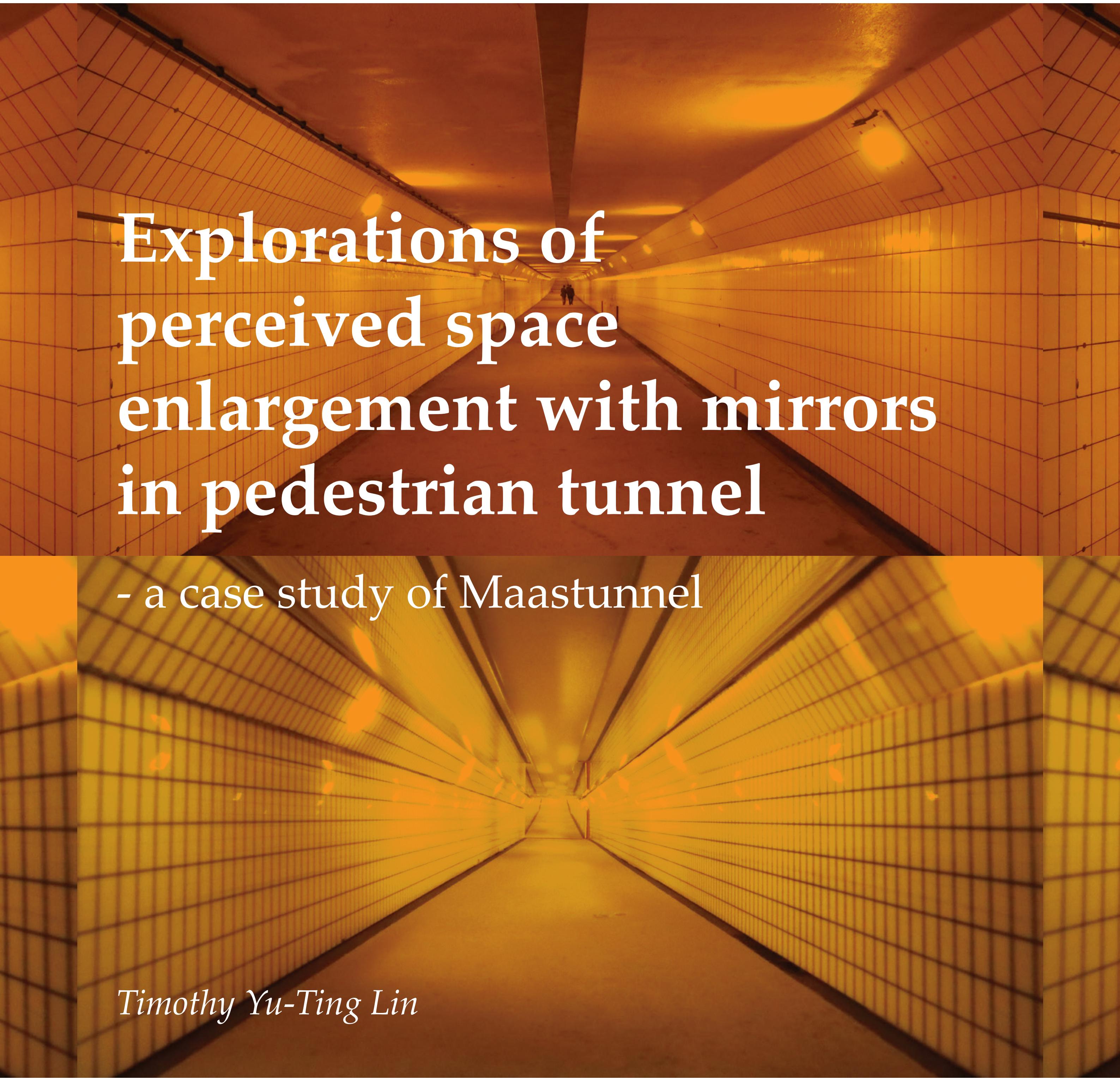
Explorations of perceived space enlargement with mirrors in pedestrian tunnel

- a case study of Maastunnel

Timothy Yu-Ting Lin



EXPLORATION OF PERCEIVED SPACE ENLARGEMENT WITH MIRRORS IN PEDESTRIAN TUNNEL — A CASE STUDY OF MAASTUNNEL

A Thesis Submitted in Partially Fulfilment of the Requirements for the Degree of Master of Science in Integrated Procude Design in the Faculty of Industrial Desing Engineering of the Delft University of Technology

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Abstract

This graduation project aims to explore the possibilities and the pitfalls when designing a pedestrian tunnel with mirrors. The research topic was derived from an assignment given by Studio Roosegaarde, a social design lab based in Rotterdam. The major problems this project aims to solve is that a designer has no systematic guidelines to follow when designing a pedestrian tunnel with mirrors. The context this work selects is Maastunnel in Rotterdam for the reason of simplicity, accessibility and its history between Studio Roosegaarde.

The keystone to the problem raised is reckoned to be the understanding of the space perception in a pedestrian tunnel and how the mirrors can alter the perceived space. A dozen of visual elements in space perception are identified through the literature survey. With the understanding to mirror perception, a handful of visual cues are selected for further step evaluation. The evaluation includes a questionnaire showing 24 photos of pedestrian tunnels to be rated. Through the survey, the correlation between the perceived visual cues and the sense of spaciousness is analysed. The visual cues correlate with the sense of spaciousness from strong to weak are the width, the height, the cleanness, the brightness of the tunnel and the reflectivity of the wall.

Thanks to the lighting simulation software Dialux, several attempts of using mirrors to alter the visual cues were made readily. The exploration reveals two most promising ways of using mirrors in a pedestrian tunnel: mirrors as the Space Doubler and mirrors as the Light Splasher. These two ways of mirror usage are put to test in scale models. Regarding the Space Doubler, it is firstly found that putting mirrors on the ceiling, referred as catoptric-heightening, may significantly enlarge the perceived space, resulting in a more open and spacious tunnel. A similar but less potent effect is also found when putting mirrors on the lower part of the walls (referred as catoptric-widening) to extend the perceived width. The observers reported feelings of disturbing and dirtiness when perceiving the catoptric-widening mirrors in a pedestrian tunnel. Regarding the Light Splasher, the experiment reveals that the mirror-induced brilliance, or reflected-brilliance, can effectively increase the brightness of the space. Contastly, the complex lighting pattern created by reflection (reflected-deflection) is not beneficial. However, it is found that the associability plays a more significant role in the perception to a space with brilliance. The observers are likely to associate the reflected-brilliance with the starry sky henceforth they perceive a higher ceiling.

According to the above findings, a list of design guidelines is formulated. The design guidelines lists almost 19 dos and don'ts, corresponds to a dozen different aspects such as openness, spaciousness, aesthetics, privacy, security, etc. This project has made a self-evaluation to the design guidelines by making a design according to which. The prototype of the design has shown the strength of the guidelines meanwhile revealing the inadequacy of the current version. The guidelines is considered useful in the early stages of design process while it lacks of guides related to the size and variation of mirrors. To further develop the guidelines into a more comprehensive version, a dynamic or fully-immersive environment is suggested as the necessary future works.

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Chapter 1 Introduction

1.1 Assignment

This project started with an assignment given by Studio Roosegaarde, a Rotterdam based design agency. Studio Roosegaarde, led by Daan Roosegaarde the social inventor, is a "social design lab" that designs interactive artworks, installations and landscapes. The Studio's design vision is a Dutch word "Schoonheid", meaning both cleanness and beauty. This design mantra leads the Studio Roosegaarde's imagination towards the future: A beautiful life with a cleaner environment, using cleaner energy and living in a cleaner society. Their earlier works have addressed the pollution of air (Smog Free Tower), the pollution of light (Van Gogh Path) and the pollution of water and global warming (Waterlicht). Taking one step further, Studio Roosegaarde considers the shrinking space in urban areas as a type of social pollution. Owing to the development of the metropolises, the densely located urban infrastructures and buildings chopped the public spaces, creating enclosed or confined divisions. Consequently, this division leads to not just a smaller shared space, but sometimes an insecure place or even a hotbed of crimes. Studio Roosegaarde concerns such a social issue and wishes to take a stance on it.

The given assignment is to find a way to transform a pedestrian tunnel by enlarging the perceived space larger than it is now. Mirror being one of the most straightforward media to enlarge the space in visual perception is the major interest in this study. The assignment therefore reformed as to find out how to exploit mirrors to design a pedestrian tunnel and reshape the perceived space larger. Accordingly, this project aims to figure out what is possible in changing the tunnel space perception using mirrors and discover the systematic knowledge for such a purpose.

As a social design lab, Studio Roosegaarde is looking for something beyond an aesthetically pleasing creation. While making exquisite designs is a must, social stimuluses are the most desirable fruits from their artworks. Through their designs Studio Roosegaarde makes statements or proposes imaginations to the future of beauty and cleanness. Furthermore, the company focuses on making their design with the "analogue-high-tech". Analogue-high-tech is a contemplation which poses against the excessive digital world of today. By taking the advantage of direct reactions based on fundamental physical laws or novel smart materials, analogue-high-tech creates immediate interactions between the artwork and the observers. To the superb standard of Studio Roosegaarde, the unique niche of their works should be aesthetically pleasing, social stimulating and analogue responsive.

1.2 Problem Definition

Tunnels, underpasses and subways are ubiquitous in the modern metropolises. These infractures, regardless the convenience they bring to city inhabitants, have taken away the sky and the open spaces, replacing them with enclosed and narrow public spaces. To address this issue, Studio Roosegaarde is interested in designs that expand or extend the visual perception of such enclosed spaces. This interest has been translated to, the assignment to redesign a pedestrian tunnel through the use of mirrors to enlarge the perceived space.

Mirror as a common furniture in domestic houses has been one of the first choices when one intends to visually enlarge the space in a salient manner. Despite using mirror sounds straightforward when enlarging a space, surprisingly, there is no common knowledge nor manual to look up when it comes to design a tunnel space. What are the visual effects can a designer achieve? Where in a pedestrian tunnel is most suitable for installing mirrors and how much of the surface can we put mirrors on? Would it compromise the safety or invite the vandals? The author has found no clear information from a known knowledge base that can answer these questions properly. I reckon such a lack of knowledge is the primary challenge of this study.

'To redesign a pedestrian tunnel by applying mirrors to enlarge the perceived space.' Taking a closer look into this design goal, several questions have emerged: How does the visual space perception work? What elements does a tunnel space has that determine our space perception? How can mirrors change the space perception? How does space perception work in a pedestrian tunnel? Synthesizing all the questions hereinabove, this study will focus on two main research questions:

What are the visual elements that affect the space perception in a pedestrian tunnel?

How can the perceived space of a pedestrian tunnel be enlarged by using mirrors to augment or create these visual elements?

Through answering these research questions, this project is looking for a summary of design guidelines in which contains the basic rules and the potential pitfalls to avoid. From there, Studio Roosegaarde may design a pedestrian tunnel using mirrors, turning a cramped tunnel spacious with aesthetics.

1.3 Context Definition

1.3.1 General Criteria

In the real world, a pedestrian tunnel, or a subway, is constructed in a wide range of varieties. Ordinarily, it can be as short as a covered road under an overpass or as long as hundreds of metres that goes under a great tract of ground. It can be a underground passage with shops and vendors or it is just a sidewalk in a general tunnel. For simplifying the environmental factors, it is necessary to define the contextual scope of this study.

To focus on the topic of how people perceive a tunnel space, the first criterion relates to the length of the tunnel. For a short pedestrian tunnel, the environmental influence from both ends may inevitably dominate the tunnel space. According to the practice in tunnel lighting design, there are several ways and standards to define a long tunnel. The most simple one is by its length; a tunnel longer than 50 metres can be treated as a long tunnel in most guides (Schreuder 1964; CETU 2017; Thorn 2004) as it would require a constant lighting all over the day. On top of the length, de Groot and de Vlieger recommended to take the height of the tunnel into account for a more precise judgement (as cited in Kretzer, 2009). According to their recommendation if the length-to-height ratio is greater than 20, one may consider it a long tunnel. Besides of using one-dimensional criteria, another evaluation is Look Through Percentage (LTP). LTP is defined as the ratio of the visual projection area of the exit with respect to which of the entrance (Rands, 2016). Referring to Figure 1.1, the LTP can be obtained through the perspective area of quadrangle EFGH divided by the area of ABCD (□EFGH/□ABCD) when an observer sees from the stopping distance, the distance that requires to make a full stop from a normal travelling speed. According to the Guide to the Lighting of Road Tunnels in Armenia, if the LTP is less than 20%, it should be considered as a long tunnel. While the stopping distance is usually up to 50 metres for an automobile, there is practically no stopping distance for a pedestrian. Consequently, the LTP for pedestrian, based on its definition, should be the visual angle that the exit claims in the entire field of view. Although LTP seems to be the most inclusive standard, the lighting guidelines from the Netherlands Institute of Illumination Engineering uses Groot & Vlieger’s norm exclusively for slow-speed tunnels and underpasses (NSVV, 2003). Accordingly, this study also adopts this standard and will search a pedestrian tunnel of which the length is longer than its height by more than 20 times (Fig. 1.2).

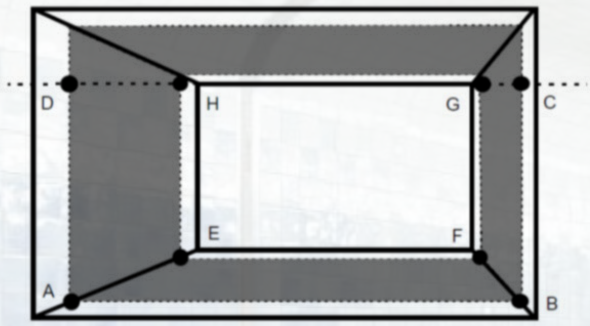
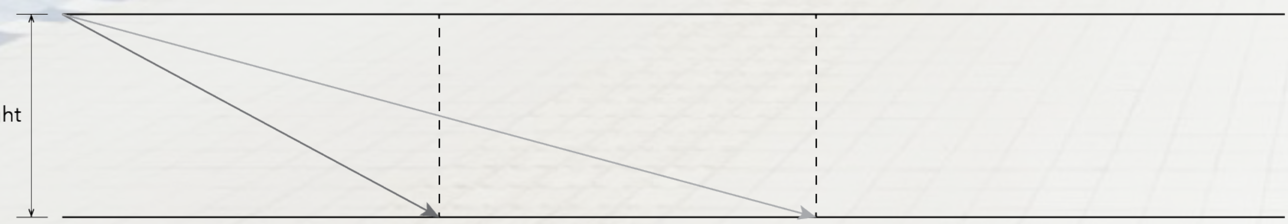


Figure 1.1 The illustration of a tunnel in perspective showing how to define the LTP, the rectangular EFGH corresponds to the exit of the tunnel.

Figure 1.2 Illustrated definition of long tunnels according to the Recommendation of Lighting of tunnels and and underpasses (NSVV, 2003).



Besides of the dimension, other tunnel criteria are set to pinpoint the focus on the key point . In this research, the pedestrian tunnel, as it literally seems, would be a tunnel exclusively for pedestrians. Bikers and vehicle drivers in general travel much faster than pedestrians. Such a speed difference may affect space perception significantly (Pardo, Oyuela-Vargas, García, Ochoa, 2005). In addition, the tunnels that contain more than one type of travellers usually have divisions for safety reasons; for example, the Amsterdam Central Station Tunnel has a strong contrast between the bikers' part and pedestrians' part (Fig 1.3). Hence, it is reasonable to keep it pedestrian only as bikers and drivers would need different concerns.

In this project, the prime interest is how the individual perceives the tunnel space. The density of the pedestrian or the traffic amount are excluded from the studying scope. Therefore, a low pedestrian density is desired so that other pedestrians will not pose an effect on the space perception. According to a lecture note concerning pedestrian studies, the pedestrians need not to adjust their movement in response to other pedestrians when the space around them is at least 5,6 m2 per person or 16 people per minute per metre (p/min/m) in terms of the flow rate (Mathew, 2014). It is a fair assumption that this number should be smaller for visual perception as the visual perception is much more far-reaching than the walking movement. However, as far as the author's survey, there is no clear standard or study specifying how the human density in a given space affects the observer's space perception. To set a criterion, this study will focus on a pedestrian tunnel that has a flow rate less than 10 p/min/m.

Figure 1.3 A photograph of Amsterdam Central Station tunnel; the left side is the pedestrian part and the right side is the cycling part.

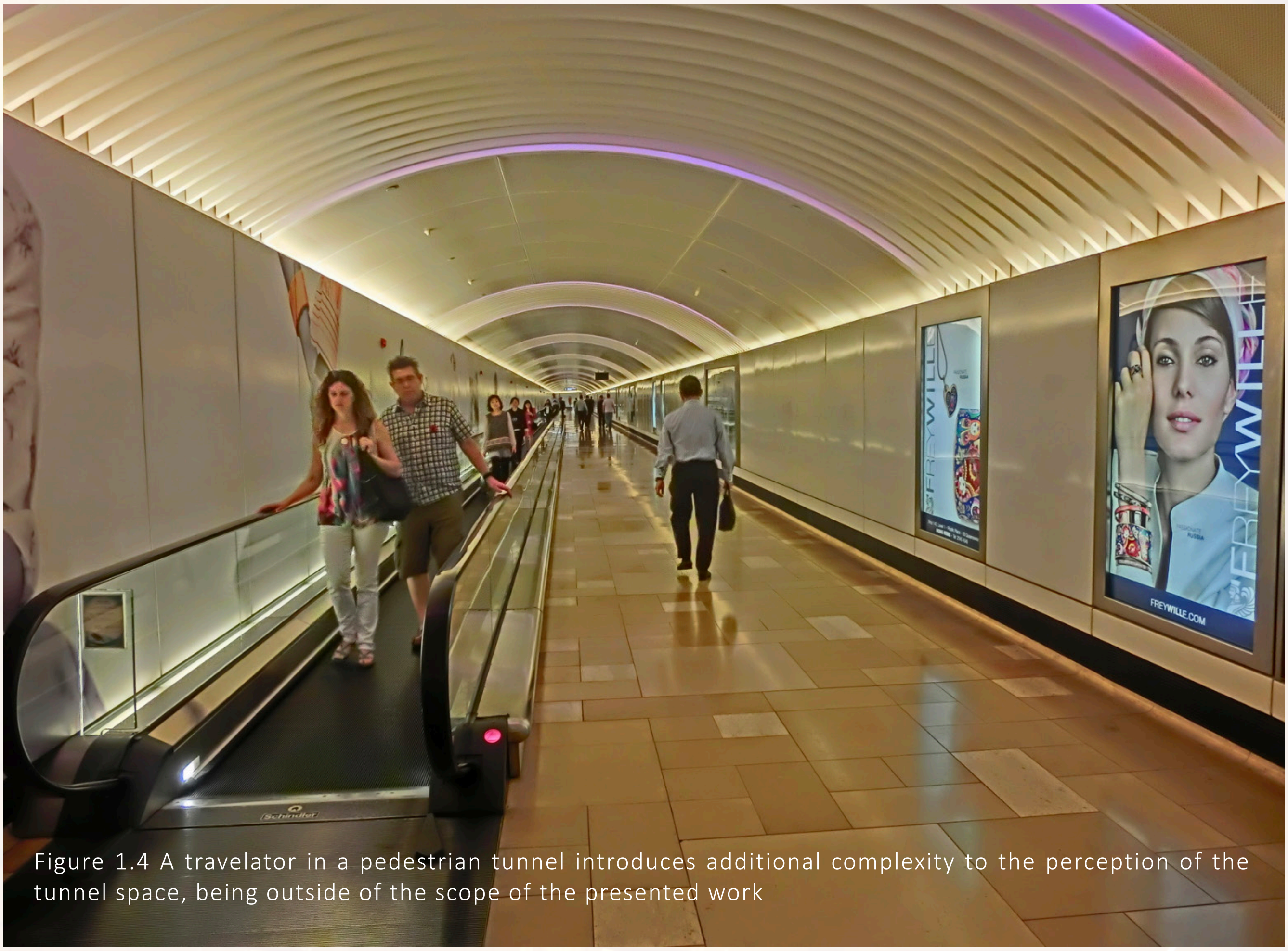


Figure 1.4 A travelator in a pedestrian tunnel introduces additional complexity to the perception of the tunnel space, being outside of the scope of the presented work

The last aspect relates to the function of the tunnel. Generally, a tunnel's primary function is for providing a passageway; given the variety of tunnels, however, stores, venders and even playgrounds exist in some tunnels. Once again, this study intends to keep its scope constrained, hence the tunnel that of this study's concern should have no other function but a simple passageway. In other words, the tunnel does not fall into the criteria if there is a facility in the tunnel provides a function other than for walking or transportation purpose. Notwithstanding a moving walkway meets this criterion, it is still not a preferable facility as it will change the travelling speed in the space; furthermore, the division it creates might also play an unwanted role in the space perception (See Fig. 1.4).

In summary, there are four criteria set for selecting the pedestrian tunnel for this study: 1. It is a long tunnel that the length to height ratio is larger than 20; 2. It is a pedestrian-only tunnel that no biker or automobile shares the underpass; 3. It is a tunnel of low traffic that the pedestrian flow rate should be less than 10 p/min/m and 4. The tunnel space should be solely a passageway. These criteria, shown in Table 1.1, set the contextual scope of this project.

Tunnel Length/Height	Tunnel Transport Type	Pedestrian Flow Rate	Function
L/H > 20	Pedestrian only	10 p/min/m	Passageway only

Table 1.1 The criteria of the pedestrian tunnel for this project

1.3.2 Maastunnel

Through the above criteria, Maastunnel in Rotterdam has come under the scope. Maastunnel was built in the 1940s and it goes under the Meuse river, connecting both sides of the riverbank in Rotterdam city. Although Maastunnel provides all kinds of transportation of cars, bikers and pedestrians, they don't share a common space. In this arrangement, the Maastunnel is actually a bundle of four isolated tunnels, two car tunnels for south- and northbound, one for bikers and one for pedestrians (Fig. 1.5). On the ground, there is an entrance building on each side of the riverbank for pedestrians and bikers (Fig. 1.6a&b). After entering the building, the pedestrians need to take the escalators, which also carry bicycles, to the underground (Fig. 1.6c&d). The pedestrians first reach the level of cycling tunnel (Fig. 1.6e) and they need to step further downstairs (Fig. 1.6f) to the pedestrian tunnel (Fig. 1.6g). Since only the pedestrian tunnel is our interest in this research, the word 'Maastunnel' hereinafter stands exclusively for the pedestrian sector in the following contents.

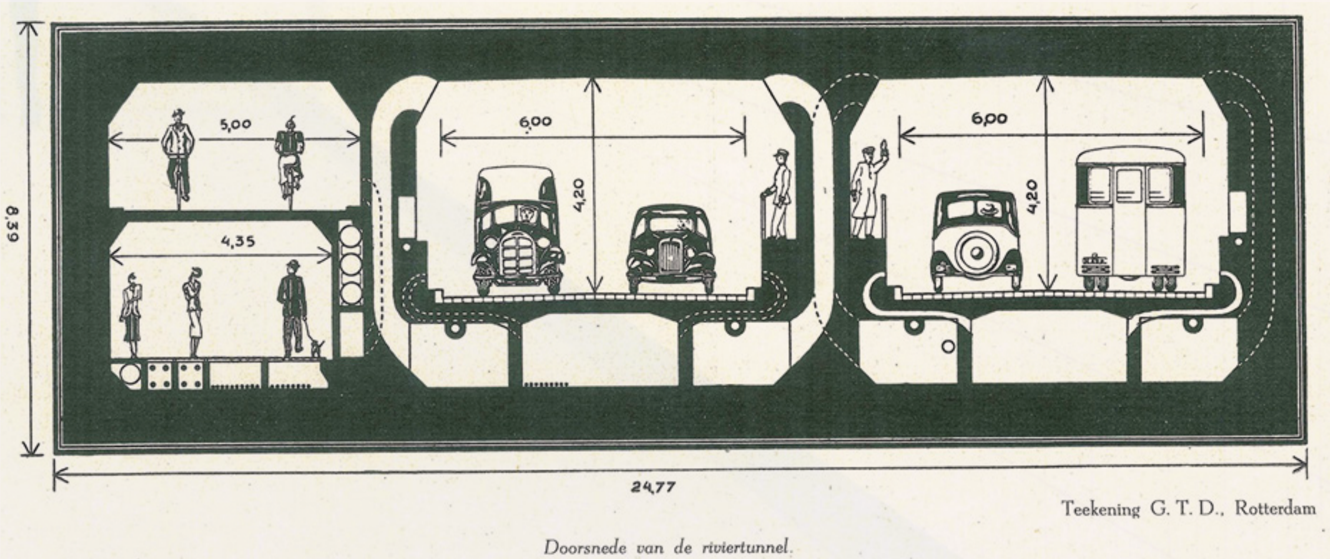


Figure 1.5 Cross-section of Maastunnel

Figure 1.6 Maastunnel from entrance on the ground to the entrance of the pedestrian part. These photos were taken around 4pm on a weekday. As seen in the photos there are very amount of people using the tunnel, implying the unpopularity of Maastunnel.

For a pedestrian tunnel, the length of Maastunnel is exceptionally long--about 550 metres. Compared to its height which is measured as 2,65 metres, the length-to-height ratio reaches beyond 200. Besides of the length, the fact that the central part of the tunnel is lower than both ends makes the exit not visible from the entrance and the zero LTP retains in the first 45% of the walking. In a forty-minute-long observation during the rush hour (16:40–17:20) on a Friday afternoon (8 June, 2018), the total number of pedestrians was 25 people, i.e. less than 1 p/min/m of pedestrian flow rate. The dimensions of Maastunnel's cross-section measured with a measuring tape are shown in Figure 1.7.

As a tunnel built more than 75 years ago, there is no advertising board, no fancy lighting, let alone moving walkway in that tunnel. Its dullness got Studio Roosegaarde's attention in 2007 when an interactive artwork, Dune, was placed in Maastunnel (Fig. 1.8). Dune features hundreds of nature-inspired fibres each with a lighting end that responses to the presence of people. During the four months of exhibition it certainly changed the perception of the tunnel, making it an interesting place to visit. This project chooses Maastunnel as the context for not just matching the criteria of a simple pedestrian tunnel, but also move of paying tribute to the early work of Studio Roosegaarde.

Figure 1.7 Measurements of cross-section of Maastunnel

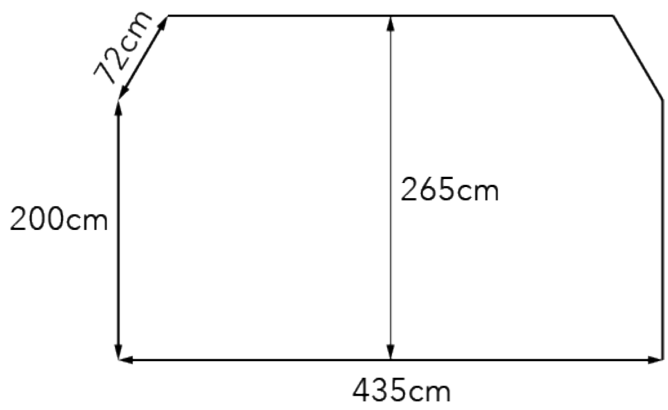


Figure 1.8 (below) A photograph the artwork 'Dune 4.1' made by Studio Roosegaarde placing in Maastunnel (pedestrian sector)

1.4 Research approach

There are two research questions to answer in this study:

What are the visual elements that affect the space perception in a pedestrian tunnel?

How can the perceived space of a pedestrian tunnel be enlarged by using mirrors to augment or create these visual elements?

The approach to answer these questions varies according to the subject of study. In Chapter 2, the author went through the literatures for identifying the visual elements that may influence the tunnel space perception. Through the scrutiny in literatures and previous works, several visual elements related to tunnel space perception will be identified. By the same approach the mirror space perception regarding distance and authenticity is introduced. The purpose of the literature review is to disclose the intersection zone of tunnel space perception and the visual cues that can be controlled by mirrors (Fig. 1.9). In Chapter 3, these visual cues with potential will be rated by an online questionnaire with two dozens pictures of pedestrian tunnels. This evaluation reveals the correlation between the visual cues and the sense of spaciousness in pedestrian tunnels. Thereafter the survey, the most prominent visual cues will be manifested.

In Chapter 4 and 5, mirror installations that are designed to alter the space perception in different ways were put to test in the scale models of Maastunnel. Mirrors in the physical models create an genuine optical effect, thereby providing a evaluation that is more reliable to the observers than a picture rendering. Through the observation evaluation, the insights of how people perceive the visual effects of mirrors in Maastunnel will be revealed. These insights will be synthesised into the design guidelines for designing a pedestrian tunnel with mirrors for enlarging the perceived space can be formulated.

In order to demonstrate the usage of the guidelines, this work will present a concept for redesigning Maastunnel with mirrors. This redesign is not just an illustration of the guidelines, but also a self-evaluation of how well the guidelines work. A final evaluation will be conducted to assess if the design reaches its goal: to make the perceived space larger and to transform the tunnel more pleasant.

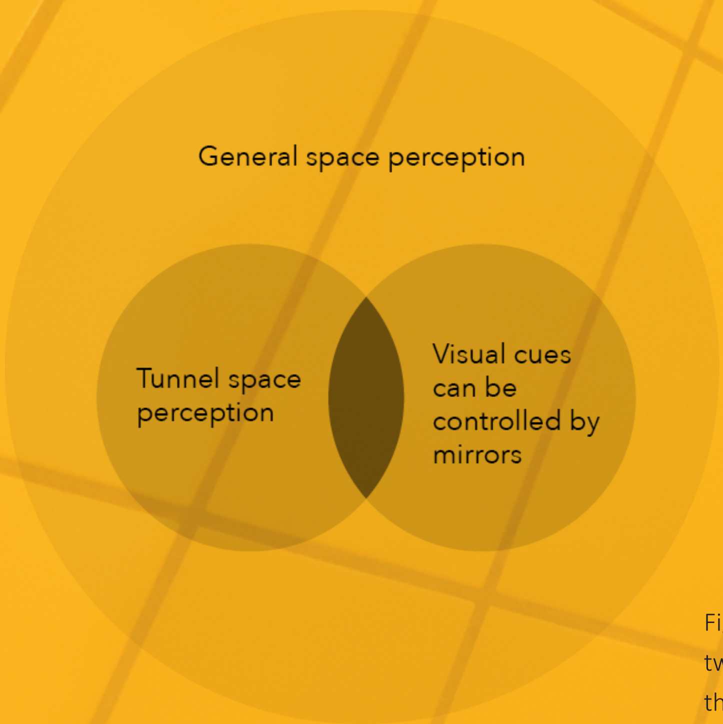


Figure 1.9 A schematic expression of the intersection of two sets representing the visual cues in a tunnel space and the visual cues that the mirrors can alter. Note that the area in this illustration poses no other information.

References

Schreuder, D. A., (25 Feb 1964). The lighting of vehicular traffic tunnels. (Doctoral dissertation, Technische Hogeschool Eindhoven, Eindhoven, the Netherlands) Retrieved from https://pure.tue.nl/ws/portalfiles/portal/3645596

Centre D'etudes Des Tunnels. (8 Mar 2017). CETU tunnel lighting guidelines Chapter 3: Lighting of short tunnels. Retrieved from http://www.cetu.developpement-durable.gouv.fr/IMG/pdf/cetu_lighting_of_short_tunnels.pdf

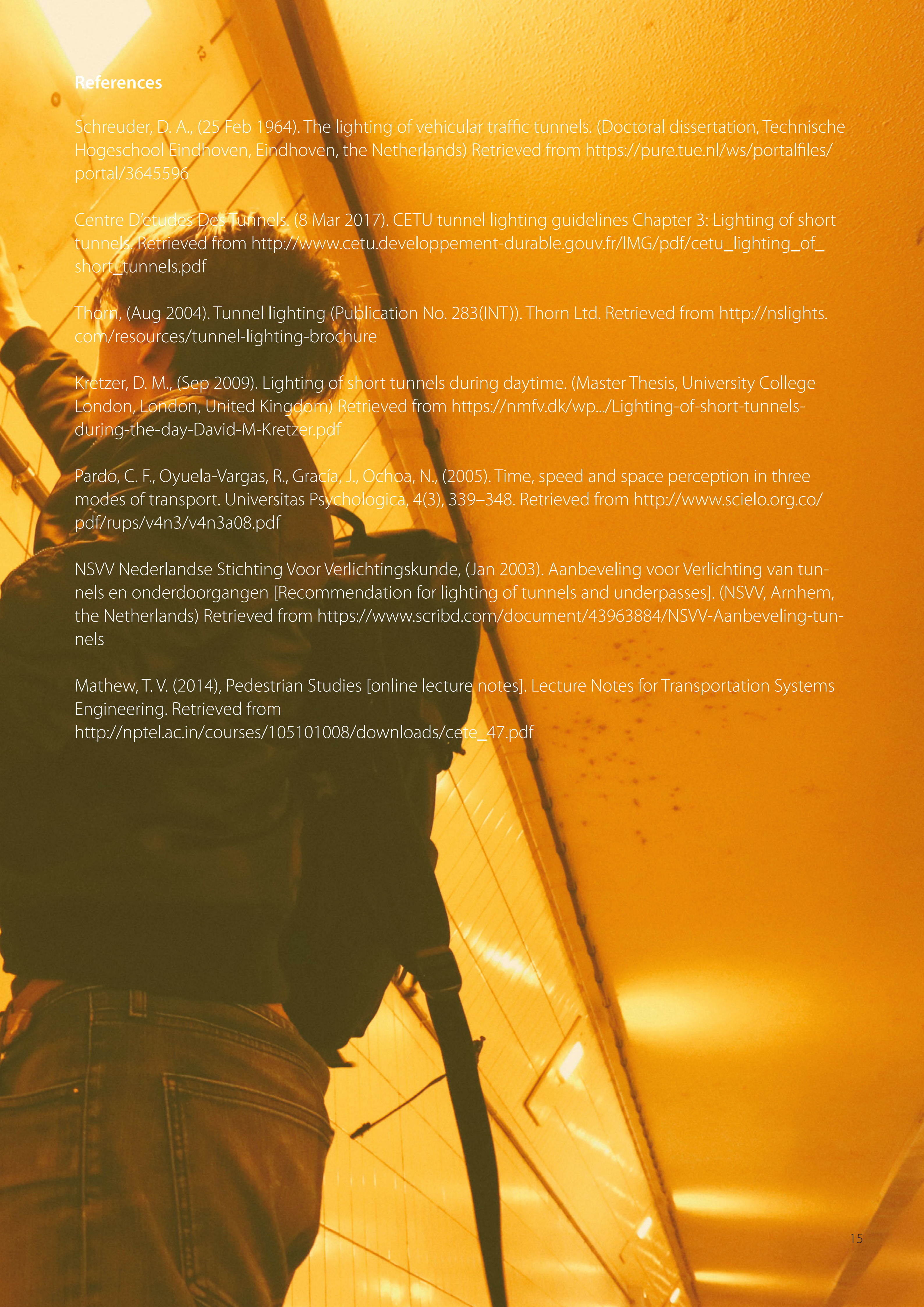
Thorn, (Aug 2004). Tunnel lighting (Publication No. 283(INT)). Thorn Ltd. Retrieved from http://nslights.com/resources/tunnel-lighting-brochure

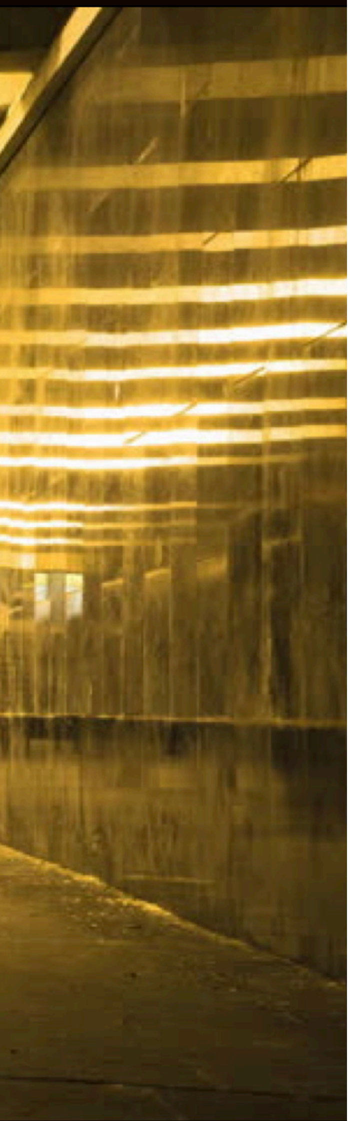
Kretzer, D. M., (Sep 2009). Lighting of short tunnels during daytime. (Master Thesis, University College London, London, United Kingdom) Retrieved from https://nmfv.dk/wp.../Lighting-of-short-tunnels-during-the-day-David-M-Kretzer.pdf

Pardo, C. F., Oyuela-Vargas, R., Gracía, J., Ochoa, N., (2005). Time, speed and space perception in three modes of transport. Universitas Psychologica, 4(3), 339–348. Retrieved from http://www.scielo.org.co/pdf/rups/v4n3/v4n3a08.pdf

NSVV Nederlandse Stichting Voor Verlichtingskunde, (Jan 2003). Aanbeveling voor Verlichting van tunnels en onderdoorgangen [Recommendation for lighting of tunnels and underpasses]. (NSVV, Arnhem, the Netherlands) Retrieved from https://www.scribd.com/document/43963884/NSVV-Aanbeveling-tunnels

Mathew, T. V. (2014), Pedestrian Studies [online lecture notes]. Lecture Notes for Transportation Systems Engineering. Retrieved from
http://nptel.ac.in/courses/105101008/downloads/cete_47.pdf





Chapter 2 Visual Stimuli in Space Perception

2.1 Visual Cues in Space Perception

“Space perception is a process through which humans and other organisms become aware of the relative positions of their own bodies and objects around them.” (Space perception, 2017) To human beings, space perception involves several sensory systems, environmental elements and cues. Among those sensory inputs, the sense of sight is no doubt the most dominant one to space perception. The holistic visual space perception is established when the light around us falls in the field of view, reaches the retina and interpreted by our brain. Notwithstanding the visual perception process is essentially determined by how our eyes and brains interpret the projected image on the retina (Carterette and Friedman, 1975), it is more important for architects and landscape designers to understand the visual cues in the environment to design.

