PROCEDURAL FACADE SCENARIOS AS A TOOL FOR MODERNISM HERITAGE PROTECTION. CASE STUDY OF ZUS HOUSING ESTATE IN LODZ, POLAND

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The paper presents an experimental method based both on procedural modelling and survey research for analysing modernism facade transformations. The method was designed as a tool for supporting decision making in the process of modernism architecture renovation.

Cities in Europe face a question of modernism legacy protection. A key to this discussion are facades of buildings characterising the communal and the modular nature of modernism housing. The second life of these buildings is visible because changes in facades affect the quality of urban landscapes. New colours, materials and patterns appear and the old ones dissolve. The difference between an official good conservation practice and the deeds of the inhabitants shows many conflicts in renovating modernism housing estates.

However, a new digital tool i.e. procedural modelling of architecture allows comparing these two visions with an original building appearance. The method described in the paper was tested in the case study of ZUS housing estate in Lodz, Poland. The data obtained from interviews conducted among stakeholders was collected and used for procedural visualisations of a chosen facade.

1. Introduction

Nowadays, modernism legacy has reached a phase of the renovation needs with two scenarios possible. More precisely, either the renovation will be strict or the modernism legacy will disappear. Modernism housing estates are the best example of urban development ideas from the beginning of the 20th century. The major voice in a discussion about their appearance is the voice of their inhabitants. These inhabitants deciding about the final buildings facades images may lose or save their original appearance depending whether the process is chaotic or it is a coordinated set of actions.

Architecture has three phases of its life (Świt-Jankowska, 2011). In the first two phases – "conceptual" & "physical formation" – architects design and construct buildings, what makes them the main stakeholders. The third phase – "long-term existence" – cedes the decision making from architectural studio onto users or owners of the housing estate. Usually, the third phase could be described as a process of adjusting buildings into requirements of its inhabitants and it may be a distortion of original architects's intentions.

Architecture is "[…] the best reflection of social and economical changes" (Biegański, 1972, p. 12). Buildings and their appearance carry plenty of information. Facades become a record of buildings life, a collection of succeeding users' decisions, an image of people's attitude – towards architecture and its nature. Since the appearance of multifamily house is a result of many factors and many activities their facade analysis may give fruitful results. Furthermore, the facade analysis may be tool for conservation policy verification, if building is listed as monument.

In this context, buildings, which are units of modernism housing estates from the first part of the 20th century, are a particular field for the described research. Enough time have already passed to capture the third phase of their life. Furthermore, housing estates of this period were designed to meet needs of mass societies and therefore standardised assets were used. Today they function in a reality driven

by an omnipresent aspiration of an individual. At the same time, modernism estates have been listed as monuments, because of their important role in cultural landscapes of cities. All these factors force a Europe-wide trial of saving or losing communal and modular nature of initial modernism housing estates.

The research presented in this paper focuses on the third phase of architecture life and it deals with social transformations of modernism housing estates appearance. The process of inheriting modernism legacy was studied on the example of ZUS housing estates – built in the eleven cities in Poland in 1930s – with a special attention on the estate located in Lodz. Being related to the CIAM idea of "Die Wohnung für das Existenzminimum" ("The Minimum Dwelling") those housing estates are well-fitted for such an analysis. A presence of another estates built by ZUS at the same time in the other Polish cities allows taking a comparative research.

80-years-old facade of the apartment block from Lodz housing estate (26 Bednarska Street) was analysed in detail by looking for transformations made by local community. The analysis was widened by surveys conducted among the inhabitants to check their visual preferences related to the chosen facade and its future image. To capture a long-term process of modernism facade transformation a new technology of procedural modelling was used. As the results of a historical query, an architecture analysis and the above mentioned survey research, six procedural scenarios of the chosen facade were prepared. Behaviours and preferences of the local community were implemented into procedural rules for shaping the scenarios.

2. ZUS modernism housing estates in Poland. Their past and presence in the European context

In 1920s and 1930s both young European architects and urban designers were fascinated with the new ideas of shaping modern cities popularised by Le Corbusier and his followers. Those ideas came true thanks to a CIAM activity (Congrès International d'Architecture Moderne) – the most known multinational organisation, whose aim was a promotion of a new, functional urban planning. Their diagnosis of the 19th century Europe was simple: overcrowded cities as the industrialisation age result should have become more green and spacious, providing better living conditions for masses. This conviction caused not only theoretical activities, but also many experimental investments (Syrkus, 1975).

