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Research Article

The Effect of Parametric Design on the Reconstruction of Cultures within the Context of Jakobson's Communication Model

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Abstract:

The aim of this study is to examine the effect of parametric design on cultural architectural works within the framework of Roman Jakobson's model of communication. The study will focus on how the use of parametric design is handled as a source of form in contemporary architecture, how it affects the way cultural buildings are perceived and how they communicate their cultural significance. In addition, the other aim of the research is to examine how social culture and architecture, which are both means of communication, can be re-established in a contemporary way through parametric design. Within the framework of Jakobson's communication model, the relationship between the five functions of communication and architecture will be analysed, and then the relation between this relationship and parametric design will be established. In this context, the cultural impact of parametric design will also be examined around four of the five basic functions of Jakobson's communication model, and how parametric design contributes to the process of cultural communication and message creation will be discussed.

The research methodology includes a literature review on parametric design, cultural constructs and Jakobson's communication model. In addition, a case study approach will be used to examine the impact of parametric design on the cultural architectures of societies. In this context, "Sunac Guangzhou Theatre" from China, which reconsiders its ancient culture shaped by geography with western culture through contemporary architecture, will be taken as a sample building. The use of parametric design tools will be analysed in the creation of the design concept and cultural quality of the building.

In the conclusion and evaluation section, the evaluation of the cultural impact of parametric design through Jakobson's communication model will be evaluated through a table, and the positive contributions of parametric design to the cultural visions of societies in contemporary form will be summarized.

1. Introduction

The use of computational design in architecture has become intertwined with the design and production process, merging digital information and production knowledge in the last decade of the 20th century. Parametric design, one of the methods of computational design, stands out among other digital design methods, particularly among architects who reject the notion of architecture solely based on function and aim to rebuild the relationship between architecture and meaning through forms. In parametric design, data related to the building, such as environmental and cultural factors, can be used as a source of form. Along with digital architecture, designers have gained the ability to create complex and curved forms such as topological forms and isomorphic surfaces more easily through parametric design, as well as the ability to associate them with other forms and change them independently of the design process. Today, the possibilities of form offered by parametric design, which are beyond the usual, make up a significant part of the architectural designs of developing countries, particularly China, the United Arab Emirates, and other countries that sustain their economic development with their cultural change. Parametric design is utilized in the designs of buildings that represent the cultures of these countries. In this study, the opportunities provided by parametric design in rethinking culture and representing it through architecture, the relationships between form-culture and form-

meaning, and how cultural and environmental information is utilized in parametric design will be examined in the context of Jakobson's communication theory. The architectural form-culture relationships, geometry-meaning relationships, and how cultural and environmental information is utilized in parametric design will be investigated through the analysis of a contemporary cultural structure designed using parametric design methods. The study will focus on the Sunac Guangzhou Grand Theatre in China, which tries to reconnect with its ancient culture that has been separated due to political reasons, but now is rebuilding its cultural connections with the influence of economic power. The study will use a descriptive survey model and will discuss qualitative research methods based on the analysis of Jakobson's communication model functions in the meaning analysis of the structure. In the discussion and conclusion section, the cultural and architectural effects of addressing the relationships between meaning-form and culture-form through the opportunities provided by parametric design in the design of cultural structures will be discussed.

2. Material and Methods

2.1 Architecture As A Sign And Communication Tool

Architectural design involves recording processes that are encrypted in different forms such as plans and sections. The architect uses diagrams, iconic visual indicators, signs, symbols, codes, qualitative and quantitative indicators in these recording processes. The codes of architectural components are typological. These codes are directly related to the function and geometry of the architectural component and represent the most prominent but only a part of architectural coding. In the design phase, both the function and geometry of the architectural component are articulated by the architect. In order to decipher the codes, it is necessary to find and recognize the codes that the architectural component harbors in order to be able to understand and evaluate the meaning of the architectural component. In order to decipher cultural and historical codes of an architectural component, one must know the social and cultural codes of the society to which it belongs, just as in deciphering a text.