2.1.1 Depth perception for general space

Space perception can be further classified as ‘Distance perception’ and ‘Depth perception’. Distance perception is an all-inclusive term generally describes the perception of the distance between the observer and an object or distance between two or more objects. Depth perception describes more specifically about the distance in front of the observer’s eye towards an object or surface (NIRE, 2004). In the field of architectural space, it is the depth perception that actually matters (Michel, 1995). Professor Lou Michel in his renowned book listed 11 visual cues for depth perception and among them only six of them can be controlled when designing an architectural space. These visual cues are discussed hereinafter:

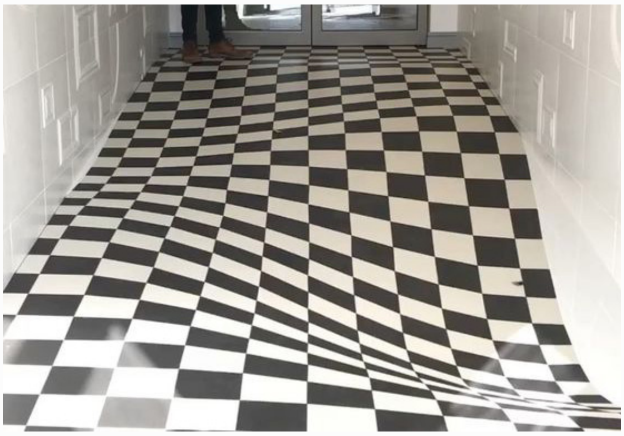


Figure 2.1 A photograph showing how perspective grid changes our perception of a flat floor

1. Linear perspective:
Linear perspective or the perspective grid originates from the projection angle of objects to our eyes. It forms the converging lines that meet at a ‘vanishing point’. Manipulating the perspective grid may strongly change the space and its surface as shown in Fig. 2.1. According to Prof. Michel, designers can put extra converging lines in the space, making it appear longer towards the vanishing point. An example applied on a pedestrian tunnel can be found in Fig. 2.2.

Figure 2.2 A pedestrian tunnel with excessive converging lines which elongate its perceived length

2. Relative size
The way we perceive the space are subjected to our previous experience (Perren & Mlecek, 2015). A known object which poses a certain general size may serve as a reference to its surrounding space. It also tells its distance to the observer as the farther the object is, the smaller its projection on the retina. In Figure 2.3, the bike in the tunnel makes the tunnel seem more cramped; the reader can use his/her finger to block the bike in the picture to neutralise this effect.

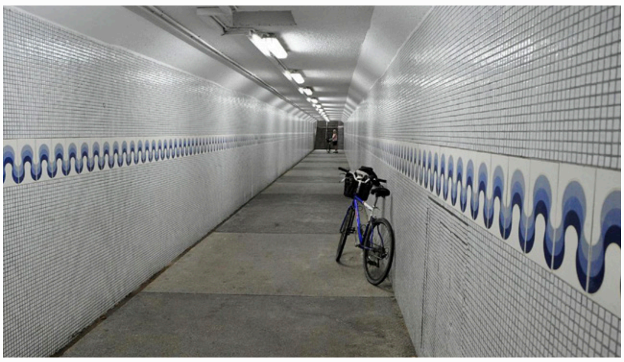


Figure 2.3 Try to cover the bike with your finger to see the relative size effect

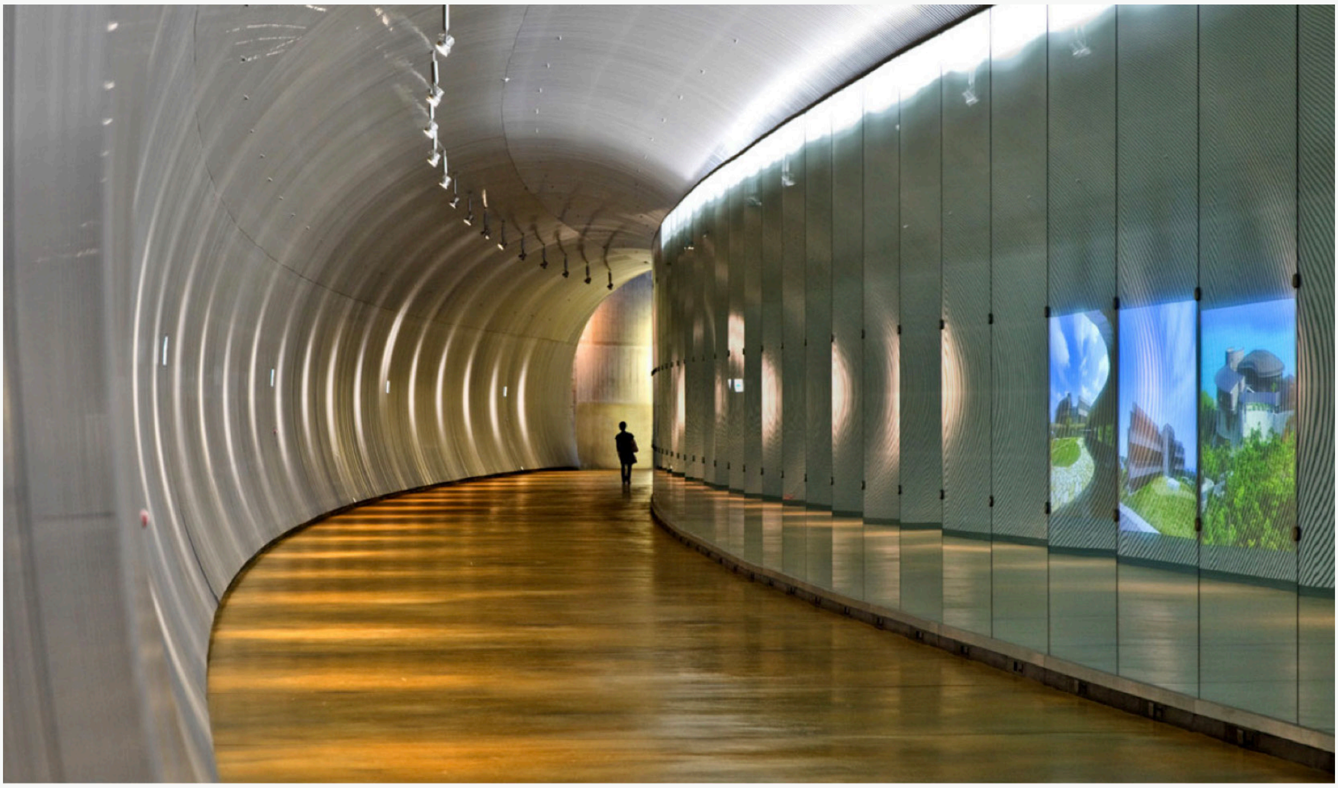


Figure 2.4 The curved wall in this tunnel have a reversed texture gradient (presented as light strips)
[Image source: http://www.sankikeiso.co.jp/agri_case_okinawauniv.html]

3. Texture gradient
If one looks right straight to a slanted surface, the texture at the farther end is more compressed to a side wall, the texture at the closer end is more visible (as shown in Fig. 2.3). Texture gradient is proportional to the steepness of the slant yet it might have a reverse gradient on a curved side wall as shown in Figure 2.4.

4. Superposition
When two objects have some overlaps in the projected image to the observer's eye, he or she can determine which one is closer based on the visual occlusion (Fig 2.5). This is not a handy-to-control visual cue in a normal space as the superposition may be compromised when people change their viewing angle. In this logic, tunnels could be good places to design an illusive superposition.

5. Relative Brightness
In a scene, a brighter object appears closer than a darker one when all the other depth cues appear the same. Note that this rule applies to an object and it concerns the relative brightness; it is contrary to the absolute brightness of a space or an entire wall as described in the following section (2.1.2).

6. Shadow
With shadows a sense of depth can be easily created. Shadows may also draw people's attention or build a contrast in spaces. The Amsterdam Central Station Tunnel is a good example of using lights and the colour of the pavements to enhance the shadows (Fig. 1.6).

6. Blurriness
In addition to the above visual cues listed by Prof. Michel, Read suggested that blurriness is the visual cue have been overlooked. When we focus on an object of certain distance, the other objects that is either much closer or farther to us will blur out. Such a depth of field gets more salient when a closer object is focused but it also works for a longer distance. According to Read, it can be more dominating than the visual disparity cue when the object is at least 30 cm away (Read, 2012).

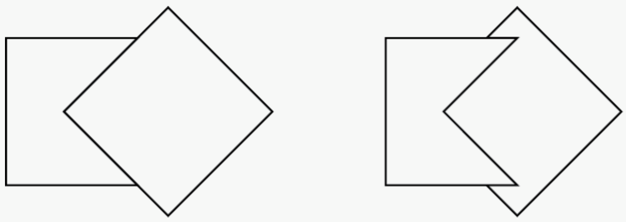


Figure 2.5 Illustration of how visual occlusion works
(Source: Michel, L. (1995))

2.1.2 Visual cues for indoor space perception

The above visual cues are concluded from general architectural spaces. A pedestrian tunnel usually classified as an outdoor space is in fact more close to an elongated indoor space. Because of the space confinement, more visual cues may play significant roles in addition to the above mentioned ones:

8. Brightness of the room
It has been known that a room of higher illumination is perceived bigger (Martyniuk et al. as cited in Coeterier, 1994). Simply light up the ceiling, known as the cove lighting, is also an efficient way to boost the spaciousness (Yücetas, 1997; Manav & Yener, 1999). Durak et al. have shown that highly illuminated wall washing light also leads to a larger perceived room size (Durak, Olguntürk, Yener, Güvenç, & Gürçınar, 2007).

9. Colour of the room (light)
An office with white painted walls has been found perceived more spacious than an office with green or red painted walls (Kwallek, as cited in Odabasşioğlu & Olguntürk, 2015). It is also found that changing the colour of lighting has the similar effect as changing the paint of walls; the white lit room is perceived more spacious that the hued lit room and the room lit with greenish light is perceived larger than which lit with reddish light (Odabasşioğlu & Olguntürk, 2015).

10. Density of object
An increase of furniture density in a room leads to a negative effect in perceived room size (Imamoglu as cited in Coeterier, 1994). In the scene of an open field, the presence of loose elements including trees, pylons and cattles also make the space perceived smaller (Coeterier, 1994).

11. Length-to-width ratio
For a rectangular room with a fixed floor area, Sadalla and Oxley found that the more elongated the room is, the larger the floor size is perceived (Sadalla & Oxley, 1984). A tunnel is practically an elongated room with the length of the tunnel is unchangeable. It is worth discussing whether the increment in width, as it would effectively reduce the length-to-width ratio, will enlarge or dwindle the perceived space.

12. Height-to-width ratio
According to Hayward and Franklin, the height-to-width ratio of an roofless space is strongly related to the openness-enclosure ratings: The taller the wall is, the more enclosed the space is perceived (Hayward & Franklin, 1974). Coeterier applied this to an open field scene and found out that the higher the boundary is, the smaller the ground size is perceived (Coeterier, 1994). It is reckoned that the height-to-width ratio will be one of the most controllable visual cue to mirrors in a pedestrian tunnel space.

As one can see there are several visual cues involved in space perception. While a single visual cue may determine how we perceive a space, multiple visual cues are usually coexisting. The space perception is ultimately the summation of all the present visual cues. In a tunnel space, some visual cues such as relative size and the density of object are usually uncontrollable while some others like the brightness and the aspect ratios (length-to-width or height-to-width) are more likely to be altered. Since both the uncontrollable and the controllable visual cues will coexist in a pedestrian tunnel, one of the major job of a designer will be to guide the people's attention to the visual cues that matter.

2.2 Mirror Space Perception

Mirrors are one of the first kind of optical devices that human has exploited. Although its working principle, the Law of Reflection, has been well and widely known in the modern society, people still get wonders when a genius mirror trick is presented (for instance, see Figure 2.6). Optically, a mirror simply strikes the ray of the light back by the same but in-the-opposite-direction angle (Fig. 2.7). When one looks into the mirror, his/her own image appears in the mirror at the distance double of which in between the observer and the mirror surface (Fig. 2.8). Just like of physical space perception, however, the mirror space perception does not always genuinely reflect the optical results.

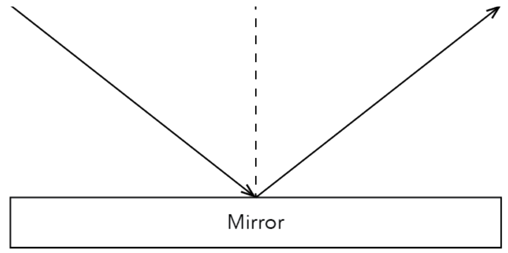


Figure 2.7 The basic law of reflection. The flip of ray direction is straightforward by easily overlooked.

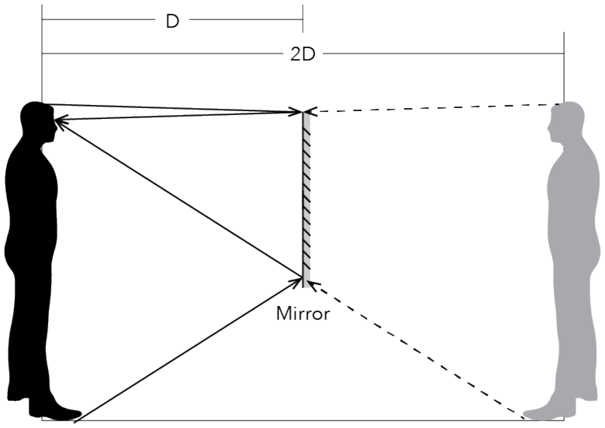


Figure 2.8 The apparent distance

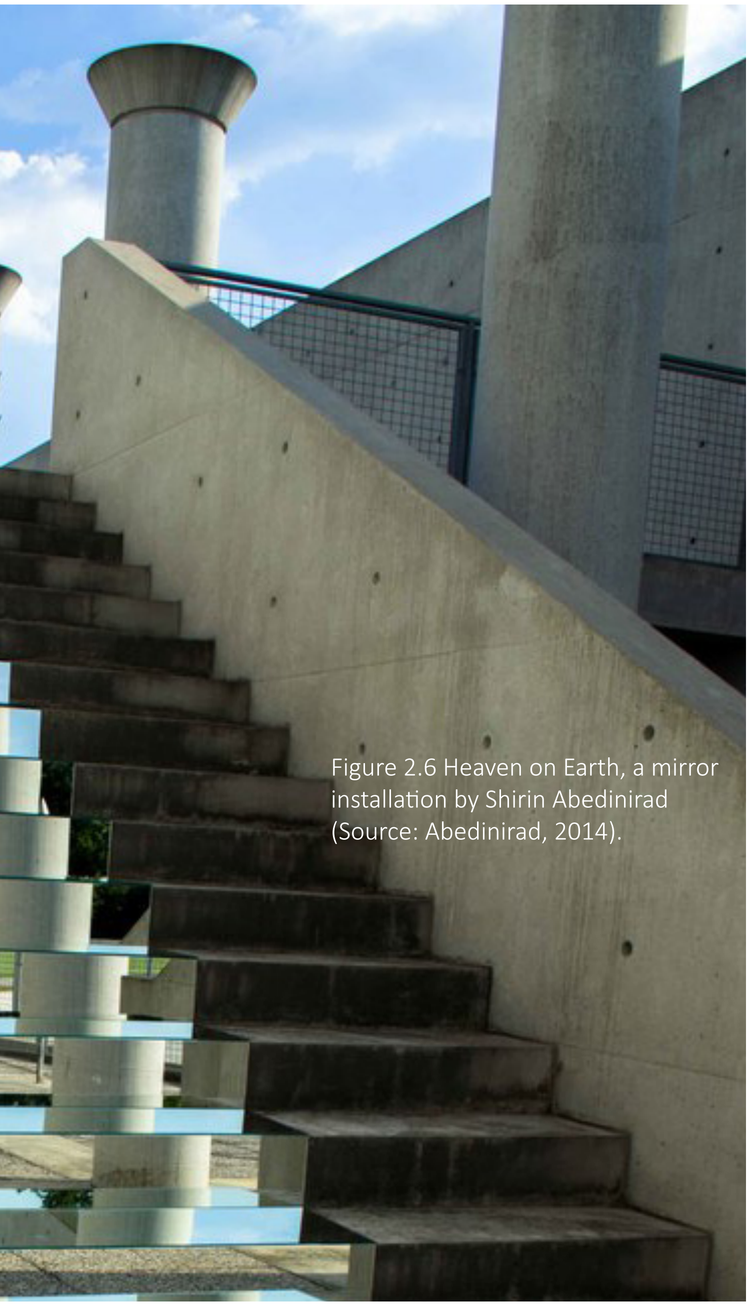


Figure 2.6 Heaven on Earth, a mirror installation by Shirin Abedinirad (Source: Abedinirad, 2014).

In perception, according to the ecological arguments, we perceive what the structure of the light specified, that said, we perceive the optical ray strikes back from the mirrors as a normal world (Wilson, 2011). The problem is, however, do we also perceive the catoptric (reflected) space as the same size as its physical counterpart? Lawson et al conducted an interesting research about how people judge the size of an object in a mirror. They prepared two identical sticks, one behind of a glass window and the other in front of a mirror. Observers are asked to judge the physical size of the stick itself and the projected size of which on the window or on the mirror surface. Although their main findings are about the overestimation of the projected size, they also verified that there is no significant difference in the physical size estimation between a catoptric image and a real image (Lawson, Bertamini & Liu, 2007). It is worth mentioning that in their experiment, when observers were standing in a far distance (6 metres), the estimated size of the stick was about 10–30% larger than it actually is. They speculated the false elongation was due to a slight distortion that only became distinguishable in the far distance (Lawson, Bertamini & Liu, 2007). In the real space, the egocentric distance perception does not directly translate to exocentric distance perception. (Kelly et al., as cited by Šikl & Šimeček, 2011). Such a disagreement also seemingly exists in a mirror space perception. In Higashiyama and Shimono's experiments, they found that when the object in the mirror is 45 metres away, the observers underestimated such a distance by as much as 50% (Higashiyama & Shimono, 2004). If this applies to a space-size perception, it could consequently jeopardise the space doubling ability of mirrors.

Besides of the mismatch in distance and size perception between the virtual (catoptric) world and the real world, the objects in the mirror image have found to be perceived less real (Sareen, Ehinger & Wolfe, 2014). In the experiments conducted by Sareen et al, objects in the mirrors received less attention than those are not, even though the observers were seeing the entire scene only on a screen. Such an effect was not found when the objects were placed behind a window (Sareen, Ehinger & Wolfe, 2014). No cause or possible reason was suggested by Sareen et al for such an less-real perception. Interestingly enough, Lee and Hernándęz-Andrés's design for teaching of optics may have provided a potential way of thinking: the image in an infinity mirror tunnel gets darker and greener after each reflection thanks to the non-ideal reflectivity and the transmitting spectral properties of normal glass (Lee & Hernándęz-Andrés, 2004). Such an imperfection should be taken into account when a designer is using the infinity mirror as the extremely salient space extender (see Fig. 2.9).

Figure 2.9 A collage of mirror-based art installations showing various of infinity mirrors and how they might disorient the pedestrians in a tunnel.

References

Space perception (22 May, 2017). In Encyclopœdia britannica online. Retrieved from https://www.britannica.com/science/space-perception

Carterette, E. C. and Friedman, M. P. (Eds.). (5 Nov 1975). Visual space perception. In Handbook of Perception (Vol. V, Seeing). Reprinted version retrieved from http://people.csail.mit.edu/whit/reprints/visual_space_perc.pdf

NIRE, The National Institute for Rehabilitation Engineering (2004). Visual distance perception & depth perception. Retrieved from: http://www.schepens.harvard.edu/images/stories/nire/distance-perception.pdf

Michel, L. (1995). Light: the shape of space. New York, NY: Van Nostrand Reinhold.

Perren, C. and Mlecek, M. (2015). Perception in architecture: Here and now. Newcastle upon Tyne, UK: Cambridge Scholars Publishing.

Read, J. C. A. (2012). Visual perception: Understanding visual cues to depth. Current Biology 22(5), R163-R165. https://doi.org/10.1016/j.cub.2012.01.048

Coeterier, J. F. (1994). Cues for the perception of the size of space in landscapes, Journal of Environmental Management 42, 333-347.

Durak, A., Olguntürl, N. C., Yener, C., Güvenç, D., & Grücınar, (2007). Impact of lighting arrangements and illuminances on different impressions of a room, Building and Environment 42, 3476-3482.

Yücetas, B. (1997). Effects of different lighting arrangements on space perception. (Master Thesis, Bilkent University, Ankara, Turkey).

Manav, B., Yener, C. (1999). Effects of different lighting arrangements on space perception. Architectural Science Review 42, 43-57.

Sadalla, E. K. and Oxley, D. (1984). The perception of room size: The rectangularity illusion. Environment and Behavior 16(3), 394-405.

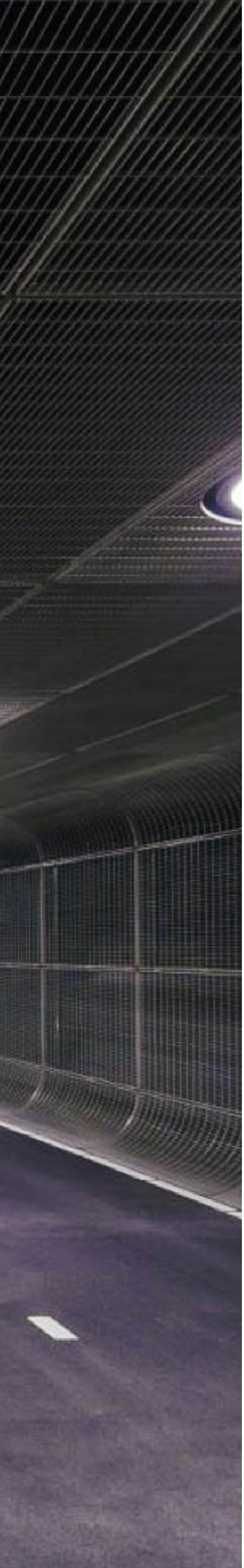
Hayward, S. C. and Franklin, S. S. (1974). Perceived openness-enclosure of architectural space. Environment and Behavior 6(1), 37-52.

Wilson, A. (16 Aug, 2011). Mirrors are literally windows to another world. Retrieved from http://psychsciencenotes.blogspot.com/2011/08/mirrors-are-literally-windows-to.html.

Lawson, R., Bertamini, M., and Liu, D. (2007). Overestimation of the projected size of objects on the surface of mirrors and windows. Journal of Experimental Psychology: Human Perception and Performance 33(5), 1027-1044.

Higashiyama, A. and Shimono, K. (2004). Mirror vision: Perceived size and perceived distance of virtual images. Perception & Psychophysics 66(4), 679-691.

Abedinirad, S. (Jun 2014). Heave on Earth. Retrieved from http://www.shirinabedinirad.com/#/heaven-on-earth/



Chapter 3 Perception of Visual Cues in Tunnel Space

3.1 Introduction

In the previous chapter, several visual cues for space perception in both general space or indoor environment are introduced. During the introduction, the potential significance of each visual cue is shortly discussed. Nevertheless, there is no study to the author's best understanding has investigated or verified any of the visual cue in a pedestrian tunnel space. To properly assess the gravity of these visual cues, a survey correlation is conducted with pictures of different pedestrian tunnels.

The survey focuses on those most promising ones that can be controlled or enhanced by a mirror in a pedestrian tunnel space. The first and the most straightforward visual cue is the height-to width ratio. Based on the basic law of reflection, a mirror can create a copy of the real world that is identical but left-right inverted. Although some studies shows that objects in catoptric image are perceived closer than it is optically, putting a mirror in a indoor room is no doubt to extend the dimension of the room. Mirrors can be placed around the walls of the pedestrian tunnel to create vertical or horizontal extensions. In this survey, participants will be asked to evaluate the perceived height and the perceived width for each tunnel.
The second one is the brightness. Using mirrors, surprisingly, will not change the average illumination unless the mirrors reflect more light than by which the walls are covered. Still, there are several empirical guidelines can be found online that suggests using mirrors to brighten the space (Moss, 2012; Gibson, 2010). Based on the author's own interpretation, such an arrangement utilises the reflection to redistribute the light coverage while creating an image of extra light sources in the mirror. If this speculation is true, using mirrors to double or triple the number of light source may also be an effective visual cue manipulation. A similar effect can be found in tunnels with surface of high reflectivity or brilliance light.

The third sets of visual cues are not listed in the previous chapter can be deduced from one or a combination of multiple visual cues. The first one is cleanness. Cleanness is usually related to a light colour of the wall or the ground. One of the most concerned maintenance aspects about a mirror installation is its cleanness for which is not maintained will compromise the major function of mirrors, reflectivity. Using mirror inappropriately could further bring down its cleanness as pedestrian tunnels are more vulnerable to vandalisation than other kinds of tunnels (NSVV, 2003). The other one is the pattern complexity. When placing on a surface, mirror can be seen as a copy of the texture from the area it reflected. Placing a mirror in a tunnel could increase the complexity in texture distribution, creating a similar picture of a messy room.

3.2 Research Methods

Summarizing the above discussion, seven descriptors are set (shown in Table 3.1) in the survey for finding the correlation between the descriptor 'Spacious'.

Geometric dimensions			Lighting dimensions			Surface dimensions	
Spacious	Wide	High	Bright	Shiny lighting	Reflective surfaces	Clean	Complex patterns

Table 3.1 The descriptors used for finding their correlation with respect to the sense of spaciousness

The survey was conducted through an online questionnaire made with Google form. The questionnaire includes 24 pedestrian tunnels and participants were prompted to make a response to the statements in which each of the descriptor is positive. They can choose only one response from 'Strongly disagree', 'Disagree', 'Somewhat disagree', 'Neutral', 'Somewhat agree', 'Agree', and 'Strongly agree'. The pictures of the pedestrian tunnel were collected from the internet by searching with the keywords 'pedestrian tunnel' or 'underpass'. The tunnel pictures are selected according to the criteria listed in Section 1.3. Though all of the selected tunnels fulfill the criteria of having a low pedestrian density and are passageway only, the other criteria were not strictly imposed as the L/H ratio is difficult to judge from a 2D picture and some pedestrian tunnels are not forbidding the cyclists. The full selection of the pedestrian tunnel pictures can be found in Appendix A.

These pictures are divided into two groups, 12 tunnels in each group, and the tunnel of the same group are presented in the same section of Google form; within the section the sequence of the tunnel was randomly presented. Greeting words were first shown to the participants in the first section. The first group of 12 tunnels, Group A, was then presented to the participants in the second section and the Group B followed in the fourth section. Between the two groups a third section was placed for offering an exit to participants who lost of their patient and they can leave the questionnaire with a group of answer submitted. Since participants may leave with only a single group of tunnels observed, the first presented group will always have more data input than the second presented one. To compensate this, the section order of Group A and Group B were swapped after a certain amount of forms were submitted. A flowchart of such practice is shown in Fig. 3.1. The other difference between the group A and B is the order of the questions for keeping the participants' attention. In the Group A, the questions are listed in the following order: bright, clean, complex pattern, reflective surface, spacious, shiny, high and wide (as shown in Fig. 3.2); in the Group B, the order swapped as follows: complex pattern, shiny, high, wide, spacious, bright, reflective surface and clean. In Appendix B the full questionnaire can be found.

In total, there were 18 participants filled in the questionnaire. The first 11 participants were presented with Group A at the beginning and then Group B; the rest 7 participants were presented in a reversed order. Thirteen out of the 18 participants filled both groups of questionnaires, 2 participants did only Group A and 4 participants only did Group B. No personal data of the participants, including gender, sex and age, are collected but each participant was only allowed to fill in the questionnaire once. To statistically analysis the collected responses, the semantic options are translated into scores; strongly disagree to value 1, disagree to value 2, somewhat disagree to value 3, and the rest of the options are assigned to integer values accordingly. The original responses are presented in Appendix C and the translated data are listed in Appendix D.

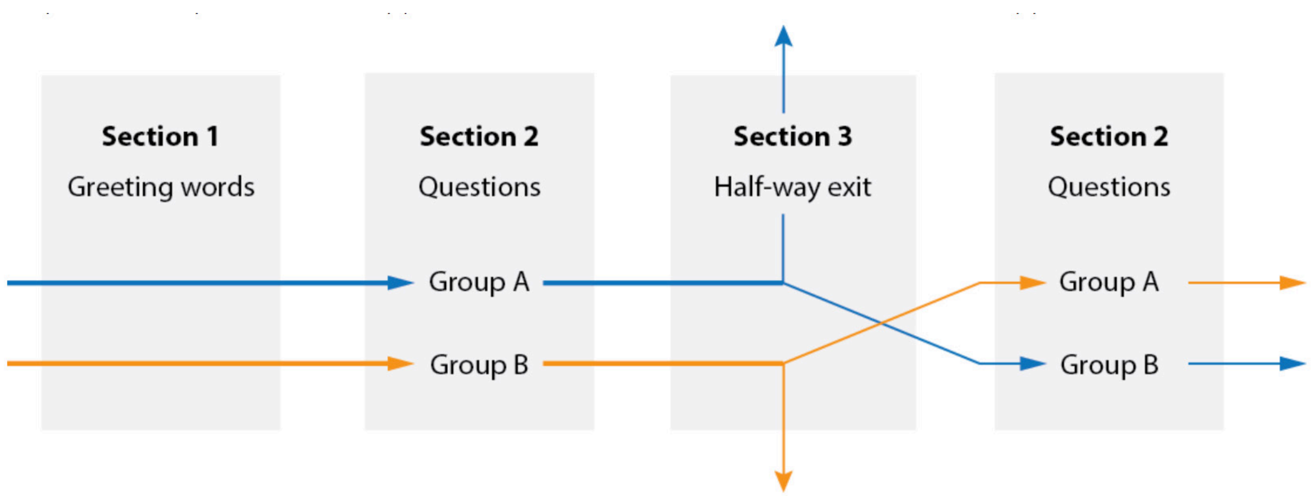
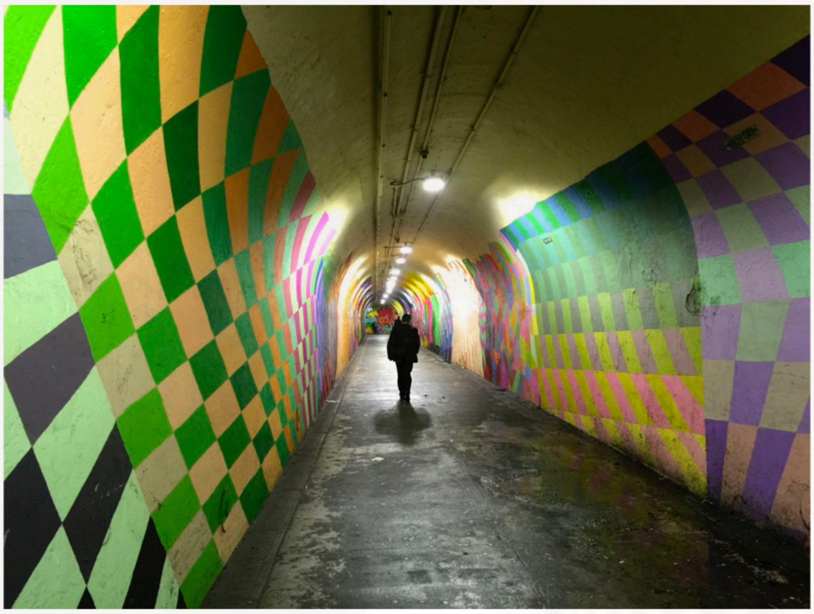


Figure 3.1 The flowchart showing the structural design of the questionnaire survey



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shiny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Figure 3.2 An example question for the tunnel visual cue survey. This sequence of question belongs to Group A.

3.3 Results and Discussion

There are 14 sets of data corresponds to tunnels in group A and 16 sets of data corresponds tunnels in group B. In the 192 columns (8 descriptors times 24 tunnels) of data, there are 122 of them have the standard deviation larger than 20% of the scale (1.2 out of 6 as the minimal is 1 and the maximum is 7). The large amount of scores having a high standard deviation suggests that people could have a very diverse perception toward the tunnel pictures based on the descriptor provided. Nevertheless, by having the maximum and the minimum data of each column trimmed, only 10 columns still remain high deviation (> 20%). The statistics is then performed with trimmed average which calculated without the maximum and the minimum value in each column. The results are listed in Table 3.2.

Table 3.2 Trimmed averages of the translated responses; the lowest possible value is 1,0 indicating 'Strongly disagree' and the highest value is 7,0 indicating 'Strongly agree

	Tunnel #	Spacious	Bright	Clean	Complex	Reflective	Shiny	High	Wide
Group A	1	3,2	4,2	4,8	2,4	3,0	2,9	3,7	3,6
	2	2,7	2,2	4,3	3,5	2,9	2,8	4,2	2,2
	3	2,8	3,8	4,0	5,1	3,4	3,6	2,2	2,1
	4	5,5	5,4	6,2	5,8	4,8	5,2	5,8	5,1
	5	3,0	2,3	2,3	5,4	2,6	2,8	4,5	3,1
	6	3,6	3,2	4,2	2,5	3,3	2,8	3,5	3,2
	7	6,2	5,6	6,1	4,4	4,8	5,1	5,8	6,3
	8	5,2	5,3	4,9	3,3	4,1	4,7	4,8	5,3
	9	5,8	3,9	5,5	4,4	4,5	4,0	5,5	5,8
	10	4,5	4,8	4,6	5,4	2,9	3,4	2,9	4,2
	11	3,7	3,8	2,7	2,2	2,8	2,4	2,7	2,7
	12	4,9	5,2	5,5	4,3	4,3	4,5	3,3	5,1
Group B	13	4,6	3,2	4,3	3,4	3,2	2,6	2,5	4,8
	14	5,1	4,0	5,6	4,1	3,7	3,3	4,5	5,1
	15	4,6	5,6	5,5	3,9	4,0	4,9	5,5	4,4
	16	3,9	4,2	5,3	4,6	4,3	4,1	4,0	4,2
	17	4,7	5,5	5,8	4,1	5,4	5,4	5,3	3,9
	18	3,6	3,6	3,7	3,9	2,9	4,1	3,3	4,1
	19	2,1	3,8	3,6	3,4	3,4	4,1	3,4	1,9
	20	3,4	3,6	4,0	2,6	3,1	2,9	2,6	3,8
	21	2,9	3,9	3,6	5,9	2,5	3,8	2,0	3,1
	22	3,9	3,0	3,4	3,6	3,3	2,9	3,2	4,8
	23	3,1	3,9	3,3	1,6	3,9	3,9	3,0	3,4
	24	3,2	4,1	3,8	5,4	3,4	3,6	3,2	2,9
		Multiplier	0,71	0,77	0,17	0,96	0,62	0,61	0,85
		R-square	0,404	0,582	0,035	0,474	0,263	0,424	0,857
		p-value	0,001	0,000	0,383	0,000	0,010	0,001	0,000

The linear correlation between each of the visual cue rating and the mean rating of spaciousness are calculated. The multiplier listed at the bottom of the list is the linear constant of the fitting line. The R-square is the coefficient of determination denoting the correlation level between each visual cue and the sense of spacious in pedestrian tunnels. The p-value is calculated with 2-tail t-distribution model and the null hypothesis is zero correlation between two sets of sample, one belongs to spaciousness and the other belongs to one of the visual cues.

