

# DEVIL IN THE DETAILS – VISUAL PERCEPTION OF THE LANDSCAPE FEATURES BY POTENTIAL RESIDENTIAL BUYERS

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| ARTICLE INFO                                                                                                                                                                                                                                                                                                                              | ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Keywords:</b><br>eye-tracker, housing, property price, visual pathways, window view                                                                                                                                                                                                                                                    | It has long been established that people attach value to window views. However, the challenge in real estate market analyses is to capture what landscape features an attractive view contains and thus how they affect the worth (individual valuation) of the real estate. Real estate research predominantly uses questionnaires to analyze the perception of the landscape. This research assesses the possibilities of using eye-tracking as an objective tool for the assessment of the visual perception of the landscape. The research aim was achieved by comparing the results of subjective surveys with a qualitative analysis of the records of gaze patterns of participants observing on-screen photos of window views. All analyses concerned the urban landscape. Surveys show that natural areas are the most attractive for potential residential buyers, while the most undesirable are industrial window views. Participants of the eye-tracking study focused their attention on details such as distinctive buildings, construction machinery, road signs and traffic lights, advertisements, graffiti, murals, street lamps and electrical boxes. These undesirable details can obscure the entirety of even the most aesthetically pleasing landscape. Thus, the results of this study are expected to inform those involved in urban design to minimize the impact of such obstructions. |
| <b>JEL Classification:</b><br>O18, R39                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Citation:</b>                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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## 1. Introduction

Real estate, like any other good or service, evokes different emotions (Renigier-Biłozor et al., 2022), which is why their buyers often make decisions that do not always seem to be entirely rational. Such decisions, even if they are made subconsciously, are based on traits the impact of which is not always easily describable. However, to decide on the purchase of a property, it is essential to carefully analyze and

evaluate all available information about the property (Wiejak-Roy, 2023). The effect of color and type of lighting on the price attractiveness and perceived quality of goods, as well as the visual attractiveness of the interior, are well established (Barli et al., 2006). Similarly, views on building façade colors are also well-established (Strzałkowski & Lewicka, 2024). In addition, attributes such as the way the property is presented (Liechty & Madhavan, 2011), its prestige (Montañana et al., 2024) and heritage (Skripkiūnas &

Navickas, 2023) are also important in the decision-making process. Moreover, a real estate broker's characteristics, such as gender, attractiveness, or persuasiveness, can influence the purchase of a property (Arndt et al., 2013), as well as certain physical traits, grooming and adornment (Garber Jr. et al., 2013). In addition, it has long been established that human behavior can be influenced by the surrounding landscape (Thompson, 2018; Bobrowska et al., 2023) and people are willing to pay more for an attractive view from their property (Potrawa & Tetereva, 2022). For example, objective quantitative research based on transactions from 2006-2007 showed that buyers of private housing in Hong Kong were willing to pay 3% more (over \$15,000) for a wide view of the harbor and 2% (over US\$11,000) more for a limited view of the harbor (Jim & Chen, 2009). In the same research, those authors observed that a wide view of the mountains reduced transaction prices by almost 7%, and a limited view of the mountains was statistically insignificant. However, Qiu et al. (2022) suggest that objective indicators (specifying whether a particular type of landscape can be seen from the window or not) cannot fully reflect the impact of landscape on property prices. Therefore, there is a growing body of research combining subjective opinions with image analysis (Jia et al., 2022; Lee et al., 2020; Qiu et al., 2022; Riccioli et al., 2021; Song et al., 2022; Zhang et al., 2024; Zhu et al., 2022). Analyses of landscape perception are carried out using a variety of quantitative, qualitative, and mixed methods (López-Contreras et al., 2019). Sensors, such as eye trackers, fMRI or EEG, are increasingly used for this purpose (Misthos et al., 2023). In addition, the number of studies using eye tracking is gradually increasing (Měkota, 2024). In addition, researchers investigating landscape perception indicate possible differences in its assessment as a result of seasonal changes in the natural environment (Kuper, 2013; McLellan & Guaralda, 2018; Szczepańska & Pietrzyk, 2022).

Nevertheless, despite research on visual perception in urban areas conducted internationally since the mid-20<sup>th</sup> century (Ito et al., 2024), there is a prominent research gap that concerns the visual perception of the landscape and the assessment of its specific features as potentially influencing residential buyers' decisions. Studies in this area are frequently only conducted as one of the stages in larger research

projects concerning the impact of the wide environment on real estate prices. This is why they are usually carried out using conventional methods (most often questionnaire surveys).

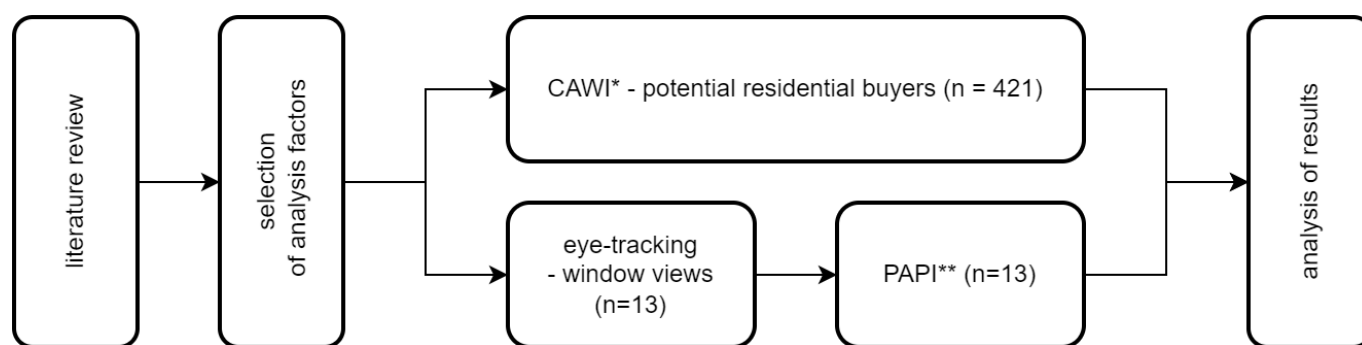
Visual perception and eye movements are closely linked, and eye-tracking provides factual evidence of visual attention, including visual processing with and without awareness (Spering & Carrasco, 2015). Therefore, the goal of this research is to assess whether it is possible to objectify the analysis of landscape perception and use eye-tracking non-subjective assessments in analyses of the real estate market. This is done by testing the following hypothesis: "The use of eye-tracking allows to objectify opinions of potential buyers about the landscape features surrounding real estate". In this research, an eye-tracker was chosen as a tool that has the potential to objectify assessments of the visual perception of the landscape. During the research, it was assessed whether the use of eye-trackers could add value in the subjective assessment of the impact of the landscape features on real estate transaction prices. In addition, this research provides useful insights for real estate agents in optimizing their clients' searches.

## 2. Material and methods

The analysis of the visual perception of the landscape from the perspective of potential buyers of real estate was carried out in Krakow (the 2nd largest Polish city in terms of size and number of inhabitants) as presented in Fig. 1.

The study used a set of landscape features that may have a positive or negative impact on prices (Table 1). These were originally proposed by Osikowska & Przetacznik (2007, 2008) during their analyses of the Krakow real estate market carried out at the turn of 2006 and 2007.

Apartments in high-rise blocks of flats are among the most common types of housing construction in Poland (Lasiewicz-Sych & Lewicka, 2024). Thus, the perception of the landscape was analyzed from the perspective of potential buyers of such properties. In Krakow, almost 23% of all buildings are buildings with three or more apartments (Węgrzynowicz et al., 2022). They include approximately 90% of all apartments available in Krakow (Public Information Bulletin, 2024).