According to Eco; conveying the function carried by a formal property of an architectural component is a cultural datum [1]. These formal properties explain how a door, a staircase, or a column is a sign. For example, after an individual acquires an image of a dwelling space (house, cave, hollow, etc.), they can convey the structure of the shelter to others using visual indicators. Thus, architectural coding creates a visual code and becomes the subject of communicative relationships [1]. When it comes to the relationship between culture and architecture, another deciphering process may be required, along with Eco's method, in order to decode cultural images. Because the cultures of societies are complex and deep, the same goes for the symbolic representation in architecture. Therefore, as proposed by Jakobson, it may be necessary to reveal the interrelated multi-layered functions to decipher a communicative phenomenon.

Linguistics researcher Roman Jakobson proposed a coding and decoding model by examining each component of the communication process in his book "Closing statement: Linguistics and Poetics" written in 1960. According to this model, the correct use of each component allows for proper understanding and effective communication. Jakobson's communication theory is based on the coding and decoding process. The coding process is the process in which the message sender conveys their meaning, while the decoding process is the process in which the message receiver extracts meaning. These two processes take place on five components referred to as source, message, channel, receiver, and code.

Drawing from the claim that the architectural design process shows similarities to the communication process, it can be concluded that designers design their designs to convey a specific message and that this message is conveyed from the source (designer), code (language), message (design), channel (architectural language), to the receiver (user). Feedback is the use and interpretation of the architectural work.

According to Leach, Jakobson's communication model can provide an important framework for the use and interpretation of language in architecture by emphasizing the symbolic nature of architecture and the differences between different architectural languages [2]. In this context, Jakobson's communication diagram is an approach to defining and understanding the functions of language and communication. This diagram can also be used in fields such as architecture and design, and can be used to analyze and evaluate designs according to communication objectives.

Essentially, considering the direction of communication for an object is also defining its primary function, i.e., an architectural object can be perceived as a communication that refers only to function (message) and physical structure (channel). In other words, this interaction can be defined as an example within the primary function of the object in communication. Jakobson divides the functions of language into five different categories: referential,

expressive, aesthetic, phatic, and metalingual [3]. These categories represent the different aspects and purposes of language. If these functions are examined from an architectural perspective, they can be applied as follows:

Function of Expression: The linguistic expression of a building's architectural use, material choices, and layout plan, which aims to define the architectural use of expression, the design and appearance of the building, the use of interior spaces, and how people feel in the building. It carries the lines of a particular style.

Aesthetic Function: It includes the use of aesthetic elements such as color, texture, geometry, form, and rhythm, which are also related to the cultures of societies in architecture.

Semiotic Function: Directly related to culture, the purpose of a building, its social and cultural meanings, symbolic values, or aesthetic goals are expressed through the appearance, form, material, color, and so on of the building.

Metalinguistic Function: Derived from history, an architectural object that was used in a cultural context in the past can be used with a new understanding. This can be defined as a reference to the source of the code. When architecture is designed to achieve a specific purpose or create a specific effect, the metalinguistic function becomes important. For example, a building's design can influence people's thoughts and behavior. It can determine the size, design, interior spaces, and how the building's appearance should be perceived and how people should feel in the building.

Injunction Function: Architectural objects and environmental objects can limit people's behavior. Especially complementary objects such as stairs and railings can serve a warning and control function on functions.

The work of Christian Norberg Schultz's language system-architecture research and Preziosi's perception and space relation research continued with Eco's efforts to interpret architecture in the 1970s. In his book "Logic der Baukunst," Schultz examined architecture through the fundamental philosophy of language, associating the components of architecture with the facts of syntax and semantics. However, such attempts have been limited to the reuse of clichés and have not been able to create a more complex syntax.

After the unsuccessful attempts of the 1970s and 1980s, it became apparent that architectural semiotics could not be reduced to either syntax or semantics. During this period, theorists and architects such as Peter Eisenman and Charles Jenks, who were at the forefront of using computer algorithms-logic and architecture triangle, worked on the use and interpretation of semiotic systems in architecture. The inclusion of computers in the design process in the "digital era of architecture" has enabled the creation of more complex and curved forms, and the concept of "form" has started to emerge in architecture, breaking away from the purely functionalist understanding.