Although it is a statistically small sample pool (14 sets and 16 sets for group A and group B, respectively), from Fig. 3.3 one may find that the sampling pool has no strong bias and the distribution is close to a normal distribution (Fig. 3.3). This suggests that these 24 tunnels can be a representative of the general pedestrian tunnel adequately in terms of spaciousness.

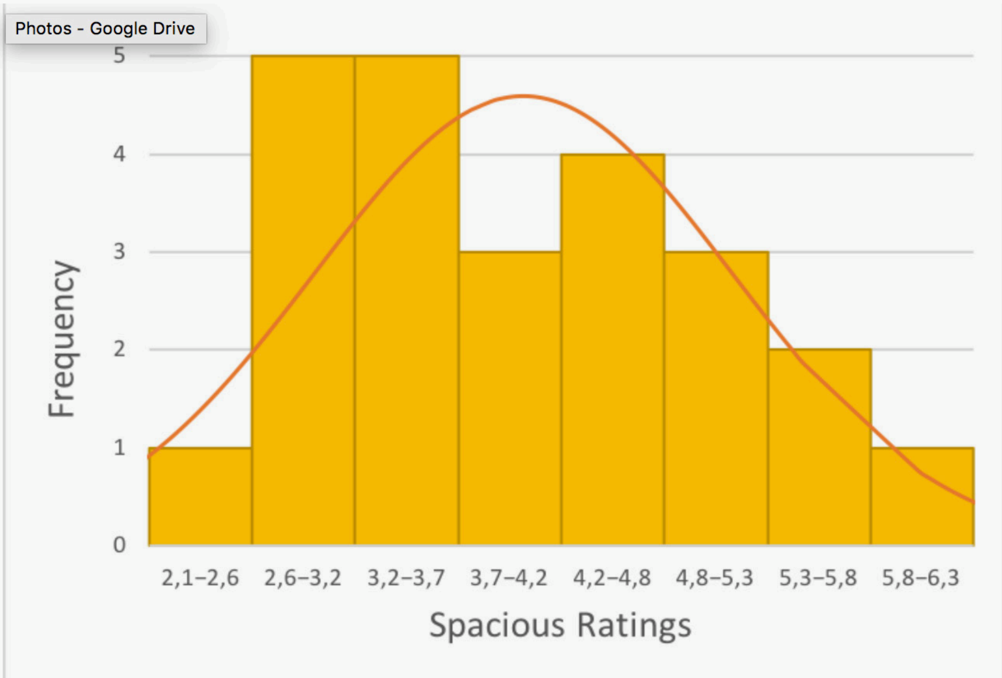
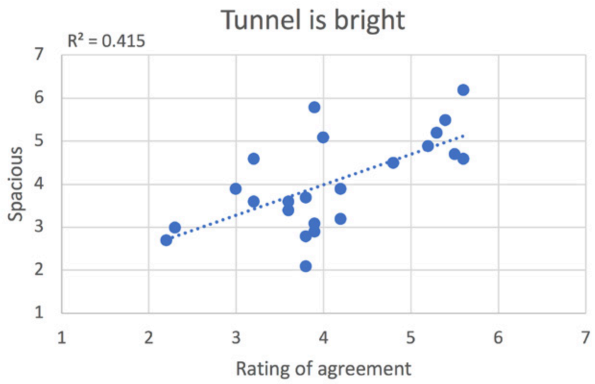
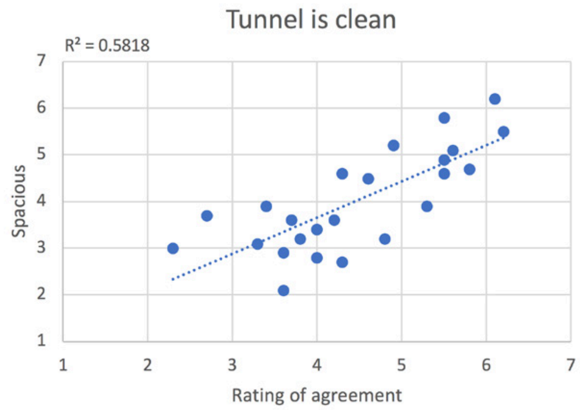
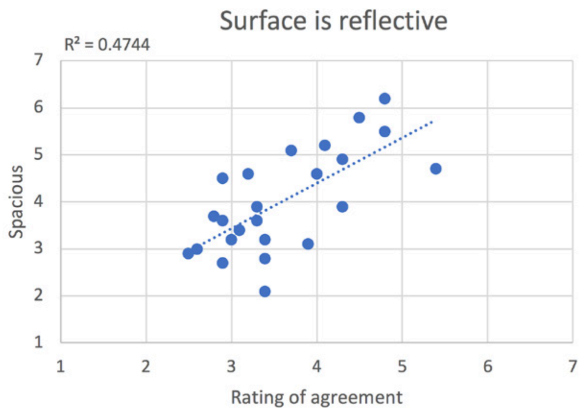
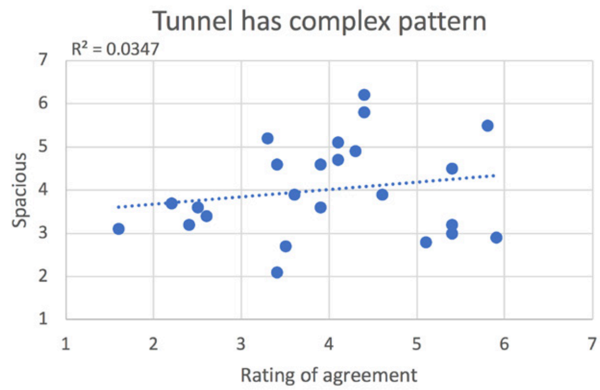


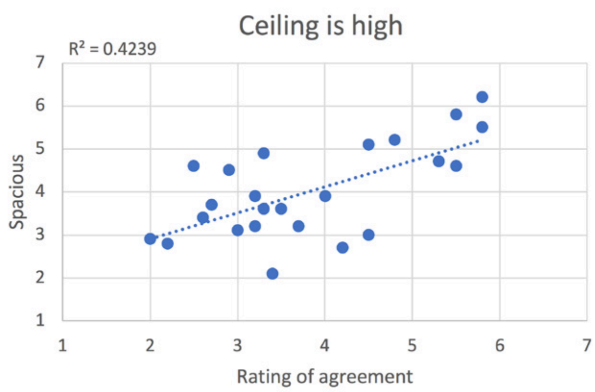
Figure 3.3 Histogram chart of spacious rating from the 24 presented tunnels in this survey; the red curve is the normal distribution fitting curve, the fitted R2 is 0,66

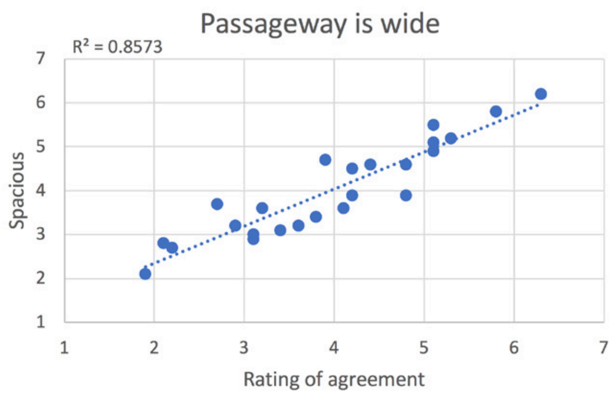












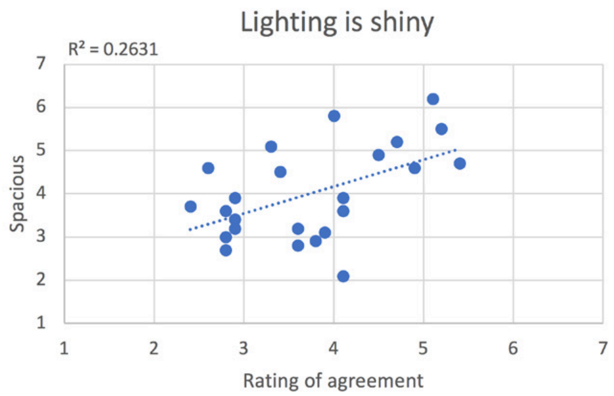


Figure 3.4 The scattered chart of each visual cue ratings against to the ratings of spaciousness. Dashed line indicates the linear trendline and the R-square is listed on the top-right corner of each chart. All the data points illustrated here are listed in Table 3.2.

In Figure 3.4, each graph presents the scattered data of each visual cue on x-axis with respect to the spacious ratings on y-axis, the trendline between the two data sets is illustrated. Correlation indications are used to determine whether each of visual cue has a significant dependence to the sense of spaciousness. According the R-square values, the width of tunnels has the strongest correlation (R2 = 0,857) to the sense of spaciousness. The height of the ceiling (R2 = 0,424), cleanness (R2 = 0,582) and brightness (R2 = 0,424)of tunnels and the reflectivity of tunnel surfaces (R2 = 0,474) are all firmly correlated with the sense of spaciousness.

Contrary to other lighting dimensions, the brilliance of the light has a weaker correlation to the sense of spaciousness. There are two possible reasons that may lead to this result: the first one is the misuse of the semantic word. Instead of using the descriptor 'Brilliant', the author mistakenly adopted the word 'shiny' which is generally used to describe the reflectivity of objects (Ganslandt & Hofmann, 1992). Such a misuse may have confused the participants, diversifying the judgements. In the trimmed standard deviation of all 192 ratings, two of the top three largest deviations (>22,5%) belong to the category of shininess. This may have hinted that there is greater disparity for people making judgement in the 'shininess of light', though of which the mean of the standard deviation is not higher than those of the other categories (for the whole table see Appendix E). The other possible reason could be the limitation of the picture evaluation. Human eyes can receive light intensity across ten orders of luminance (10–6–104 cd/m2). Compared with contrast the modern LCD can provide, usually around 1000, the brilliance level could be significantly compressed when presenting scenes with an LCD screen. On the other hand, the way we perceive brilliance also depends on the general illumination level of the environment. For instance, a military-grade flashlight with the luminance of 20,000 lumen may hardly attract our attention in a full-bright sunny day. Since participants filled the survey online, no controlled environment was provided when they made these visual judgements. Regardless, the results still suggest a certain level of correlation and the p-value of 0,01 confirms its significan

Only one visual cue is insignificant to the sense of spaciousness, the complexity of the pattern. Most of the tunnels that are rated with high complexity have obvious graffitis or a large coverage of posters on the walls. These tunnels are usually perceived as insecure or messy and hence the hypothesis was that it might also lead to a sense of cramp. The author further made a wild supposition that the complexity of the pattern might have the similar effect as the density of the furniture in a room. Such a wild guess is now found to be a false hypothesis. Nevertheless, it also denotes that introducing the mirrors in a tunnel, even with some complex patterns, would not pose a negative effect on the space perception.

Through this survey, there are five visual cues that are verified to be significant to the tunnel space perception: brightness, cleanness, width, height and the reflectivity of the wall. The shininess of the light has fair significance even though the descriptor 'Shiny' is not semantically correct to describe the brilliance of light. These findings will serve as the foundation of the following research stages: how and how much can these visual cues to be enhanced by mirrors?

References

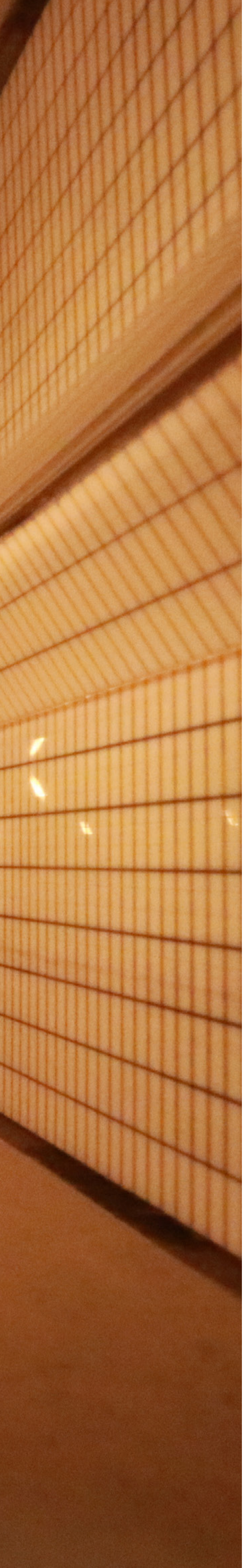
Moss, L. (10 Apr, 2012). Tricks of the trades: 5 smart ways to use mirrors in small spaces. Retrieved from https://www.apartmenttherapy.com/5-perfect-ways-to-use-mirrors-in-small-spaces-168900.

Gibson, R. (3 Nov, 2010). How to enlarge your space using mirrors. Retrieved from https://freshome.com/2010/11/03/how-to-enlarge-your-space-using-mirrors/

NSVV Nederlandse Stichting Voor Verlichtingskunde, (Jan 2003). Aanbeveling voor Verlichting van tunnels en onderdoorgangen [Recommendation for lighting of tunnels and underpasses]. (NSVV, Arnhem, the Netherlands) Retrieved from https://www.scribd.com/document/43963884/NSVV-Aanbeveling-tunnels

Coeterier, J. F. (1994). Cues for the perception of the size of space in landscapes, Journal of Environmental Management 42, 333-347.

Ganslandt, R. and Hofmann, H. (1992). Handbook of Lighting Design. Wiesbaden, Germany: Vieweg & Sohn Verlagsgesellschaft mbH



Chapter 4 Mirrors in the Tunnel: the Space Doubler

4.1 Introduction

In the previous chapter, the width of a pedestrian tunnel is found to be the most strong visual cues for people to perceive the tunnel as spacious. The height of the ceiling, though less consistent, also significantly correlates to the spaciousness. These visual cues are probably the most controllable ones for mirrors to put a spin upon. Actually, in the practice of interior design, mirrors are commonly suggested to be installed in a narrow hallway, which happens to be a space is similar to a pedestrian tunnel. By doing so, the mirror "will act to widen the space" (Fox News, 2012). Covering an entire wall with a mirror in an indoor space, it copies the real space's image by 'mirror symmetry', as a result, optically, the mirror is a space doubler. In a tunnel environment that has an elongated dimension, it is unclear if this optical trick will work just fine or it may cause any unwanted effect. Therefore, in this chapter, mirrors will be put in Maastunnel to test its effect to our visual perception.

Placing mirrors on every wall in a room can no doubt create the most extreme effect as it creates a space that extends to all dimensions to, in theory, infinity. The disorienting immersion can be as fascinating as in Kusama Yayoi's artworks (Zara, 2017) or as tormenting as Erik's 'torture-chamber' in Gaston Leroux's famous novel 'The Phantom of the Opera' (Leroux, 1910). Regardless of its aesthetic impact, on the contrary, the disorienting effect is one of the least phenomena one would expect from a pedestrian tunnel. To avoid such a result and to explore the possibilities of mirrors in Maastunnel, the lighting simulation software Dialux is utilised for quick explorations. Once a proper coverage is determined, an observer evaluation is performed by physical mirrors in scale models. Scale model provides a more immersive way to the observers and the mirror effect that the catoptric substance creates is as genuine as in a full scale space.

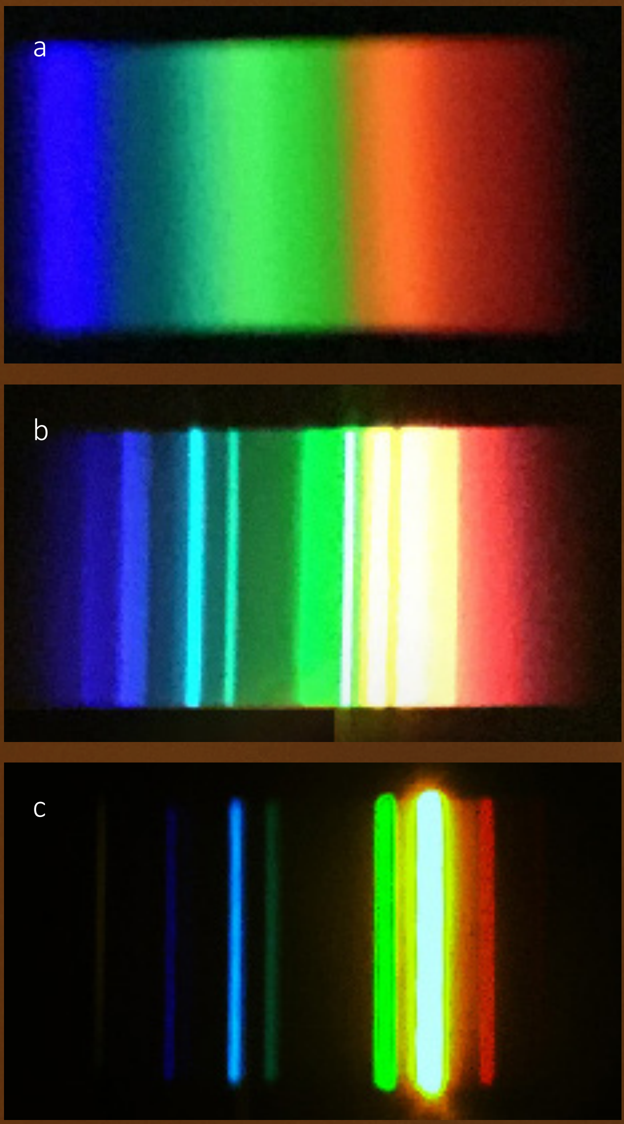


Figure 4.1 Spectrographs of (a) daylight, (b) lighting in Maastunnel and (c) LPS la

4.2 Simulation

4.2.1 Environmental settings

The tunnel model was rebuilt in Dialux with the exact measurements in Fig 1.7. Besides of these dimensions, the lighting fixture interval is 5,9 m and the two sides of fixtures are placed interdigitally. Instead of building the full 584-metre-long tunnel, only 70 metre was built with entities as half of the tunnel and the other half was created by placing a mirror at the midpoint. Using an end-mirror is not just an optional move for saving the simulation time, but also an essential trick to rebuild Maastunnel's one of the most prominent feature: the slope. According to one of the earliest archival drawing of Maastunnel, the slope of the tunnel is 1:28 (see Appendix F), i.e. it descends/ascends by 1 metre for every 28 metres of horizontal distance. In Dialux, an end-mirror with 2 degrees (obtained by taking the arctangent value of 1/28) of slant creates virtually the same scene while greatly reduces the amount of work than to build everything in an angle. Nevertheless, such a technique inevitably creates a sharp transition between the reflection and the real scene; in Maastunnel the bottom part has a curvature radius of 2.500 metres which leads a barely sensible transition.

The lighting in Maastunnel has a colour temperature appears warmer than most of the modern light. Judging by the colour rendering of the 'white tiles' in Maastunnel, the light source could be a low colour-rendering-index (CRI), high-pressure-sodium (HPS) lamp as it prevailed in street lighting in the last century. Another supporting evidence was collected with a portable spectroscope. In Figure 4.1, the difference between the spectra of a known lower-pressure-sodium (LPS) lamp (SOX55 12PK, Philips) and of the Maastunnel's light is clearly noticeable. In addition, one can also find the similarity between the captured spectrograph and the textbook reference as shown in Fig. 4.2 (Brown et al., 2015). Accordingly, the author is confident that the light source in Maastunnel is HPS lamps. Without knowing the exact fixture model used in Maastunnel, an HPS lamp of similar size is applied in Dialux simulation (see Appendix G for fixture and lamp details).

Most material textures are selected from the Dialux material library. The tile in the model has a reflective coating value of 2% for mimicking the specular reflection of tile surface; no reflective coating was set to the ceiling and the ground. All the mirrors used in the simulation have the reflection factor of 68% and the reflective coating of 90%, except for the end-mirror which was set as 85% and 90% (both are the maximum) for reflection factor and reflective coating, respectively. To accurately render the warm colour temperature of HPS light, the white balance in Dialux was set at 5000K, i.e. rendering 5000K as neutral white.

4.2.2 Dialux simulation

The rebuilt Maastunnel is presented in Fig. 4.3. Note that the dummy man on the scene is 185 cm high. The first exploration attempts to use mirrors to widen the tunnel, by placing mirrors on the sidewalls. As mentioned hereinabove, excessive mirror coverage may cause to an overwhelming spatial impression as demonstrated in Fig. 4.4 (a). To reduce such an infinity mirror effect, the exploration leads to a partial coverage and it is found that having mirrors at the lower part of the sidewalls is most desirable. There are two reasons explain why the low mirror installation is favoured: The first one is that the pedestrian cannot escape from the infinity mirror if the mirrors are placed close to the eyeheight (as shown in Fig. 4.4 (b)); by putting the mirrors at a low angle, such an disorienting effect is limited. The second one is that the ground is reflected by the mirrors when they are adjacent each other. This placement seems to be valid as it visually extends the ground size; for the reason of fluency, such an placement is coined as Catoptric-Widening (CW).

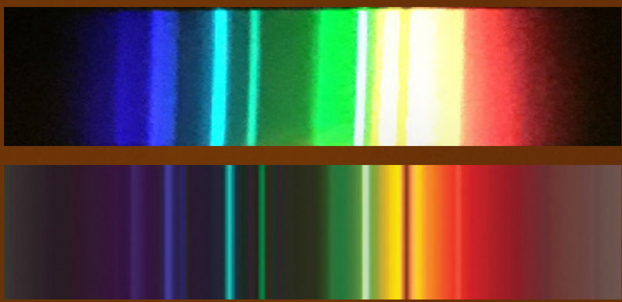


Figure 4.2 Spectrographs of lighting in Maastunnel (upper) and HPS source (lower); the captured spectrum (upper) is intentionally stretched to meet the aspect ratio of which from the textbook 'Chemistry: The Central Science' (lower)w

Figure 4.3 Rebuilt Maastunnel model in Dial

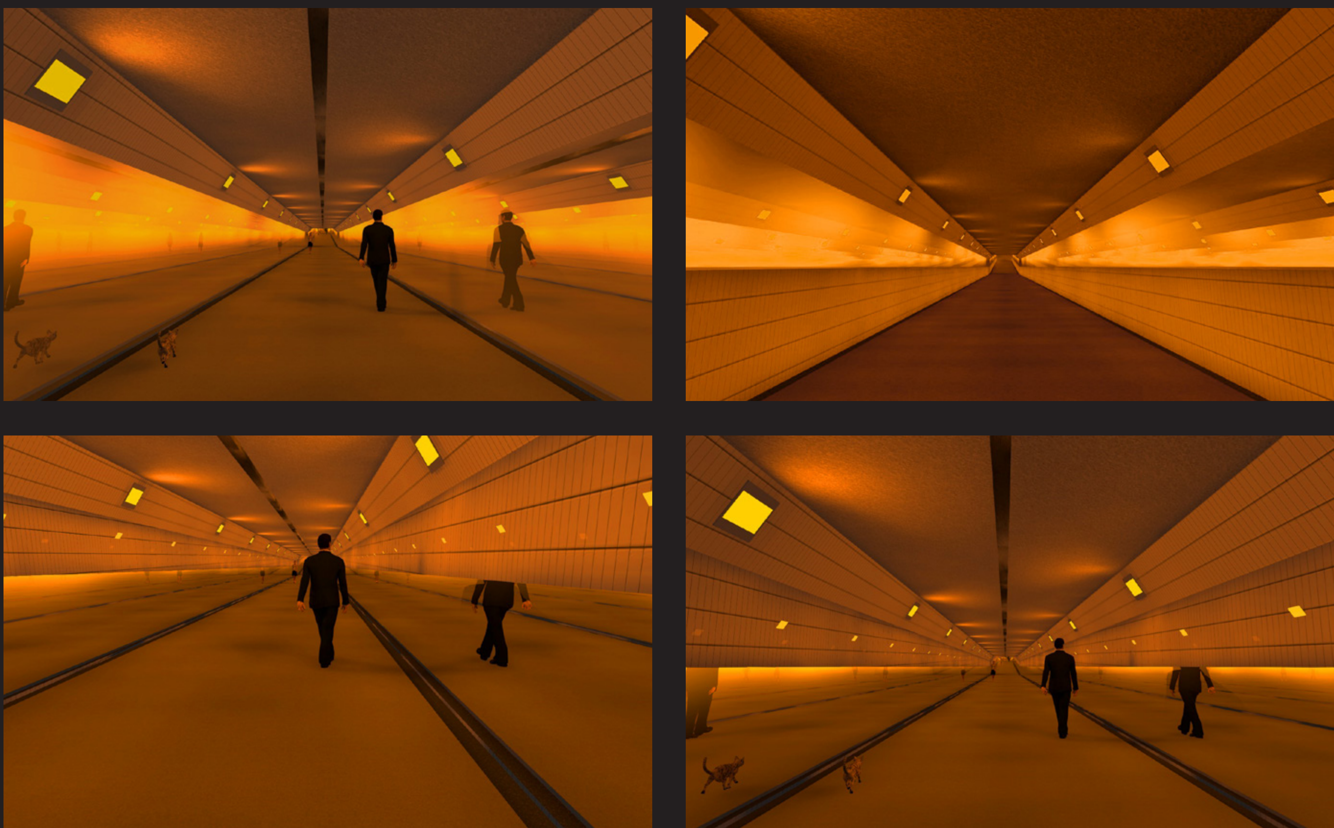


Figure 4.4 Explorations of width extension by placing mirrors on the walls

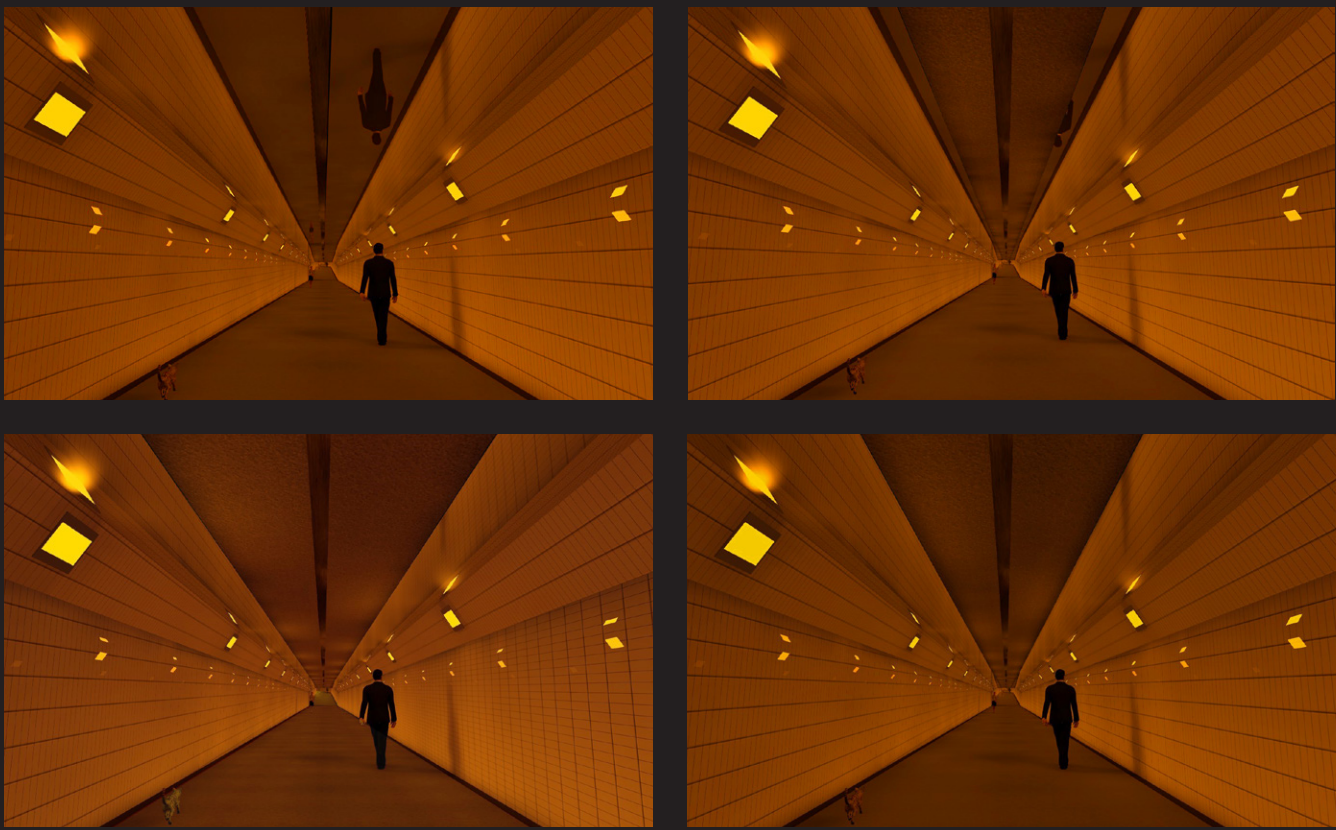
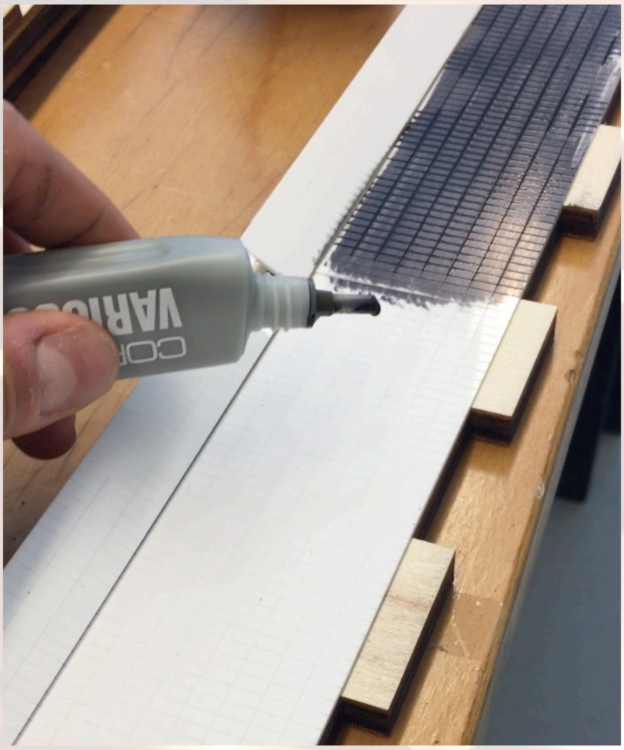


Figure 4.5 Mirror on the ceiling of Maastunnel; from the top left corner the mirror coverage rate is 100%, 70%, 60%, 50% in a clockwise order, respectively

The other exploration is about the manipulation of height. Following the same logic, the mirror on the ceiling efficaciously extends the height of the walls (Fig. 4.5). Unlike the case of CW, it is less likely that a single mirror on top would cause the catoptrophobia thanks to the absence of the infinity mirror effect. Furthermore, people can never go straight up, hence it also reduces the likelihood of being disorienting. In Figure 4.5, the four renderings show the visual effects of different coverage rates, from about 50% to full coverage. In contrast to CW, such an installation is therefore coined as Catoptric-Heightening or CH. A desirable mirror coverage rate in CH has been found to be around 60% to 70% of the ceiling in Maastunnel so that the reflection extends the wall to its maximum height to the ground is merely reflected. An excess coverage of CH does not further contribution to the heightening effet according to Fig. 4.

4.3 Scale model

With the simulation results in mind, the scale models are built for the observer evaluation. The main structure of the 1:40 scale models are made of plywood and medium-density fibreboard (MDF) via laser cutting. Given the limitation of material size and laser cutting facility, the scale tunnel is shorter than it supposed to be; the physical length of the model is 900 mm. The mirror is made of laser-cut acrylic-based mirror. According to the Dialux simulation the width of mirrors in CH is 30 mm, scaling up as 1,2 m, and the height of mirrors in CW is 25 mm, scaling up as 1 m. The front side of the scale models is lifted by a few stepping forms to create the 4,4% slope in Maastunnel. The length of the scale model is optically doubled by the end mirrors which stand vertically to the observation plane, creating the image of a tunnel that goes down and up. With the end-mirrors the apparent height-to-length ratio reaches 1:27. The full dimensions and the technical chart can be found in Appendix H. Though the structure of Maastunnel is not complicated to build, its texture and the lighting condition turned out to be challenging to imitate. The tiles, besides of having the white base and the dark grid lines, are slightly reflective. After few trials it is found that a glossy acrylic plate with laser-engraved grids works satisfactorily. The grid lines are coloured by applying the Copic ink B110 onto the engraved acrylic and later wiping away the surface ink (see Fig. 4.6). In addition, white concrete ceiling and the dark plate floor in Maastunnel was simulated with white-painted MDF and grey-painted plywood, respectively. A even darker grey was applied to the edge of the floor to give the appearance of ditche



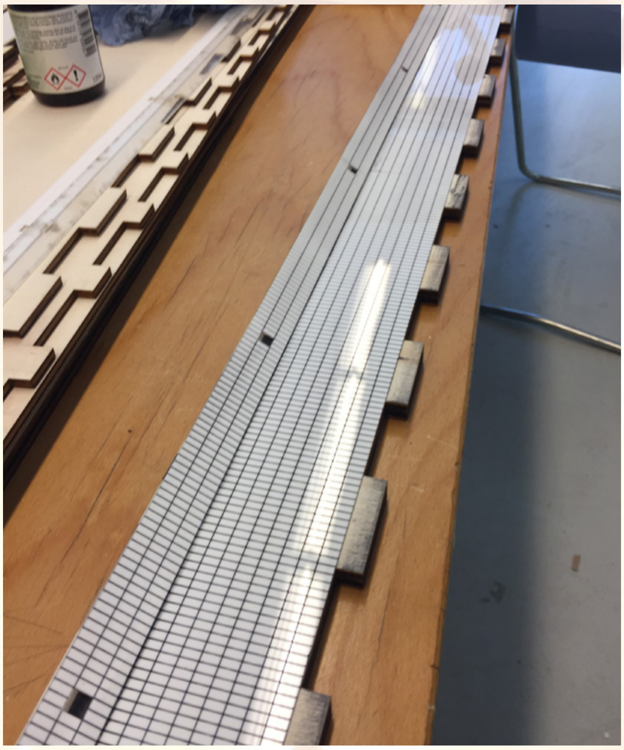


Figure 4.6 Tile imitation in scale models, the alcohol-soluble ink (B110, Copic) ensures the excess can be wiped

Figure 4.7 Different attempts for mimicking the HPS lighting: (a) Neutral white 4000K; (b) Neutral white 4000K + LED-RG; (c) Neutral white 4000K + Filter-RY; (d) LED-R + Filter-Y; (e) LED-RG; (f) LED-RG + Filter-R; (g) No lighting showing the Filter-RY at the left side; (h) Extra warm white 2100 K.

The attempt to imitate the HPS lighting is much more gruelling since there are more technical criteria to be met: the faint luminance, the extra warm colour temperature and the most challenging one—the low CRI. The most straightforward answer seems to be an authentic HPS lamp. However, the light spread from a distant light source (since there is no miniature HPS lamp exists) can only cast the pattern of the square openings in the scale model. Only a point light source locates at the proper position in the scale model can recreate the iconic light stripes in Maastunnel. Consequently, that leaves only the LED lights or traditional tungsten bulbs are the plausible choices. Nevertheless, none of these light sources can have a low CRI as HPS lamps have. The failed attempts, including using RGB-controllable LEDs and colour filters are unsatisfied (see Fig. 4.7). The final solution (Fig. 4.7 (h)) sets on the extra warm LEDs (2100K) though the CRI is also exceptionally high (CRI>95).

Figure 4.8 showing all the photographs of scale models that were put to observe. Besides of the construction and lighting setup, each tunnel contained two human puppets, implying both the low pedestrian density in and the relative size of Maastunnel. From the photographs in Fig. 4.8, the peephole from which the observer will look into each model can be seen at the far end of the tunnel. Note that the peepholes in the photographs belong to the reflected image in the end mirror, so does the farther half of the apparent tunnel in each picture.

Figure 4.8 Scale models for observation test. From top to bottom is the original Maastunnel replicate, the CH tunnel and the CW tunnel. The black circle at the end of the tunnel is the reflected peephole

4.4 Research Method

To study the space perception with mirrors in Maastunnel, an observation session has been conducted. The observation session aims to collect the qualitative feedback and quantitative ratings with regard to the Maastunnel space with mirrors from the voluntary observers. The Maastunnel space was recreated into scale models as described in the previous session.

