens et al., 2012, Carbon and Leder, 2005, Wittmann et al., 2007). Therefore, the aesthetic A-HA theory is proposed. The main claim of this theory is that when we perceive something as challenging and find the potential to cope, we are motivated to explore it. Recognizing hidden objects in visual patterns increases our appreciation for images, reflecting our propensity and joy in uncovering perceptual structures (Muth & Carbon, 2013). This perceptual insight during refinement has a role in challenging perceptual appreciation. According to the aesthetic A-HA theory, the researchers found an explanation for a phenomenon found in Martina Jakesch's 2013 experiment: Blurred pictures were more interesting than non-blurred pictures at shorter and longer durations. Furthermore, the average interest scores for blurry pictures increased significantly from 10ms to 50ms, 10ms to 100ms, and 10ms to 500ms. For non-blurred pictures, no such duration effect was found (Table 2). Aesthetic A-HA theory answers the perceiver's favored source of ambiguity and translucency. This appreciation comes not only from the challenge, but also from the process of interpreting the potential.

Table. 2. A comparative experiment with blurry pictures (Martina Jakesch, 2013)

Experiment Results About Ambiguity				
	Experiments 2a 10 ms vs. 50ms	Experiments 2b 10 ms vs. 100ms	Experiments 2c 10 ms vs. 500ms	ambigous / Non-ambigous
Data				Liking / Interest / Felt fluency
Analysis	The aim of the current series of experiments was to investigate the relationship between ambiguity/fluency and aesthetic judgments. In order to compare the two fluency manipulations, ambiguous (original) and (manipulated) non-ambiguous Magritte paintings were presented 10ms and 50ms (Experiment 2a), 10ms and 100ms (Experiment 2b) and 10ms and 500ms (Experiment 2c). Experiment 3 (100ms versus 1000ms) was run to compare longer durations. In all experiments, liking, interest and subjective fluency were measured as dependent variables.			

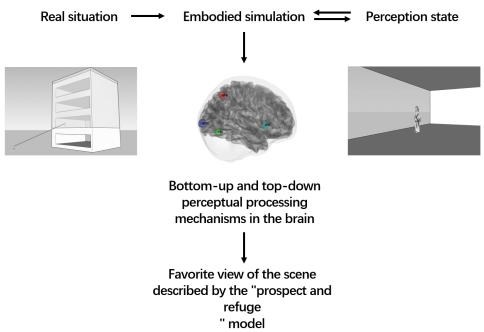


Fig. 4. Effects of Embodied Simulation on Perception

4-2. Aesthetic preference proposed by Embodied simulation and prospect-refuge theory

In the definition of Embodied simulation, Embodied simulation is not only triggered when observing their behavior, but also on the elements of the environment we are in, projecting from Embodied simulation theory to architectural theory. For the subject of this chapter, Embodied simulation is triggered at least to some extent during architectural appreciation.(fig. 4) This claim is demonstrated in Oshin Vartanian's 2015 experimental argument on openness. On this basis, the discussion of the prospect-refuge model becomes a necessary step.

According to the prospect-refuge model developed by Habitat Theory, a habitat with the properties of the prospect-refuge model is an ideal habitat during the Embodied simulation of buildings. By projecting the ideas of symbolism into Appleton's prospect-refuge theory. The literature mentions that any feature that directly or indirectly promotes the opportunity to expand horizons includes prospect[11]. At the same time, any element that suggests hiding or shelter is considered a sanctuary[12]. In the discussion of translucent buildings and architectural structures,

11) Cushing, Debra Flanders, and Evonne Miller, 『Creating great places: evidence-based urban design for health and wellbeing』, Routledge, 2019.

12) Fisher, Bonnie S., and Jack L. Nasar, Fear of crime in relation to three exterior site features: Prospect, refuge, and escape, Environment and Behavior, Vol.24, No.1, 1992, pp.35-65.