Figures 1. – 4. Modernism housing estates from 1920s and 1930s: 1. Karl Marx-Hof, Vienna, Austria; 2. Weiße Stadt, Berlin, Germany; 3. Osiedle im. Montwiłła-Mireckiego, Lodz, Poland; 4. Kiefhoek, Rotterdam, The Netherlands. Source: Jakub Zasina (2010-2013).

New housing estates – as the laboratories of the expected new better world – were built mainly in the Central Europe (Figures 1. – 4.). Significant examples of this stream could still be found in Germany. Frankfurt am Main became the city of the widest public housing policy of Europe due to the efforts of Ernst May and his team. A place of such activities was also Berlin, which faced a great demand for affordable housing. A well-known example of public housing projects of this time is Vienna governed by a social democracy. Furthermore, Dutch architects and urban designers also took trials

of constructing modern housing estates in Amsterdam and Rotterdam (Brenne, Haspel and Kühne, 2009, pp. 139-153).

A lack of cheap flats providing good quality of living was one of the most visible problems of young newly independent Republic of Poland in this period. Some of the largest Polish cities (e.g. Lodz) started than their own public housing programmes inspired by western examples. Unfortunately, their budgets were unsatisfactorily large for meeting this challenge. A trial for solving this problem was a founding in 1930 a special nation-wide investment programme for public and affordable housing. Finally, the organisational body for this purpose became an association of regional insurance companies (ZUS). This institution provided founds and a team of designers for one simple task: a delivery of as much affordable flats as possible. Finally, more than 4 000 flats were built in the eleven large cities of the country. The result was lower than expected originally, but the initiative was remembered as the biggest trial in this field in Poland before the World War II. Moreover, all of these housing estates were designed by the same team in ZUS headquarter in Warsaw in use of the identical rules for their location selection and further built in use of similar window or door types and finishing materials. Despite different locations – about 100-150 kilometres between housing estates – each of them had a similar architectural expression achieved by similar visual solutions (Piotrowski, Ponikiewski, Sadowski, 1934).

Nowadays, the consistent architectural expression of ZUS housing estates is no longer clearly visible for observers. Almost in each of the eleven cities the housing estates have been modified by their users. These changes destroyed the original appearance of the buildings, because of the very chaotic use of new painting colours, new shapes of windows or doors and new finishing materials – to point out the most common transformations. Figures 5. – 7. present blocks of flats from the three of ZUS housing estates built in the 1930s after nearly 80 years of their existence. In the beginning of their life the appearance of each housing estate was similar to each other and was easy to notice by observers. Unfortunately, substantial transformations have been made. Users of the ZUS buildings in Lviv, Ukraine (Figure 5.) has a tendency to change balconies into additional rooms of their flats. An example from Gdynia, Poland (Figure 6.) shows the new colour scheme, which bases on blueish and yellowish colours. Finally, the building from Warsaw, Poland (Figure 7.) presents quite good practice, i.e. the pattern of the plaster changed, but the colours remain similar to the original ones. Hence, these examples of modernism housing estates from 1930s after mentioned transformations remind other periods of architectural expression. The survey research – presented further in this paper – provided an information that people mark the building from Gdynia as a typical Polish architecture of 1970s and they mark the building from Warsaw as a contemporary apartment house from the beginning of the 21st century. It shows how much modernism architecture is susceptible for such transformations and how easy its original appearance could be lost resulting in a dramatical change of their perception.

Figures 5. – 7. Current state of ZUS modernism housing estates from 1930s: 5. Lviv, Ukraine; 6. Gdynia, Poland; 7. Warsaw, Poland. Source: Google StreetView (2011-2012).

Occurrences similar to those noticed in the case of ZUS housing estates have been found all over Europe. Probably, the first and the best known example is Cité Fruges in Pessac, France. Designed by Le Corbusier it quickly changed its appearance, when people started living there. Five points of modern architecture (Les cinq points de l'architecture moderne) had been ironically overturned there into solutions known from vernacular and traditional architecture.