A few more items or parts were built around the scale models for the observation session. Firstly, three disguise boxes, one for each tunnel, covered the front of the scale models, keeping the observers to see the physical dimensions from outside of the tunnels; accordingly, observers can only look into the tunnels through a peephole. Secondly, for the same purpose, a black curtain extended the coverage till the end of the scale models; in addition, it also keeps the excess light from disturbing the observing environment. Figure 4.9 (a) shows what the observers can see when they are presented with the models from the front side. Finally, the scale models are placed at the eye level of a sitting posture with the help of a stepping frame. The eye level was determined by adding the average sitting eye height from the Dined database (international, mixed gender) and seat height of an adjustable office chair set at its midpoint. Figure 4.9 (b) shows the scale model settings from a side view without the black curtain covered.

Figure 4.9 Settings of the scale models of Maastunnel for observation; in front view (a), the original Maastunnel replicate is in the middle, and the left and right one are CW and CH, respectively. In side view (b), the glowing part is the excess lighting of the models which was covered during the official observation session.

In this observation sessions, ten observers, 8 females and 2 males, are invited. All of them are students of Industrial Design Engineering in TU Delft and their age ranges from 18–30 years old. In each observation, only one observer was involved at a time. The observers were first greeted and provided with the consent form from which they received the general procedure of the evaluation session, description of risks and benefits and personal data handling protocols (see Appendix I). Afterwards, observers were prompted to recall their last experience of walking-by a pedestrian tunnel. This step serves as a warm-up for the following observation. Once finished describing how they felt about the latest-experienced pedestrian tunnel, observers received the introduction of Maastunnel with a printed picture shown in Fig 4.10. While they were viewing the picture, observers were asked to imagine themselves walking in the tunnel presented. Started playing from that moment till the end of the observation, a 30-minute-long recording of background sounds collected from Maastunnel on a Friday afternoon rush hour (16:20–16:50, 8th June, 2018) provided additional auditory cues for the space perception.

Figure 4.9 Settings of the scale models of Maastunnel for observation; in front view (a), the original Maastunnel replicate is in the middle, and the left and right one are CW and CH, respectively. In side view (b), the glowing part is the excess lighting of the models which was covered during the official observation session.

After the first look at the picture of Maastunnel, the observers were asked to observe the scale model in the middle through the peephole (Fig. 4.9 (a)) which was introduced as the replicate of the Maastunnel in its status quo. They were prompted to observe all the details of the scale model, including the close- and far-ends, the walls, the ceiling, the lighting and the poppets, etc. Once they finished the observation of the original tunnel, half of the observers were instructed to first inspect the one on the left (CW) and then on the right (CH) in tandem; ordinarily, the other half of the observers were instructed to take the inspection in an opposite order. This practice is expected to minimise the first impression bias between CH and CW. Later, the observers were granted the freedom to revisit any of the scale models whenever they want.

Following the observation, an evaluation form was provided to each observer. The evaluation form is based on a one-to-seven-scale rating of different descriptors. Besides of what has been used in the previous chapter, the semantic descriptors are mainly adopted from Franz's indoor environment perception study. These descriptors can be clustered into three categories: space perception, general feelings and functionality. In space perception, except the perceived size of space, the descriptors of openness-enclosure and the sense of claustrophobia are included. In general feelings, descriptors are related to the aesthetic and atmospheric ratings such as pleasantness, impressiveness, arousal and cleanness. In functionality, it concerns the main function of a pedestrian tunnel: a passage of sufficient lighting for pedestrians to walk through it. Table 4.1 lists all the descriptors used in the evaluation form.

Fig 4.10 The photograph of Maastunnel which was shown in print to the obser

Category	Dimension	Negative Extreme	Positive Extreme
Space Perception	Perceived size of the space	Cramped	Spacious
	Perceived width	Narrow	Wide
	Perceived height	Low	High
	Openness-Enclosure	Enclosed	Open
	Sense of claustrophobia	Claustrophobic	Non claustrophobic
	General size of the tunnel	Small	Large
General Feelings	Pleasantness	Unpleasant	Pleasant
	Impressiveness	Unimpressive	Impressive
	Comfort	Uncomfortable	Comfortable
	Atmosphere	Gloomy	Cheerful
	Arousal	Boring	Interesting
	Cleanness	Dirty	Clean
	Aesthetics	Ugly	Beautiful
Functionality	Brightness	Dim	Bright
	Walking assistance	Hinder	Help
	Walking speed	Slower	Faster

Table 4.1 Descriptors used in the evaluation for mirrors as the space doub

An additional part in the end of the form asked what kind of activities the observers would do in such a tunnel. This is a test based on the concept of affordance. According to Gibson's theory, human perception and human action are mutually dependent and developing. The possibilities for an environment to support actions, coined as affordance, may have a nontrivial relationship between spatial perception (Cañal-Bruland & van der Kamp, 2015). Nevertheless, this part of the experiment does not intend to verify such a relationship, but to serve as a supporting data for the space perception in Maastunnel. Table 4.2 shows the listed activities, ranging from normal walking to some radical activities such as sleeping and reading. The entire evaluation form can be found in Appendix J.

The participants were asked to speak out the reasons and thoughts of their ratings when filling the evaluation form. The author exploited these reasons and feedbacks as the qualitative input alongside the quantitative ratings. The whole experimental flow of the observation session is illustrated in Fig. 4.11.

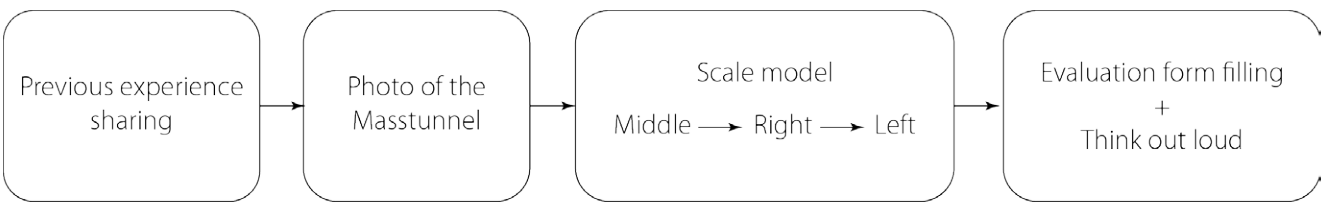


Fig 4.11 Flowchart for observation session procedure

4.5 Results

The quantitative results are summarised as a bar chart in Fig. 4.12. Each bar represents the mean value of each description and the error bar illustrates the sampling standard deviation (±σ). Besides, the p-values in two-tail T-test with the null hypothesis of equal variances between these tunnels are introduced to determine the significance of difference. There are two denotations for p-values, a sole p denotes the probability of having equal variances between the ratings of catoptric-augmented tunnel (either CH or CW) and the original one; with subscription, pHW denotes the probability of equal variant ratings between the CH and the CW tunnels. In Fig. 4.12, the bars with stripe pattern represents the significance of which is not significant enough ($p > 0,05$). Note that the value of the rating "Sense of Claustrophobia" was reversed since on the evaluation form it was 7 that refers to non-claustrophobic and 1 refers to claustrophobic. The author believes that by reversing the values, i.e. 1 to 7, 2 to 6, 3 to 5 and vice versa, the presentation of Fig. 4.12 will be more comprehensible then it was. The raw data and the statistic process method can be found in Appendix K.

All of the ten observers scored the CH tunnel as the highest one (7 as High) while six of them scored the CW tunnel with 6 and above in perceived width. Analogously, the CH tunnel is perceived more spacious (6,1) than the CW tunnel (3,8). As a matter of fact, the CW tunnel is not perceived significantly different than the original one (3,1) with the p-value being 0,179. Nevertheless, in the rating of enclosure-openness, both the CW and the CH tunnels are perceived as more open tunnels (4,8 for CW and 5,9 for CH) than the original one (2,5). In addition to the difference between the catoptric-augmented tunnels and the original tunnel, the differences between the two augmented tunnels (CW & CH) are considered insignificant in perceived width (pHW = 0,052), sense of claustrophobia ($p = 0,3428$) and the general size of the tunnel (pHW = 0,3239). In the general feelings, both catoptric-augmented tunnels get higher ratings in positive descriptors but there is little difference between CH and CW ones. For instance, in atmosphere and arousal, the difference between CH and CW tunnels is not significant (pHW > 0,05). In pleasantness and cleanness, the CH tunnel gets higher scores than the CW tunnel while the latter one is not significantly distinct from the original tunnel ($p = 0,061$ & 0,129). The CH tunnel excels not just the original tunnels but also the CW tunnel significantly in both impressiveness and aesthetics (pHW = 0,02). In the functionality, the observers perceive the CH tunnel somewhat brighter than the original one. They also expect to walk slower in the same tunnel than in the original tunnel for taking their time observing the space. Note that the differences between CW and CH tunnels in the three functionalities are all insignificant (pHW > 0,3).

The number of observers in this experiment cannot be referred as a large sample size, commonly known as 30 or above, nevertheless, we have seen several indexes are showing significant difference, especially in space perception dimensions. Besides of the quantitative data, further insights are revealed in qualitative data.

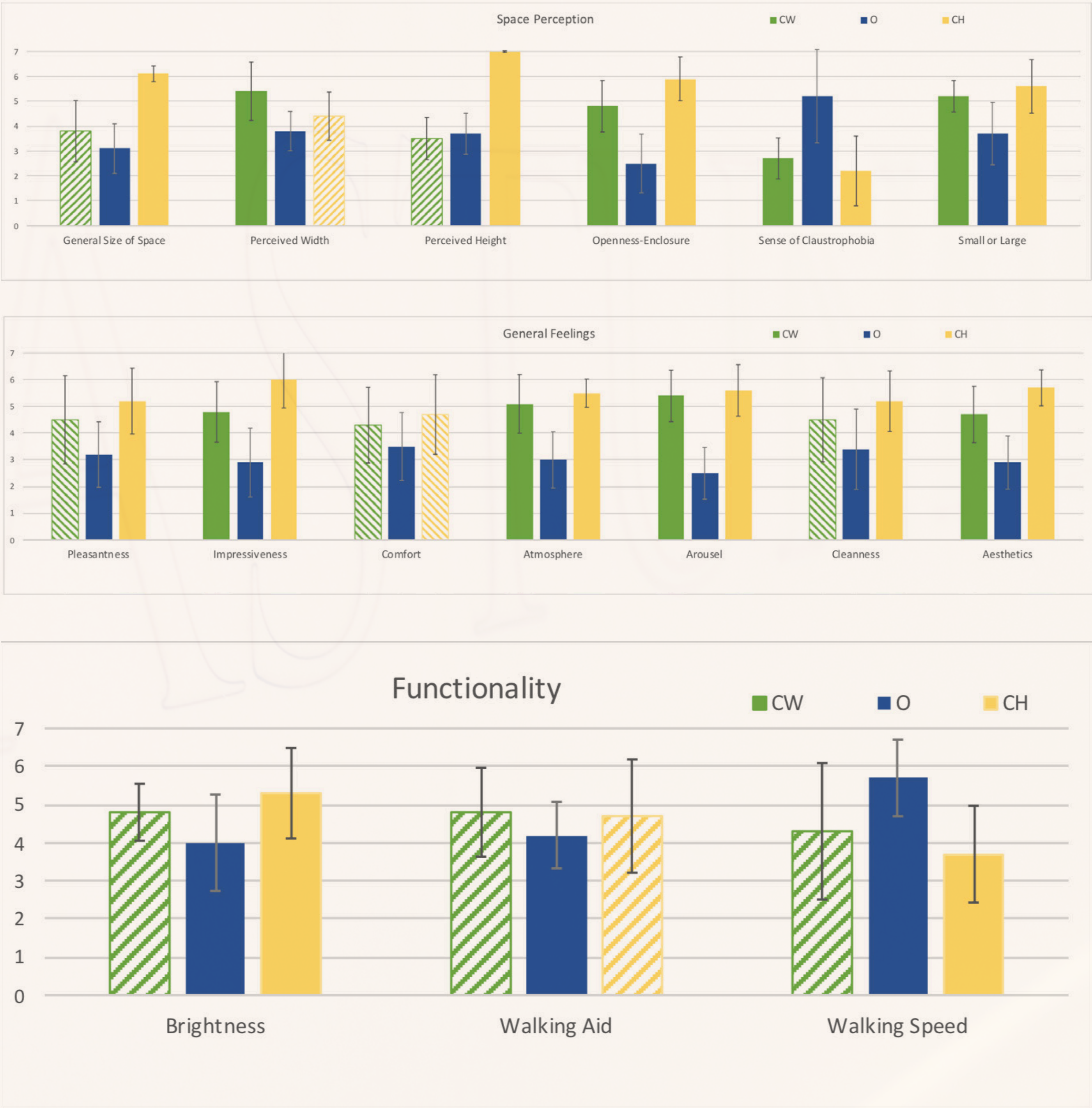


Figure 4.12 Bar chart of average ratings with the standard deviation (±σ) as the error bar. The stripe pattern indicates the value of which is not significant with respect to the original tu

The qualitative results are mainly the spoken reasons for the observers' ratings and their comments. It is based on the loose interview between the experiment conductor and the participant when the later one is filling the evaluation form. To almost every observer, they found the space is convincingly enlarged by the mirrors in both cases. Though one observer mentioned that she perceive it narrower in CH tunnel, the quantitative data do not support such an opinion. In the CH tunnel, some observers mentioned that the heightened aspect ratio triggers them to associate the tunnel space with a department store or a shopping mall. In both of CH and CW tunnels there is a great portion of the participants concern about the reflection of other pedestrians. When the mirrors are on the ceiling (CH), some people concern about their own privacy and the others worry about unexpected eye contact. Contrarily, when the mirrors are on the lower part of the walls (CW), some observers expressed their concerns about seeing the other pedestrians' feet. "I personally do not like having mirrors by the feet, it creates a sense of uncertainty. As mirrors usually reflects the upper part of the body, seeing feet in the mirrors makes me feel looking at people walking without their upper body.", said by an observer. She also mentioned that such an low-installed mirrors could be easily stained or vandalised, "Even though it is clean, I would still feel that it is dirty." Nevertheless, some other observers provided a different point of view about the reflection. "Through the mirrors on the ceiling," one mentioned, "I feel safe because I can see who is walking behind of me." Three other observers also mentioned the similar concept and two of them specifically mentioned that they would feel insecure walking in the original Maastunnel as a woman walking alone. The other benefit that some observers have addressed is that the tunnels with mirrors are seemingly brighter; as an observer said, "Because here you have it (the mirrors) on the ceiling, it's kind of feels a bit lighter...the light reflected on the ceiling makes it brighter...with the mirrors on the ceiling, your focus goes somehow more higher, so you notice less things on the ground and wall." Looking the mirrors as a whole, a substantial part of the observers express that mirrors in the tunnel would make the space more interesting. It broadens the possibilities to support more various activities than a simple pedestrian tunnel. For instance,

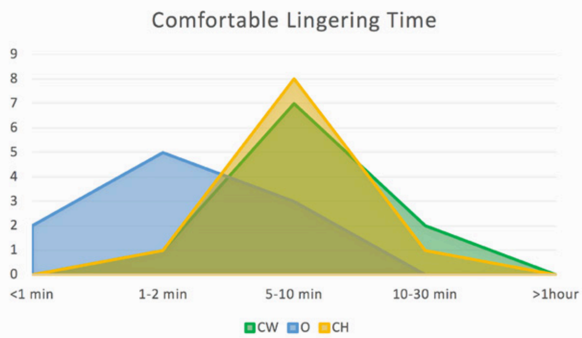


Figure 4.13 Distribution of all the participants' reported comfortable lingering time in the three tunnels

observers are willing to dance in CW tunnel as they mentioned "It would be interesting to see only my feet dancing in the mirror." There are also considerably more participants want to take photos in the CH tunnel. "This kind (CH) of mirror installation is much rarer (in public spaces) than the one on the walls (CW)...I definitely want to take some picture of it."

The qualitative data and the quantitative data have disclosed an appreciable amount of findings and insights. In quantitative results, we see that mirrors can successfully extend the dimension of tunnel space in both directions, but only CH tunnel can effectively enlarge the perceived size of space in general. Both of the CH and CW receive positive feedbacks in most of the descriptions regarding the general feelings. From the qualitative feedbacks, we have learned that in addition to double the tunnel space, mirrors also provide a broader view to the pedestrian tunnel which is greatly valued by female observers; the same feature, however, prompts the concern of privacy and awkward eye contact. Some of these results were anticipated based on previous studies and the general tunnel perception experiment in Chapter 3 while more findings are unexpected or has its own peculiarity. In the following section, the most interesting ones will be discussed along with the author's own interpretation.

4.6 Discussion

One of the most interesting findings is that the CH tunnel enlarges the perceived size of space to a further extent than the CW tunnel does. Recalling the space perception study in an open field, it found that the higher the boundary is, the smaller the ground space is perceived (Coeterier, 1994). The contradictory results could be attributed to the very nature of the space to be perceived: perceiving the size of a given ground is judging a piece of 2D surface while the perceiving the size of the tunnel space is judging a mass of 3D volume. In the former case, the boundary acts as an external perturbation as it does not belong to the space to be judged; in the latter case, on the contrary, the wall itself is part of the building block of the space. Elongating the wall is therefore intuitively enlarging the tunnel space as a whole, which is supported by the quantitative data. If the same logic is applicable, it would also explain another contradictory relationship between the openness-enclosure rating and the height-to-width ratio. As mentioned in Chapter 2, Hayward and Franklin found that the larger the height-to-width ratio is (ranging from 0,25 to 1,0 in their settings), the more enclosed the space are perceived regardless of the size thereof (Hayward & Franklin, 1974). The quantitative data shown in Fig. 4.12 has revealed that not only both the CH and CW tunnel increase the sense of openness in the tunnel space, the CH tunnel (optical height-to-width ratio = 1,22) is perceived more open than the CW tunnel (optical height-to-width ratio < 0,2). In both of the previous experiments, the space perception focuses on the roofless outdoor environment. The pedestrian tunnel is technically an indoor space with two axises of dimension confined. The fundamental difference of the space is believed to lead to the contradictory results in perceived size and openness-enclosure. Further study for the root cause of such a difference between an open and indoor space is out of the scope of this thesis.

The correlation between the perceived dimension in height or width and the perceived spaciousness, however, is still no consistent comparing the two experiments in this Chapter and the previous one. In Chapter 3, through the survey of various pedestrian tunnels, it is found that the width of the passageway has the stronger correlation to the spaciousness than the height of the ceiling (Fig. 3.4). On the contrary, with the scale models being observed, the CW tunnel was perceived less spacious than the CH one (Fig. 4.12). It is suspected that the disturbing reflection of pedestrian feet and the concerns of getting stained on the low-mirror-installation could have diminished the widening effect of CW tunnel, consequently limits the ability of space extension. Placing at a distance from the pedestrian's eye, the CW space does not fall into the central viewing angle as the CH does. In the earlier section it has been discussed that the mirrors can be placed only on the low part of the wall to avoid disorientation in the pedestrian tunnel; consequently, the CW tunnel can only extend the width to a limited extend, resulting in a less salient space doubling. In spite of such, the CH tunnel has proven to be a successful way to reshape the tunnel space. By heightening the tunnel visually, it changes the impression of the space as such a aspect ratio is not common to a pedestrian tunnel. The unique aspect ratio may prompt pedestrians making the space association with which has a similar aspect ratio, for instance, a department store. With such an association, according to the observer's feedback, the tunnel also appears brighter and less sketchy.

References

Fox News. (16 Aug, 2012). The Do's and don'ts of decorating with mirrors. Retrieved from http://www.foxnews.com/lifestyle/2012/08/16/do-s-and-donts-decorating-with-mirrors.html

Zara, J. (9 Nov, 2017). Yayoi Kusama's Infinity Mirrors reignites art's selfie debate, The Guardian. Retrieved from https://www.theguardian.com/artanddesign/2017/nov/09/yayoi-kusama-infinity-mirrors-art-the-broad-los-angeles

Leroux, G. (1910). The Phantom of the Opera. Retrieved from https://en.wikisource.org/wiki/The_Phantom_of_the_Opera/Chapter_XXIV

Franz, G. (2006). Space, color and perceived qualities of indoor environments. Paper presented in Environment, Health and Sustainable Development (IAPS 19). Seattle, WA, USA. Retrieved from http://kyb.mpg.de/fileadmin/user_upload/files/publications/attachments/iaps06_franz_%5b0%5d.pdf

Cañal-Bruland, R. & van der Kamp, J. (2015). Embodied perception: A proposal to reconcile affordance and spatial perception. i-Perception, 6, 63–66. https://dx.doi.org/10.1068/i0709jc

Coeterier, J. F. (1994). Cues for the perception of the size of space in landscapes, Journal of Environmental Management 42, 333-347.

Hayward, S. C. and Franklin, S. S. (1974). Perceived openness-enclosure of architectural space. Environment and Behavior 6(1), 37-52.

4.7 Summary

Starting from the making of scale models of Maastunnel, this chapter has shown the capability of mirrors as the space doubler in a pedestrian tunnel. With the Dialux simulation, the size and the position of the mirrors are determined. In the making of the scale model, one of the most difficult feature to replicate is the colour temperature and the low CRI of the lighting in the Maastunnel. An exceptional warm colour temperature (2100K) LED was eventually adopted even though it possesses a high CRI (>90), resulting in a less orange tunnel lighting than the actual Maastunnel. Through the observation evaluation to the scale models, it has been found that placing mirrors on the ceiling of the tunnel (CH) is the most desirable way to enlarge the perceived space in Maastunnel.

Chapter 5 Mirror in the Tunnel: the Light Splasher

5.1 Introduction

Perceptually, a mirror can create an extra space by copying the image of its surroundings; optically, it simply bounces the ray back. According to the Law of reflection, a mirror is actually a ray redirector. While a well-controlled reflection angle can redistribute the light of a fixture, randomly-placed mirrors, especially in miniature pieces, has been widely used in entertaining occasions to create the vivacity. This is the second way of using mirrors: to redirect or redistribute the lights. In Chapter 3, it has been found that the reflectivity of the surfaces and the shininess of the lighting in pedestrian tunnels are noticeably correlated to the rating of spaciousness.

Similar to the previous chapter, the following research intends to find the ways to create or enhance the reflectivity or the brilliance light in the Maastunnel environment. This part of the study will first start with finding a proper way to increase the brilliance with mirrors in the tunnel and thereafter put the prototype to a test. Through this experiment, it is expected to discover the ability of mirrors as a light splasher, through which one can play with brilliance. The starting hypothesis is by using mirrors to increase the brilliance, the pedestrians will see the tunnel brighter and consequently perceive it more spacious.

5.2 Creating Brilliance Light with Mirrors

According to the Handbook of Lighting Design (Ganslandt & Hofmann, 1992), there are three types of light in lighting design: diffuse light, focus light and brilliance light. The diffuse light is basically the general brightness of the space, the focus light is the accent lighting which casts shadows, the brilliance light is those lights that belong to neither the diffuse light nor the focus light. Brilliance light can be further classified into two types based on how the light appears. The first type of brilliance light is usually described as the starry-sky lights, it can be the twinkling light bulbs on a Christmas tree or it can be the specular reflection on a glossy surface (Fig. 5.1 (a)). The second type of the brilliance light can be found as a complex pattern of light shined on a surface or an object (Fig. 5.1 (b)). The two types of brilliance light are in fact ubiquitous in daily lighting occasions, from the dynamic ray on a concert stage to the antique chandelier in a household living room. As a matter of fact, chandelier is a common example of using reflective materials, though not exactly mirrors, to create the brilliance light in a space.

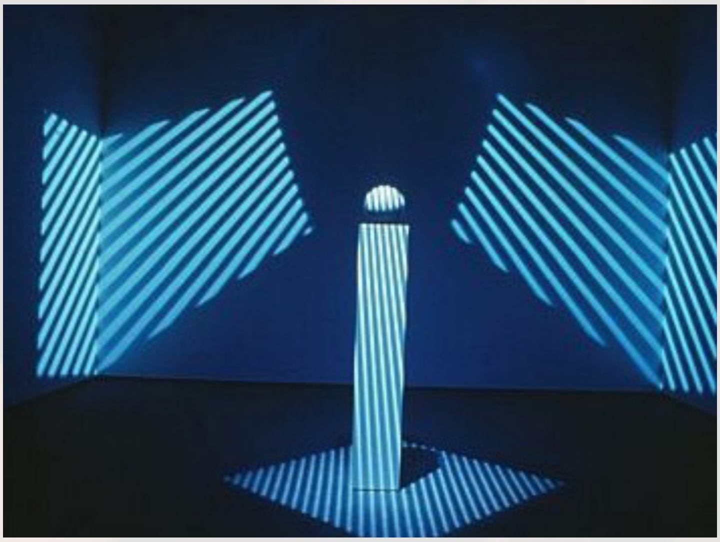


Figure 5.1 The two types of brilliance light; (a) the twinkling light and the glossy reflection, (b) the complex pattern from projectors

The first idea to increase the brilliance in Maastunnel is to reflect the existing lightings towards pedestrians. In Figure 5.2, a piece of mirror was placed in front of each fixture in the exact angle to reflect the light into the observing position. Placing mirrors in such a way, one can see that the number of light sources is perceived as doubled, the same effect was also noticed by the observers in the CH tunnel. Instead of visually doubling the number of fixtures, these well-angled mirrors increase even more brilliant by reflecting the front view of the fixture to pedestrians. Despite of the intense effect, these well-angled mirrors are subjected from a specific viewing angle, which is considered as an impractical installation in pedestrian tunnels. To broaden the viewing angle, another attempt is to exploit the mirror-like spangles. By hanging them randomly on the ceiling, it is expected to create a more dynamic brilliance reflection meanwhile creating a more uniform distribution across the tunnel. The spangles are hanged with nylon wires which can be clearly seen in Fig. 5.3 (a) became almost invisible in Fig. 5.3 (b). The result is not so satisfying as the spangles are flat and when hanging freely they can only reflect the light towards the ceiling. Further test with the spangles was aborted for the appearance of which was not aesthetically pleasi

Figure 5.2 A quick test of using fixed-angle mirrors to increase the brilliance. The large piece of mirrors on the lower part of the walls are the remnants of previous experiment in Chapter 4.

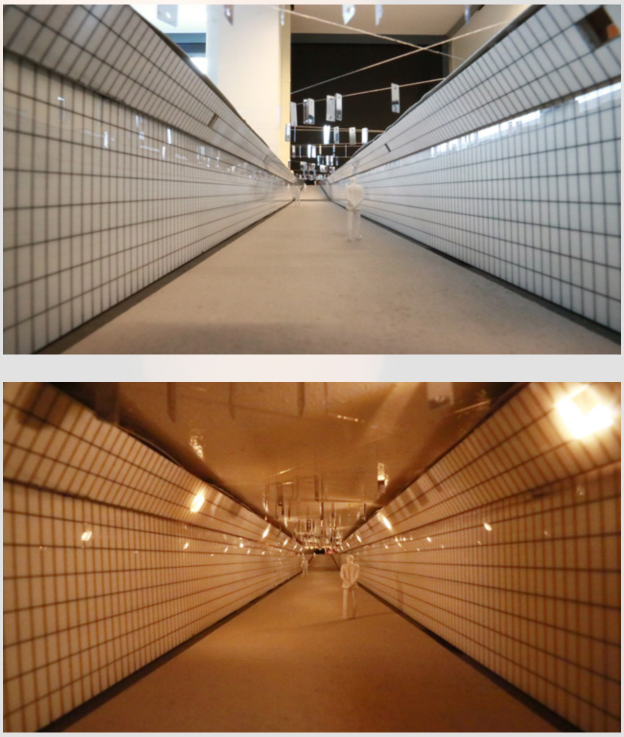


Figure 5.3 Photos of hanging spangles in the tunnel (a) without the roof and the lighting on and (b) with full installation of the tunnel. The size of a spangel is about 3 mm x 10 m.

The tests with mirrors or mirror-like spangles have revealed the limitation of flat mirrors. To discover more possibilities, other optical materials with similar working principle are considered. One of the most promising materials is glass beads. Glass beads are not technically mirrors, the light goes into a glass bead will also be reflected in the other direction. Unlike the spangles, glass beads can reflect or refract the light in all possible directions since it is a sphere. Moreover, it is also a retroreflective material, meaning that it also bounces the light back to the incident angle. Figure 5.4 shows how the glass beads "light-up" when shined with halogen focus light. The diameter of each glass bead is about 0,3 mm. Applying glass beads on the ceiling we can see how the brilliance light is increased in a subtle and non-intrusive way as shown in Fig. 5.5. Since the brilliance light is created through the reflection, such a brilliance hereinafter is referred as Reflected Brilliance (RB).

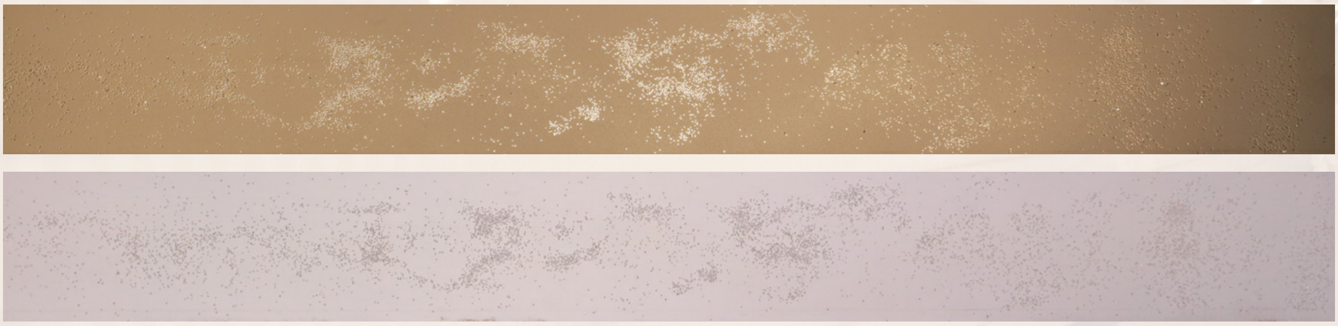


Figure 5.4 Bottom view of randomly-arranged glass beads on the ceiling panel of scale model. The upper one and the lower one are the same ceiling panel shot in different lightings: the upper photo was shot with a focus light and the lower photo was shot with a diffuse light. The yellow-tune in the upper photo was originated from the halogen focus light.

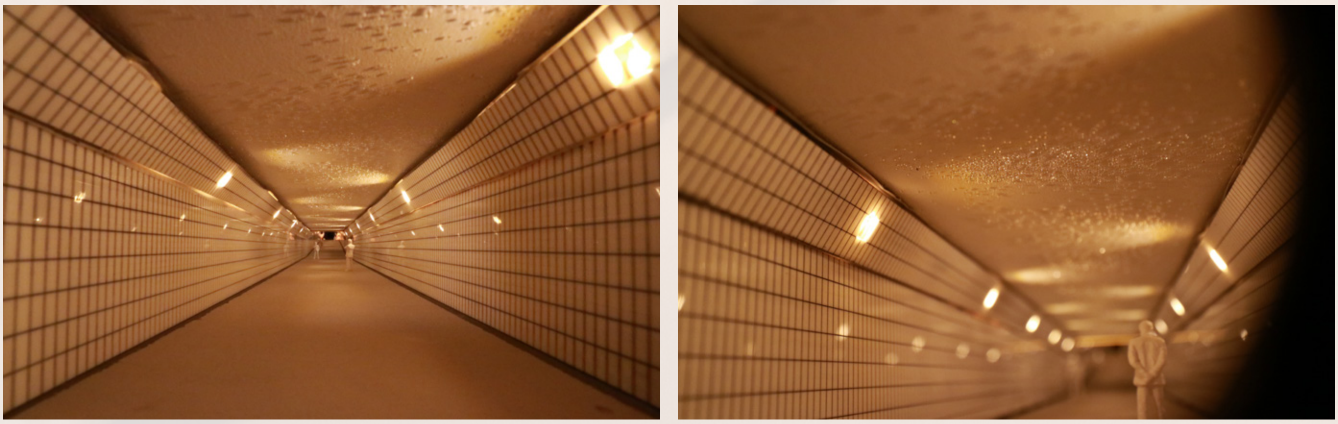


Figure 5.5 Photographs of scale model with glass beads creating RB on the ceiling. The glass beads are attached to the ceiling with spray glue.

The other type of brilliance light, the complex lighting pattern, was achieved through the plexiglass columns. These transparent columns serve as prisms which deflect the lights and thereby creating the stripe shadows as shown in Fig. 5.6. Just like glass beads, the plexiglass columns According to the results in Chapter 3, the complexity of light has little correlation with the rating of spaciousness in general pedestrian tunnels. Therefore, it is expected that this type of brilliance light will have little influence to the perceived space in Maastunnel. This expectation did not stop the researcher putting it into the test as which might serve as a good reference for bias ratings from observers.

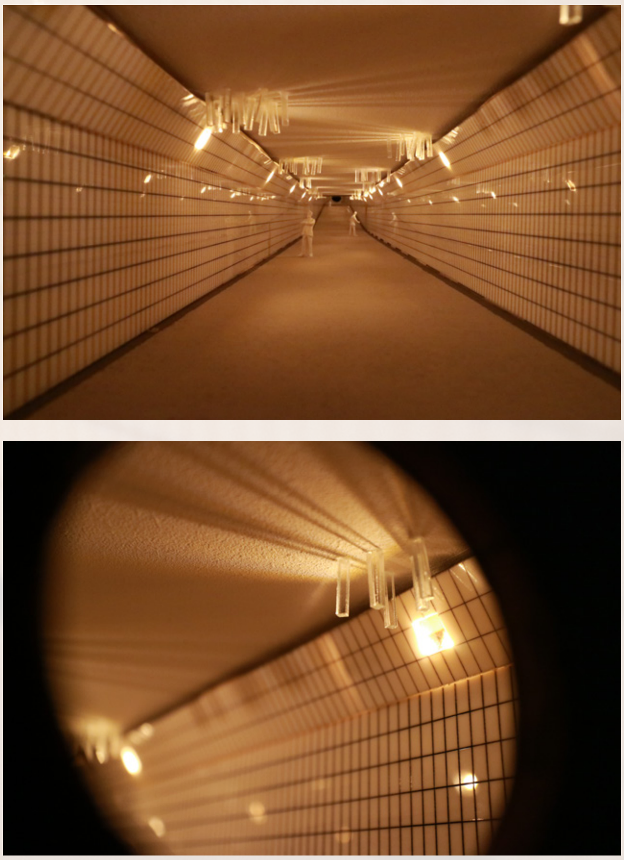


Figure 5.6 Photographs showing the RD of lightings in the scale model of the Maastunnel. It was the most readily feasible way to create a complex lighting pattern on the scale model with a satisfying effect.

5.3 Research Method

The main research method remains the same as in the last chapter. In total 13 observers were invited to participate the observation session, seven males and six females. All of them are master students from TU Delft, aging between 23 to 30 years old. Among the participants, six of them also participated the previous observation session (mirrors as the space doubler) and the other seven were the first time participants in this project. To start with, the first-time observers were prompted to recall their last experience walking through a pedestrian tunnel; in contrast, the repeat observers were prompted to recall their last visit to the scale models of Maastunnel.

Owing to the nature of increasing brilliance light with reflective materials, the selection of descriptors is largely different from the previous experiment. Descriptors regarding space size perception are limited into two: the size of the space and the perceived height. As one can see that both the RB and RD decorations are placed on the ceiling of the tunnel, no visual cue that might be able to change the perceived width is foreseeable. The openness-enclosure is no longer a rating of interest since the width-to-height ratio is kept as original in all three tunnels that are put to test. Inherited from the survey in Chapter 3, brightness, complexity of light and cleanness are the three ratings that are expected to have a significant dependence with the brilliance light. The rest of the descriptors are mainly related to the different aspects of aesthetic values. Besides of Franz's study (Franz 2006), most of these aesthetic descriptors are adopted from Chuang, Liu & Liu's work concerning the aesthetic evaluation on interior design (Chung, Liu & Liu, 2013). The selected descriptors are listed in Table 5.1.

Besides of some alteration in descriptors, the rest of the experimental procedure is identical to the previous experiment. The list of activities and the comfortable-staying duration are not included in this evaluation for the reason of which provided insufficient insight given the tedious effort it requires from the observers. The whole evaluation form can be found in Appendix L.