\*CAWI – Computer-Assisted Web Interview; \*\*PAPI – Pen & Paper Personal Interview

**Fig. 1.** Scheme of the tests. *Source:* own study.

**Table 1**

| Landscape features that potentially affect the transaction price |                                                 |
|------------------------------------------------------------------|-------------------------------------------------|
| Positive impact                                                  | Negative impact                                 |
| Park/garden                                                      | Industrial buildings, warehouses, wholesalers   |
| Water (river, ponds, sea, lake)                                  | Post-industrial and post-mining areas           |
| Forested hills                                                   | "Blind" wall of the neighboring building        |
| Panorama of the city                                             | High voltage line                               |
| Forest                                                           | Railway areas                                   |
| Historic buildings                                               | Cemetery                                        |
| Vast open space                                                  | Street, intersection, major roads, parking lots |
| "Idyllic" view of the countryside                                | "Chaotic" developments                          |
| Fields and meadows                                               | "Wild fields", unarranged greenery              |
| Port, marina                                                     |                                                 |
| Amusement park                                                   |                                                 |
|                                                                  | Supermarket                                     |
|                                                                  | Modern architecture                             |
|                                                                  | Allotment gardens                               |
|                                                                  | Airport                                         |

*Source:* Based on Osikowska & Przetacznik (2007) and Osikowska & Przetacznik (2008).

## 2.1. Surveys

The survey was conducted for two groups: (1) potential residential buyers; and (2) participants of the eye-tracking experiment. The responses of group 1 were collected using the Computer-Assisted Web Interview (CAWI) method. Study participants from group 2 responded immediately after viewing the photos in the eye-tracking study. Their responses were collected using the Pen & Paper Personal Interview (PAPI) method. To link the answers given by the participants from group 2 with the results of eye-tracking examinations, the questionnaires were numbered according to the order of participation in the study with the eye-tracker.

The survey involved 434 potential residential buyers. This group included thirteen eye-tracking participants. All participants were recruited in Krakow, Poland.

The questionnaires comprised two parts: (1) Potential residential buyers evaluated the landscape

features identified by Osikowska and Przetacznik (2007; 2008) as having a positive or negative impact on real estate transaction prices; (2) Potential residential buyers assessed the impact of landscape features on the transaction price by declaring which features they would be willing to pay for. This assessment was based on a zero to ten score, where zero meant the lowest and ten the greatest impact on the price. This is a relative measure that does not consider the absolute monetary willingness to pay. This approach reduces the impact of budget constraints, which are likely to affect people's willingness to pay (Pachali et al., 2023).

## 2.2. Eye-tracking

Eye-tracking is a method that examines visual perception. Tests using eye-trackers can be carried out stationarily by displaying images on a computer screen or VR goggles, as well as through direct field observation, the results of which are recorded using mobile devices worn around the eyes (Duchowski,

2017). Eye-tracking (especially with the use of a stationary device, in the case of which the eye-tracker is mounted below the monitor) is a non-invasive method of measuring eye positions, eye movement and pupil size to detect zones in which the user has a particular interest at a given point in time. During the study, real-time data on the place of focusing the gaze is collected by a camera that records light in the near-infrared band. Importantly, the results of the study performed using photos are not affected by external conditions, such as weather (Zhou et al., 2023). In addition, Suzianti et al. (2015) suggest that reliable conclusions can be drawn based on small study groups of only ten people. Similarly, Pernice and Nielsen (2009) observe that, in the case of qualitative research, this number could be even lower. However, they also recommend that in analyses based mainly on the visual paths of individual participants, the research group should consist of at least six people.

The eye-tracking research was carried out using a stationary Gazepoint GP3 HD device. The aim of the eye-tracking experiment was to assess which features of the landscape seen as a window view are the first to attract the eye's attention, and which features are completely omitted. The research group consisted of thirteen participants recruited among the participants of group 1 (potential residential buyers). They self-selected following a receipt of an invitation to participate in an online survey or an eye-tracking study. Participants were shown unedited photos of window views from multistorey residential buildings located in Krakow (Poland). Such views were selected due to the dominant nature of such residential developments in Krakow (Poland) (Public Information Bulletin, 2024). The analyzed images (fourteen in total) contained seven different views. Each of the views was presented from the perspective of an upper floor (sixth or higher, depending on the building) and from the perspective of a ground floor apartment (i.e., floor starting some 1-1.5m above ground level). The photos used for the eye-tracking analysis were taken in winter 2023. The decision to use winter window views was made consciously to minimize the influence of greenery, which could affect the results (Eroğlu et al., 2012). Greenery in urban areas is a very strong visual attribute that directly captivates the visual senses in terms of aesthetics and beauty (Biswas & Roy, 2023) and greatly affects real estate market prices (Szczepańska et al., 2016). As the experiment aimed to check what landscape features participants pay attention to, the winter greenery would have been less

prominent in the presented views. However, greenery in the form of evergreen trees (e.g., fir, spruce, pine), evergreen shrubs (e.g., thuja, juniper, yew) and lawns before the first frost are visible on them, which provides an indication of what the view would look like during other seasons.

Each photo was shown for 5 seconds. During this time, the device recorded the components of eye movement, i.e.:

- saccades, i.e., intense rapid movements of the eyes that abruptly change the point of fixation, larger movements are typically made while gazing around a room, and
- fixations, i.e., relatively fixed positions of the eyeball, during which small vibrations occur (Purves et al., 2018; Salvucci & Goldberg, 2000).

It is assumed that during saccades, stimuli reaching the brain are not analyzed and no material cognitive process occurs, whereas during fixation, information reaches the brain and is consciously processed (Wolf & Lappe, 2021).

Based on the data collected, images were prepared for each photo showing:

- a gaze plot presenting the arrangement of successive saccades (solid lines) and fixations (circles – size depending on the length of the fixation) of individual participants (each is assigned a different color),
- heat maps presenting the total intensity of attention using colors (red – maximum, blue – minimum attention), and
- an inverted heat map presenting only the areas collectively noticed by the research group (omitted objects are obfuscated).

As a result of the research, images in the form of fourteen visual paths, fourteen heat maps and fourteen inverted heat maps were obtained. These were analyzed qualitatively.

### 3. Results and discussion

The responses of the PAPI and CAWI surveys were analyzed jointly. This was followed by testing if the preferences of the participants of the eye-tracking study were comparable to the entire group of potential real estate buyers (section 3.1). Subsequently, the results of the eye-tracking study were analyzed using qualitative techniques (section 3.2), and finally, the preferences from the subjective study were compared to the results of the eye-tracking study (section 3.3).

### 3.1. Survey

The results of the survey are presented on separate charts for each participant group. These charts contain the average scores of the features selected in the study (Osikowska & Przetacznik, 2007, 2008) as increasing or decreasing the transaction price of real estate. The scores were ranked from highest to the lowest. Bars corresponding to the same features in the charts for objects raising the price (Fig. 2) and on the charts for objects lowering the price (Fig. 3) are marked with the same colors.

According to participants from group 1 (potential residential buyers), the most desirable window view is the one with *forested hills*, which received an average score of 8.2. The next highest rated view is the *forest* with an average score of 7.3. Slightly lower scores were given to *water (river, ponds, sea, lake)* and a *park/garden* (average score of 7.2). According to the participants from this group, the worst views included *an airport*, *a supermarket* and *an amusement park*, which received a score of 0.7-1.2 (Fig. 2a).