2.2 Parametric Design as a Cultural Recreation Tool

Greg Lynn's book "The Folding in Architecture" published in 1993 has been a turning point for digital design beyond a digital design understanding that only includes CAD tools. Based on Leibniz's mathematics, Lynn argues that there is nothing in the universe, including architecture, that cannot be digitized. However, Lynn is not interested in "Modular" digitization or the deconstructivist focus on the breaking of form with predetermined and selected forms for the world or architecture. Instead, "the fold is chasing heterogeneity and differentiation. The fold allows unrelated elements to constantly blend together [4].

Lynn's philosophy focuses on topological forms that can be forgotten due to the difficulty of their production in the past and can be reshaped at any moment. The Baroque connotation added to Deleuze's metaphor of "fold" has directed architectural practice towards a paradigm where structures are transformed into a complex with multiple layers that symbolizes a higher level of reality, containing different meanings and moving away from both the post-modernist understanding of the 80s and the complex deconstructionist discourse of the 90s. While Baudrillard describes this paradigm as "cultural hyperreality", Greg Lynn has pointed out that "digital architecture is more concerned with the production of virtual representations than any other discipline [5].

In the early days of digital architecture, the most important problem designers faced was the difficulty of controlling the unlimited geometric structure inherent in topological forms. While this "limitlessness" develops the creativity of the designer in the production of conceptual forms, it has caused difficulties in the practical implementation of design in a discipline such as architecture where there are limitations. The most important of these difficulties have been the association of topological forms that coincide with the needs of architectural design with different geometries. In response to these problems, designers have developed the parametric design method based on parametric algorithms, which are easy to use and enable the production of unlimited geometries, and see architectural knowledge as a source of form. Parametric design is a digital design understanding

based on the relationships between models. Based on the tool to generate a geometry in variable forms, it relies on constraints. As a tool for controlling geometric relationships, parametric design enables the creation and modification of elements that constitute a design by differentiating them. The basis of parametric design tools is numerical algorithms. Thus, it increases the control of the designer on the design geometry and allows the evaluation of certain conditions by the designer. The geometry of the design is determined, designed, associated with different geometries and modified through interfaces called "schemas" with the help of code that can perform algorithmic calculations. These schemas perform an interface function where any geometric form can be created, manipulated, and associated with other geometries (Figure 1). "Thinking of parametric design logic as a new form of digital design, thinking promises to continue to influence future developments in theories and technologies of design media [6].

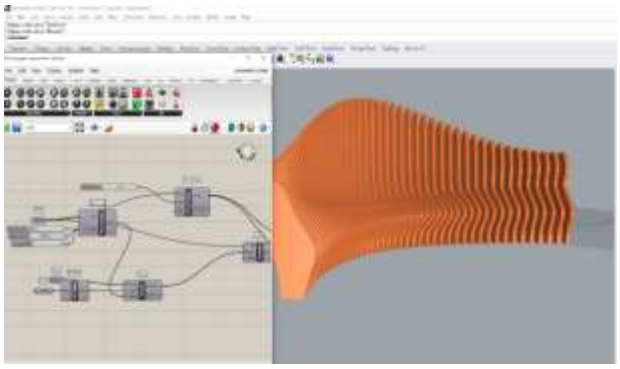

***Figure 1**. Parametric design geometries are created In the scheme, the forms can be related to each other, simultaneously can be manipulated.*

Certain computer software is often used as parametric design tools. The most important of these are Rhino-Grasshopper and Revit-Dynamo. In addition to these, programs specific to the needs and characteristics of the project can be written codes. The common features of all these programs are that they allow design criteria such as light, topography and wind to be handled as codable geometric forms. Desired forms can be created in schemes with the help of codes according to certain desired characters.

Parametric Design Has Adaptatiton Ability

Parametric design brings flexibility and also creates the concept of "adaptation" in design. In a parametric design scheme, one or more basic form particles that will constitute the design are taken into account. These form particles replicate and differentiate according to the algorithm written, ultimately creating the main form. As a result, the designs created can adapt to another design or become a part of it by modifying their data. In parametric design, the concept of "adaptation" can regulate not only the design geometry but also the relationships of the structure with its environment. For instance, creating a local pattern that represents a culture parametrically can provide "cultural adaptation" to the structure, and shaping its facade according to sunlight, wind, and topography can provide "environmental adaptation." Environmental adaptation can enhance the sustainability of the structure. For example, using the angles of the sun's rays and other information as the source of the form can solve the issue of openness in buildings and increase the utilization of natural light.