Category	Dimension	Negative Extreme	Positive Extreme
Visual Features	Perceived size of the space	Cramped	Spacious
	Perceived height	Low	High
	Brightness	Dark	Bright
	Complexity of Light	Simple	Complex
	Cleanness	Dirty	Clean
	Aesthetics	Ugly	Beautiful
Aesthetic Values	Attractiveness	Unattractive	Attractive
	Stylishness	Old-fashioned	Modern
	Coherence	Incoherent	Coherent
	Ornateness	Too little	Too much
	Luxuriousness	Poor	Luxurious

Table 5.1 Descriptors used in the evaluation for mirrors as the light splasher

5.4 Results

From the 13 observers' input the quantitative data are processed to examine the statistical significance. Same as in the previous experiment, the bar height in Figure 5.7 stands for the mean value of the 1 to 7 rating in each dimension and the error bar is the standard deviation. In quantitative data, both the perceived size of the space and the height of the tunnel are not significantly better than the original tunnel. The RD-tunnel is perceived substantially lower than the other two tunnels, correlating the lower ratings in perceived size. The brightness perception in both RB and RD, as expected, are brighter than the original tunnel; nevertheless, there is practically no difference between the two brilliance-enhanced tunnels. It is also worth mentioning that the deviation of perceived spaciousness and cleanness in both the RB- and RD-tunnels is considerably large. The deviated ratings can be further explained by the qualitative data in which controversial opinions are collected. In aesthetic values, observers found that both brilliance-enhanced tunnels are almost equally attractive and stylish and luxurious. Despite of the positive feedbacks, tunnel with RD was rated as incoherent and excessively ornate. The raw data with the rest of the statistic numbers can be found in Appendix M.

Almost every observer has associated the brilliance-enhanced tunnels with a scene or an object. For tunnel with RB, the reported associations are with starry sky, vapour droplets and dust. For the RD-tunnel, observers associate the columns with chandelier, crystal lamps and stalactite in caves. It is found that observers are having diverse thoughts to both of the designs and the RD-tunnel receives more controversial opinions than the RB-one. One observer said "It (RD) makes me feel like being in a hotel...just like an actual chandelier...it's very royal, walking in this tunnel will make me feel fancy." But the other observer said "I am afraid of those sticks (columns in RD) might fall, it looks like a chandelier (stalactite) cave....I (would) feel suppressed if walking in this tunnel...feels like walking in a stalactite cave." When perceiving brightness, though both brilliance-enhanced tunnels received the same mean ratings, the polarisation of opinion persists in the RD-tunnel. Three out of 13 observers rated it darker, mentioning that the shadows on the ceiling is to blame. Regarding the incoherence of the RD-tunnel, most people stated that the stick-out columns does not feel belong to the Maastunnel environment because the impression of which is intrusive. One particular observer stated that the random arrangement of the glass beads in the RB-tunnel is perceived as less coherent than the rectangular columns in the RD-tunnel.

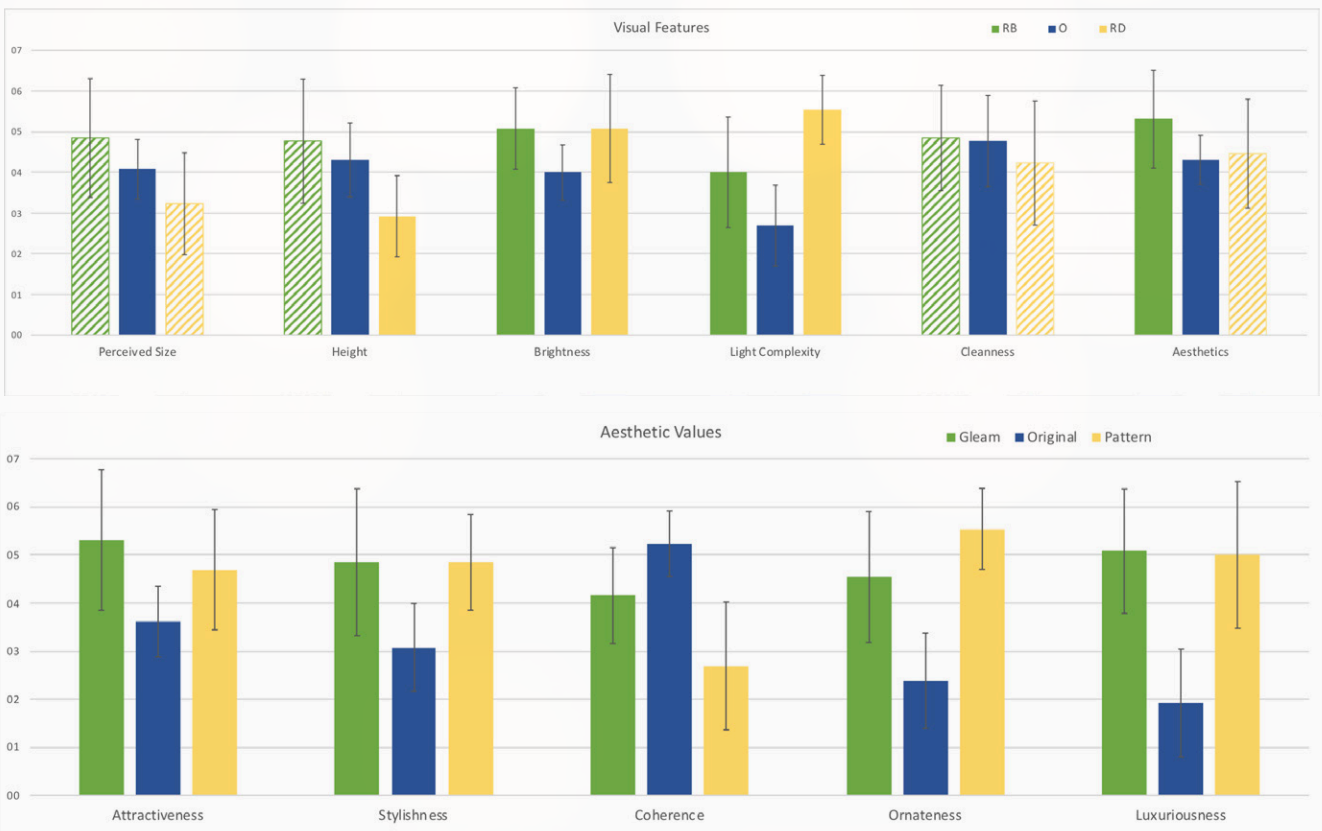


Figure 5.7 Bar chart of quantitative ratings regarding using mirrors as the light splasher. The stripe-pattern filling denotes the rating has no statistically significance when pairing with the original tunnel (p > 0,05).

5.5 Discussion

In a general indoor scene, the brighter the room is, the more spacious the room is perceived Martyniuk et al. as cited in Coeterier, 1994). In this part of the experiment, the hypothesis is that by using mirrors or reflective materials to increase the brilliance in a pedestrian tunnel, it would be perceived as brighter, consequently more spacious. In Figure 5.7 we have seen that such an hypothesis has been nullified as the rating of brightness does not reflect on the sense of spaciousness. However, from the qualitative feedback it appears that the scene or object people might associate with plays a significant role to how people perceive the space. If one associates the pattern or effect of brilliance with a usually spacious place, e.g. a hotel lobby or the sky, the observer seems to be able to infuse the previous experiences into the tunnel space, profoundly changing the space perception. From the diversity in the scene association, it is deduced that the prior experience of a pedestrian may predominate how she or he will make the linkage.

The two types of brilliance light at the first glance have the same ability in brighten up the space; if one only looks up the mean ratings of brightness, the RB- and RD-tunnels received almost the same score. Complemented by the qualitative feedback, however, it is found that two observers who put their attention on the transparent columns, they perceive the light more brilliant than the observers who focus on the light patterns. The shadows appear to dim the overall brightness as three observers perceived the RD-tunnel even darker than the original tunnel. As a matter of fact, the former group of observers pointed out a side effect of using acrylic columns: additional reflected brilliance is created at the bottom end of each column. In other words, the transparent columns created not just the complex pattern (RD) on the ceiling but also the glittering brilliance (RB) from itself. If the ratings from the observers who put their attention on RB instead of RD are neglected, the mean rating of brightness will be no significant different than the original one. Such a result suggests that without an extra light source, the complex light pattern created by reflective materials will do little help in increasing the brightness. On the contrary, the RB receives positive remarks in general, regardless the shape of the media in this experiment. At this point, the author is confident to say that there is no doubt the RB can enliven the tunnel space through reflecting lights to the pedestrians' viewing angle. The question is what element or scene the designer desires to have the passers-by associate with when putting in the brilliance in a pedestrian tunnel?

5.6 Summary

In summary, it has been found that mirrors or reflective materials have a great potential to enhance or alter the brilliance of a space without changing its pristine lighting condition. With the glass beads and acrylic columns, two different types of brilliance light are created: 1. the reflected brilliance (RB) creates the glossy reflections and the twinkling lights; and 2. the reflected deflection (RD) creates the complex pattern on the ceiling. Though none of which enlarged the space perception in Maastunnel in the scale-model-observation experiment, the RB is perceived more elegant and bright than the RD-tunnel. Unlike using mirrors as the space doubler in the previous chapter, the perception and the interpretation to the light splasher is controversial. The observers tend to associate the design with a particular scene or landscape and depending on the association they developed into different perceptions. For instance, most of the observers associate the glass beads with the starry sky, resulting a higher perceived ceiling and a larger perceived space. But few observers associate the same glass beads with dusts, leading to a less clean and crappy space impression. It is concluded that how people associate the design with plays a dominating role in the tunnel space perception when creating brilliance light with mirrors.

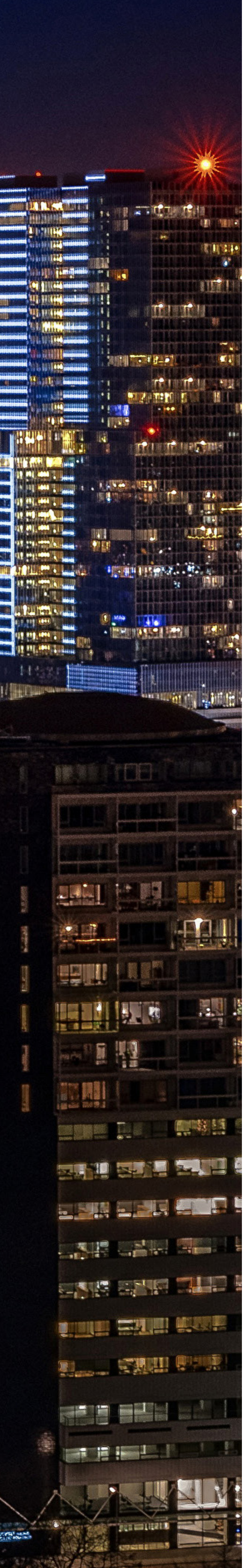
References

Ganslandt, R. & Hofmann, H. (1992). Handbook of Lighting Design. Wiesbaden, Germany: Vieweg & Sohn Verlagsgesellschaft GmbH.

Franz, G. (2006). Space, color and perceived qualities of indoor environments. Paper presented in Environment, Health and Sustainable Development (IAPS 19). Seattle, WA, USA. Retrieved from http://kyb.mpg.de/fileadmin/user_upload/files/publications/attachments/iaps06_franz_%5b0%5d.pdf

Chung, H.-T., Liu, S.-Y. & Liu, Y.-C. (Aug, 2013). An Analysis of Aesthetic Evaluation on Interior Design Works. Paper presented at the 5th International Congress of the International Association of Societies of Design Research, Tokyo, Japan. Retrieved from http://design-cu.jp/iasdr2013/papers/1519-1b.pdf

Coeterier, J. F. (1994). Cues for the perception of the size of space in landscapes, Journal of Environmental Management 42, 333-347.



Chapter 6 Synthesis and Embodiment

6.1 Synthesis

To summarise the findings in the project, several ways, possibilities and potential pitfalls when using mirrors to enlarge the perceived space of Maastunnel has been revealed. There are two major ways to utilise the mirrors in a pedestrian tunnel: mirrors as the space doubler and mirrors as the light splasher. Hereinafter the research findings of these two types of mirrors will be introduced.

With the space doubling mirrors, it is found that the perceived space enlargement is substantially effective. Placing mirrors on the ceiling, the CH tunnel is perceived as more spacious, more open and even slightly brighter. The fact that the ceiling is projected more toward the centre of the pedestrians' viewing angle intensifies the space enlargement effect. In addition, putting mirrors on the ceiling may keep them away from the dirt on the floor and the vandalisation. These potential drawbacks are manifested by the CW tunnel where the mirrors are placed on the lower part of the walls. The low-installed mirrors are also reported as disturbing when seeing legs walking in the catoptric space. The reasons why the CW mirrors have to be put on the lower part of the wall are to avoid any disorientation and the compelling infinity mirrors. Putting mirrors on the upper part of the wall, alternatively, is also rejected by the trapezium shape of Maastunnel.

With the light splashing mirrors, the pedestrian tunnel is enlivened with more brilliance light. By using the glass beads, a substitute material for tiny mirrors, the reflected brilliance (RB) light brightens up the tunnel space. It is found that the shimmering brilliance light created by RB is more desirable than the static pattern projection created by the reflected deflection (RD). The space perception in the brilliance-enhanced tunnels, contradicting to the hypothesis, is not dominated by the brilliance light but subjected by the pedestrians' imagination and association. If a pedestrian associate the brilliance design with a spacious landscape, e.g. the starry sky, the connection will draw the sense of spaciousness into the tunnel space. On the contrary, if a pedestrian associate the design as a dusty wall, the sense of spaciousness will also be compromised by the association. Notwithstanding the limited improvement in the sense of spaciousness, the most prominent contributions of brilliance light is mainly related to aesthetic values.

6.2 The Design Guidelines

Synthesising the above findings, the design guidelines is hereby formulated. This design guidelines is created for designers who want to design or redesign a pedestrian tunnel with mirrors. Several do's and don'ts are listed hereinbelow for the design goal of making a tunnel brighter, more spacious and aesthetically pleasing.

Perception	Open	Dos	Do put mirrors on the ceiling adjacent to the walls to make the space perceived higher, pedestrians perceive such to be more open
	Spacious	Dos	Do put mirrors on the ceiling, adjacent to the walls, and have the reflection extend the whole wall to efficaciously enlarge the perceived space
			Do create some patterns that related to an enormous object or scene; for instance, starry-sky patterns on the ceiling makes the tunnel perceived higher
			Do use large pieces of mirror or a seamless design to make the catoptric space convincing
		Don'ts	Don't put mirrors that stick out from a surface because this will shorten the perceived distance between the pedestrians and the surface, resulting a smaller perceived space
	Bright	Dos	Do put mirrors next to the light sources to create light reflection
			Do reflect the light to the ceiling to enhance the perceived brightness
			Do use small pieces of mirror to reflect the light with high complexity
			Don't cast a shadow with mirror objects because the shadow makes the space looks darker
Feeling	Beautiful	Dos	Do create some patterns and variations to increase the aesthetics
			Be aware of the geometry and pattern you are using because the less they are coherent to the tunnel environment, the less aesthetic it would perceived
	Interesting	Dos	Do use mirrors to build some interaction between pedestrians, they tend to interact with the reflections, making the place more interesting
	Private	Don'ts	Don't put a large piece of mirror around the eyeheight because this also makes the pedestrians feel their privacy is compromised
			Don't put mirror close to the floor because it might offend pedestrians' privacy.
	Secure	Dos	Do use mirrors on the places where pedestrians can oversee the other pedestrians behind them, it increase the sense of secure/safe
	Fear	Don'ts	Don't do infinity mirror in pedestrian tunnel because it could frighten people
	Suppressive	Don'ts	Don't put mirrors that stick out from the ceiling which makes pedestrians feel suppressed
Functionality	Dirty	Don'ts	Don't put mirrors close to the ground/floor because they are vulnerable to vandalisation
	Disorientating	Don'ts	Don't put a large piece of mirror around the eyeheight because pedestrians may not be able to tell the real-catoptric difference

6.3 Design for Maastunnel

A design concept is proposed and embodied for Maastunnel to illustrate the design guidelines meanwhile demonstrate its application. Through the practice the author also expects to find the limitation or misleading of such a guidelines. As this project is an assignment from Studio Roosegaarde, this design will be sketched as a design proposal to the company. As Studio Roosegaarde is having "Schoonheid" as the design vision, this design should align to the company's portfolio as being an imagination carrier to a future of cleanness and beauty.

The design goals are:
To enlarge the perceived space of Maastunnel
To enliven the space with subtle interaction, preferably through an analogue-hightech method
To introduce a narrative through which people may have a reflection on the urban space

According to the design guidelines, putting mirrors on the ceiling can significantly enlarge the perceived space. To take the most advantage of this capability, the catoptric-heightening mirrors are put at both ends of the tunnel. Such an arrangement is expected to astonish the pedestrians at the moment they enter Maastunnel, building the impression of being in a spacious space. The design canvas will be limited within the surface of the ceiling for the consistency reasons; additionally, there are limited methods to embody the design in a 1:40 scale model within the given time and resources.

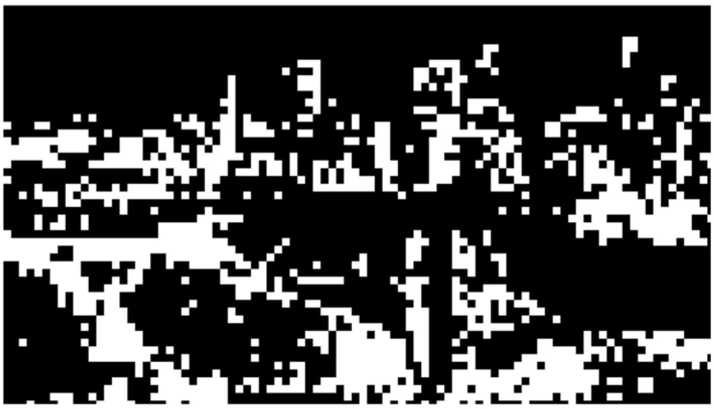
The guidelines also suggests that the brilliance light will enhance the brightness in the space, whereas the appearance of the design will affect how people perceive the space. In the beginning, several massive objects and scenes are considered as the inspiration. Later in the design process, the author has decided to make a strong linkage to the city where Maastunnel located. Rotterdam is one of the biggest city in the Netherlands and the city is not accommodating more than 600 thousand inhabitants. Most of the modern Rotterdam was built after the World War II, during when the Maastunnel was built. It is safe to say that the Maastunnel is just as old as the modern Rotterdam. A stock picture of Rotterdam's city view shot from Euromast, which is located at the north end of Maastunnel, is exploited as the starting point. In Figure 6.1 one can see the four stages of image processing: Fig. 6.1 (a) is the original picture, Fig. 6.1 (b) is made in grayscale with minor contrast adjustment, Fig. 6.1 (c) is after the crystalise filter and the level adjustment, and the last one (Fig. 6.1 (d) is applied with the mosaic filter.

Figure 6.1 The image process of pixelating the photo of Rotterdam city view

Figure 6.2 The design pattern of which the mirrors will be placed on top of the ceiling. Only the fractured part is shown, along with the transition to the large piece of mirrors at both ends.

Figure 6.2 shows the central part of the design on the ceiling of the tunnel with the transition to the space doubling mirrors. The pattern in Fig 6.1 (d) is split into upper part and lower part and are placed at the left and the right of Fig. 6.2, respectively. With this design the pedestrians will experience the catoptric-heightening in the beginning, after a while they will notice the catoptric-heightened wall starts to falling apart into a mysterious pattern.

The embodiment technique is primarily based on laser cutting. Figure 6.3 shows the three segments of ceiling, placing side by side. The three segments are assembled in-line as one tunnel and the total length of the scale model is 2700 mm with each segment's length of 900 mm. The rest of the dimensions remain the same as described in Chapter 4 whereas the end mirror is replaced with a photograph picturing the exit of Maastunnel. The final result is shown in Fig. 6.4. The three photographs are taken at the entrance (Fig. 6.4 (a)), the first one-third (Fig. 6.4 (b)) and the second one-third (Fig. 6.4 (c)) of the tunnel.



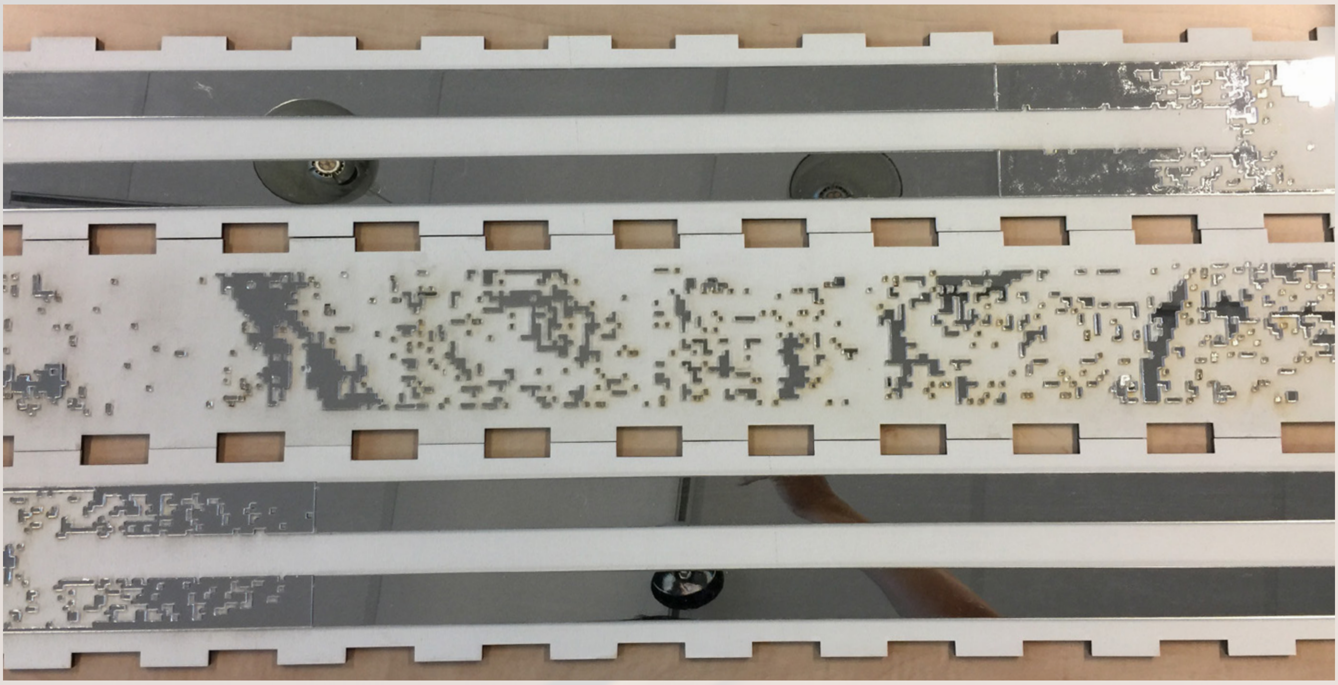


Figure 6.3 Embodiment of the design: The ceilings of the scale model are decorated with the laser-cutted mirrors. The smallest mirror is slightly less than 3 mm x 3 mm for which is the minimum possible size to laser cutting.

Figure 6.4 The photograph of the design using mirrors to decorate the Maastunnel presented in a 1:40 scale model. Although the dummies are not shown, they are present in the evaluation session as a relative size visual cue.

6.4 Evaluation Method

The evaluation of the design is set for validating the design goals. The validation will also exploit an observation session following by a short interview. Unlike the mirrors in the previous observation session, the design changes its pattern across the entire tunnel and most of which is imperceptible to an observer looking from the entrance. The observation is therefore combined with a video showing the simulated view of walking through the entire tunnel. The video was filmed with an iPhone 6+ with a wide-angle lens attached. Because the tunnel construction is anchored on the floor panel, the filming is divided into three clips, one for each segment of the tunnel. The setting for video filming is shown in Fig. 6.5.

Five participants are invited to the evaluation, two female and three male, all of them are master students in Industrial Design Engineering of TU Delft and none of who has participated the previous observation session. Individual participant was first greeted with a short introduction to the session during which the consent form is signed. Without the prior information the participant was instructed to observe the tunnel from the entrance. During the observation, the background sound recorded from Maastunnel are played. The observers were told to imagine themselves walking in this tunnel and were prompted to speak out what they are looking and how they perceive the tunnel space. The evaluation intended to collect the genuine feeling and thoughts therefore no hint or descriptor was given. After the participant finished observation the scale model, usually between 1-3 minutes, he or she was then instructed to seat in front of a TV on the floor. They were informed to watch a video to help them "walk through" the tunnel they just saw and they were suggested to put their attention on the ceiling.

After the video playing, a short interview was conducted. Five questions are thrown to the participants:

How do you think about this tunnel in general?
How do you perceive the tunnel space in terms of its size & volume?
How do you think about the lighting in this tunnel?
How do you think about the mirrors in this tunnel?
How do you think about the pattern on the ceiling?

Following the above questions, a short explanation to the design was orally given as below:

This tunnel is Maastunnel in Rotterdam. It was built 75 years ago and was one of the earliest tunnel in the Netherlands. The design intends to extend the perceived space in the tunnel. The pattern is derived from the city view of Rotterdam when seeing from Euromast, which is located at the north end of the Maastunnel. The design not only aims to increase the perceived space but also serves as a reflection to the cramped urban space.

Then the last question asked is:

After learning the design concept, do you have any thoughts or feedback about this?

Figure 6.6 The track setting for the filming of the scale model. Note that the moving part is the whole tunnel, not the camera, which was not discernable to all the observers.

6.5 Results and Discussion

Through the interview, it is again proven that the CH mirrors can create the extra space in a very convincing way. Even an observer who is aware of the spaciousness is created by the mirrors mentioned "I am surprised, I just saw the end of the tunnel and realise how small the tunnel physically is." Just like in the previous scale models, the observers cannot see the physical size of the tunnel from the outside. The other observer said "This is a very long tunnel, but I like the mirrors on the ceiling, I never saw anything like that before...I found the intention is very obvious...making it appears higher and wider in a confined space." And she continued, "I think it is smart have the angle at the top, with the mirrors it appears like four lamps (in a raw)." The angle she mentioned is the slant corner where the lighting fixtures are placed and it is actually part of the original Maastunnel. Nevertheless, this point of view may have helped to explain the success of CH mirrors: the angle interrupts the continuity between the real wall and the catoptric wall therefore creates different levels of space meanwhile concealing the fact that the catoptric wall is less real than the real wall.

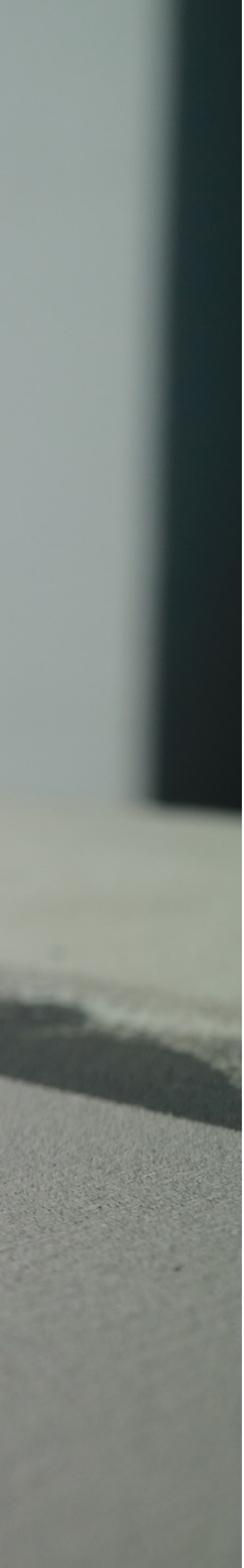
The intention using pixelate mirrors was to create the brilliance reflection and therefore to enliven the space. Though the brilliance does increase, only one participant has noticed the reflecting light as she mentioned "In the fracture part I think the light is a little too complicate. It is now randomly scattering. I would like to see the light from the blocks shining more unidirectional." Another observer associate the pixels with crystal salt. The others simply curious about it without any clue what it is doing. Because of the limit of using laser cutter, the pixels can only be as small as 3-mm-high cubes. To the participants who "walked-through" the 1:40 scale mode, they were looking at hundreds of 12-cm-high cubes attached on the ceiling. The scaled size is suspected to be the main reason that the effect of brilliance is less noticed.

After the narrative of the design is revealed, two observers mentioned that they think the story is well reflected by the design itself as one says "I can directly feel the difference of the space when the mirrors become just small cubes, it immediately become smaller." Such a change reflects the part of narrative that a smaller space we can only have when living in such a crowded city. Nevertheless, all of the observer reported that the pixelate pattern is too abstract to tell which part of Rotterdam the design is showing even after knowing the narrative. It is basically impossible to understand it without an explanation.

6.6 Reflection to Design Guidelines

The design guidelines includes dozens of dos and don'ts which is handy to follow in the beginning. However, the lack of guide in size or any other dimensions limits the usage of the guidelines in the design process. The design guidelines provides some general ideas of using mirrors in a tunnel but there is insufficient information about the size effect, especially when designing with a smaller piece of mirrors. For example, the size threshold between a space doubling mirror and a brilliance enhancing spangle is not addressed. Without the knowing of such it is unclear to a designer which effect he might be able to achieve with a given size of mirror. Another found shortage relates to the applicability of the design guidelines. Notwithstanding developed upon Maastunnel, the design guidelines has no address about the length of the tunnel. Since it is unwise to have a single design placing all over the entire tunnel in such a lengthy one like Maastunnel, the design guidelines could have provided some suggestions in tackling with such an manner. Nevertheless, the several potential pitfalls mentioned in the design guidelines serve as a clear reference to the designer as the reasons and the consequences of doing it wrong are well described.

In conclusion, though it is found useful in the early stage of design process, the current version of the design guidelines is considered insufficient with numbers, particularly the size of mirrors. In addition, the design guidelines has insufficient insight regarding the lengthy tunnel. A possible reason for such a negligence is that the research was based on solely statistic space observation. This research method may be sufficient for a single living room but it appears to be inadequate for a flowing space as a pedestrian tunnel.



Chapter 7 Conclusion and Reflection

This project begins with the assignment which requests to find the ways to transform a pedestrian tunnel by enlarging the perceived space. The goal of this project was to provide a design guideline for the designers in Studio Roosegaarde to redesign an existing pedestrian tunnel with mirrors. The pedestrian part of Maastunnel is chosen as the context of the project for the environment is a rather basic tunnel. With the problem definition is it found that several stages of research is necessary to answer the following research questions:

What are the visual elements that affect the space perception in a pedestrian tunnel?

How can the perceived space of a pedestrian tunnel be enlarged by using mirrors to augment or create these visual elements?

To answer the first research question, this work started with a fundamental literature review following by an online survey with questionnaires. Through these research, the answer to the first research question can be summarised as such:

The crucial visual cues are the perceived width, the brightness, the cleanness and the reflectivity of the walls. The wider, the brighter, the cleaner and the more reflective the tunnel is, the more spacious the tunnel is perceived.

The second research question requires more works to answer. According to the findings in the first two chapters, attempts of using mirrors to alter the most promising visual cues were made. The visual cues that were enhanced by mirrors are referred as catoptric-augmented cues. Two observation sessions were conducted to validate the effect of catoptric augmentation, each observation sessions correspond to a type of mirrors. The first type is coined as the space doubler for which doubles the space along a direction optically. The second type is coined as the light splasher for which deflects the light to create more brilliance in the space. According to the validation and the extra findings, the second research question can finally be answered:

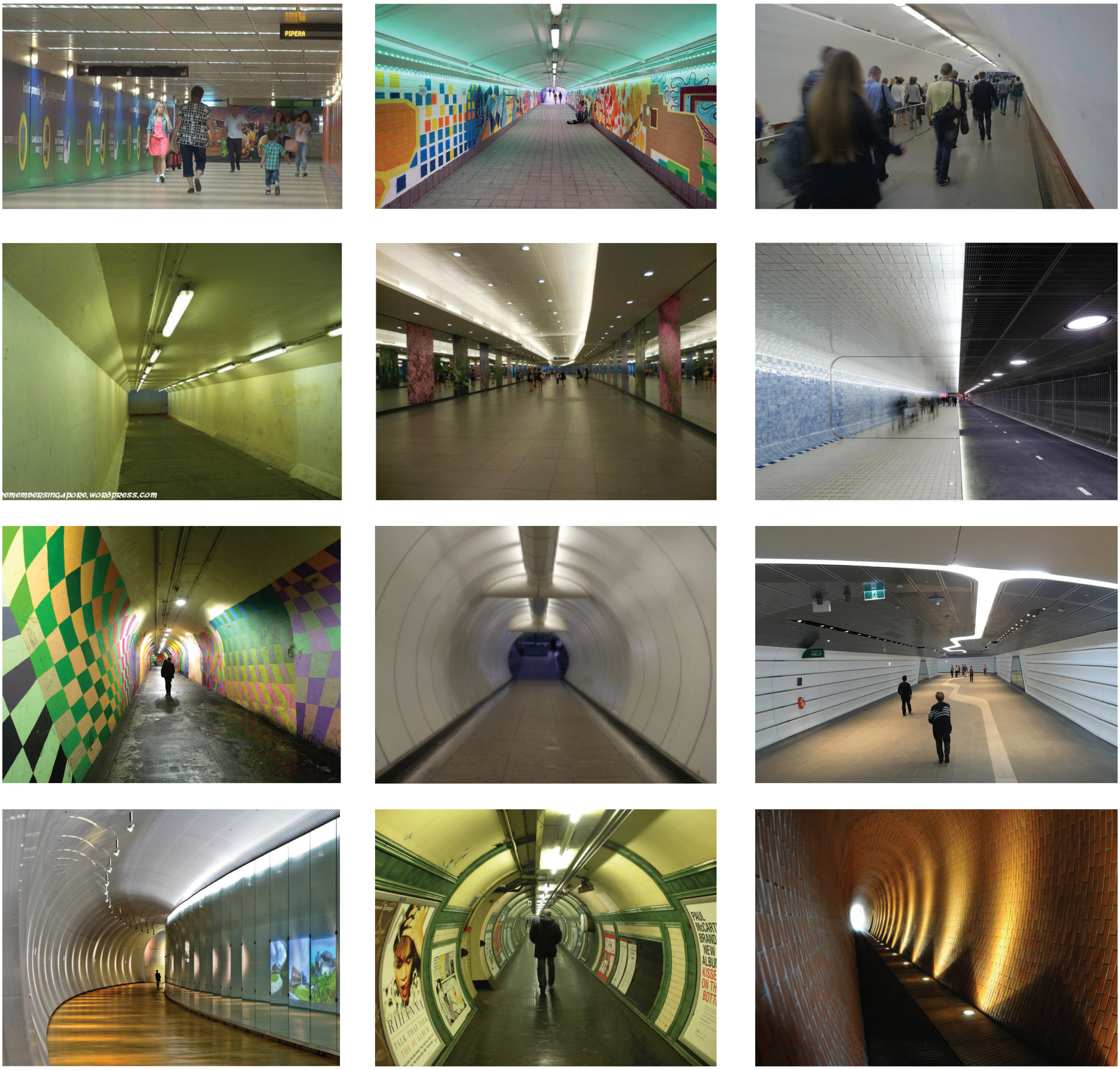
The mirrors can be used as the space doubler in a pedestrian tunnel and it is most salient to double the height of a tunnel by placing mirrors on the ceiling. Additionally, with the miniature mirrors as the light splasher, the brilliance light can be increased, thereby brightening up the space and improving the aesthetics of the tunnel.

These findings are synthesised into a list of design guidelines with which it is expected to help the designers who is interested in designing tunnels with mirrors. The design guidelines is composed of several dos and don’ts with the designated effect and potential pitfalls given. The author has formulated a design for Maastunnel to illustrate the design guidelines while evaluate its usability. Through the design process and the evaluation of the design, the efficacy of the design guidelines is double confirmed while some shortage of which is exposed. It is found that such design guidelines may be useful in the beginning of the design phase as it states the fundamental ways of using mirrors and the potential pitfalls. Nevertheless, the design guidelines lacks in further definitions, therefore it is less beneficial in the later design phase. Besides, the guidelines is insufficiently applicable to lengthy tunnels for which provides no guide to in making variation to deal with the long walk-through duration. Such an deficiency put the research method to be blame as it did not include a dynamic test, resulting in an insufficient findings in a walking scenario.