However, modernism housing estates from 1930s have received a status of cultural heritage recently. Cities in Europe decide to list them as monuments to preserve their original appearance. A homeland of good examples of such initiatives are Germany. Berlin and Duisburg public authorities responsible for heritage management prepared special brochures for inhabitants with guidelines for any kind of renovation modernism housing estates of this type. All of these information are presented in the very simple form, what makes them easy to understand by people of a different sense of aesthetics and a level of knowledge. Some more good practices in this field provided a private company (Deutsche Wohnen) and a non-govermental organisation (Freunde und Förderer der Hufeisensiedlung Berlin-Britz e.V.) at Hufeisensiedlung (Horseshoe housing estate) also in Berlin, what made it one of the best examples of public-private cooperation in a field of modernism housing heritage protection.

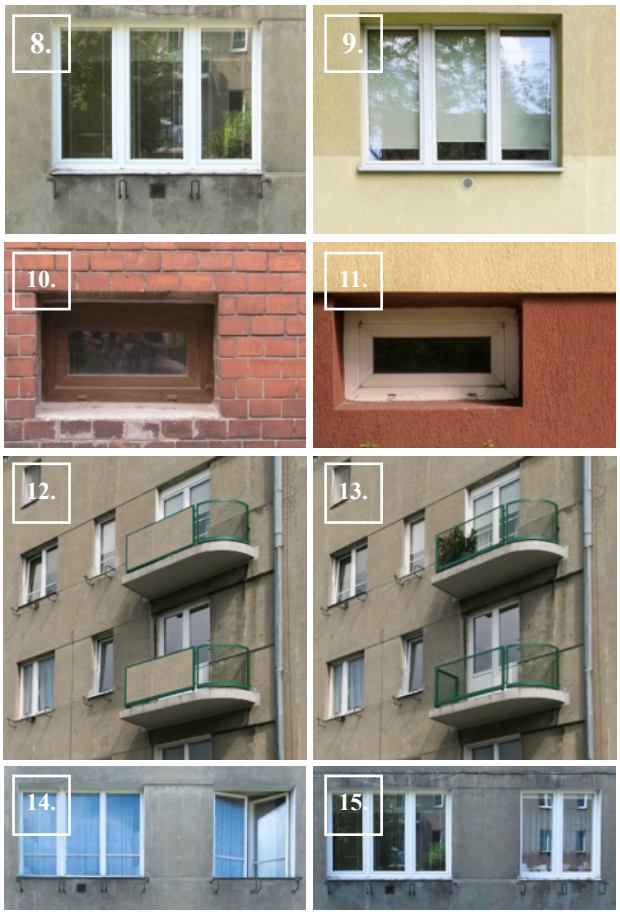
3. Three phases of life of ZUS housing estate in Lodz, Poland

ZUS housing estate in Lodz was designed by the architects gathered in a design studio in ZUS headquarter in Warsaw in use of the guidelines for all of the housing estates in Poland built by the association. A general plan of Lodz estate reflects urban design trends of this time in Western Europe. Furthermore, a proof of this statement are similarities between plans of given housing estate and of the Riedhof residential area from Frankfurt am Main, Germany.

A plot bought by ZUS for this investment was divided into two sections: a western, bigger one for blue- and an eastern, smaller one for white-collar-workers. Only the second section was completed – the first section was built partly because of the lack of funds. A gap between these sections was finally developed as a municipal park. The investment provided 7 buildings with 490 flats. In 1932, when construction works were finished, this housing estate was located in the south suburban district of Lodz. Nowadays, its location is considered as a quite close one to the city centre.

An analysis of the architectural design of the units, which consist ZUS housing estate in Lodz, reveals its key attributes. First of all, the image of the housing estate is not monotonous. Every building (a unit) consists of segments, which types are purposely interspersed. Secondly, an architecture detail relates to the *streamline* trend, what makes it visually dynamical. Finally, housing estate received an architectural icon (a habitable water tower) defining its identity. However, it must be remembered the design guidelines, the assets (especially windows and doors) and the finishing materials were coherent to those used in other cities of ZUS initiative (Olenderek, 2012).