The identity of parametric design is formed by the designer's approach to geometries and the ability to relate them to each other. In the scheme, non-Euclidean, topological forms can be associated with each other, replicated through iteration and differentiated to create the main form (continuous differentiation and differentiation). Along with these operations, various rotating and advancing variations of the same form can be derived. (Figure 2). All of these elements form the formal character of parametric design and ensure its formal harmony.

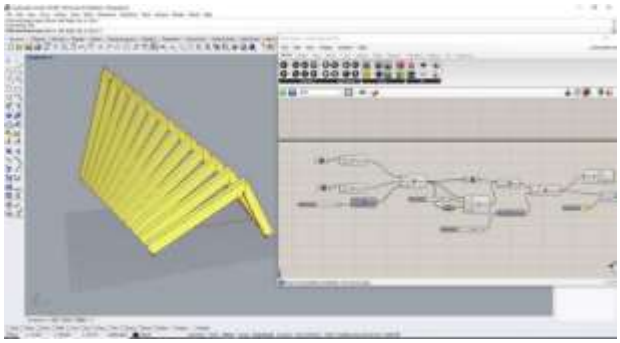

***Figure.2:** Same as Continious Differentiation and iteration methods reproduction and reproduction of the form with different variables. Reference:Author's Design.*

Parametric Design Uses Data(s) As the Source of Form

In architecture, one of the most important components of design is having tectonic knowledge, which includes the mathematical and three-dimensional morphology of a structure. "Parametric design implies the ability (knowledge as well as digital skills) to mediate tectonic knowledge [7]. The source, representation, metaphorical or any geometric structure can be a source of knowledge, which can be processed into a parametric schema and form. In a performative and form-generating parametric schema, shapes that are compatible with forces that affect the structure such as the angle of the sun, wind direction, and topography can be

created. These forces can shape the design and material and production systems can be coded to be compatible with the design (Figure 3).

In his article Patrik Schumacher defines parametric design as "a design paradigm beyond a formal style that can utilize purely environmental effects to create all tectonic textures from environmentally adaptive façade geometries to light-controlled apertures" [8]. A specific cultural pattern, form, or geometry that represents a culture can be taken as the source of the form, modified, transformed, and presented with a new understanding.

With the increasing density of communication in the post-Fordist knowledge society, social communications have become more complex and intensified. The post-Fordist knowledge society demands that individuals communicate as much as possible with the outside world. This communication system, consisting of various social relationships, becomes stages of the social knowledge system where the morphology of spaces is redefined. Social communication and social memory change and develop simultaneously. The concentration and complexity of social communication along with knowledge lead to the densification and complexity of social memory.

Parametric design is based on "data" exchange. Each data representing social memory can be approached in the form of algorithms. The form-generating qualities (rules) of parametric software such as differentiation and adaptation have now begun to separate and relate urban and architectural subsystems to represent each other. Over time, the urban memory that has been layered uncontrollably due to increased information density can be reconsidered and transformed into refined design geometry. A specific cultural pattern, form, or geometry that represents a culture can be taken as the source of the form, modified, transformed, and presented with a new understanding. Likewise, through parametric design, the representational geometry that forms the structure of a museum as a space of memory can be metaphorically recreated, and the relationship between culture and structure can be established in this way.

Relation Between Culture and Architecture can be established through the use of information as a source of form through parametric design. This can strengthen the cultural qualities of a structure. The "Abu Dhabi Louvre Museum" located in Abu Dhabi can be considered as an important example in this regard. The roof of the structure has been reconsidered in a contemporary form through parametric design, utilizing the traditional component of Arab architecture, the "Mashrabiya" (Figure 3).