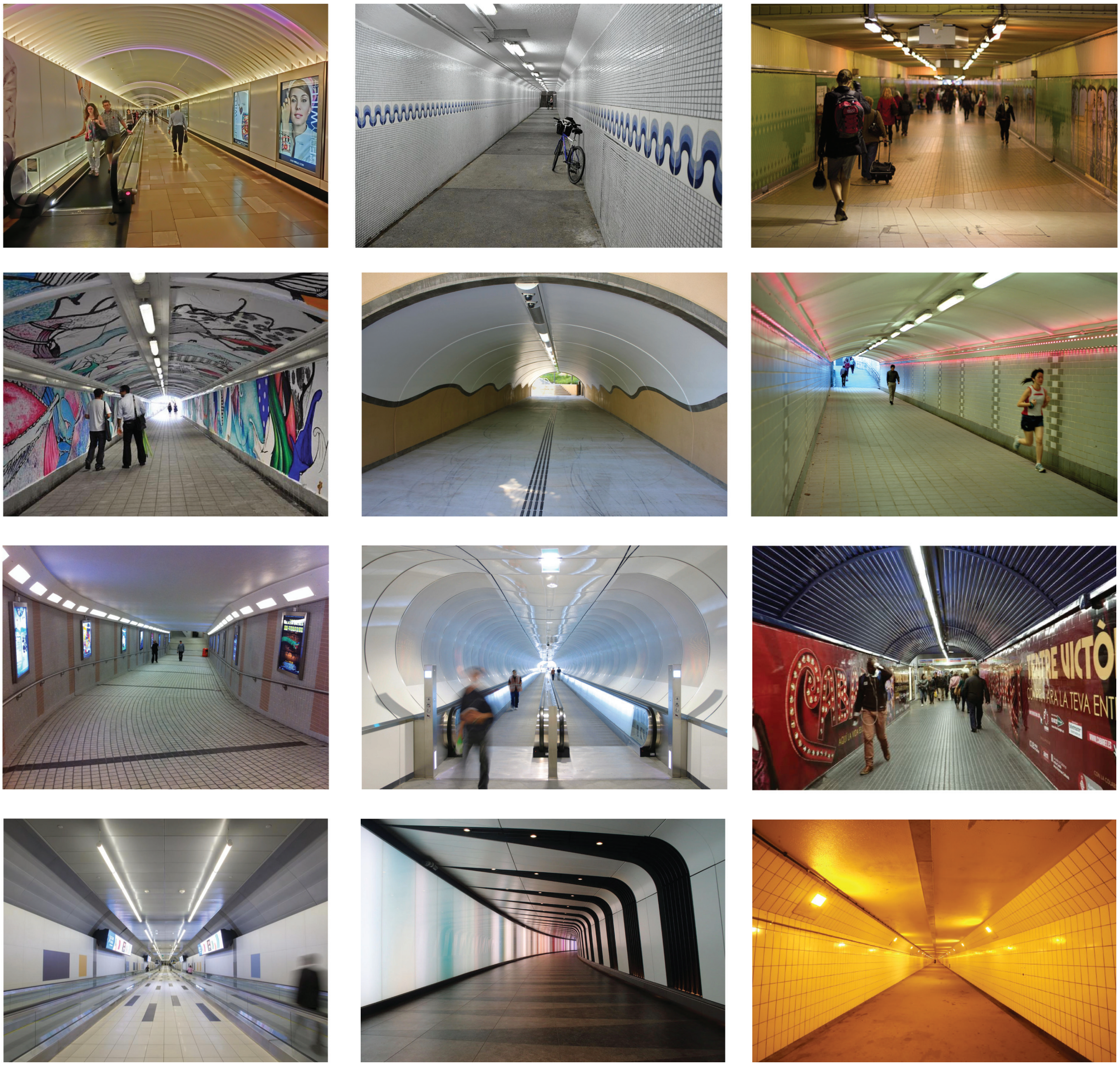
This project, started with a simple topic, has proven to be challenging as its knowledge cornerstone is scattered and covert. Along the way of research several experimental methods were raised, tried and failed. The use of mirrors was so straightforward that it became a difficult starting point for design and research. Nevertheless, gradually gaining the knowledge background of the fundamentals, the author has endeavoured to map out a path toward the answers. While the proposed design guidelines may serve as a template for designing the other types of tunnels with mirrors, the author also believes that the framework of the entire research process can be a beneficial note for the future researchers who are interested in discovering the design possibilities with any other kind of materials in any given types of context.

Appendix A: photos of pedestrian tunnels in questionnaire

Group A



Group B



Appendix B: Questionnaire for general pedestrian tunnel analysis

Tunnel Analysis

Hello, this is a general survey about the perception of pedestrian tunnels. In this survey I would like you to score several pedestrian tunnels based on perceptual descriptors such as brightness, pattern, colour, lighting, etc.

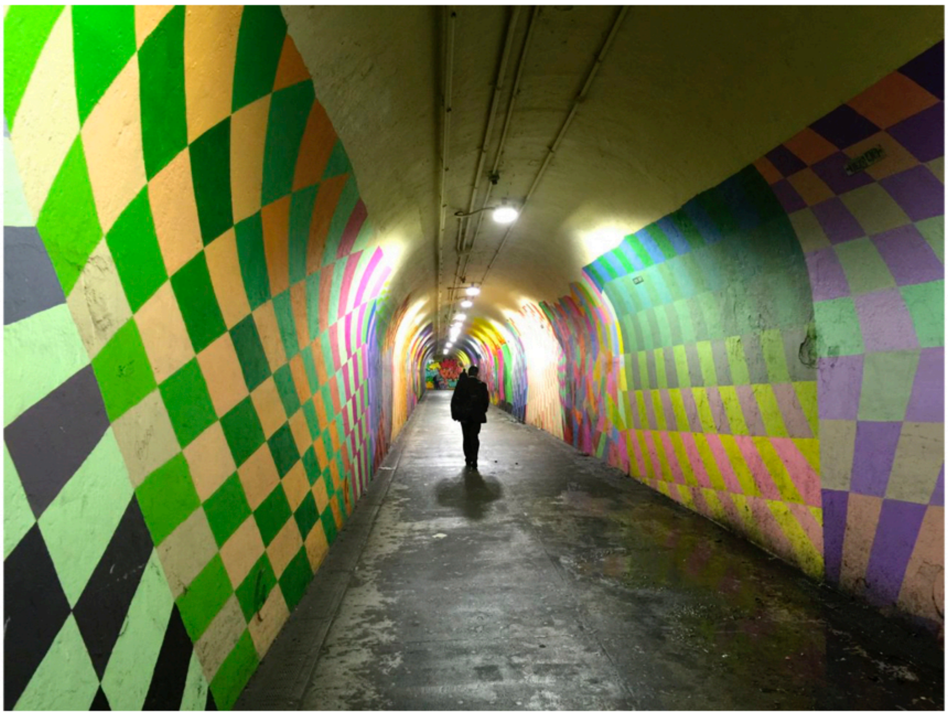
This survey nomarlly takes about 15 minutes and it would be very helpful to us for identifying the visual cues of space perception in a pedestrian tunnel. Through this survey, it is expected to discover some insights that benefit the future design of tunnels.

It is our future, and we are glad that you are willing to participate.

-Tim Lin

* Required

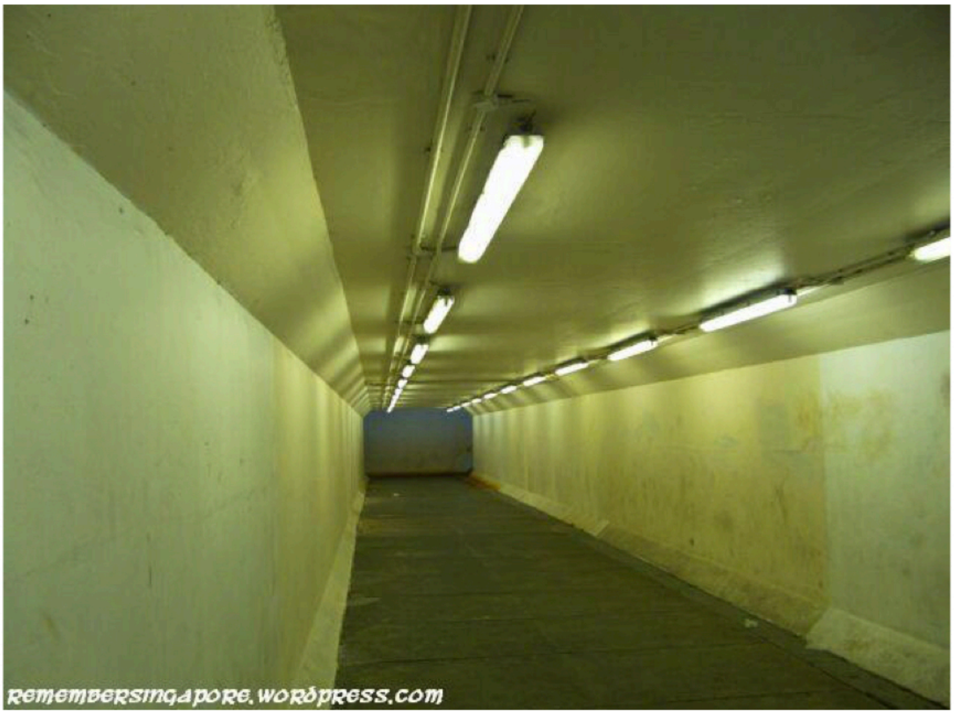
1. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shiny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭

2. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

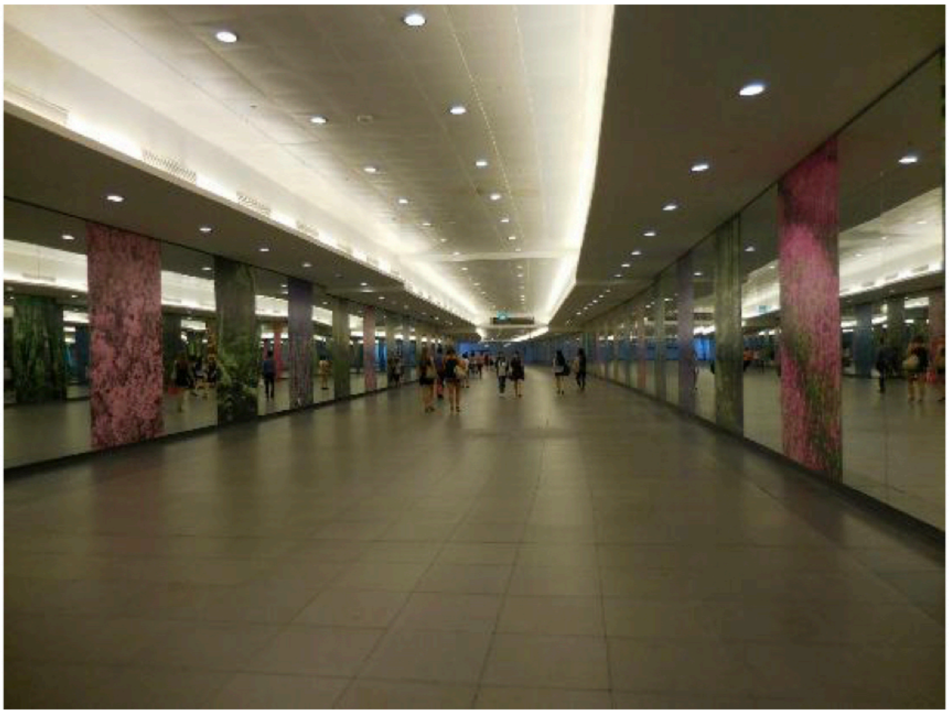
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shiny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭

3. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shiny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯

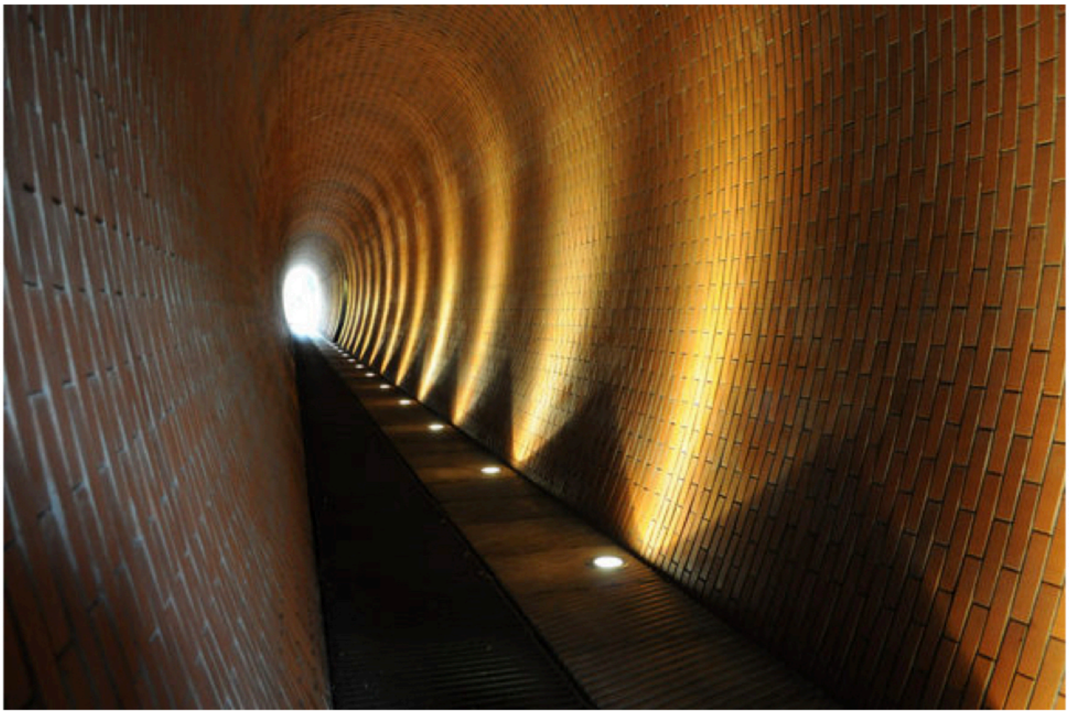
4. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shiny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯

5. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shiny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭

6. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shiny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯

7. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright							
This tunnel is clean							
This tunnel has complex patterns							
The surface of this tunnel is reflective							
This tunnel is spacious							
The lighting in this tunnel is shiny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							

8. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

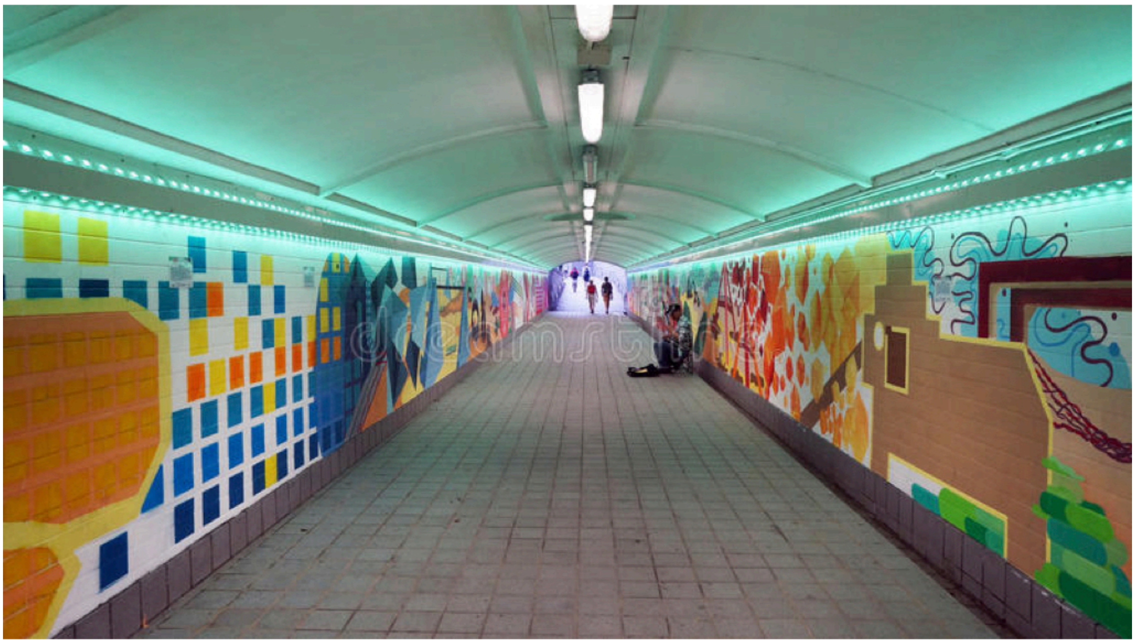
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shiny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯

9. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright							
This tunnel is clean							
This tunnel has complex patterns							
The surface of this tunnel is reflective							
This tunnel is spacious							
The lighting in this tunnel is shiny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							

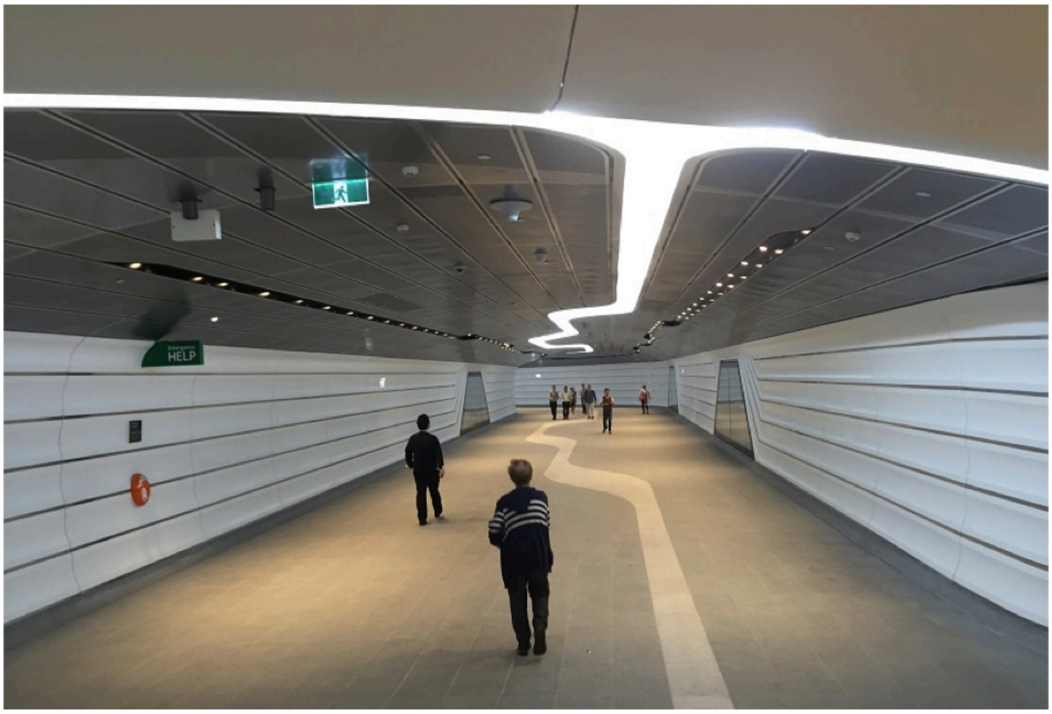
10. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shiny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯

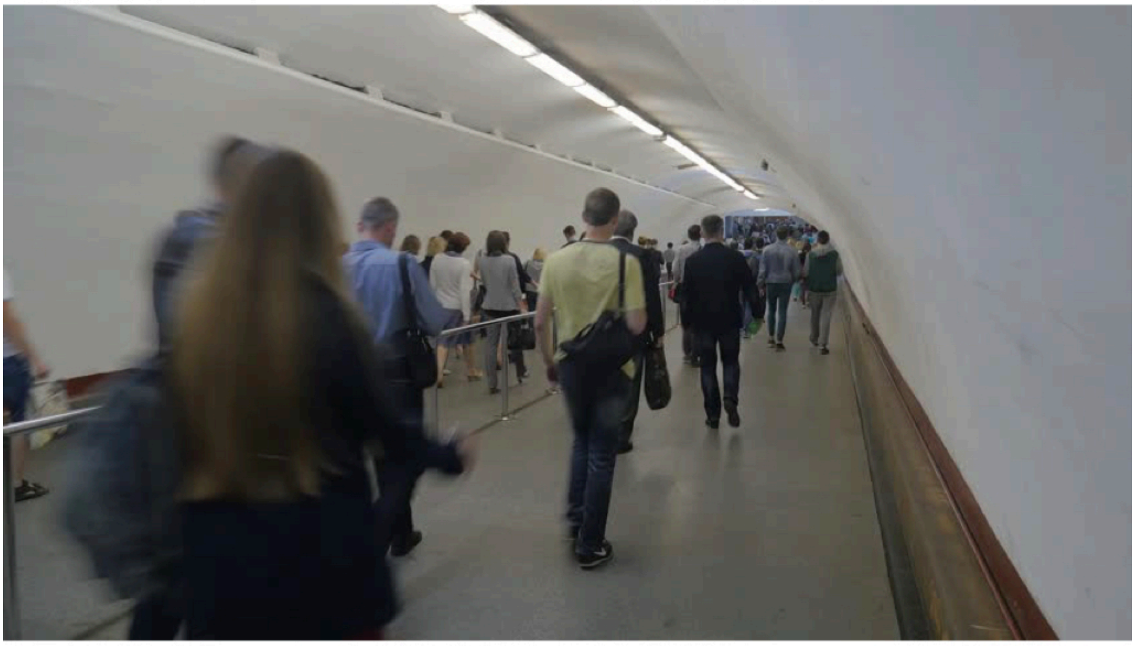
11. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shiny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭

12. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shiny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯

Half way there!

Twelve tunnels to go......

13. **Would you finish this form?**

Mark only one oval.

◯ I want to help you and keep finishing this form! *Skip to question 14.*

◯ I am done! *Stop filling out this form.*

Thank You! Let's keep going...

14. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns							
The lighting in this tunnel is shinny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							
This tunnel is spacious							
This tunnel is bright							
The surface of this tunnel is reflective							
This tunnel is clean							

15. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

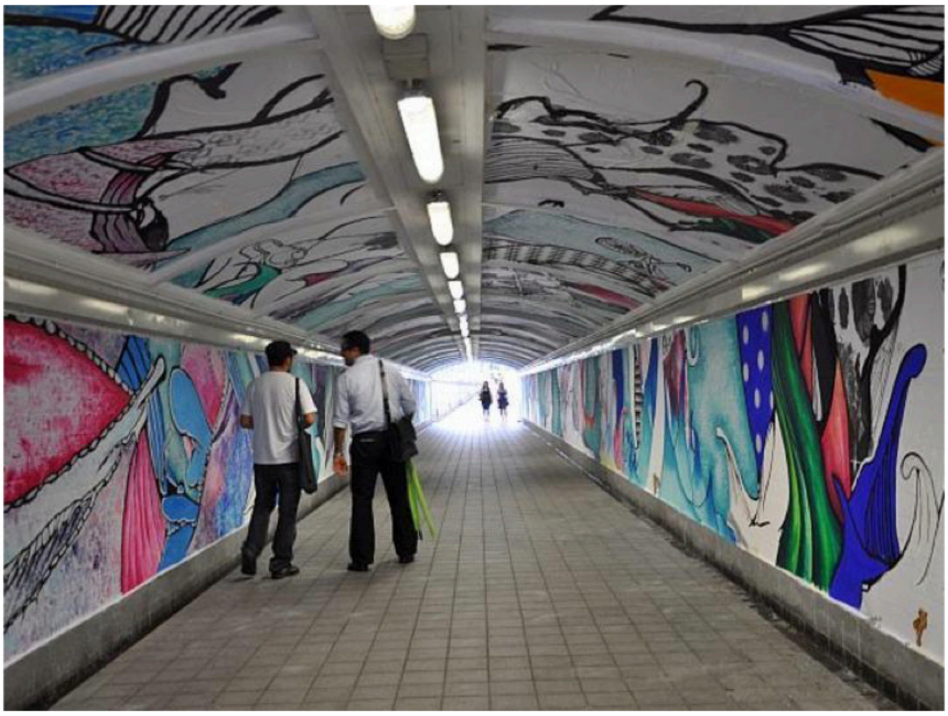
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shinny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭

16. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns							
The lighting in this tunnel is shinny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							
This tunnel is spacious							
This tunnel is bright							
The surface of this tunnel is reflective							
This tunnel is clean							

17. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shinny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯

18. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shinny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭

19. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns	◯	◯	◯	◯	◯	◯	◯
The lighting in this tunnel is shinny	◯	◯	◯	◯	◯	◯	◯
This tunnel (is tall) has high ceiling	◯	◯	◯	◯	◯	◯	◯
This tunnel (is wide) has broad passage way	◯	◯	◯	◯	◯	◯	◯
This tunnel is spacious	◯	◯	◯	◯	◯	◯	◯
This tunnel is bright	◯	◯	◯	◯	◯	◯	◯
The surface of this tunnel is reflective	◯	◯	◯	◯	◯	◯	◯
This tunnel is clean	◯	◯	◯	◯	◯	◯	◯

20. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

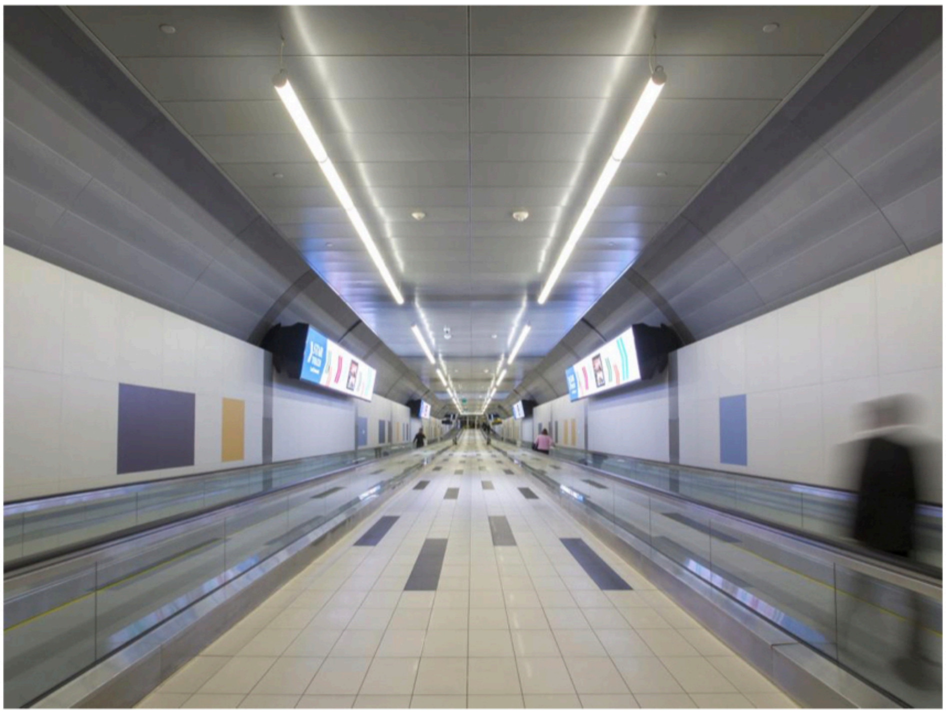
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shinny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭

21. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns							
The lighting in this tunnel is shinny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							
This tunnel is spacious							
This tunnel is bright							
The surface of this tunnel is reflective							
This tunnel is clean							

22. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

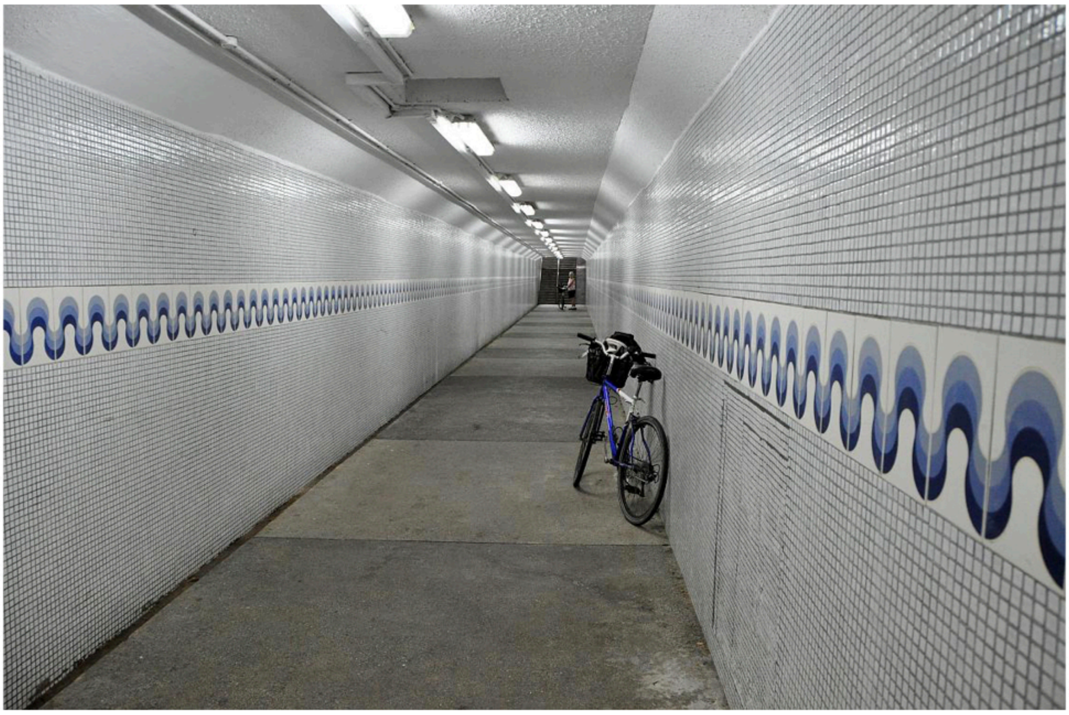
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The lighting in this tunnel is shinny	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is tall) has high ceiling	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel (is wide) has broad passage way	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is spacious	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is bright	⬭	⬭	⬭	⬭	⬭	⬭	⬭
The surface of this tunnel is reflective	⬭	⬭	⬭	⬭	⬭	⬭	⬭
This tunnel is clean	⬭	⬭	⬭	⬭	⬭	⬭	⬭

23. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns							
The lighting in this tunnel is shinny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							
This tunnel is spacious							
This tunnel is bright							
The surface of this tunnel is reflective							
This tunnel is clean							

24. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *



Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns							
The lighting in this tunnel is shinny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							
This tunnel is spacious							
This tunnel is bright							
The surface of this tunnel is reflective							
This tunnel is clean							

25. **Please look at the picture of this tunnel, imagine you are in it when answering the following questions.** *

Mark only one oval per row.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
This tunnel has complex patterns							
The lighting in this tunnel is shinny							
This tunnel (is tall) has high ceiling							
This tunnel (is wide) has broad passage way							
This tunnel is spacious							
This tunnel is bright							
The surface of this tunnel is reflective							
This tunnel is clean							

Appendix C: Raw responses to the questionnaire for general pedestrian tunnel analysis

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21	Disagree	Somewhat Agree	Disagree	Somewhat Agree	Somewhat Disagree
6/26/2018 3:35:20	Somewhat Agree	Neutral	Disagree	Disagree	Strongly Disagree
6/26/2018 3:48:54	Somewhat Disagree	Disagree	Neutral	Somewhat Disagree	Disagree
6/26/2018 3:59:12	Somewhat Disagree	Somewhat Agree	Somewhat Disagree	Neutral	Neutral
6/26/2018 4:00:28	Somewhat Disagree	Agree	Strongly Disagree	Strongly Disagree	Somewhat Disagree
6/26/2018 4:41:12	Disagree	Somewhat Disagree	Somewhat Disagree	Disagree	Disagree
6/26/2018 5:55:10	Agree	Somewhat Agree	Disagree	Somewhat Agree	Somewhat Disagree
6/26/2018 6:28:03	Agree	Agree	Somewhat Agree	Agree	Agree
6/26/2018 6:53:33	Agree	Somewhat Agree	Disagree	Neutral	Somewhat Disagree
6/26/2018 9:45:11	Somewhat Agree	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Neutral
6/26/2018 15:32:45	Somewhat Agree	Somewhat Agree	Strongly Disagree	Strongly Disagree	Neutral
6/26/2018 16:14:41	Neutral	Somewhat Agree	Neutral	Somewhat Disagree	Somewhat Disagree
6/26/2018 16:19:50					
6/26/2018 17:20:13					
6/26/2018 18:20:40					
6/27/2018 11:46:03					
6/27/2018 15:26:21	Disagree	Somewhat Disagree	Disagree	Disagree	Disagree
6/30/2018 23:18:24	Agree	Agree	Strongly Disagree	Disagree	Somewhat Agree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Disagree	Agree
6/26/2018 3:35:20	Disagree	Strongly Disagree	Strongly Disagree	Disagree	Neutral
6/26/2018 3:48:54	Disagree	Neutral	Neutral	Somewhat Disagree	Neutral
6/26/2018 3:59:12	Neutral	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Somewhat Disagree
6/26/2018 4:00:28	Disagree	Somewhat Agree	Somewhat Agree	Disagree	Neutral
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6/26/2018 16:19:50					
6/26/2018 17:20:13					
6/26/2018 18:20:40					
6/27/2018 11:46:03					
6/27/2018 15:26:21	Somewhat Disagree	Somewhat Disagree	Disagree	Disagree	Somewhat Disagree
6/30/2018 23:18:24	Disagree	Disagree	Somewhat Agree	Disagree	Agree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21	Somewhat Agree	Agree	Neutral	Somewhat Disagree	Neutral
6/26/2018 3:35:20	Disagree	Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree
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6/26/2018 5:55:10	Somewhat Disagree	Disagree	Disagree	Disagree	Neutral
6/26/2018 6:28:03	Neutral	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Agree
6/26/2018 6:53:33	Somewhat Disagree	Neutral	Strongly Agree	Strongly Agree	Somewhat Disagree
6/26/2018 9:45:11	Somewhat Agree	Disagree	Somewhat Disagree	Disagree	Agree
6/26/2018 15:32:45	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Strongly Agree	Agree
6/26/2018 16:14:41	Disagree	Strongly Disagree	Strongly Disagree	Disagree	Disagree
6/26/2018 16:19:50					
6/26/2018 17:20:13					
6/26/2018 18:20:40					
6/27/2018 11:46:03					
6/27/2018 15:26:21	Agree	Somewhat Disagree	Disagree	Disagree	Strongly Agree
6/30/2018 23:18:24	Somewhat Agree	Strongly Disagree	Disagree	Disagree	Somewhat Disagree

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6/26/2018 1:45:21	Somewhat Disagree	Somewhat Agree	Somewhat Agree	Agree	Agree
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6/26/2018 18:20:40					
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6/30/2018 23:18:24	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Disagree	Disagree