The third phase of life of modernism architecture started with a strict control of its designed appearance. In 1930s local rules limited transformations and a placement of advertisements there. In the second part of the 20th century only few transformations of the facades were made. Unfortunately, an essential part of them took place in 1990s and 2000s, what happened usually without respecting the conservation guidelines. A small number of the original windows and doors have survived till today. The most common modifications are the changes of the material (PCV instead of wood) and an abolishment of the original subdivisions of windows and doors. Moreover, new window blinds and lattices have appeared, mainly on the ground floor. Vertical concrete faces on the balconies have been removed, making the balconies more transparent. Some of the original wall plasters have been hidden under the layer of styrofoam and new plasters. Figures 8. – 15. presents original and secondary design solutions found on the walls of Lodz ZUS housing estate units.



Figures 8. – 15. Examples of original (left) and secondary (right) design solutions from ZUS modernism housing estate in Lodz, Poland: 8. & 9. colour and pattern of plaster; 10. & 11. plinths; 12. & 13. balconies; 14. & 15. windows' subdivides. Source: Jakub Zasina (2013).

The survey research conducted among the local community of Lodz ZUS housing estate revealed that some of the transformations are highly socially desirable. Using the Figures 8. – 15. for a method of visual preferences, the analysis of the described transformations key aspects were socially judged. A case study was a one unit of the housing estate (26 Bednarska Street), whose inhabitants became the survey target population. Representatives of 41 households (53% of unit's capacity) participated in the survey research between June and July 2013.

Most of the families had a strong relationship with this housing estate (due to the high level of the length of residence). Although, the level of their appreciation of the modernism architecture in general was quite low, they used positive qualities, when asked for a description of their place of living. However, the survey research pointed out that majority of the inhabitants prefer new, yellowish painting (Figure 9.) than saving original colour of a plaster (Figure 8.). At the same time they preferred original brick plinths (Figure 10.), instead of hiding them behind a styrofoam layer (Figure 11.). It was the only case, when the original architectural solution received more votes than the new one. It means, people prefer also new windows (Figure 15.), doors and balconies (Figure 13.). The survey results proved the conflict between preferences of the inhabitants and modernism heritage preservation guidelines. In this context it is worth mentioning that inhabitants declared a need of coordination of further investments and renovation works.

4. Nature of procedural modelling and its implication for modernism facade design

A nature of a procedural modelling means, that everything, what user wants to shape is done not by a manual use of a computer mouse, but it is automatically generated in use of previously typed text rules. These procedural rules contains a queue of operations. Using them in defined order shapes a building sequentially. This method of modelling allows user to generate sophisticated and complex digital models much faster in comparison to the use of traditional manual modelling. This advantage could be achieved especially when a model is relatively large, because procedural rules save time of modelling big structures or smaller ones, but often repeated. Nowadays, procedural techniques of modelling are used in the entertainment industry – especially for a cinematography and video games.

One of the most common contemporary consumer software for a procedural modelling is ESRI CityEngine, which was created as a tool for large urban environments modelling. Developed originally by Swiss company Procedural Inc. and further acquired by ESRI this software was used in the case study presented in the paper. The authors of the software prepared a special programming language called CGA: Computer Generated Architecture (Haegler, Müller and van Gool, 2009). What is important to mention, syntax of the procedural rule files written in this language clearly relates to the modular nature of the modernism architecture. Knowing Le Corbusier's formulas of constructing modernistic buildings their similarities with procedural generation of digital objects could be intuitive found: rules shape initially general elements of buildings, what further allows constructing more sophisticated objects. Every design decision is reflected in succeeding lines of a code. Details of buildings and their facades are given sequentially in a rule file. Once written rule could be used as many times as needed, also in different configurations.

A recipe of preparation of the CGA rule files for a building facade is presented in Figure 16. A facade is being divided into floors. A Floor divides into tiles, which become a place to insert assets (e.g. a window or a door). A rule of one tile could be consequently repeated to organise a structure of entire floor. A placement of every asset, as well as floors and tiles proportions, are specified in rules by their author. Therefore, procedural facade is very flexible making it easy to change building height, length and other attributes defined by author, e.g. wall colour (Müller *et al.*, 2007).

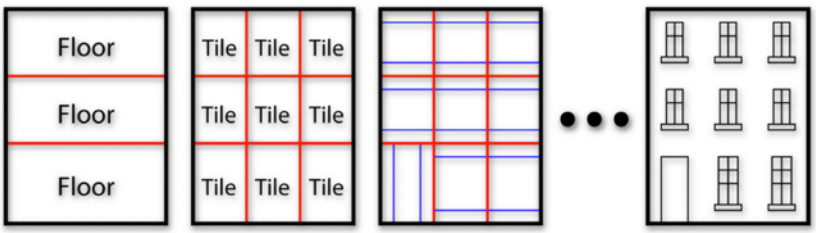


Figure 16. Stages of procedural facade modelling in use of CGA rules. Source: Müller *et al.*, 2007.