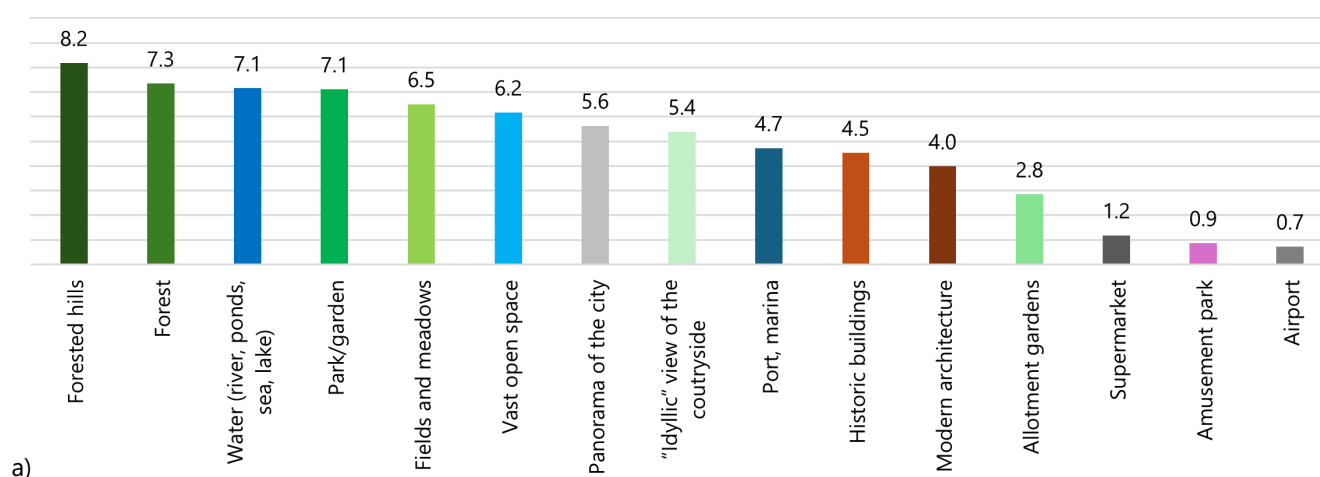
Similar perceptions were shared by the participants of the eye-tracking survey, who preferred features such as *water (river, ponds, sea, lake)* (average score 8.3), *forested hills* (average score 8.2), a *forest* (average score 7.4) and a *park/garden* (average score 7.2) in the landscape viewed from the property they were potentially buying. This group of participants also decided that a *supermarket*, *airport* and *amusement park* are features that they would least like to see from the windows of their property. The scores did not

exceed 1.0 in any of these cases (Fig. 2b).

Both groups consistently observed that green areas, *water (river, ponds, sea, lake)* and other natural landscape features increase the transaction price of the property. Conversely, all anthropogenic features do not have such causative power. Thus, the participants were asked which features observed in the window view have a negative impact on the price of the property.

According to potential residential buyers, views of *a blind wall of a building* (average score 8.8) and *industrial buildings, warehouses, warehouses* (average score 8.4), as well as *post-industrial areas, post-mining areas* (average score 7.9) and *airports* (average score 7.7) have the most negative impact on transaction prices (Fig. 3a). However, *wild fields*, *unarranged greenery* (average score 2.7) and *modern architecture* (average score 3.5) do not have such an impact.

Similar scores were given by participants of the eye-tracking study, who, apart from *industrial buildings, warehouses, wholesalers* (average score of 9.5), *post-industrial areas, post-mining areas* (average score of 9.5), *blind walls of a neighboring building* (average score of 9.4) and *an airport* (average score of 8.7), added a *cemetery* (average score of 8.8) as having a negative impact on prices (Fig. 3b). According to this group of participants, the least unwanted in the window view were *wild fields*, *unarranged greenery*, *modern architecture* and *allotment gardens*, all of which received scores of three or less.



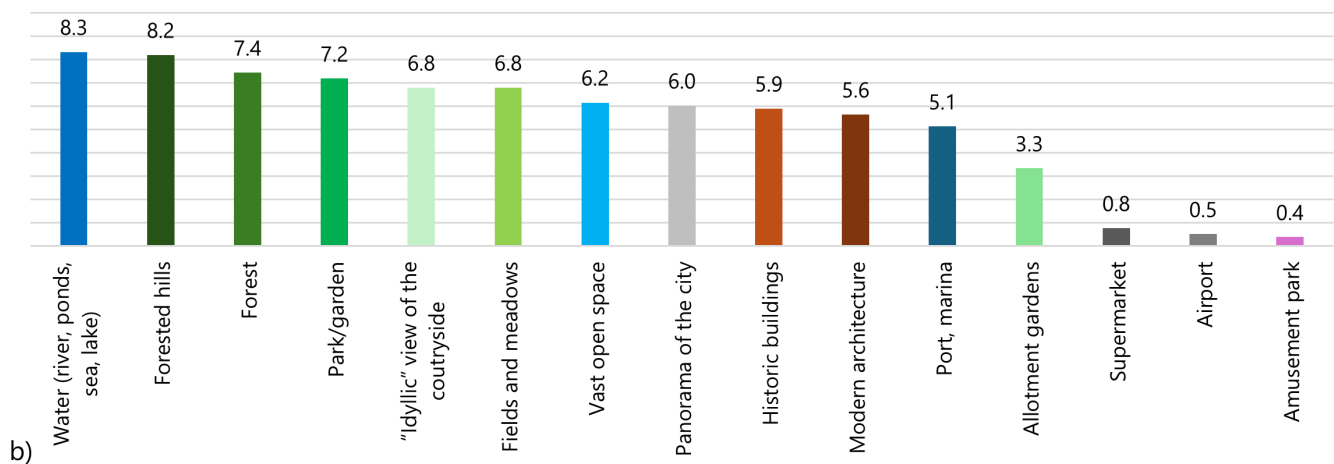


**Fig. 2.** Objects that increase the price: a) potential residential buyers; b) eye-tracking participants. *Source:* own study.