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6/26/2018 1:45:21	Somewhat Disagree	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Strongly Agree
6/26/2018 3:35:20	Somewhat Disagree	Neutral	Somewhat Disagree	Disagree	Somewhat Agree
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6/26/2018 6:53:33	Agree	Agree	Disagree	Disagree	Strongly Agree
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6/26/2018 6:53:33	Strongly Agree	Agree	Neutral	Strongly Agree	Agree
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6/26/2018 15:32:45	Strongly Agree	Agree	Somewhat Agree	Strongly Agree	Agree
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6/26/2018 18:20:40					
6/27/2018 11:46:03					
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6/26/2018 1:45:21	Disagree	Somewhat Agree	Somewhat Disagree	Neutral	Neutral
6/26/2018 3:35:20	Neutral	Neutral	Disagree	Disagree	Strongly Disagree
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6/26/2018 9:45:11	Neutral	Disagree	Somewhat Disagree	Disagree	Disagree
6/26/2018 15:32:45	Somewhat Agree	Neutral	Disagree	Disagree	Somewhat Agree
6/26/2018 16:14:41	Disagree	Neutral	Disagree	Strongly Disagree	Somewhat Disagree
6/26/2018 16:19:50					
6/26/2018 17:20:13					
6/26/2018 18:20:40					
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6/30/2018 23:18:24	Somewhat Agree	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21	Neutral	Somewhat Disagree	Somewhat Disagree	Somewhat Agree	Agree
6/26/2018 3:35:20	Disagree	Strongly Disagree	Strongly Disagree	Agree	Agree
6/26/2018 3:48:54	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Neutral	Somewhat Agree
6/26/2018 3:59:12	Neutral	Neutral	Neutral	Agree	Agree
6/26/2018 4:00:28	Disagree	Somewhat Disagree	Disagree	Somewhat Agree	Strongly Agree
6/26/2018 4:41:12	Somewhat Disagree	Neutral	Somewhat Disagree	Agree	Agree
6/26/2018 5:55:10	Disagree	Neutral	Neutral	Agree	Agree
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6/26/2018 6:53:33	Disagree	Agree	Somewhat Agree	Agree	Strongly Agree
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6/27/2018 11:46:03					
6/27/2018 15:26:21	Somewhat Agree	Somewhat Agree	Neutral	Somewhat Agree	Somewhat Agree
6/30/2018 23:18:24	Disagree	Disagree	Disagree	Somewhat Agree	Strongly Agree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
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6/26/2018 3:35:20	Somewhat Agree	Agree	Strongly Agree	Agree	Agree
6/26/2018 3:48:54	Neutral	Disagree	Agree	Neutral	Agree
6/26/2018 3:59:12	Disagree	Agree	Agree	Agree	Agree
6/26/2018 4:00:28	Disagree	Disagree	Strongly Agree	Somewhat Agree	Strongly Agree
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6/26/2018 16:19:50					
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Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21	Neutral	Neutral	Somewhat Agree	Somewhat Agree	Disagree
6/26/2018 3:35:20	Disagree	Somewhat Disagree	Somewhat Disagree	Neutral	Strongly Disagree
6/26/2018 3:48:54	Somewhat Agree	Neutral	Somewhat Agree	Agree	Somewhat Disagree
6/26/2018 3:59:12	Agree	Neutral	Agree	Agree	Disagree
6/26/2018 4:00:28	Somewhat Agree	Neutral	Agree	Agree	Disagree
6/26/2018 4:41:12	Somewhat Agree	Neutral	Somewhat Agree	Agree	Agree
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6/26/2018 3:48:54	Neutral	Somewhat Agree	Somewhat Agree	Somewhat Agree	Somewhat Disagree
6/26/2018 3:59:12	Agree	Neutral	Neutral	Agree	Neutral
6/26/2018 4:00:28	Agree	Disagree	Agree	Agree	Disagree
6/26/2018 4:41:12	Agree	Agree	Somewhat Agree	Somewhat Agree	Somewhat Agree
6/26/2018 5:55:10	Neutral	Somewhat Agree	Strongly Disagree	Somewhat Agree	Strongly Disagree
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6/26/2018 6:53:33	Strongly Agree	Somewhat Disagree	Agree	Strongly Agree	Strongly Agree
6/26/2018 9:45:11	Agree	Somewhat Agree	Agree	Strongly Agree	Agree
6/26/2018 15:32:45	Agree	Somewhat Agree	Agree	Agree	Somewhat Agree
6/26/2018 16:14:41	Neutral	Neutral	Somewhat Disagree	Agree	Somewhat Disagree
6/26/2018 16:19:50					
6/26/2018 17:20:13					
6/26/2018 18:20:40					
6/27/2018 11:46:03					
6/27/2018 15:26:21	Agree	Somewhat Agree	Neutral	Strongly Agree	Somewhat Agree
6/30/2018 23:18:24	Agree	Somewhat Agree	Agree	Agree	Somewhat Agree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
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6/26/2018 4:41:12	Agree	Agree	Agree	Neutral	Somewhat Agree
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6/26/2018 18:20:40					
6/27/2018 11:46:03					
6/27/2018 15:26:21	Agree	Strongly Agree	Agree	Somewhat Agree	Agree
6/30/2018 23:18:24	Somewhat Agree	Somewhat Agree	Somewhat Agree	Somewhat Agree	Agree

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6/27/2018 11:46:03					
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Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
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Timestamp	Please look at the picture	Would you finish this form	Please look at the picture	Please look at the picture	Please look at the picture
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6/26/2018 3:48:54	Neutral	I want to help you and ke	Somewhat Disagree	Neutral	Somewhat Agree
6/26/2018 3:59:12	Agree	I want to help you and ke	Disagree	Agree	Disagree
6/26/2018 4:00:28	Somewhat Agree	I want to help you and ke	Disagree	Disagree	Neutral
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6/26/2018 5:55:10	Strongly Agree	I want to help you and ke	Somewhat Agree	Disagree	Disagree
6/26/2018 6:28:03	Agree	I want to help you and ke	Somewhat Disagree	Somewhat Disagree	Disagree
6/26/2018 6:53:33	Somewhat Agree	I want to help you and ke	Neutral	Somewhat Disagree	Disagree
6/26/2018 9:45:11	Agree	I am done!			
6/26/2018 15:32:45	Somewhat Agree		Neutral	Strongly Disagree	Somewhat Disagree
6/26/2018 16:14:41	Somewhat Agree	I want to help you and ke	Neutral	Neutral	Disagree
6/26/2018 16:19:50		I am done!	Somewhat Disagree	Somewhat Disagree	Neutral
6/26/2018 17:20:13		I am done!	Somewhat Disagree	Disagree	Strongly Disagree
6/26/2018 18:20:40		I am done!	Neutral	Disagree	Strongly Disagree
6/27/2018 11:46:03		I am done!	Somewhat Disagree	Disagree	Disagree
6/27/2018 15:26:21	Somewhat Agree	I want to help you and ke	Neutral	Somewhat Disagree	Neutral
6/30/2018 23:18:24	Somewhat Agree	I want to help you and ke	Somewhat Disagree	Disagree	Disagree

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6/26/2018 4:41:12	Neutral	Neutral	Neutral	Somewhat Disagree	Somewhat Disagree
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6/26/2018 6:28:03	Somewhat Agree	Somewhat Agree	Disagree	Somewhat Disagree	Somewhat Disagree
6/26/2018 6:53:33	Agree	Neutral	Agree	Somewhat Agree	Agree
6/26/2018 9:45:11					
6/26/2018 15:32:45	Neutral	Neutral	Somewhat Agree	Somewhat Agree	Somewhat Agree
6/26/2018 16:14:41	Neutral	Neutral	Neutral	Somewhat Disagree	Somewhat Agree
6/26/2018 16:19:50	Disagree	Disagree	Somewhat Disagree	Disagree	Somewhat Disagree
6/26/2018 17:20:13	Somewhat Disagree	Somewhat Disagree	Neutral	Disagree	Strongly Disagree
6/26/2018 18:20:40	Neutral	Neutral	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree
6/27/2018 11:46:03	Somewhat Agree	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Disagree
6/27/2018 15:26:21	Somewhat Agree	Neutral	Somewhat Disagree	Somewhat Agree	Neutral
6/30/2018 23:18:24	Somewhat Agree	Somewhat Disagree	Somewhat Agree	Disagree	Somewhat Agree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21					
6/26/2018 3:35:20	Somewhat Disagree	Neutral	Strongly Disagree	Strongly Disagree	Strongly Disagree
6/26/2018 3:48:54	Somewhat Disagree	Somewhat Disagree	Neutral	Somewhat Disagree	Neutral
6/26/2018 3:59:12	Disagree	Somewhat Agree	Agree	Disagree	Disagree
6/26/2018 4:00:28	Somewhat Disagree	Neutral	Somewhat Disagree	Disagree	Disagree
6/26/2018 4:41:12	Somewhat Disagree	Neutral	Somewhat Agree	Somewhat Disagree	Somewhat Disagree
6/26/2018 5:55:10	Strongly Disagree	Agree	Neutral	Strongly Disagree	Strongly Disagree
6/26/2018 6:28:03	Disagree	Somewhat Agree	Agree	Disagree	Disagree
6/26/2018 6:53:33	Somewhat Agree	Agree	Neutral	Somewhat Disagree	Neutral
6/26/2018 9:45:11					
6/26/2018 15:32:45	Agree	Somewhat Agree	Neutral	Disagree	Disagree
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6/26/2018 16:19:50	Neutral	Somewhat Disagree	Disagree	Disagree	Disagree
6/26/2018 17:20:13	Neutral	Somewhat Disagree	Somewhat Disagree	Disagree	Disagree
6/26/2018 18:20:40	Somewhat Disagree	Somewhat Agree	Disagree	Strongly Disagree	Somewhat Disagree
6/27/2018 11:46:03	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Strongly Disagree	Strongly Disagree
6/27/2018 15:26:21	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
6/30/2018 23:18:24	Somewhat Disagree	Disagree	Disagree	Disagree	Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
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6/26/2018 3:48:54	Somewhat Agree	Somewhat Agree	Neutral	Somewhat Disagree	Somewhat Disagree
6/26/2018 3:59:12	Disagree	Neutral	Somewhat Disagree	Disagree	Disagree
6/26/2018 4:00:28	Somewhat Agree	Disagree	Neutral	Disagree	Disagree
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6/26/2018 5:55:10	Agree	Somewhat Agree	Agree	Disagree	Somewhat Agree
6/26/2018 6:28:03	Somewhat Disagree	Somewhat Agree	Somewhat Agree	Disagree	Somewhat Agree
6/26/2018 6:53:33	Somewhat Agree	Neutral	Somewhat Agree	Disagree	Neutral
6/26/2018 9:45:11					
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6/26/2018 16:19:50	Somewhat Disagree	Disagree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree
6/26/2018 17:20:13	Somewhat Disagree	Somewhat Disagree	Somewhat Agree	Neutral	Disagree
6/26/2018 18:20:40	Neutral	Disagree	Strongly Disagree	Disagree	Somewhat Disagree
6/27/2018 11:46:03	Disagree	Disagree	Strongly Disagree	Strongly Disagree	Disagree
6/27/2018 15:26:21	Somewhat Disagree	Somewhat Agree	Somewhat Disagree	Neutral	Somewhat Disagree
6/30/2018 23:18:24	Somewhat Agree	Disagree	Somewhat Agree	Disagree	Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
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6/26/2018 3:35:20	Strongly Disagree	Disagree	Strongly Disagree	Somewhat Disagree	Somewhat Disagree
6/26/2018 3:48:54	Somewhat Disagree	Neutral	Neutral	Neutral	Somewhat Disagree
6/26/2018 3:59:12	Agree	Agree	Agree	Neutral	Somewhat Agree
6/26/2018 4:00:28	Disagree	Somewhat Disagree	Disagree	Neutral	Disagree
6/26/2018 4:41:12	Neutral	Somewhat Agree	Neutral	Neutral	Neutral
6/26/2018 5:55:10	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Somewhat Agree	Somewhat Agree
6/26/2018 6:28:03	Somewhat Disagree	Somewhat Agree	Neutral	Neutral	Somewhat Agree
6/26/2018 6:53:33	Somewhat Agree	Agree	Somewhat Agree	Agree	Somewhat Agree
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6/26/2018 15:32:45	Disagree	Somewhat Disagree	Neutral	Neutral	Disagree
6/26/2018 16:14:41	Somewhat Disagree	Somewhat Disagree	Disagree	Disagree	Somewhat Disagree
6/26/2018 16:19:50	Disagree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Disagree
6/26/2018 17:20:13	Disagree	Somewhat Disagree	Somewhat Disagree	Disagree	Strongly Disagree
6/26/2018 18:20:40	Disagree	Somewhat Disagree	Somewhat Disagree	Neutral	Disagree
6/27/2018 11:46:03	Disagree	Neutral	Neutral	Somewhat Disagree	Disagree
6/27/2018 15:26:21	Disagree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Neutral
6/30/2018 23:18:24	Disagree	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21					
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6/26/2018 3:48:54	Neutral	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree
6/26/2018 3:59:12	Agree	Agree	Agree	Agree	Agree
6/26/2018 4:00:28	Somewhat Disagree	Agree	Disagree	Disagree	Disagree
6/26/2018 4:41:12	Neutral	Agree	Neutral	Somewhat Disagree	Somewhat Disagree
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6/26/2018 15:32:45	Somewhat Agree	Strongly Agree	Disagree	Strongly Disagree	Disagree
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6/26/2018 16:19:50	Somewhat Disagree	Agree	Somewhat Disagree	Disagree	Somewhat Disagree
6/26/2018 17:20:13	Neutral	Agree	Neutral	Somewhat Disagree	Somewhat Disagree
6/26/2018 18:20:40	Disagree	Strongly Agree	Somewhat Agree	Strongly Disagree	Somewhat Disagree
6/27/2018 11:46:03	Disagree	Agree	Neutral	Strongly Disagree	Somewhat Disagree
6/27/2018 15:26:21	Somewhat Disagree	Agree	Disagree	Disagree	Neutral
6/30/2018 23:18:24	Somewhat Agree	Agree	Disagree	Strongly Disagree	Somewhat Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21					
6/26/2018 3:35:20	Strongly Disagree	Somewhat Disagree	Disagree	Somewhat Disagree	Disagree
6/26/2018 3:48:54	Somewhat Disagree	Neutral	Somewhat Disagree	Neutral	Agree
6/26/2018 3:59:12	Somewhat Agree	Disagree	Somewhat Disagree	Somewhat Disagree	Disagree
6/26/2018 4:00:28	Disagree	Somewhat Disagree	Disagree	Neutral	Somewhat Agree
6/26/2018 4:41:12	Somewhat Agree	Somewhat Agree	Neutral	Neutral	Somewhat Disagree
6/26/2018 5:55:10	Disagree	Somewhat Disagree	Somewhat Disagree	Neutral	Disagree
6/26/2018 6:28:03	Somewhat Agree	Neutral	Somewhat Disagree	Neutral	Neutral
6/26/2018 6:53:33	Neutral	Somewhat Agree	Neutral	Agree	Somewhat Disagree
6/26/2018 9:45:11					
6/26/2018 15:32:45	Disagree	Agree	Strongly Disagree	Somewhat Disagree	Agree
6/26/2018 16:14:41	Somewhat Disagree	Somewhat Agree	Somewhat Disagree	Somewhat Agree	Somewhat Agree
6/26/2018 16:19:50	Disagree	Somewhat Agree	Disagree	Disagree	Neutral
6/26/2018 17:20:13	Somewhat Disagree	Neutral	Somewhat Disagree	Neutral	Somewhat Agree
6/26/2018 18:20:40	Disagree	Disagree	Disagree	Disagree	Disagree
6/27/2018 11:46:03	Somewhat Disagree	Somewhat Disagree	Strongly Disagree	Strongly Disagree	Somewhat Agree
6/27/2018 15:26:21	Somewhat Disagree	Neutral	Disagree	Somewhat Disagree	Disagree
6/30/2018 23:18:24	Disagree	Somewhat Agree	Disagree	Somewhat Agree	Somewhat Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
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6/26/2018 3:35:20	Somewhat Disagree	Disagree	Disagree	Disagree	Disagree
6/26/2018 3:48:54	Disagree	Neutral	Somewhat Agree	Neutral	Somewhat Disagree
6/26/2018 3:59:12	Somewhat Disagree	Disagree	Somewhat Agree	Neutral	Disagree
6/26/2018 4:00:28	Disagree	Somewhat Agree	Somewhat Agree	Somewhat Agree	Disagree
6/26/2018 4:41:12	Neutral	Neutral	Neutral	Somewhat Disagree	Neutral
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6/26/2018 6:28:03	Somewhat Disagree	Agree	Agree	Agree	Disagree
6/26/2018 6:53:33	Agree	Somewhat Disagree	Somewhat Agree	Neutral	Somewhat Agree
6/26/2018 9:45:11					
6/26/2018 15:32:45	Somewhat Disagree	Somewhat Agree	Agree	Somewhat Disagree	Neutral
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6/26/2018 16:19:50	Somewhat Disagree	Somewhat Disagree	Somewhat Agree	Neutral	Somewhat Disagree
6/26/2018 17:20:13	Neutral	Neutral	Somewhat Agree	Somewhat Agree	Neutral
6/26/2018 18:20:40	Somewhat Disagree	Strongly Disagree	Neutral	Neutral	Somewhat Disagree
6/27/2018 11:46:03	Somewhat Disagree	Neutral	Agree	Agree	Neutral
6/27/2018 15:26:21	Strongly Disagree	Disagree	Neutral	Disagree	Disagree
6/30/2018 23:18:24	Disagree	Disagree	Agree	Somewhat Disagree	Somewhat Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21					
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6/26/2018 3:59:12	Neutral	Somewhat Agree	Disagree	Somewhat Disagree	Disagree
6/26/2018 4:00:28	Disagree	Somewhat Disagree	Disagree	Agree	Neutral
6/26/2018 4:41:12	Somewhat Disagree	Somewhat Disagree	Disagree	Agree	Somewhat Agree
6/26/2018 5:55:10	Somewhat Disagree	Neutral	Strongly Disagree	Somewhat Agree	Disagree
6/26/2018 6:28:03	Agree	Somewhat Agree	Disagree	Neutral	Neutral
6/26/2018 6:53:33	Neutral	Somewhat Agree	Strongly Disagree	Somewhat Disagree	Disagree
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6/26/2018 16:14:41	Somewhat Disagree	Neutral	Disagree	Disagree	Disagree
6/26/2018 16:19:50	Somewhat Disagree	Disagree	Disagree	Somewhat Disagree	Neutral
6/26/2018 17:20:13	Neutral	Neutral	Strongly Disagree	Neutral	Neutral
6/26/2018 18:20:40	Somewhat Disagree	Disagree	Disagree	Somewhat Disagree	Disagree
6/27/2018 11:46:03	Somewhat Agree	Disagree	Strongly Disagree	Strongly Agree	Neutral
6/27/2018 15:26:21	Neutral	Disagree	Disagree	Neutral	Somewhat Disagree
6/30/2018 23:18:24	Disagree	Somewhat Disagree	Strongly Disagree	Strongly Disagree	Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21					
6/26/2018 3:35:20	Strongly Disagree	Strongly Disagree	Somewhat Disagree	Disagree	Disagree
6/26/2018 3:48:54	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree
6/26/2018 3:59:12	Disagree	Disagree	Disagree	Somewhat Agree	Somewhat Agree
6/26/2018 4:00:28	Somewhat Disagree	Disagree	Somewhat Agree	Somewhat Agree	Somewhat Disagree
6/26/2018 4:41:12	Neutral	Neutral	Agree	Neutral	Neutral
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6/26/2018 6:28:03	Somewhat Disagree	Somewhat Disagree	Disagree	Somewhat Agree	Neutral
6/26/2018 6:53:33	Somewhat Agree	Somewhat Disagree	Strongly Agree	Somewhat Agree	Agree
6/26/2018 9:45:11					
6/26/2018 15:32:45	Somewhat Agree	Somewhat Agree	Agree	Somewhat Agree	Disagree
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6/26/2018 16:19:50	Somewhat Disagree	Somewhat Disagree	Disagree	Somewhat Agree	Disagree
6/26/2018 17:20:13	Neutral	Neutral	Neutral	Somewhat Disagree	Somewhat Agree
6/26/2018 18:20:40	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Disagree	Strongly Disagree
6/27/2018 11:46:03	Somewhat Agree	Somewhat Agree	Strongly Agree	Somewhat Disagree	Disagree
6/27/2018 15:26:21	Somewhat Disagree	Disagree	Neutral	Somewhat Agree	Somewhat Disagree
6/30/2018 23:18:24	Disagree	Disagree	Disagree	Strongly Disagree	Somewhat Agree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21					
6/26/2018 3:35:20	Disagree	Disagree	Strongly Disagree	Strongly Disagree	Strongly Disagree
6/26/2018 3:48:54	Agree	Somewhat Disagree	Neutral	Somewhat Disagree	Somewhat Disagree
6/26/2018 3:59:12	Agree	Somewhat Agree	Agree	Agree	Agree
6/26/2018 4:00:28	Agree	Disagree	Somewhat Disagree	Disagree	Somewhat Disagree
6/26/2018 4:41:12	Agree	Neutral	Neutral	Neutral	Agree
6/26/2018 5:55:10	Disagree	Somewhat Agree	Disagree	Disagree	Disagree
6/26/2018 6:28:03	Somewhat Agree	Somewhat Disagree	Somewhat Agree	Somewhat Agree	Somewhat Agree
6/26/2018 6:53:33	Strongly Agree	Strongly Agree	Somewhat Disagree	Disagree	Neutral
6/26/2018 9:45:11					
6/26/2018 15:32:45	Strongly Agree	Disagree	Somewhat Disagree	Disagree	Disagree
6/26/2018 16:14:41	Agree	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Disagree
6/26/2018 16:19:50	Somewhat Agree	Neutral	Neutral	Somewhat Disagree	Somewhat Disagree
6/26/2018 17:20:13	Strongly Agree	Somewhat Disagree	Neutral	Somewhat Disagree	Somewhat Disagree
6/26/2018 18:20:40	Somewhat Disagree	Somewhat Disagree	Disagree	Disagree	Neutral
6/27/2018 11:46:03	Agree	Neutral	Disagree	Somewhat Disagree	Somewhat Disagree
6/27/2018 15:26:21	Somewhat Agree	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree	Disagree
6/30/2018 23:18:24	Somewhat Agree	Neutral	Somewhat Disagree	Somewhat Disagree	Somewhat Disagree

Timestamp	Please look at the picture	Please look at the picture	Please look at the picture
6/26/2018 1:45:21			
6/26/2018 3:35:20	Disagree	Disagree	Somewhat Disagree
6/26/2018 3:48:54	Somewhat Disagree	Somewhat Disagree	Neutral
6/26/2018 3:59:12	Somewhat Agree	Neutral	Somewhat Agree
6/26/2018 4:00:28	Neutral	Disagree	Somewhat Disagree
6/26/2018 4:41:12	Somewhat Agree	Neutral	Somewhat Agree
6/26/2018 5:55:10	Somewhat Agree	Somewhat Disagree	Neutral
6/26/2018 6:28:03	Somewhat Disagree	Disagree	Somewhat Disagree
6/26/2018 6:53:33	Agree	Somewhat Agree	Agree
6/26/2018 9:45:11			
6/26/2018 15:32:45	Agree	Somewhat Agree	Somewhat Disagree
6/26/2018 16:14:41	Somewhat Agree	Somewhat Agree	Somewhat Agree
6/26/2018 16:19:50	Somewhat Agree	Neutral	Somewhat Disagree
6/26/2018 17:20:13	Neutral	Neutral	Neutral
6/26/2018 18:20:40	Somewhat Disagree	Disagree	Neutral
6/27/2018 11:46:03	Somewhat Disagree	Somewhat Agree	Disagree
6/27/2018 15:26:21	Disagree	Disagree	Disagree
6/30/2018 23:18:24	Somewhat Agree	Disagree	Somewhat Agree

Appendix D: Translated responses with pedestrian tunnel photos

Timestamp	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide
Avg	4.2	4.8	2.4	3.0	3.2	2.9	3.7	3.6	2.2	4.3	3.5	2.9	2.7	2.8	4.2	2.2
6/26/2018 1:45:21	2	5	2	5	3	3	3	3	2	6	5	6	4	3	4	3
6/26/2018 3:35:20	5	4	2	2	1	2	1	1	2	4	2	2	1	1	1	1
6/26/2018 3:48:54	3	2	4	3	2	2	4	4	3	4	4	3	4	3	5	3
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6/26/2018 5:55:10	6	5	2	5	3	5	5	3	2	4	3	2	2	2	4	2
6/26/2018 6:28:03	6	6	5	6	6	6	6	6	1	3	4	3	3	3	6	2
6/26/2018 6:53:33	6	5	2	4	3	4	3	5	3	6	3	4	7	7	3	3
6/26/2018 9:45:11	5	5	3	3	4	3	3	3	2	6	5	2	3	2	6	2
6/26/2018 15:32:45	5	5	1	1	4	2	6	5	3	5	3	3	3	7	6	2
6/26/2018 16:14:41	4	5	4	3	3	3	3	3	2	3	2	1	1	2	2	2
6/26/2018 16:19:50																
6/26/2018 17:20:13																
6/26/2018 18:20:40																
6/27/2018 11:46:03																
6/27/2018 15:26:21	2	3	2	2	2	3	3	2	2	3	6	3	2	2	7	2
6/30/2018 23:18:24	6	6	1	2	5	2	2	5	2	6	5	1	2	2	3	1

Timestamp	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide
Avg	3.8	4.0	5.1	3.4	2.8	3.6	2.2	2.1	5.4	6.2	5.8	4.8	5.5	5.2	5.8	5.1
6/26/2018 1:45:21	5	5	6	6	3	5	3	3	7	7	6	5	6	5	6	6
6/26/2018 3:35:20	6	6	3	5	3	4	3	2	5	5	4	4	3	3	4	4
6/26/2018 3:48:54	5	4	4	4	2	3	2	2	4	5	6	4	4	4	6	6
6/26/2018 3:59:12	2	5	4	4	4	4	2	2	2	6	5	5	5	4	4	4
6/26/2018 4:00:28	3	3	6	2	1	4	1	1	6	7	7	4	6	5	7	7
6/26/2018 4:41:12	2	3	4	2	4	2	2	2	6	6	6	5	6	6	6	4
6/26/2018 5:55:10	6	6	6	5	2	6	2	2	5	6	6	6	5	6	6	5
6/26/2018 6:28:03	2	3	5	5	3	4	5	3	6	6	6	4	6	6	5	5
6/26/2018 6:53:33	6	6	7	4	6	6	2	2	7	7	6	4	7	6	6	5
6/26/2018 9:45:11	2	2	6	2	2	3	2	2	6	6	6	6	6	6	6	6
6/26/2018 15:32:45	3	2	6	1	2	4	2	2	6	7	6	5	7	6	7	6
6/26/2018 16:14:41	5	5	6	4	3	3	2	2	5	6	4	4	3	4	4	4
6/26/2018 16:19:50																
6/26/2018 17:20:13																
6/26/2018 18:20:40																
6/27/2018 11:46:03																
6/27/2018 15:26:21	5	3	5	2	4	1	3	3	4	5	5	5	6	5	6	4
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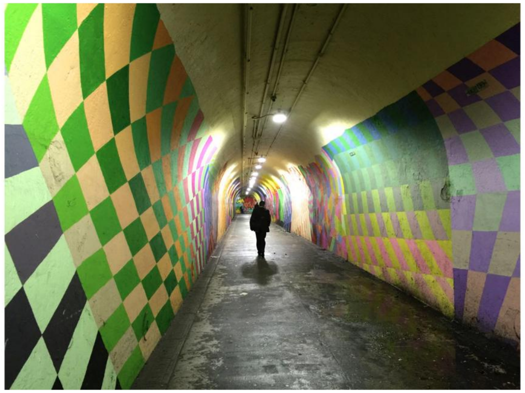

Timestamp	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide
Avg	2.3	2.3	5.4	2.6	3.0	2.8	4.5	3.1	3.2	4.2	2.5	3.3	3.6	2.8	3.5	3.2
6/26/2018 1:45:21	2	2	5	4	3	3	3	3	2	5	3	4	4	4	3	3
6/26/2018 3:35:20	4	3	5	2	7	3	7	7	4	4	2	2	1	2	1	1
6/26/2018 3:48:54	2	2	6	2	2	2	3	4	3	2	3	3	4	3	3	3
6/26/2018 3:59:12	2	2	6	4	2	4	2	2	2	4	4	4	3	4	4	4
6/26/2018 4:00:28	3	3	6	2	2	2	5	2	2	5	2	2	2	2	3	2
6/26/2018 4:41:12	2	2	4	2	5	2	5	2	3	4	4	3	4	3	4	3
6/26/2018 5:55:10	2	4	6	5	4	2	6	6	3	4	2	3	4	2	4	4
6/26/2018 6:28:03	3	2	5	3	5	3	5	5	4	5	2	6	5	5	5	5
6/26/2018 6:53:33	2	7	1	2	3	2	5	3	4	7	2	6	4	2	6	5
6/26/2018 9:45:11	4	2	6	4	3	5	6	4	4	2	3	2	2	2	2	2
6/26/2018 15:32:45	2	1	7	2	3	5	5	2	5	4	2	2	5	2	5	4
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6/26/2018 16:19:50																
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6/27/2018 15:26:21	2	2	5	2	2	3	4	2	2	4	2	5	5	5	5	4
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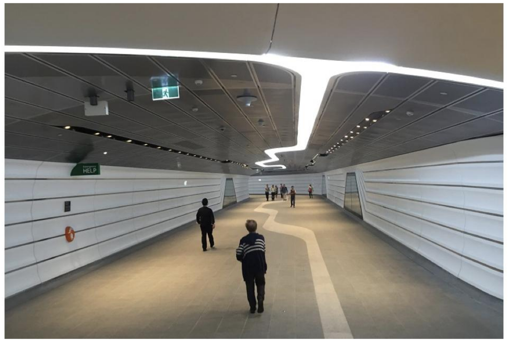

Timestamp	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide
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6/26/2018 1:45:21	5	6	5	5	5	4	5	5	2	3	2	3	4	4	5	5
6/26/2018 3:35:20	6	6	5	6	7	6	6	7	5	4	2	2	2	3	3	4
6/26/2018 3:48:54	4	5	4	2	6	4	6	6	5	6	5	5	5	4	5	6
6/26/2018 3:59:12	6	6	2	6	6	6	6	6	7	7	2	4	6	4	6	6
6/26/2018 4:00:28	5	7	2	2	7	5	7	7	5	6	3	3	5	4	6	6
6/26/2018 4:41:12	6	6	4	6	6	4	5	6	6	4	4	4	5	4	5	6
6/26/2018 5:55:10	6	6	3	6	6	5	6	6	6	6	2	6	4	6	4	3
6/26/2018 6:28:03	6	6	6	6	6	6	6	6	5	5	2	3	6	6	6	6
6/26/2018 6:53:33	6	7	4	6	6	4	6	6	5	6	4	4	7	5	6	6
6/26/2018 9:45:11	7	6	5	5	6	5	6	7	6	2	5	5	6	6	5	3
6/26/2018 15:32:45	6	6	5	6	7	6	6	7	6	6	3	4	6	6	3	5
6/26/2018 16:14:41	5	6	5	3	5	3	5	5	3	4	4	2	4	3	4	6
6/26/2018 16:19:50																
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6/26/2018 18:20:40																
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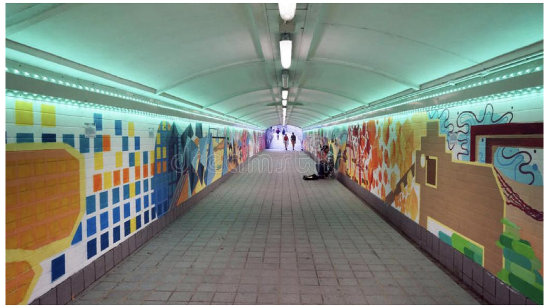
6/27/2018 15:26:21	5	5	5	4	6	6	5	6	5	3	5	6	6	5	6	5
6/30/2018 23:18:24	5	7	6	2	7	6	6	7	6	6	3	6	5	5	3	5



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6/26/2018 1:45:21	2	6	4	5	5	3	5	5	6	6	6	6	6	5	5	6
6/26/2018 3:35:20	1	1	1	1	1	1	1	1	5	4	4	3	2	3	2	2
6/26/2018 3:48:54	3	4	5	5	5	3	5	5	2	2	6	3	2	3	2	3
6/26/2018 3:59:12	2	6	4	4	6	4	5	4	3	4	4	4	6	4	4	4
6/26/2018 4:00:28	2	6	2	6	6	2	7	6	6	6	6	2	5	2	1	5
6/26/2018 4:41:12	6	6	6	5	5	5	6	6	6	4	5	3	5	4	4	5
6/26/2018 5:55:10	3	4	5	1	5	1	5	6	6	6	6	6	4	6	3	4
6/26/2018 6:28:03	6	6	6	3	6	6	6	6	3	3	2	3	5	3	3	5
6/26/2018 6:53:33	7	7	3	6	7	7	6	7	2	3	7	2	4	3	3	4
6/26/2018 9:45:11	5	6	5	6	7	6	6	7	6	6	6	2	5	2	2	6
6/26/2018 15:32:45	6	6	5	6	6	5	6	7	5	4	6	1	4	2	3	3
6/26/2018 16:14:41	2	4	4	3	6	3	5	5	5	5	4	2	4	4	4	4
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6/26/2018 18:20:40																
6/27/2018 11:46:03																
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Timestamp	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide	Bright	Clean	Complex	Relfective	Spacious	Shiny	High	Wide
Avg	3.8	2.7	2.2	2.8	3.7	2.4	2.7	2.7	5.2	5.5	4.3	4.3	4.9	4.5	3.3	5.1
6/26/2018 1:45:21	2	3	2	2	2	2	2	2	6	6	4	5	5	5	3	4
6/26/2018 3:35:20	5	4	2	2	7	2	7	7	5	4	3	2	2	3	3	3
6/26/2018 3:48:54	4	3	3	3	3	3	3	3	4	5	5	4	3	3	3	4
6/26/2018 3:59:12	7	2	2	4	7	2	2	2	4	7	2	6	6	4	4	6
6/26/2018 4:00:28	2	2	7	7	2	2	2	2	5	6	6	5	6	5	5	5
6/26/2018 4:41:12	2	2	2	2	2	2	2	2	6	6	5	5	5	5	4	5
6/26/2018 5:55:10	6	4	2	3	4	5	4	4	6	6	5	6	6	6	4	7
6/26/2018 6:28:03	2	2	2	2	5	3	5	4	6	6	3	5	6	6	6	6
6/26/2018 6:53:33	6	3	3	4	3	4	3	3	6	6	5	4	4	6	3	5
6/26/2018 9:45:11	4	2	2	2	7	2	2	2	3	3	5	2	5	5	4	6
6/26/2018 15:32:45	5	2	1	1	2	2	2	2	5	5	6	5	4	4	2	5
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6/26/2018 16:19:50																
6/26/2018 17:20:13																
6/26/2018 18:20:40																
6/27/2018 11:46:03																
6/27/2018 15:26:21	3	3	2	5	4	3	3	4	3	4	3	5	5	3	2	5
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									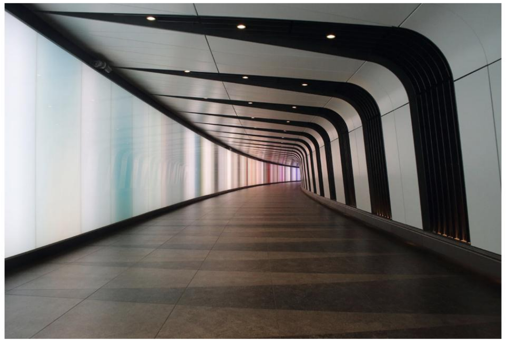							
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6/26/2018 1:45:21																
6/26/2018 3:35:20	3	2	2	2	1	2	2	3	5	3	3	4	3	1	2	3
6/26/2018 3:48:54	3	4	5	5	4	4	3	4	3	3	5	5	5	4	4	5
6/26/2018 3:59:12	2	6	2	5	5	4	4	4	4	5	2	5	5	4	4	4
6/26/2018 4:00:28	2	2	4	5	5	3	2	6	2	2	6	6	6	5	5	6
6/26/2018 4:41:12	4	3	3	4	6	3	4	4	6	4	5	6	6	6	4	6
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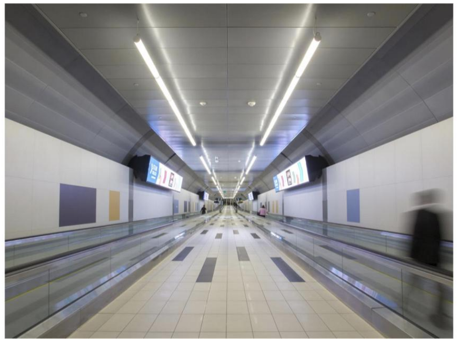
6/26/2018 16:14:41	4	4	2	5	5	4	3	5	5	4	4	5	5	4	4	5
6/26/2018 16:19:50	3	3	4	6	5	3	4	5	5	5	4	5	5	4	3	6
6/26/2018 17:20:13	3	2	1	3	3	2	1	2	2	2	3	4	4	4	3	7
6/26/2018 18:20:40	4	2	1	2	4	4	3	2	3	4	3	3	3	2	2	5
6/27/2018 11:46:03	3	2	2	5	6	1	4	3	3	3	5	5	6	4	4	7
6/27/2018 15:26:21	4	3	4	5	5	4	5	5	6	4	4	5	5	4	5	6
6/30/2018 23:18:24	3	2	2	5	3	3	2	5	5	2	5	5	5	3	3	6

																
Timestamp	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean
Avg	3.9	4.9	5.5	4.4	4.6	5.6	4.0	5.5	4.6	4.1	4.0	4.2	3.9	4.2	4.3	5.3
6/26/2018 1:45:21																
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6/26/2018 4:00:28	3	4	6	6	6	6	3	6	6	5	5	4	3	5	6	6
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6/26/2018 6:28:03	2	6	6	6	6	6	6	6	5	5	5	5	5	3	5	5
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6/26/2018 9:45:11																
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6/26/2018 16:19:50	5	3	5	3	3	6	2	6	5	5	5	4	4	3	5	5
6/26/2018 17:20:13	1	5	5	5	5	5	4	7	4	4	4	3	3	4	3	7
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6/27/2018 15:26:21	5	5	5	5	5	6	5	5	5	4	5	5	3	3	5	4
6/30/2018 23:18:24	5	6	5	3	4	5	3	5	5	3	2	5	3	3	3	5