5. Conceptual framework of procedural facade scenarios and achieved results

Heritage protection is no longer a discipline reserved for specialists of monuments conservation only. In the contemporary, post-modern world the aim of successful heritage use could be described as a complex cooperation between different stakeholders. It is believed that involvement of people with differentiated backgrounds into this process could provide a durable and a sustainable future of a built heritage and it could help preserving it for next generations (Zasina, 2013).

This approach was recognised as a key reason of preparation of the procedural scenarios of the given facade. A tool of this kind was conceived as an supportive element of investment process (both for heritage preservation officers and for owners of heritage). Due to the nature of procedural modelling these scenarios were believed to be easy available and adjustable allowing users doing visual analyses

of planned actions effects, e.g. renovations. On-demand comparison between facade scenarios was intended as an opportunity for finding common points of view between stakeholders and for helping them better understanding each other. New technology of procedural modelling was almost dedicated for such an action also because of its nature related to the nature of modernism architecture, what was explained above.

17.

18.

19.

Figures 17. – 19. Procedural facade scenarios for 26 Bednarska Street in Lodz, Poland (the unit of ZUS modernism housing estate): 17. "Built", 18. "Present", 19. "Future". Source: Jakub Zasina (2013).

During 80-year-old story Lodz ZUS housing estate facades faced many transformations made by their inhabitants. To catch a process of facade changes a depth analysis was taken done. Every phase of gathering data had another nature, but finally every of them resulted in one procedural scenario of a given facade. A result are six procedural scenarios of the facade. To sum up, original design decisions (coherent to conservation guidelines), behaviours of people and their visual preferences were transposed into procedural rules and further generated as three-dimensional models. In other words, every scenario bases on detailed calculations. It means, that number of asset types (i.e.. windows, doors, balconies, blinds and bowls) visible on the final visualisations strictly relates to their real frequencies (Table 1.). None of the visualisations present a photorealistic image of the facade, but each of them capture the overall percentage of each asset in shaping the facade image.

<table>
<tr><th>assets</th><th>Scenario
"Built"
(1932)</th><th>Scenario
"Present"
(2013)</th><th>Scenario
"Future"</th></tr>
<tr><td>wall colour</td><td>100% original solution
0% secondary solution
original plaster</td><td>100% original solution
0% secondary solution
original soiled plaster</td><td>0% original solution
100% secondary solution
original, newly painted plaster</td></tr>
<tr><td>plinths</td><td>100% original solution
0% secondary solution
original bricks</td><td>100% original solution
0% secondary solution
original soiled bricks</td><td>100% original solution
0% secondary solution
original soiled bricks</td></tr>
<tr><td>single windows subdivisions</td><td rowspan="4">100% original solution
0% secondary solution</td><td>22% original solution
78% secondary solution</td><td rowspan="4">0% original solution
100% secondary solution</td></tr>
<tr><td>double windows subdivisions</td><td>27% original solution
73% secondary solution</td></tr>
<tr><td>triple windows subdivisions</td><td>25% original solution
75% secondary solution</td></tr>
<tr><td>balcony window subdivisions</td><td>18% original solution
82% secondary solution</td></tr>
<tr><td>balconies</td><td>100% original solution
0% secondary solution</td><td>0% original solution
100% secondary solution</td><td>0% original solution
100% secondary solution</td></tr>
<tr><td>bowls</td><td>100% original solution
0% secondary solution</td><td>13% original solution
76% secondary solution</td><td>no data:
a copy of Scenario "Present" (2013)</td></tr>
<tr><td>radio and TV antennas</td><td>100% original solution
0% secondary solution
no antennas</td><td>92% original solution
8% secondary solution</td><td>85% original solution
15% secondary solution</td></tr>
<tr><td>blinds</td><td>100% original solution
0% secondary solution
no blinds</td><td>54% original solution
46% secondary solution</td><td>42% original solution
68% secondary solution</td></tr>
</table>

Table 1. Detailed calculations of procedural facade scenarios for 26 Bednarska Street in Lodz, Poland (the unit of ZUS modernism housing estate). Source: Jakub Zasina (2013).