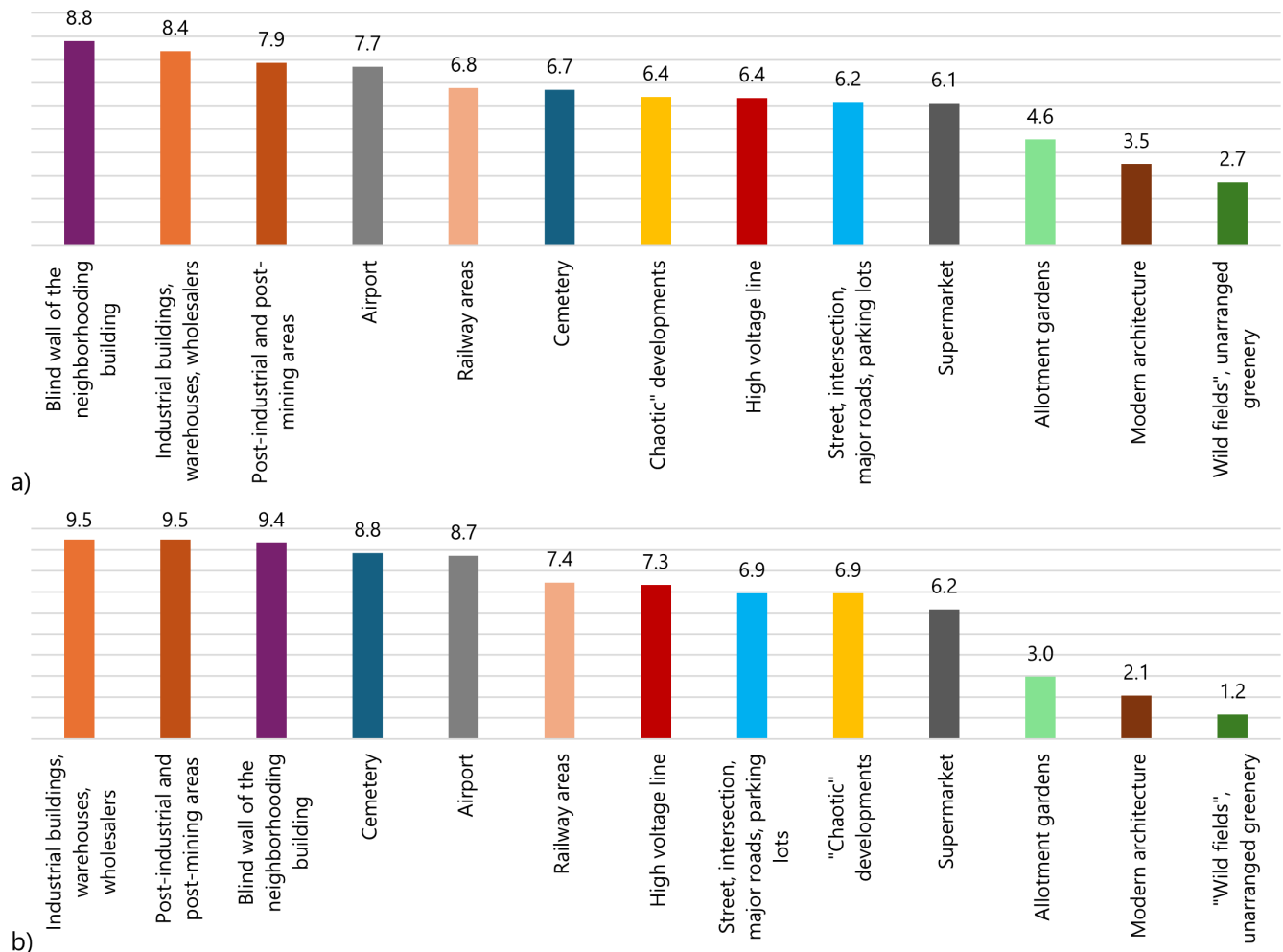


**Fig. 3.** Objects that reduce the price: a) potential residential buyers; c) eye-tracking participants. *Source:* own study.

As in the case of landscape features that have a positive impact on transaction prices, a similar observation can be made for features negatively impacting transaction prices. Participants from both groups agree that landscape features related to all

types of industry, such as *industrial buildings, warehouses, wholesalers* and *post-industrial and post-mining areas* are most undesirable. Low scores were given to green, although not always highly aesthetic, landscape features, including *wild fields, unarranged*

greenery and allotment gardens. Modern architecture viewed from the windows of the property does not seem to have a negative impact on transaction prices either.

### 3.2. Eye-tracking

Photos showing the same view, but from different perspectives (upper floor and ground floor) were

analyzed together. Based on the obtained images showing visual paths, heat maps and inverted heat maps, a qualitative analysis of the perception of window views of apartments in multistorey buildings was performed for each of the analyzed photos. Examples of results are shown in Fig. 4. All photos and study results are included in Appendix A.

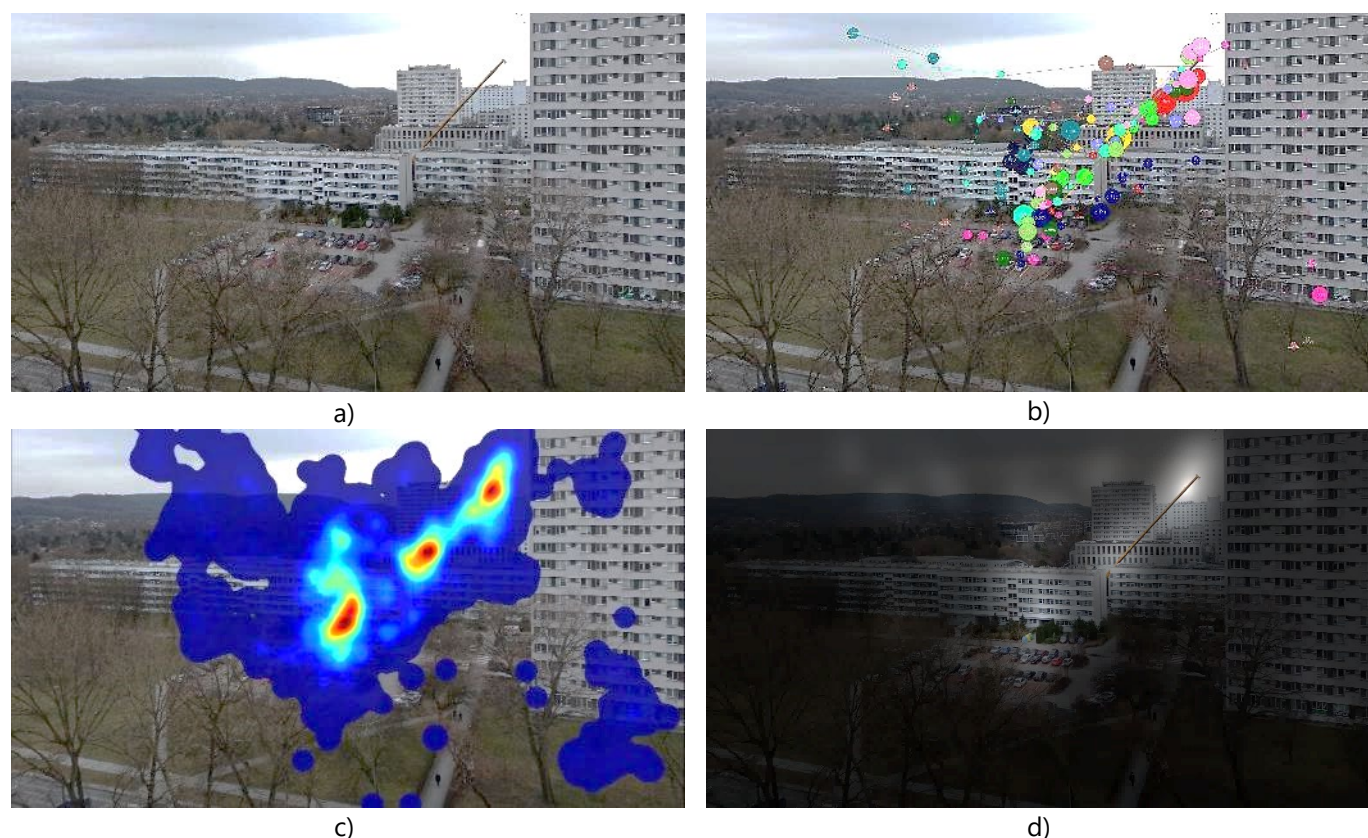


**Fig. 4.** Examples of eye-tracking test results: a) the analyzed photo; b) gaze plot; c) heat map; d) inverted heat map. *Source:* own study.

Since the images were subject to qualitative analysis, primarily images showing the paths of the eyes of individual participants (example image – Fig. 4b) were used. These were then supported by heat maps (Fig. 4c) and inverted heat maps (Fig. 4d). Images with visual paths show how each participant's gaze moved, i.e. which element caught their attention and how long they looked at it (the larger the dot, the longer the observation time) and in what order they looked at each object (the dots are numbered and connected by dashes showing from which place the participant's gaze passed). The visual paths of individual participants are marked using different colors.