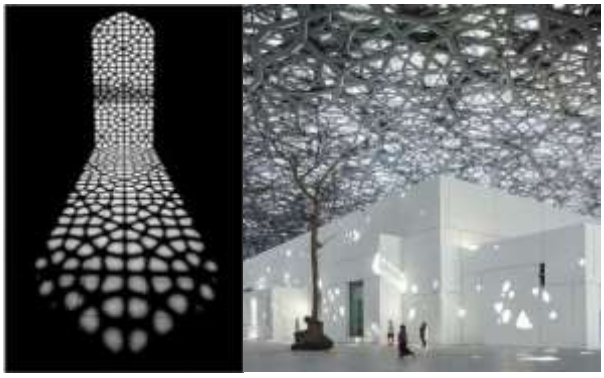

Figure 3*: The roof of the Louvre in Abu dhabi parametric mashrabiya It is designed by reconsidering it through algorithms.*

In this section, the current cultural architecture of a society trying to recreate its cultural structure in a contemporary way will be examined in the context of the possibilities provided by parametric design. The consequences of using cultural memory and environmental data as a source of form in cultural structures will be discussed. In the framework of the examination, the "Guangzhou Sunac Grand Theater" from China, which reinterprets its ancient culture in a contemporary way with economic power, will be taken as an example.

In the analysis, the museum, designed with a parametric design approach, will be examined as a cultural communication object, and its architectural components and represented cultural phenomena will be analyzed. The methods of analyzing the functions that make up Roman Jakobson's communication model will be used as the analysis method. In this context, the plan scheme, main geometry, relationship with the surroundings and topography, material, and structural structure of the building will be discussed with the methods stated, and the possibilities provided by parametric design in establishing form-culture and form-meaning relationships will be examined.

3. Case study: Sunac Guangzhou Grand Theatre

In 1949, with Mao's Cultural Revolution, China weakened its ties with its past, restricted its relations with the West, and began to rebuild its culture with the revival of its economy and renewed relations with the West in the early 21st century. In this context, Western-style museums, art galleries, theaters, and opera houses began to be built, especially in Beijing and Guangzhou, which were redesigned as the country's gateway to the West, and these structures were mostly designed by Western architects such as Zaha Hadid, Patrik Schumacher, and Perkins+Will. China attached great importance to theater structures, which have an important place

in its culture, and more than 400 theaters have been built in just the last decade of the 21st century [9]. In the design of theaters, not only elements of Western culture, but also elements from traditional Chinese theater designs and symbols representing Chinese culture were used, and parametric design was mainly preferred due to its use of local culture and associated topographic elements as form sources, as well as its iconic form and size understanding. Sunac Guangzhou Grand Theater can be considered as one of the most important examples of these theater structures both culturally and symbolically (Figure 4).

Figure 4. *Sunac Guangzhou Grand Theater. Reference: Steven Chilton Architects.*

In this study, the Sunac Guangzhou Grand Theater, which takes on cultural symbols and architectural elements of traditional Chinese theater through parametric design, will be investigated as an example. The cultural symbols that form the source of the theater's design will be analyzed in the context of Jakobson's communication model, and the contribution of parametric design to societies that recreate their cultures through architecture and the ability of parametric design to transmit local culture will be examined. One of the most important features of Guangzhou, where the theater is located, is that it is the center of silk production and the starting point of the Silk Road. Moreover, the city, which is also the birthplace of the myth of the "phoenix" bird, which has an important place in Chinese culture, was also one of the important centers of traditional Chinese theater culture in the past, which was restricted during the Mao era. Silk fabric and phoenix bird images were used as form sources in the design of the exterior shell of the structure. The fluidity of silk fabric was digitized through parametric design algorithms, combined with the shape resembling the wings of the phoenix bird, and refined again through parametric algorithms to reach the final geometry (Figure 5). The use of the image of the phoenix, which can be reborn from its own ashes in mythology, alongside the image of silk

Figure 5. *Sunac Guangzhou Grand Theather's form source is a silk fabric and phoenix created with parametric design tools. Reference: Dezeen.com*

fabric, symbolizes the traditional Chinese theater, which was once restricted but has been revived in a contemporary form. According to Ahuja, each fold in the outer shell is designed to symbolize the Guangzhou valley, where silk is processed [10].
The folded shell hangs down at one end of the structure and is finished with another folded entrance. This curved entrance is also a reference to the iconic curved curtains of traditional Chinese theater that were once banned, and it is intended to highlight the main entrance of the theater (Figure 6).