First of all, original designs of estate units drawn in 1930 (stored in the National Archive in Lodz) were used for preparation of the first scenario called "Designed". Its aim was a presentation of the first

image of the facade given by its architects. Secondly, a use of private archives of photographies and a use of ZUS association publication from 1930s resulted in the second scenario called "Built". This one provided a verification of the first scenario's materialisation in 1932, when housing estate was completed. Some differences between original project and its realisation were found. Moreover, the original appearance of the building is the most coherent to the appearance postulated by municipal heritage preservation office, what makes it the most important one in doing comparative research. Thirdly, existing image of the facade was presented as the scenario called "Present". It was prepared thanks to the architectural survey done in 2013 and it summarises the deeds of the inhabitants. Finally, the scenario for a future was provided and called "Future". This one bases on the survey – explained above – made among the local community representatives and it presents inhabitants of the building expectations for future image of the facade. Thanks to flexibility of procedural modelling two more scenarios were prepared additionally. Both of them present a modified facade from Lodz estate in a likeness of those spotted Lviv and Gdynia (Figures 5. & 6.).

All of the six presented scenarios were developed as 1 digital model in 1 rule file of the ESRI CityEngine software in use of 75 CGA rules, 82 assets and 1 239 code lines. The purpose of possibility on taking on-demand comparative analyses by different stakeholders was achieved by exporting the model into a CityEngine Web Viewer – a tool for discovering CityEngine models in a web browser (Figure 20.). The model described in this paper was published online in use of ArcGIS Online cloud service.

Figure 20. ESRI CityEngine WebViewer's comparison mode of the procedural facade scenarios ("Built" & "Gdynia") for 26 Bednarska Street in Lodz, Poland (the unit of ZUS modernism housing estate). Source: Jakub Zasina (2013).

6. Implication of procedural facade scenarios for modernism heritage protection. Discussion and conclusions

After a century of the first triumph of the modernism approach to architectural design and urban planning its results are being listed as monuments. Pioneering examples of this time, which broke up with an architectural and urban tradition, start to be considered from a historical point of view. A modernity is have been comprehended as an heritage, what makes it very interesting from the semantic analysis also. However, the appreciation of modernism architecture and its values is still relatively rare. There is nothing surprising in this phenomenon: the attributes of modernism architecture are not associated with the heritage image rooted in human perception. After all, such architectural elements, like simplified facades, glazings and flat roofs are still a domain of a contemporary architecture (Prudon, 2012).

The preparation of presented six procedural facade scenarios was a trial of presentation of the investors' behaviour influence on the appearance of modernism architecture. Changes, which have already happened, and changes, which could happen in the future, were captured and compared with the original design of the given facade.

The prepared scenarios could become an educational tool and could simplify explanation of the role of each element of the building facade in saving its original appearance. This use seems to be very important because of the lack of appreciation of facade original appearance in the eyes of the inhabitants, what was diagnosed in the mentioned survey research. The visual preferences of inhabitants identified in the survey suggest that original facade assets will dissolve in the future, by replacing them by secondary solutions. This process is expected to be proceed though units of the ZUS housing estate in Lodz were comprehended as a heritage by their users. Therefore, it seems that proactive educational manner will be required in order to maintain the original appearance of the buildings.

Worth to mention is relatively wide use of the described procedural rules. Their flexibility suggests few more areas of their potential use. After some small modifications they could be used to do a digital *a priori* test of planned renovation works and other investments related to the building's facade. Thus, it would be possible to select the best solutions. Furthermore, the prepared procedural rules could be used for a dialogue between municipal heritage preservation office and the inhabitants of the ZUS housing estate in a search of aesthetical and technical solutions. An online, on-demand visualisation of both stakeholders' attitude could support a process of building of mutual trust and understanding. Recalling the results of the survey, it appears that such action will be the key for the successful heritage management in the future.

Outcomes of the described analysis are a part of the wider discussion on the implementation of new technologies into the field of built heritage by presenting the results possible to achieve by applying the procedural modelling. The idea of a presentation of the facade as a result of human behaviour and their visual preferences seems a valuable contribution. Both aspects could be extended in further analyses.

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