Heat maps, on the other hand, show the areas of focus of all participants. They are created by applying

colors to the image that indicate which elements have attracted the most attention of all users. In the images generated for this study, warm colors (red) were used to indicate areas that had attracted the attention of many study participants for longer periods of time. Cold colors (blue), on the other hand, indicate areas that fewer people paid attention to or those that were looked at for a shorter time. The absence of color indicates a lack of interest in the area.

As is the case with heat maps, colors obscure the image; inverted heat maps are more suitable to analyze the observed landscape features, i.e., the areas which the participants were particularly interested in are clearly visible. However, the visibility depends on how much interest there was (the larger the area, the less obscured by "fog"). Other areas are darkened.

The first pair of photos shows mainly multi-family buildings, greenery and road infrastructure. In the photo showing the upper floor window view (Fig. 4), a large number of research participants drew attention to *modern buildings*. A few participants glanced briefly around the *parking* area and the windows of the nearest buildings. However, the greatest curiosity was aroused by a construction crane located between the existing buildings in the area. Each of the research participants looked at it at least once and, compared to the rest of the objects in the photo, devoted a lot of time to it. When observing the same view from the ground floor, the participants focused their eyes on road signs, an advertising billboard and an information pole. Some of them also looked at trees and shrubs.

The second pair of photos shows mainly the intersection of large streets and multi-family buildings. In addition, a large part of the window view from the ground floor is taken up by a lawn. Observing the view from the upper floor, the research participants still focused their attention mainly on construction cranes. In addition, they often looked at advertising billboards and some of them looked at residential buildings. In the view from the ground floor, the advertising billboard in the center of the photograph attracted the most attention. Then the eye movement focused on features such as traffic lights, road signs and another nearby billboard. At the end of the eye-tracking experiment, some participants began to look around at the nearby trees and focused their eyes on them.

The third pair of photos shows mainly an urban layout with residential buildings and parking lots. In addition, in the foreground of the photo taken from the ground floor, there is a low, glazed, non-residential building. Its flat roof can be seen in the photo taken from the upper floor. The upper floor window view also includes a fragment of a sports ground and a sports stadium in the background. When observing the photo showing the view from the perspective of a higher floor, the eyes of most of the participants wandered around the parking lot for some time. The city stadium also attracted significant attention. Some of the participants focused their attention on the tall blocks of flats visible in the upper part of the photo and the greenery. The sports ground attracted the attention of two participants for some time. When looking at the photo taken from the window on the ground floor, the participants' eye movement was rather chaotic. Only the road and a

pedestrian caught the attention of the research participants. Some of the survey participants were also interested in the view of nearby trees and shrubs.

The fourth pair of photos includes a large street intersection, residential buildings with parking lots and a hospital building. In the background, from the perspective of the upper floor, one can see the forest. While observing the views from an upper floor, the study participants followed the multi-family building visible on the right, as well as the forest and the hospital building, but without any clear interest. They did, however, focus on the advertising billboard visible in the lower left corner and the nearby pedestrian crossing. Several participants were interested in the residential building visible on the left. In the photo showing the view from the ground floor, research participants were mainly interested in cars and individual residential buildings on the left. Saccadic eye movements were also observed to follow the nearby apartment block and trees.

The fifth pair of photos shows residential buildings. In the photo from the perspective of the upper floor, one can see mainly their roofs, and the view from the perspective of the ground floor additionally includes objects such as garages and garbage cans covered with graffiti. In the photo from above, most of the participants focused their eyes on the roofs of buildings and blocks of flats, which were distinguished by their height compared to others. Several participants also looked at the neighboring trees for a short time. On the other hand, in the view from the perspective of the ground floor, graffiti attracted the greatest attention of the research participants. Moreover, rather chaotic movement of the participants' eyeballs was observed when they looked at the nearby apartment block and trees. Features of utility installations (e.g., street power boxes) visible on the left side of the photograph also attracted a lot of attention.

The sixth pair of photos shows objects such as a school, parking lots, modern architecture, acoustic screens and multi-family buildings. In the view from the ground floor, these buildings are obscured by arranged greenery. While observing the view from the perspective of the floor, several research participants focused their attention on the modern apartment block to the left of the photograph. Saccadic movements of participants' eyes were also observed for residential buildings in the background, buildings adjacent to the school building and acoustic screens. However, the most observed was the mural painted

on the wall of the school. In the photo taken from the window on the ground floor, the research participants briefly paid attention to a modern apartment block visible on the left side of the image. However, they focused longest time on a passing truck (even though it was partially obscured by evergreen greenery). Most participants also looked at the acoustic screen visible on the right side of the photo. The participants' eyes also focused on a street lamp for a relatively long time.

The seventh pair of photos shows a sports ground, parking lots, an exhibition tent and residential buildings. The features that the participants paid the most attention to in the photo from the perspective of the upper floor included an advertising banner and a sports ground (especially the football goal). While observing this photo, research participants also looked at the parking lot, the white tent to the left of the photo, or the apartment blocks visible in the background. In the case of observing the view from the ground floor, it is not possible to clearly indicate which feature of the landscape participants focused on. They were found to look around the parking lot, cars and sports ground rather chaotically. Several participants focused on the advertising banner visible on the left.

### 3.3. Survey vs. eye-tracking

No relationship was found between survey responses and eye-tracking results. Participants from both groups were in favor of natural views and indicated a reluctance to industrial facilities. Theoretically, potential residential buyers, looking for the most suitable property, seek positive features in window views that they would like to see on a daily basis, and negative features that they would like to avoid. These negative features allow them to quickly reject properties that are not suitable for them.

However, in the eye-tracking images of the views from the windows, the participants' eyes were mainly focused on details such as individual distinctive (disharmonious or modern) residential buildings, construction machinery, road signs and traffic lights, information poles, billboards and advertising banners, graffiti and murals, street lamps and electrical boxes, as well as unusual buildings visible in the background, such as a sports stadium or a hospital. In addition, especially in the photos taken from the ground floor, participants were interested in moving objects, such as various vehicles and pedestrians. Only in the case of some photos (photos No. 3a and 4a), did the

participants of the eye-tracking study superficially pay attention to greenery (most often in the background). The details that caught the attention of the participants of the eye-tracking study included mainly the landscape features that had previously been identified as having a negative impact on transaction prices, such as streets, intersections, roads and parking lots. Properties that they would be interested in buying, after considering the preferences shown in the survey, are then subject to a thorough assessment, during which the buyer decides on how to proceed with the property based on the landscape features that deter them from the potential purchase.

It is completely natural for people observing the landscape to focus their eyes on those elements that stand out from the surroundings (Janowski et al., 2024). Therefore, in an eye-tracking study, it is not the participants' preferences that are recorded, but their attention. This means that landscape features or their more visible elements (often classified in the study as undesirable in the windowed view) are shown as more frequently noticeable in the study. As a result, landscape features that are indicated in surveys as having a positive impact on the price level may be overshadowed by negative landscape features that were captured by the participants of the eye-tracking study. For example, high ratings for natural landscape views can be lowered by looming on eye-catching billboards on the horizon. Similarly, the positive perception of arranged greenery, which fills almost the entire view from the window, can be negatively affected by noticing advertising objects or communication infrastructure, such as road signs or traffic lights, between the trees.

In connection with the above, it can be concluded that potential residential buyers would like to see greenery from the window in various forms, but due to the way the urban landscape is shaped, they notice mainly features of transportation and technical infrastructure. Thus, what catches the eye of eye-tracking study participants is not necessarily what they would like to see in the view from the window.

### 4. Conclusions

The view observed from the property undoubtedly has an impact on the perception of the property by potential residential buyers and can be a significant price-setting factor. In practice, however, capturing this impact is extremely difficult and is usually based on the subjective opinions of potential residential buyers, or real estate market experts. Therefore, the

aim of the described research was to assess whether it is possible to objectify the analysis of landscape perception by considering the results of objective eye-tracking research in the context of subjective questionnaire studies.