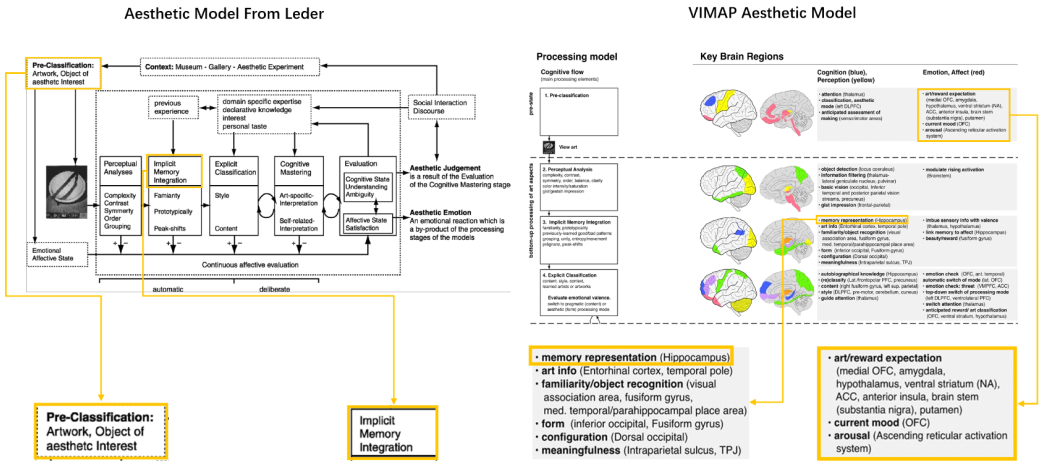
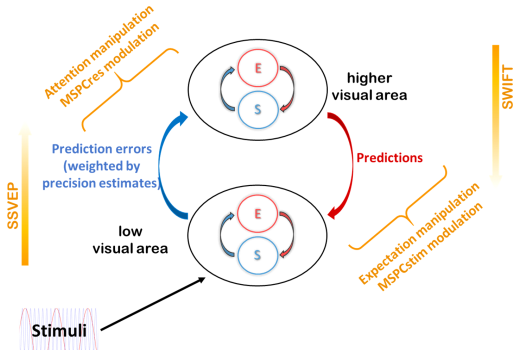


Fig. 5. Aesthetic Model Comparison

translucent architectural skins can undoubtedly facilitate the opportunity to expand the view during Embodied simulation, while architectural structures can take on elements that suggest hiding or shelter. In the process of architectural design, not only the visual unity of translucent architectural skins and architectural structures should be considered, but also the symbolic meaning of prospect-refuge should be considered by designers.

4-3. Visual characteristics requirements of human beings for architectural skins and architectural structures under the comparative analysis of aesthetic models

The aesthetic model not only guides the direction of research on aesthetics, but is also a summary description of empirical research on cognitive neuroaesthetics. In 2004, Leder's aesthetic model and Matthew Pelowski's VIMAP presented almost indistinguishable unity in the processing in the early stage of perception, although there are some differences in the processing in the later stages of aesthetics. (In fact, the VIMAP model is perfected on the basis of the Leder model). In the early stage of perception, in the VIMAP model, the improvement of the two stages of perceptual



F i g. 6 Expectation, attention, MSPC, and predictive coding (Noam Gordon, 2019)

analyses and implicit memory integration in the Leder model mainly focuses on the impact of semantics in expectations and implicit memory on perception. (f i g. 5) In fact, the impact on this part is well documented in empirical research. These include the effect of priming semantic concepts on aesthetic appreciation (based on RET theory)[13], expectations and attention that increase the integration of top-down and bottom-up signals through different pathways in perception[14] (f i g. 6).

13) Gordon, Noam, et al., Expectation and attention increase the integration of top-down and bottom-up signals in perception through different pathways, PLoS biology, Vol.17, No.4, 2019, p. e3000233

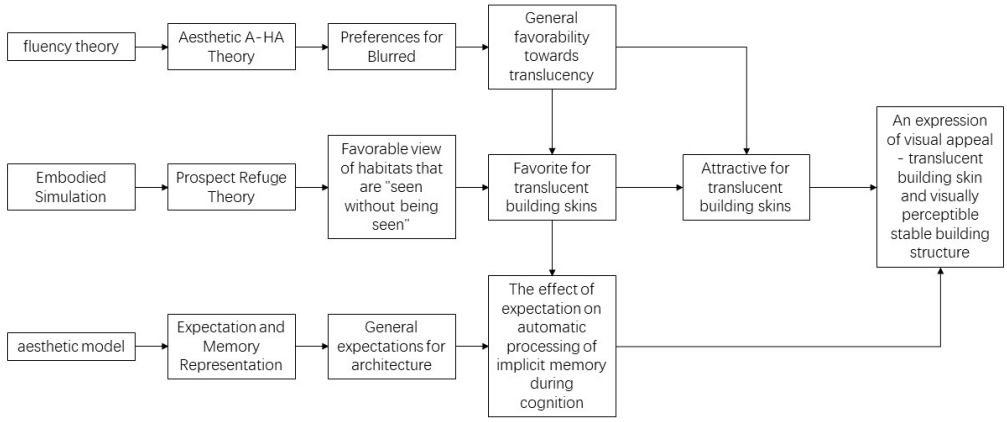


Fig. 7 Research Process

(Based on electroencephalography (EEG) technique).

According to this chapter, expectations are involved and have an impact during the perceptual analyses phase of aesthetic perception, and implicit memory is involved during the implicit memory integration phase. Memory representation is one of the important factors in the involvement of implicit memory described in the model. The nature of memory representations used to control attention is one of the oldest topics in cognitive science (James, 1890; Pillsbury, 1908). The ability to notice multiple objects in the field of view is limited. When introspected, however, people feel like they see the entire visual world at once. Some scholars believe that this sense of introspection is based on short-lived sensory memory representations[15]. This sensory memory representation is under the unconscious drive of implicit memory. In response to the theme of this paper, we introduce the concepts of expectation, implicit memory, and memory representation (fig. 7) in the aesthetic process of architecture. Regarding expectations for the building, we used three core aspects of architectural design proposed by the Roman architect Vitruvius (fig. 8) His pioneering Vitruvian triad has been admired by a large number of architects and philosophers, and the attention to this theory across time and cultures reflects common expectations for architecture. This expectation of architecture exists in the implicit memory of most perceivers, which affects our retrieval of memory representations.