Figure 6. *The entrance of the building is decorated with the curtains of traditional Chinese theatre symbolises. Reference: Steven Chilton Architects.*

The outer shell of the building, which provides its curved geometry, is made of perforated aluminum to support its flexibility and curved form, and it is painted in red, representing Chinese culture and art (Figure 7). Artist Honfei has drawn phoenix (Fenghuang) patterns on the surface. According to Ahuja, Fenghuang represents virtue and grace, and strengthens the purpose of the building [10]. The building's floor plan is designed with the theater hall at the center, surrounded by other spaces around it. The circular traditional Chinese theater scheme is used in the design of the hall, while other spaces are designed in accordance with the geometry of the building through parametric algorithms (Figure 8). If Sunac Guangzhou Grand Theater's cultural communication features are considered through Jakobson's communication model:

Figure 7. Facade, *is made of perforated aluminum to support its flexibility and curved form, and it is painted in red, representing Chinese culture and art. Reference: Steven Chilton Architects.*

Figure 8. *Circular plan diagram of the building designed by parametric algorithms. Reference: Steven Chilton Architects.*

Metalingual Function: Updating and reusing an architectural form used in the past, recreating traditional Chinese theater through parametric algorithms.

Expressive Function: Designed through parametric design. The floor plan is circular and two-story like traditional Chinese theaters. The structure is made of steel and concrete, with a red anodized aluminum shell decorated with Phoenix bird figures.

Semiotic Function: The sources of the curved geometry of the façade include silk fabric, an important symbol in Chinese culture, the wings of the Phoenix bird, the elevations of Guangzhou Valley, and the shape of the unified shell becoming the form of the theater curtain opening at the entrance.

Aesthetic Function: The soft, hyperbolic, and curved shell geometry created through parametric algorithms, the use of red color in both interior and exterior spaces.

4. Conclusions

In this study, the impact of parametric design on cultural structures in contemporary architecture has been examined in the context of Jacobson's communication model. Architects and thinkers who opposed the post-modernist approach to design, which was based solely on function, searched for ways to give meaning back to architecture and approached architecture as a sign and communication tool. The ability of parametric design to use cultural symbols as a source of form has made it a frequently used tool in the cultural structures of societies that recreate their culture through architecture, especially in the contemporary era. When the iconic form approach is added to the qualities of parametric design, it has become one of the leading architectural styles of countries that want to present their cultural development along with their economic power, such as China and the UAE. Based on the assertion that architecture is a communication tool, the qualities of parametric design were analyzed through the example of Sunac Guangzhou Grand Theater. Four of the five functions proposed by Jacobson's communication model were used, and the results were presented in a table (Table 1).

Table 1. *Analysis of the structure according to the Jakobson model of communication*

Metalungial function	Expressive function	Semiotic function	Aesthetic function
Recreation of traditional Chinese theatre through parametric algorithms.	-It was designed by means of parametric design. -The plan scheme is circular and two-storeyed, as in traditional Chinese theatres.	-The form sources of the curved geometry of the façade; silk fabric representing silk, which has an important place in Chinese culture, the wings of the phoenix, the elevations of the Guangzhou valley, -The transformation of the monolithic shell into the opening of the theatre curtain at the entrance.	-Soft, hyperbolic and curved shell geometry generated by parametric algorithms -Use of red colours in interiors and exteriors
Updating of Ancient Culture	Rebirth of a forgotten culture.	Iconicisation of ancient but restricted culture with forgotten geometries.	Presentation of the new face of contemporary China with its past culture.

From a narrative perspective, the structure represents a contemporary expression of bringing together multiple cultural elements that are beginning to fade away or be forgotten, while the curved surfaces

created through parametric algorithms depict China's new architectural and aesthetic understanding. The iconic appearance of the structure reinforces its symbolic aspect and sanctifies ancient cultural images. The redesign of traditional Chinese theater in a contemporary form, which had an important place in China's culture in the past but was restricted during the Mao era, constitutes the superordinate function of the structure. The result of this study shows that parametric design has a significant impact on cultural structures in architecture. Examples like the Sunac Guangzhou Grand Theatre provide important clues on how parametric design can be utilized in the reconstruction of culture. When examined in the context of Jakobson's communication model, the study shows that architectural practices play a significant role in the reconstruction of culture in cultural structures.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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