Surveys show that the public prefers natural views. The survey results are therefore consistent with various studies conducted around the world, which have quantitatively shown a positive effect of the view of greenery on the level of real estate prices (Des Rosiers et al., 2002; Wang et al., 2015; Teo et al., 2023), or water (Wang et al., 2015; Castro Noblejas et al., 2023). However, participants of the eye-tracking study pay more attention to details relating to public infrastructure (distinctive buildings, construction machinery, road signs and traffic lights, information poles and billboards and advertising banners, graffiti and murals, street lamps and electrical boxes) which somewhat contradicts the above observation. These small features of the landscape can therefore significantly affect the perception of the entire landscape. Therefore, urban space should be shaped to "hide" the negative, frequently small elements that attract attention. Alternatively, it can be co-created by improved management of advertising spaces to increase the visibility of specific valuable objects in the urban environment (Gasparini, 2017). Alternatively, the window view affecting the price of the property should be subjected to greater segmentation to consider the impact of its smallest, but most characteristic features. If landscape features occupying most of the window view are perceived as positively affecting the price, potential buyers of such a property can decide to "short-list" such properties for further verification during site inspections. However, if the positive elements do not overshadow the negative details, a potential residential buyer may consider the price too high and revise their interest in the property.

Finally, it should be remembered that the presented research has limitations. In all the surveys, the participants evaluated their idea of the window view and not a real view, which would most likely be larger and viewed in contrast to the inspected interiors. In real conditions, potential residential buyers would likely check many (or possibly all) available window views and draw their conclusions on their combined observations (the net effect of the positive and negative impact of the seen landscape features). Moreover, the research was conducted for one type of residential real estate and thus further research on lower-density developments is likely to

provide useful insights into buyers' preferences.

Importantly, knowledge about the perception of the landscape by potential real estate buyers can be useful for all market participants. Licensed real estate valuers should take it into account in the valuation process. However, it is the real estate agents and sellers of new developments, who would benefit from this knowledge. Well-revised theory of the perception of window views would help in developing marketing strategies tailored to potential customers. On the other hand, potential residential buyers, knowing what they are really paying attention to (and not just pointing out what they potentially like or dislike), should find it easier and faster to make decisions about buying (or not buying) a certain real estate. Given the above, it would be advisable to include various photos of window views in real estate sales offers. This could significantly shorten the first stage of real estate transaction processes and reduce the costs of brokerage agencies.

Finally, this study emphasizes that the eye-tracking experiment should be treated as preliminary research, which should be carried out in the future on various local markets and during different vegetation seasons, not only among potential residential buyers but also among real estate professionals.

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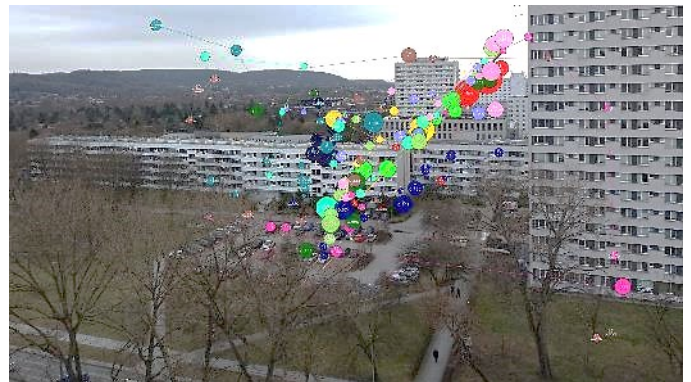
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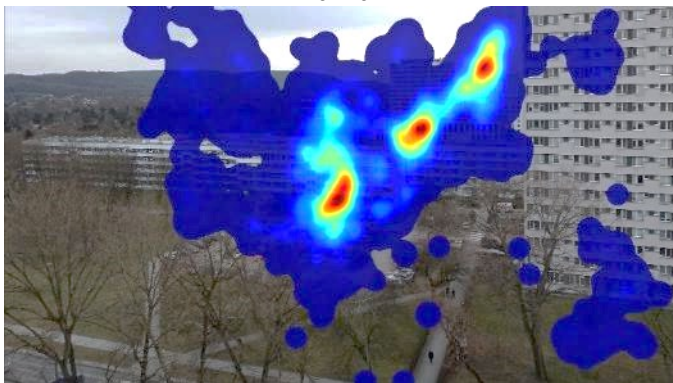
**Appendix A:** Eye tracking test results (a – the analyzed photo; b – gaze plot; c – heat map; d – inverted heat map)