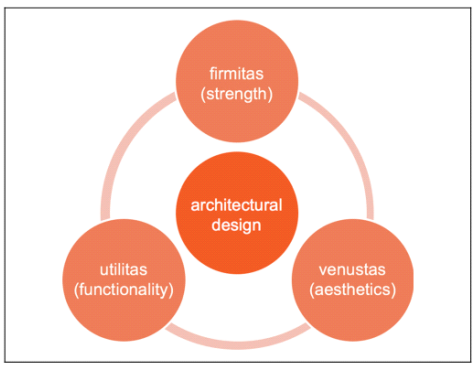


Fig. 8 Vitruvian triad (Alex Coburn, 2017)

14) Faerber, Stella J et al., Priming semantic concepts affects the dynamics of aesthetic appreciation, Acta Psychologica, Vol.135, No.2, 2010, pp.191-200.

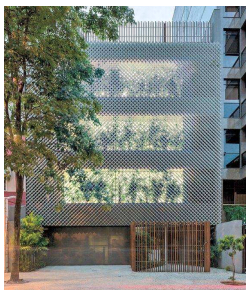
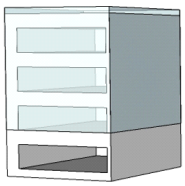
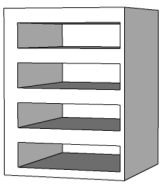
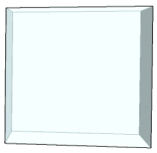
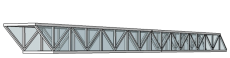
15) Vandenbroucke, Annelinde RE, et al., Accurate metacognition for visual sensory memory representations, Psychological science, Vol.25, No.4, 2014, pp.861-873.

Therefore, in the visual environment, architecture should conform to general expectations and definitions of architecture in implicit memory. According to the Vitruvian triad theory, the definitions in expectations and implicit memory should conform to three aspects: solid and structurally stable, satisfying functional needs, and aesthetically pleasing. In expectations, people have individual differences in functional requirements, and the function of a building is defined by requirements. In this context, this paper turns the perspective to two other aspects: one is solid and stable structure, and the other is aesthetic sense.

For the other two aspects, namely solidity and structural stability and aesthetic sense, how should architectural skins and architectural structures be designed?

In 4.1, the universality of human's goodwill towards transparency is discussed, and this source of goodwill should be applied to architectural design. Still, is a completely transparent building aesthetic? In this article the author does not think so. As discussed in 4.2, according to the Embodied simulation and the prospect-refuge model, the building should have the property "could be seen but not seen", which can be produced by translucent building skins. However, in the discussion in 4.3, the memory representation that the perceiver meets the expectations should be both robust and structurally stable and aesthetically pleasing. As advocated in Alberti's "Dualism", the building structure should undertake the task of being visually strong and structurally stable. Therefore, under the premise of transparent building skins, the building structure needs to have enough visual stability.

Table. 3. A Visually Appealing Architectural Expression

A Visually Appealing Architectural Expression			
architecture	model	architectural skin	building structures
 Bernardes Arquitetura Area (2015)			
 Fernandes Arquitetos Associados (2012)			

5. Conclusion

In this study, the human preference for transparency was first studied according to the

fluency theory and the aesthetic A-HA theory. A condition for the generation of good feelings is based on experimental data on ambiguity - semi-transparent building skin (see 4-1). Under the premise of semi-transparent building skin, the ideal architectural characteristics are discussed in this study according to the "Prospect and Refuge" model based on dwelling theory. The visual role of translucent architectural skin and building structure of the "Prospect and refuge" model are determined from the perspective of symbolism (see 4-2). The influence of expectation on the memory expression of perceptual processing is found through the comparative analysis of the aesthetic model (see 4-3). According to the expected universal value of Vitrine's architecture, the visual character of the architectural structure is proposed with translucent skin by the interplay of the representation of expectation and memory.

Based on this, this study makes the following recommendations:

1. Buildings with translucent skin are attractive

2. The translucent building skin should indicate that it is supported by a solid structure.

3. Considering the semi-transparency of the skin, it can give a stronger good feeling if it satisfies the "Prospect and Refuge" model proposed by evolutionary aesthetics.

4.Translucent skin and solid structure can meet human's universal expectation for architecture during the cognitive process, which has a positive effect on memory representation. The good feelings generated in this automatic cognitive processing process based on unconscious implicit memories can have a positive impact on cognitive outcomes.

Therefore, an expression with visual appeal - translucent architectural skin and visually perceived stable building structures are proposed in this study. (Table. 3)

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