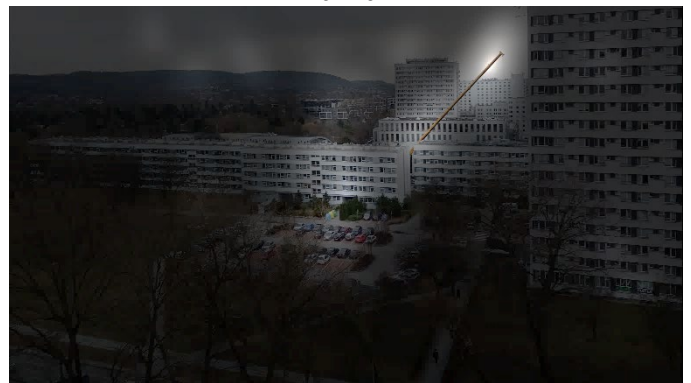
1a – a



1a – b



1a – c



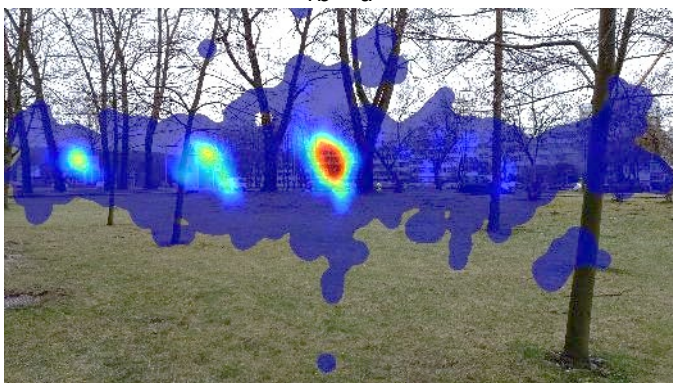
1a – d



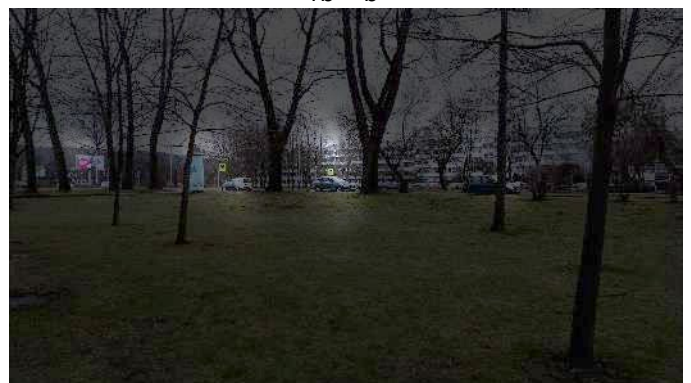
1b – a



1b – b



1b – c



1b – d



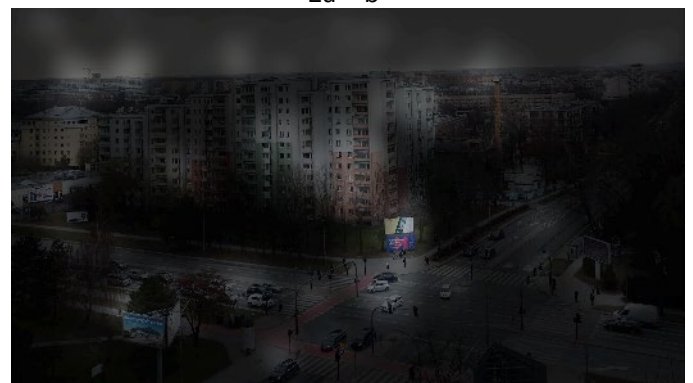
2a – a



2a – b



2a – c



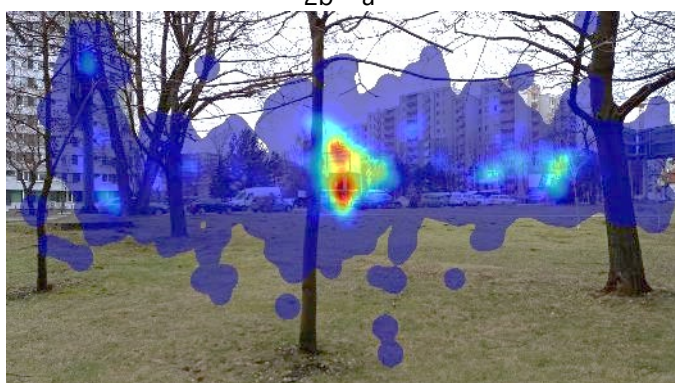
2a – d



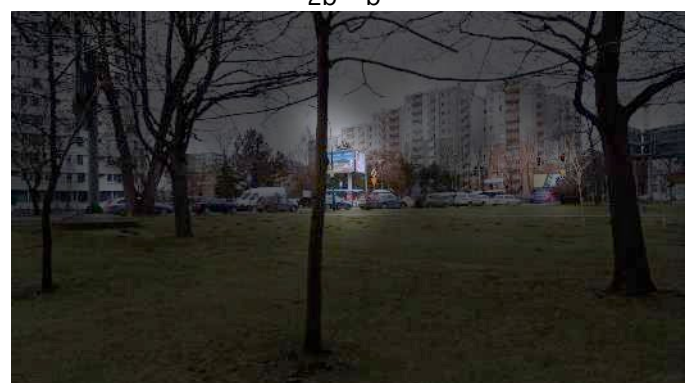
2b – a



2b – b



2b – c



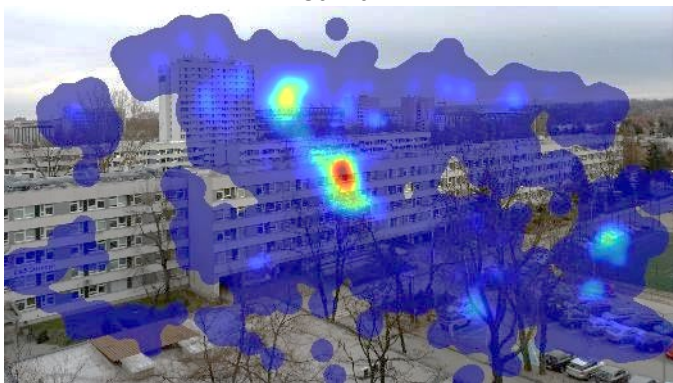
2b – d



3a – a



3a – b



3a – c



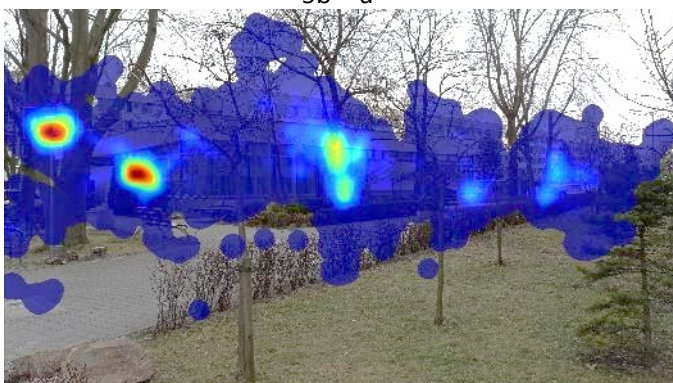
3a – d



3b – a



3b – b



3b – c



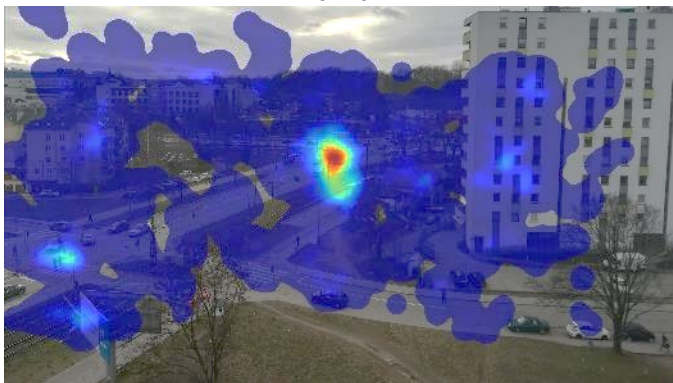
3b – d



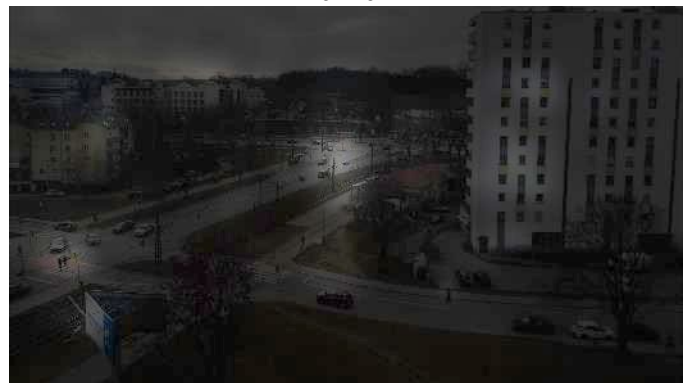
4a – a



4a – b



4a – c



4a – c



4b – a



4b – b



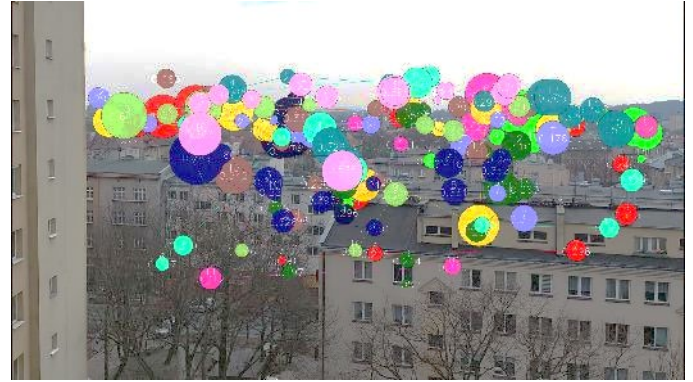
4b – c



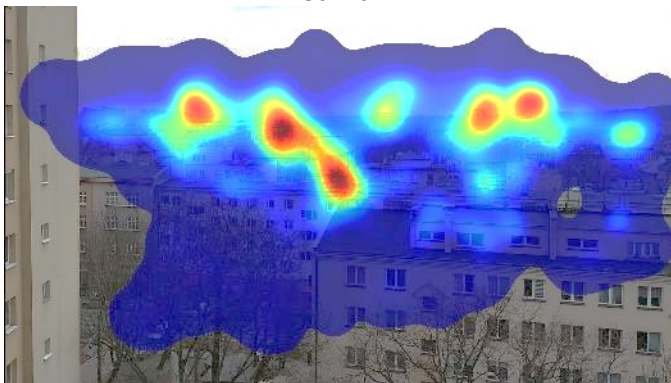
4b – d



5a – a



5a – b



5a – c



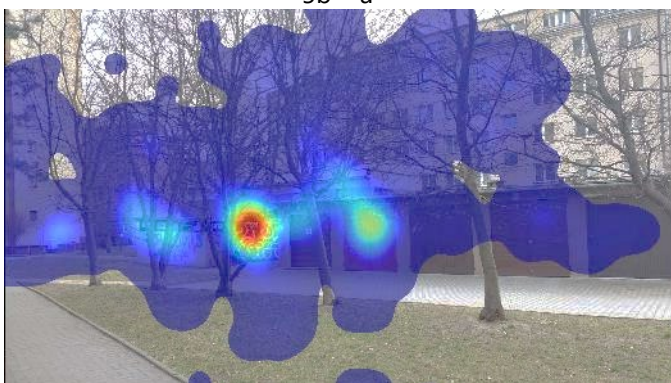
5a – d



5b – a



5b – b



5b – c



5b – d



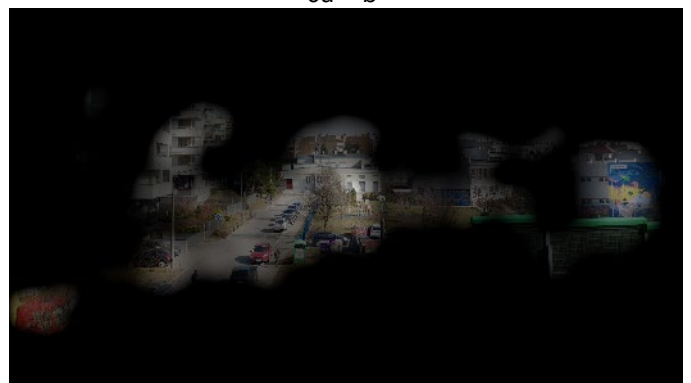
6a – a



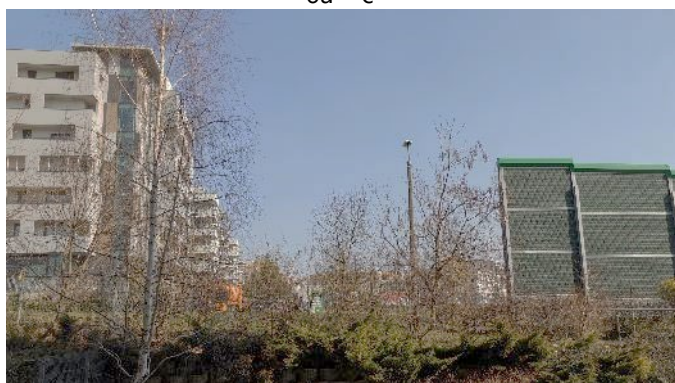
6a – b



6a – c



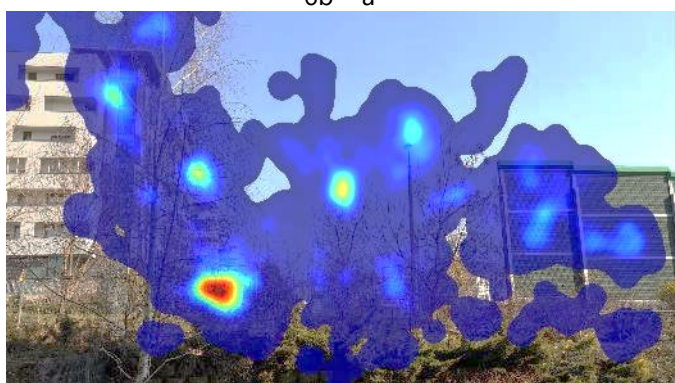
6a – d



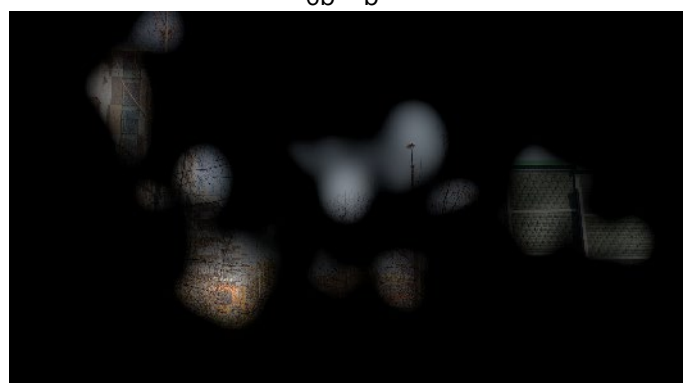
6b – a



6b – b



6b – c



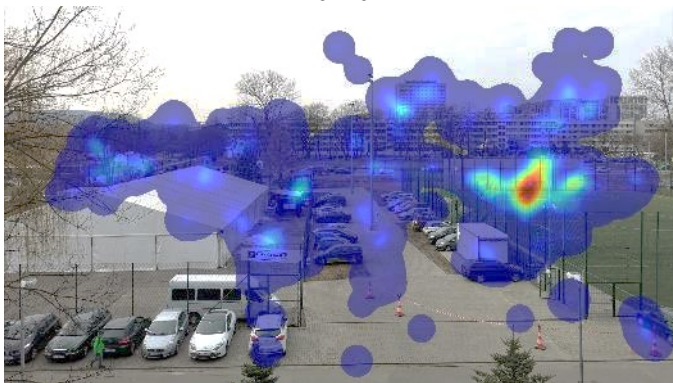
6b – d



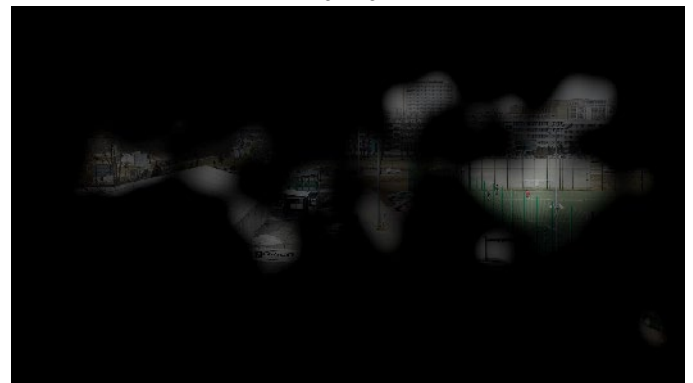
7a – a



7a – b



7a – c



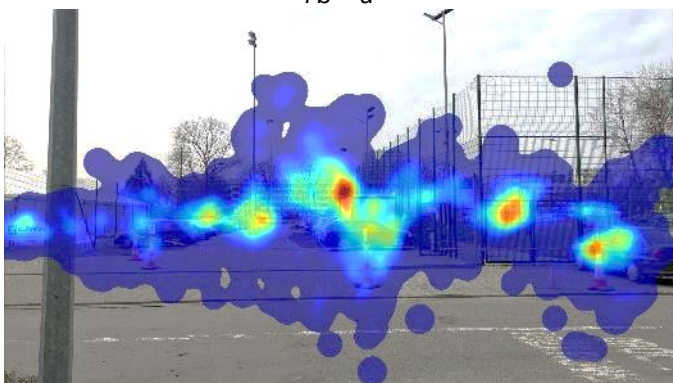
7a – d



7b – a



7b – b



7b – c



7b – d