Timestamp	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean
Avg	4.1	5.4	5.3	3.9	4.7	5.5	5.4	5.8	3.9	4.1	3.3	4.1	3.6	3.6	2.9	3.7
6/26/2018 1:45:21																
6/26/2018 3:35:20	4	5	4	3	3	3	4	4	2	3	3	3	2	3	2	3
6/26/2018 3:48:54	3	4	5	3	5	5	4	5	4	4	4	4	3	4	3	4
6/26/2018 3:59:12	2	6	6	6	6	4	5	5	4	6	6	6	6	2	3	3
6/26/2018 4:00:28	2	3	6	3	5	6	5	6	5	5	3	3	2	5	2	5
6/26/2018 4:41:12	7	7	7	4	6	7	6	6	4	3	4	4	4	4	3	3
6/26/2018 5:55:10	7	7	6	3	3	6	6	6	5	3	4	3	3	2	2	4
6/26/2018 6:28:03	2	6	6	6	6	6	6	6	3	3	3	5	5	2	3	3
6/26/2018 6:53:33	5	6	5	5	6	7	6	7	5	6	5	6	4	6	5	6
6/26/2018 9:45:11																
6/26/2018 15:32:45	2	5	6	3	6	7	7	6	5	4	3	4	4	5	5	5
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6/26/2018 16:19:50	5	5	6	5	5	6	5	6	2	3	2	2	2	3	2	3
6/26/2018 17:20:13	7	5	1	3	3	4	7	5	5	4	2	3	3	4	2	1
6/26/2018 18:20:40	3	6	4	2	2	3	6	6	2	4	3	4	4	3	3	3
6/27/2018 11:46:03	2	4	5	6	6	6	5	7	4	3	1	5	5	3	3	2
6/27/2018 15:26:21	6	6	5	5	4	6	6	6	5	5	4	5	4	3	5	4
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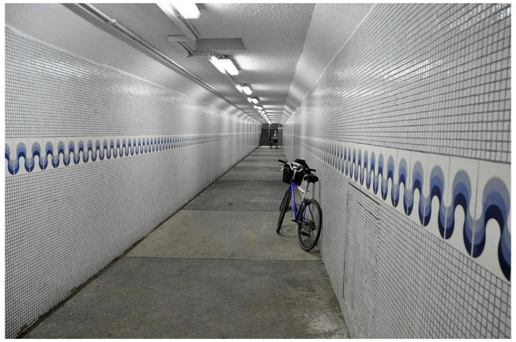

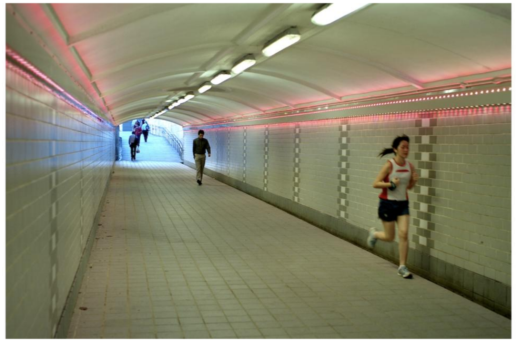

Timestamp	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean
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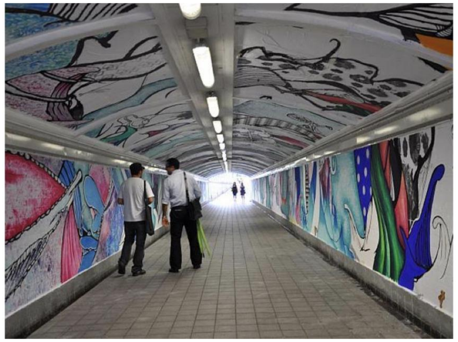
6/26/2018 1:45:21																
6/26/2018 3:35:20	3	4	1	1	1	3	4	4	2	3	1	2	1	3	3	4
6/26/2018 3:48:54	3	3	4	3	4	5	5	4	3	3	3	4	4	4	3	4
6/26/2018 3:59:12	2	5	6	2	2	2	4	3	2	2	6	6	6	4	5	6
6/26/2018 4:00:28	3	4	3	2	2	5	2	4	2	2	2	3	2	4	2	3
6/26/2018 4:41:12	3	4	5	3	3	3	3	2	5	4	4	5	4	4	4	4
6/26/2018 5:55:10	1	6	4	1	1	6	5	6	2	5	3	3	3	5	5	4
6/26/2018 6:28:03	2	5	6	2	2	3	5	5	2	5	3	5	4	4	5	5
6/26/2018 6:53:33	5	6	4	3	4	5	4	5	2	4	5	6	5	6	5	6
6/26/2018 9:45:11																
6/26/2018 15:32:45	6	5	4	2	2	6	5	5	3	2	2	3	4	4	2	5
6/26/2018 16:14:41	4	4	3	2	2	3	2	2	3	3	3	3	2	2	3	4
6/26/2018 16:19:50	4	3	2	2	2	3	2	3	3	3	2	3	3	3	2	3
6/26/2018 17:20:13	4	3	3	2	2	3	3	5	4	2	2	3	3	2	1	4
6/26/2018 18:20:40	3	5	2	1	3	4	2	1	2	3	2	3	3	4	2	2
6/27/2018 11:46:03	3	3	3	1	1	2	2	1	1	2	2	4	4	3	2	2
6/27/2018 15:26:21	5	4	3	2	1	3	5	3	4	3	2	3	3	3	4	3
6/30/2018 23:18:24	3	2	2	2	2	5	2	5	2	2	2	5	3	3	2	5



Timestamp	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean
Avg	5.9	3.8	2.0	3.1	2.9	3.9	2.5	3.6	3.6	2.9	3.2	4.8	3.9	3.0	3.3	3.4
6/26/2018 1:45:21																
6/26/2018 3:35:20	4	4	1	1	1	3	2	3	2	3	2	2	2	2	2	3
6/26/2018 3:48:54	5	3	3	3	3	4	3	4	6	2	4	5	4	3	4	4
6/26/2018 3:59:12	6	6	6	6	5	2	3	3	2	3	2	5	4	2	4	5
6/26/2018 4:00:28	6	2	2	2	2	3	2	4	5	2	5	5	5	2	2	3
6/26/2018 4:41:12	6	4	3	3	5	5	4	4	3	4	4	4	3	4	3	3
6/26/2018 5:55:10	6	5	2	2	2	3	3	4	2	2	2	3	3	3	3	4
6/26/2018 6:28:03	6	4	3	5	5	4	3	4	4	3	6	6	6	2	6	5
6/26/2018 6:53:33	6	6	1	4	4	5	4	6	3	6	3	5	4	5	4	5
6/26/2018 9:45:11																
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6/26/2018 18:20:40	7	5	1	3	2	2	2	2	2	3	1	4	4	3	3	2
6/27/2018 11:46:03	6	4	1	3	3	3	1	1	5	3	4	6	6	4	5	2
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6/30/2018 23:18:24	6	2	1	3	2	5	2	5	3	2	2	6	3	3	2	3

Timestamp	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean	Complex	Shiny	High	Wide	Spacious	Bright	Reflective	Clean
Avg	1.6	3.9	3.0	3.4	3.1	3.9	3.9	3.3	5.4	3.6	3.2	2.9	3.2	4.1	3.4	3.8
6/26/2018 1:45:21																
6/26/2018 3:35:20	1	2	1	1	1	3	2	2	2	2	1	1	1	2	2	3
6/26/2018 3:48:54	3	3	3	3	3	3	3	3	6	3	4	3	3	3	3	4
6/26/2018 3:59:12	2	3	2	2	2	2	5	5	6	5	6	6	6	5	4	5
6/26/2018 4:00:28	2	6	4	3	2	5	5	3	6	2	3	2	3	4	2	3
6/26/2018 4:41:12	2	6	5	4	4	6	4	4	6	4	4	4	6	5	4	5
6/26/2018 5:55:10	1	5	2	4	4	5	5	4	2	5	2	2	2	5	3	4
6/26/2018 6:28:03	2	4	4	3	3	2	5	4	5	3	5	5	5	3	2	3
6/26/2018 6:53:33	1	3	2	5	3	7	5	6	7	7	3	2	4	6	5	6
6/26/2018 9:45:11																
6/26/2018 15:32:45	2	6	4	5	5	6	5	2	7	2	3	2	2	6	5	3
6/26/2018 16:14:41	2	2	2	4	3	2	2	2	6	5	3	3	2	5	5	5
6/26/2018 16:19:50	2	3	4	3	3	2	5	2	5	4	4	3	3	5	4	3
6/26/2018 17:20:13	1	4	4	4	4	4	3	5	7	3	4	3	3	4	4	4
6/26/2018 18:20:40	2	3	2	3	3	3	2	1	3	3	2	2	4	3	2	4
6/27/2018 11:46:03	1	7	4	5	5	7	3	2	6	4	2	3	3	3	5	2
6/27/2018 15:26:21	2	4	3	3	2	4	5	3	5	3	3	3	2	2	2	2
6/30/2018 23:18:24	1	1	2	2	2	2	1	5	5	4	3	3	3	5	2	5

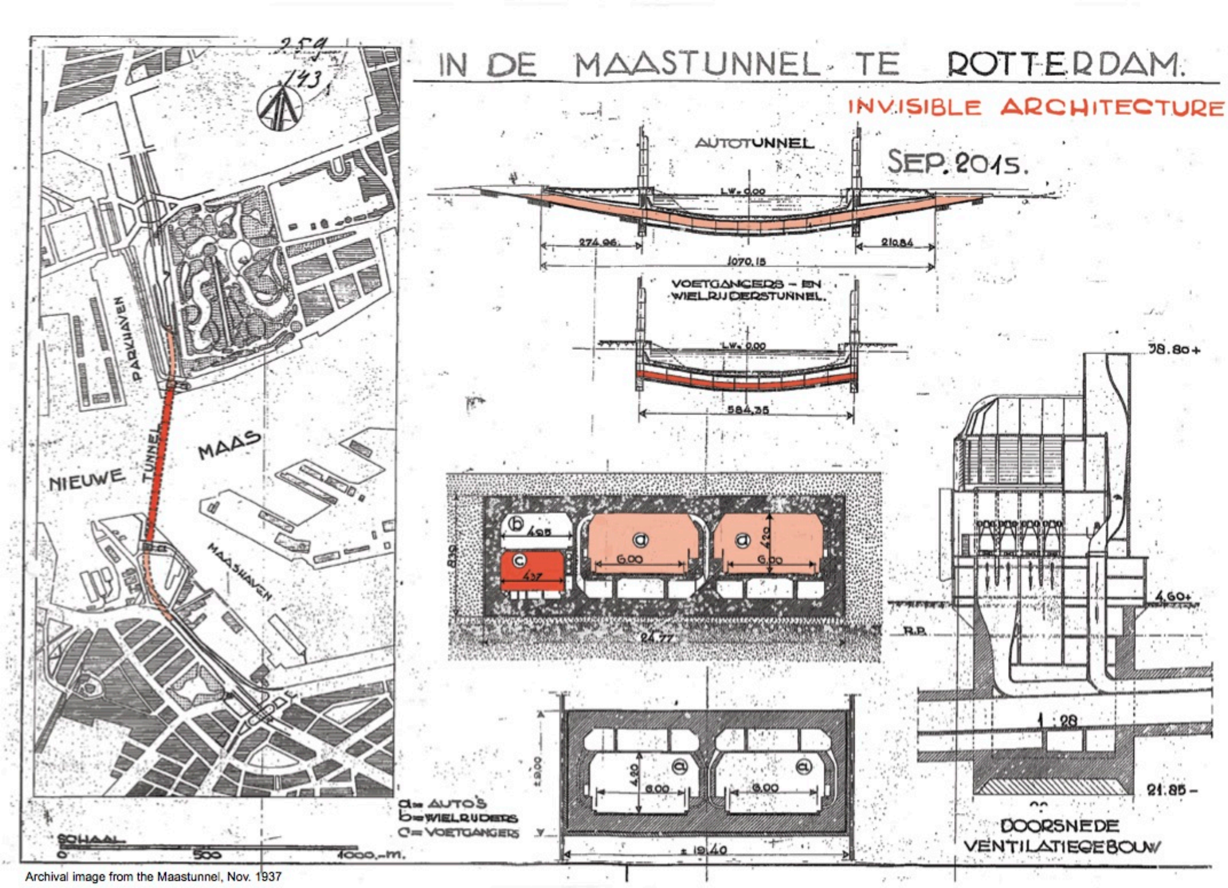
Appendix E: Statistic data of general pedestrian tunnel analysis

	Tunnel #	Spacious	Bright	Clean	Complex	Relfective	Shiny	High	Wide
Group A	1	3,2	4,2	4,8	2,4	3,0	2,9	3,7	3,6
	2	2,7	2,2	4,3	3,5	2,9	2,8	4,2	2,2
	3	2,8	3,8	4,0	5,1	3,4	3,6	2,2	2,1
	4	5,5	5,4	6,2	5,8	4,8	5,2	5,8	5,1
	5	3,0	2,3	2,3	5,4	2,6	2,8	4,5	3,1
	6	3,6	3,2	4,2	2,5	3,3	2,8	3,5	3,2
	7	6,2	5,6	6,1	4,4	4,8	5,1	5,8	6,3
	8	5,2	5,3	4,9	3,3	4,1	4,7	4,8	5,3
	9	5,8	3,9	5,5	4,4	4,5	4,0	5,5	5,8
	10	4,5	4,8	4,6	5,4	2,9	3,4	2,9	4,2
	11	3,7	3,8	2,7	2,2	2,8	2,4	2,7	2,7
	12	4,9	5,2	5,5	4,3	4,3	4,5	3,3	5,1
Group B	13	4,6	3,2	4,3	3,4	3,2	2,6	2,5	4,8
	14	5,1	4,0	5,6	4,1	3,7	3,3	4,5	5,1
	15	4,6	5,6	5,5	3,9	4,0	4,9	5,5	4,4
	16	3,9	4,2	5,3	4,6	4,3	4,1	4,0	4,2
	17	4,7	5,5	5,8	4,1	5,4	5,4	5,3	3,9
	18	3,6	3,6	3,7	3,9	2,9	4,1	3,3	4,1
	19	2,1	3,8	3,6	3,4	3,4	4,1	3,4	1,9
	20	3,4	3,6	4,0	2,6	3,1	2,9	2,6	3,8
	21	2,9	3,9	3,6	5,9	2,5	3,8	2,0	3,1
	22	3,9	3,0	3,4	3,6	3,3	2,9	3,2	4,8
	23	3,1	3,9	3,3	1,6	3,9	3,9	3,0	3,4
	24	3,2	4,1	3,8	5,4	3,4	3,6	3,2	2,9
		Coefficient	0,71	0,77	0,17	0,96	0,62	0,61	0,85
		R-square	0,404	0,582	0,035	0,474	0,263	0,424	0,857
		p-value	0,001	0,000	0,383	0,000	0,010	0,001	0,000

Histogram Chart Data				
Class	Freq	Normal Distribution		Fitting
1,6–2,1	0	Average	Std Dev	Correlation
2,1–2,6	1	4,0	1,06	0,816
2,6–3,2	5			
3,2–3,7	5			
3,7–4,2	3			
4,2–4,8	4			
4,8–5,3	3			
5,3–5,8	2			
5,8–6,3	1			
6,3–6,9	0			

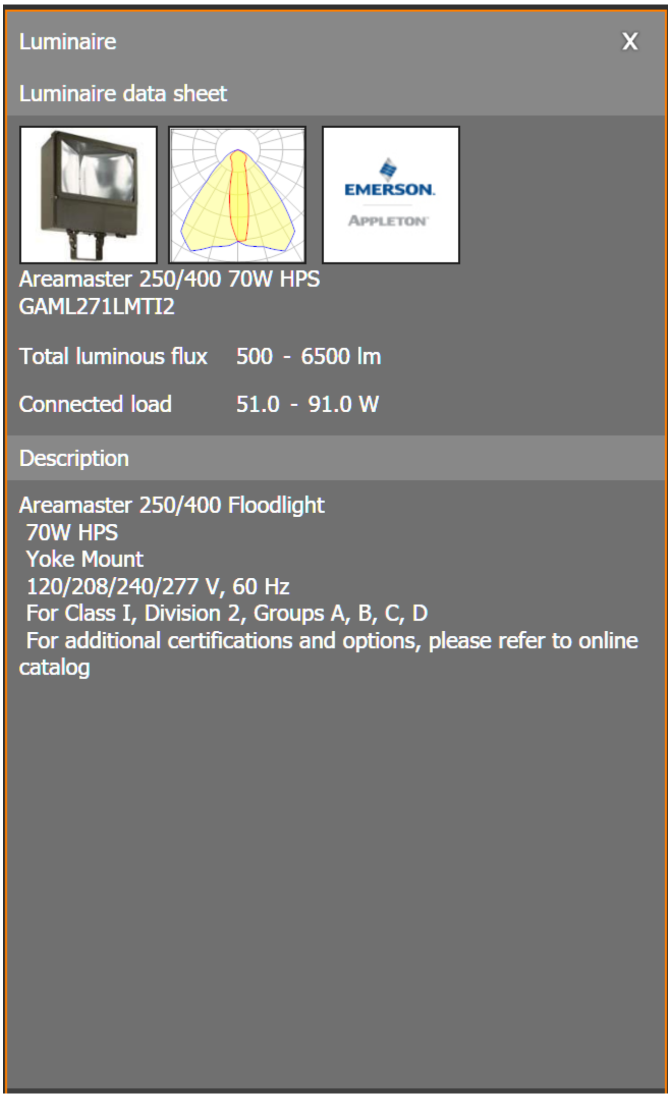
Appendix F: An archival drawing of Maastunnel

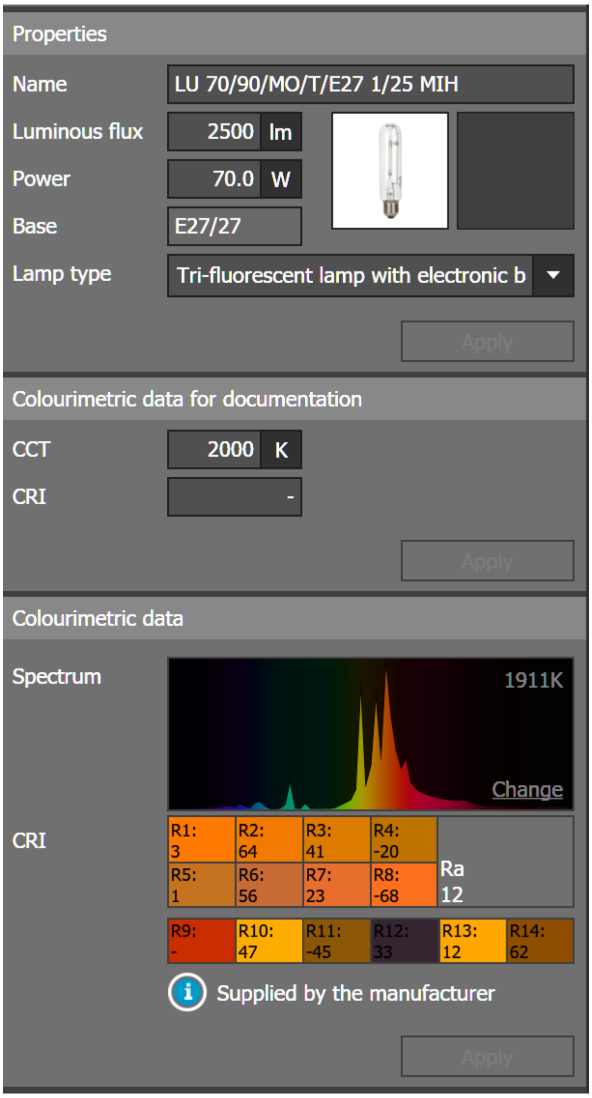
Retrieved from http://sajjra.net/chrs/?p=2693



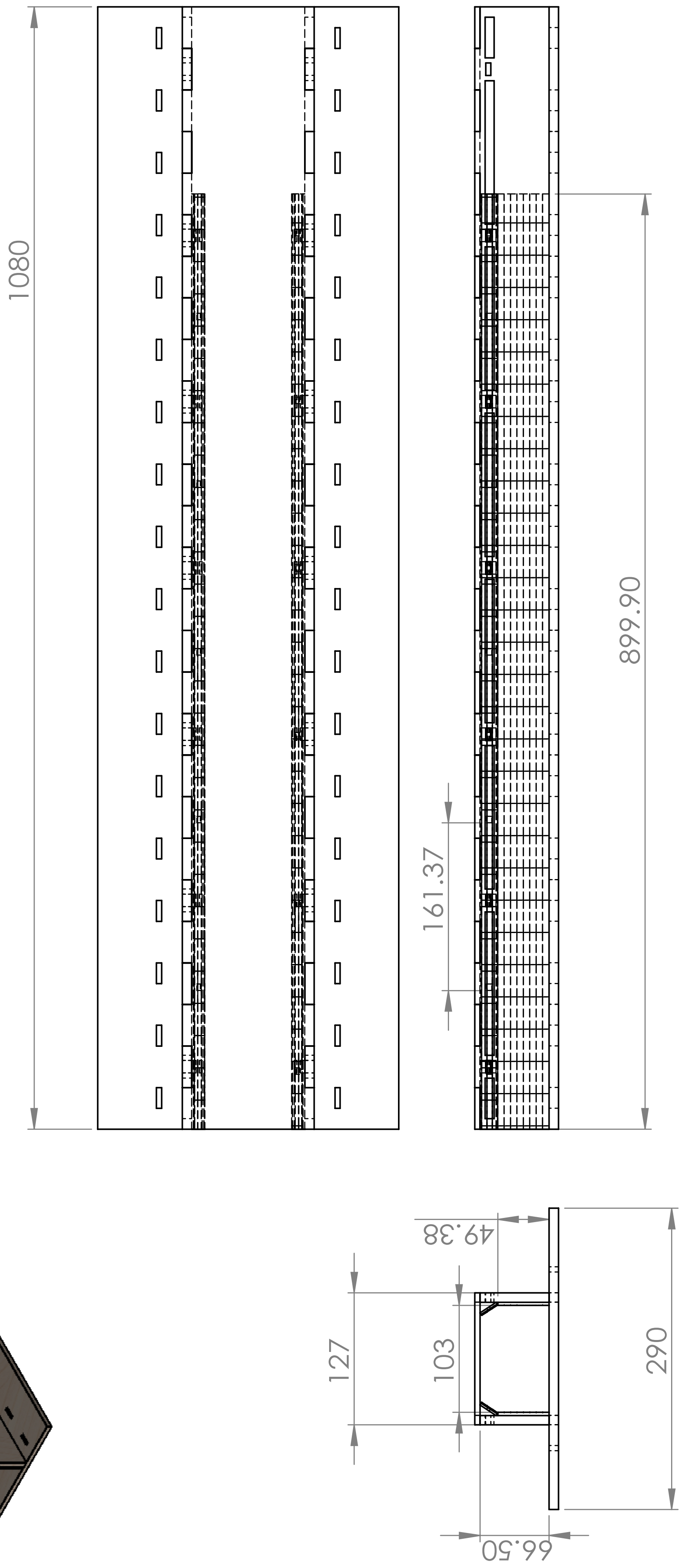
Archival image from the Maastunnel, Nov. 1937

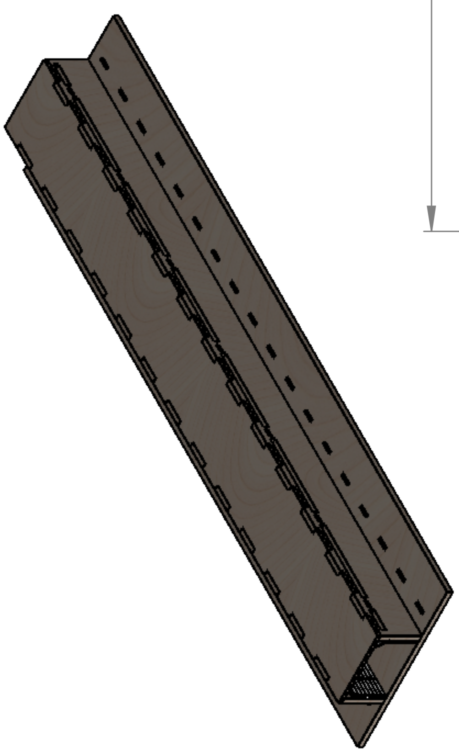
Appendix G: Lighting conditions used in Dialux simulation





Appendix H: Dimensions of 1:40 scale model of Maastunnel





Appendix I: Consent form for experiment regarding the space doubler

Observer Evaluation Info Consent Form

TOPIC: Space perception and the designs of Maas Tunnel, a pedestrian tunnel in Rotterdam

GENERAL: You are invited to be an observer of a scale model which represents the space in the pedestrian part of the Maas Tunnel in Rotterdam. There are three different variations of the scale model presented here and you will be asked to evaluate them.

DESCRIPTION: You will be prompted to recall an recent experience of walking by a pedestrian tunnel. A photo of Maas Tunnel will be shown to you and you will be asked to observe the replicated scale model of Maas tunnel. You will then observe the other two scale models in tandem by an assigned order. After the observation an evaluation form will be provided in which refers to the indices of space perception.

The whole evaluation process will be audio recorded. Photos of the observant, namely you, will be taken occasionally during the observation process.

RISKS AND BENEFITS: There are no physical pain or discomfort to be expected since observation uses scale models to do the space perception with a single eye. Your seat can be adjusted to the most comfortable height and you may move it freely when observing between each models. Although the light level has been well-tuned, observing the scale model for a lengthy period of time might cause minor visual fatigue; in this case, you may take a break or cancel the participation at any moment.

DURATION: The total session including introduction, observation, evaluation may take up to 15 minutes.

PARTICIPANT RIGHTS: Your personal details will be handled anonymously, will be reported on a group level and cannot be referred to a person. Photos will only be published on the master thesis and , if there's any, directly-evolved papers for academic purpose. You may request to blur out the photos of you or to keep them undisclosed. The audio record will not be reproduced in any form but only use for documentation on paper anonymously. The participation is voluntary, including that you have the right to cancel your approval anytime without any consequences.

DATA PROTECTION AND STORAGE: All the collected data, whether it is published or not, will be translated into digital form and stored on password-protected devices for at least 24 months from now. The data on paper form will be stored for at least 6 months from now, in a place where only the researchers of this project will have the exclusive access to it. You have the rights to retrieve your data in digital form and to request these data to be erased or shredded anytime.

By signing this consent form I agreed to participate in the evaluation, and understood that there is no monetary compensation for participating. I also understood that my participation is voluntary and I am entitled to refuse to participate or stop the performance at any time without any consequences.

NAME AND SIGNATURE____

DATE AND PLACE____

CONTACT INFORMATION: If you have any questions, concerns or complaints about this participation, its procedures, risks and benefits, contact Tim Lin (phone number 06 44495886, email y.lin-13@student.tudelft.nl)

Appendix J: Evaluation form for experiment regarding the space doubler

Section I Space Perception

Please score the **General Size of the Space** for each tunnel

Left	Cramped	1	2	3	4	5	6	7	Spacious
Middle	Cramped	1	2	3	4	5	6	7	Spacious
Right	Cramped	1	2	3	4	5	6	7	Spacious

Please score the **Perceived Width** for each tunnel

Left	Narrow	1	2	3	4	5	6	7	Wide
Middle	Narrow	1	2	3	4	5	6	7	Wide
Right	Narrow	1	2	3	4	5	6	7	Wide

Please score the **Perceived Height** for each tunnel

Left	Low	1	2	3	4	5	6	7	High
Middle	Low	1	2	3	4	5	6	7	High
Right	Low	1	2	3	4	5	6	7	High

Please score the **Openness-Enclosure** level for each tunnel (Open as in a field, Enclosed as in an elevator)

Left	Enclosed	1	2	3	4	5	6	7	Open
Middle	Enclosed	1	2	3	4	5	6	7	Open
Right	Enclosed	1	2	3	4	5	6	7	Open

Please score the **Sense of Claustrophobia** for each tunnel (not everyone can feel this)

Left	Claustrophobic	1	2	3	4	5	6	7	Non claustrophobic
Middle	Claustrophobic	1	2	3	4	5	6	7	Non claustrophobic
Right	Claustrophobic	1	2	3	4	5	6	7	Non claustrophobic

In general, do you refer each tunnel as a **Small** or **Large** tunnel?

Left	Small	1	2	3	4	5	6	7	Large
Middle	Small	1	2	3	4	5	6	7	Large
Right	Small	1	2	3	4	5	6	7	Large

Appendix J: Evaluation form for experiment regarding the space doubler

Section II General Feelings

How would you rate your **Pleasantness** if you are walking through each tunnel

Left	Unpleasant	1	2	3	4	5	6	7	Pleasant
Middle	Unpleasant	1	2	3	4	5	6	7	Pleasant
Right	Unpleasant	1	2	3	4	5	6	7	Pleasant

How would you rate the **Impressiveness** if you are walking through each tunnel

Left	Unimpressive	1	2	3	4	5	6	7	Impressive
Middle	Unimpressive	1	2	3	4	5	6	7	Impressive
Right	Unimpressive	1	2	3	4	5	6	7	Impressive

How would you rate the **Comfort** if you are walking through each tunnel

Left	Uncomfortable	1	2	3	4	5	6	7	Comfortable
Middle	Uncomfortable	1	2	3	4	5	6	7	Comfortable
Right	Uncomfortable	1	2	3	4	5	6	7	Comfortable

How would you rate the **Atmosphere** if you are walking through each tunnel

Left	Gloomy	1	2	3	4	5	6	7	Cheerful
Middle	Gloomy	1	2	3	4	5	6	7	Cheerful
Right	Gloomy	1	2	3	4	5	6	7	Cheerful

How would you rate the **Arousal** if you are walking through each tunnel

Left	Boring	1	2	3	4	5	6	7	Interesting
Middle	Boring	1	2	3	4	5	6	7	Interesting
Right	Boring	1	2	3	4	5	6	7	Interesting

How would you rate the **Cleanness** if you are walking through each tunnel

Left	Dirty	1	2	3	4	5	6	7	Clean
Middle	Dirty	1	2	3	4	5	6	7	Clean
Right	Dirty	1	2	3	4	5	6	7	Clean

How would you rate the **Aesthetics** if you are walking through each tunnel

Left	Ugly	1	2	3	4	5	6	7	Beautiful
Middle	Ugly	1	2	3	4	5	6	7	Beautiful
Right	Ugly	1	2	3	4	5	6	7	Beautiful

Appendix J: Evaluation form for experiment regarding the space doubler

Section III Functionality

As a pedestrian walking through each tunnel, do you...

...find the lights **Dim** or **Bright**?

Left	Dim	1	2	3	4	5	6	7	Bright
Middle	Dim	1	2	3	4	5	6	7	Bright
Right	Dim	1	2	3	4	5	6	7	Bright

...find the environment **Hinder** or **Help** your walking?

Left	Hinder	1	2	3	4	5	6	7	Help
Middle	Hinder	1	2	3	4	5	6	7	Help
Right	Hinder	1	2	3	4	5	6	7	Help

...rather to walk **Slower** or **Faster** through the tunnel?

Left	Slower	1	2	3	4	5	6	7	Faster
Middle	Slower	1	2	3	4	5	6	7	Faster
Right	Slower	1	2	3	4	5	6	7	Faster

Till how long would you still feel comfortable for staying in each tunnel?

Left	<1 minute	1-2 minutes	5-10 minutes	10-30 minutes	>1 hours
Middle	<1 minute	1-2 minutes	5-10 minutes	10-30 minutes	>1 hours
Right	<1 minute	1-2 minutes	5-10 minutes	10-30 minutes	>1 hours

Appendix J: Evaluation form for experiment regarding the space doubler

What kind of activities would you like to do in each tunnel?

Left				
Walking	Running	Dancing	Talking on the phone	Using smartphone
Sitting	Sleeping	Taking photos	Check yourself in the mirrors	Putting make-ups
Filming	Reading	Playing music	Other__________	
Middle				
Walking	Running	Dancing	Talking on the phone	Using smartphone
Sitting	Sleeping	Taking photos	Check yourself in the mirrors	Putting make-ups
Filming	Reading	Playing music	Other__________	
Right				
Walking	Running	Dancing	Talking on the phone	Using smartphone
Sitting	Sleeping	Taking photos	Check yourself in the mirrors	Putting make-ups
Filming	Reading	Playing music	Other__________	

Personal Info

Name ____

Gender Female Male Others

Age <18 18-22 23-26 27-30 31-35

36-45 46-60 61-70 71-80 >80

Would you like to join the follow-up observation sessions?

Yes No

If yes, please fill in your contact methods (email, text or phone)

____

Appendix K: Raw and processed data from experiment of using mirrors as the space doubler

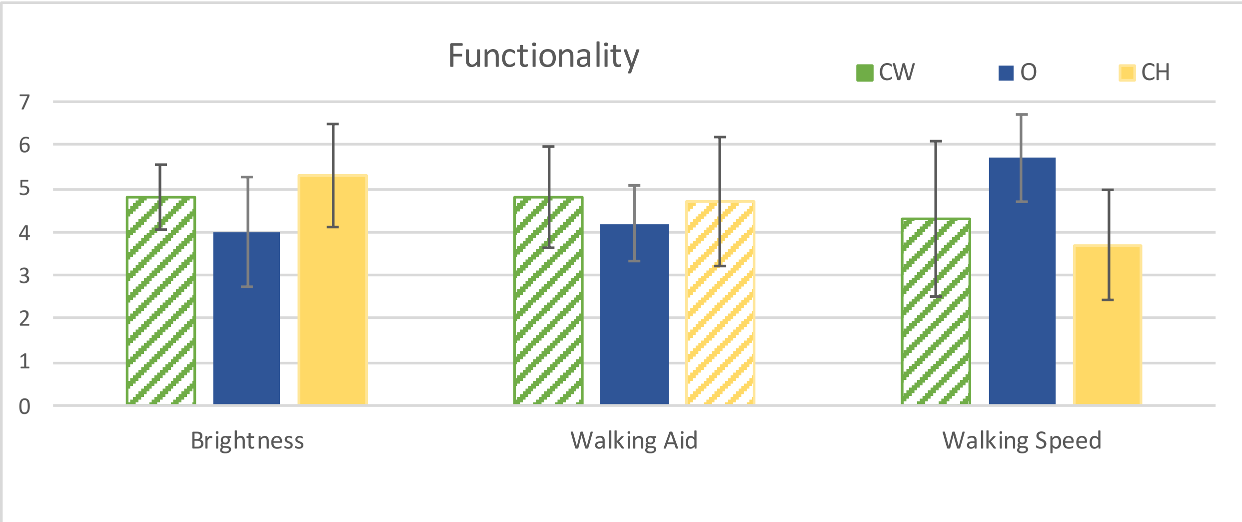
	Space Perception																	
	Size of Space			Perceived Width			Perceived Height			Openness			Claustrophobia			Small or Large		
	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH
O1	2	4	6	3	4	5	5	4	7	5	2	6	3	6	2	5	3	6
O2	5	2	6	7	4	3	4	4	7	7	2	4	2	7	5	6	2	4
O3	2	4	6	6	4	4	2	5	7	5	4	6	2	1	1	6	4	5
O4	5	4	6	6	5	3	3	3	7	5	3	5	3	4	2	5	4	7
O5	3	2	6	5	4	4	3	3	7	3	1	6	3	5	2	5	4	6
O6	5	4	7	6	4	5	4	4	7	4	4	7	1	7	1	5	3	7
O7	5	2	6	6	3	5	4	4	7	5	2	6	3	6	4	6	5	5
O8	3	4	6	4	4	5	3	4	7	5	2	6	3	5	3	4	6	4
O9	4	2	6	5	2	6	3	2	7	4	1	6	3	7	1	5	2	6
O10	4	3	6	6	4	4	4	4	7	5	4	7	4	4	1	5	4	6
Avg	3,8	3,1	6,1	5,4	3,8	4,4	3,5	3,7	7,0	4,8	2,5	5,9	2,7	5,2	2,2	5,2	3,7	5,6
Std	1,23	0,99	0,32	1,17	0,79	0,97	0,85	0,82	0,03	1,03	1,18	0,88	0,82	1,87	1,40	0,63	1,25	1,07
p-value	0,179		0,000	0,002		0,146	0,600		0,000	0,000		0,000	0,001		0,001	0,003		0,002
p(W/H)		0,0000			0,0521			0,0000			0,0193			0,3428			0,3239	

	General Feelings																				
	Pleasantness			Impressiveness			Comfort			Atmosphere			Arousal			Cleanness			Aesthetics		
	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH
O1	5	4	6	6	1	7	3	4	5	5	4	6	5	2	6	6	2	5	5	3	6
O2	7	1	2	5	2	6	6	4	2	7	3	5	6	2	7	5	5	6	5	3	6
O3	3	4	6	3	4	6	3	5	6	3	4	5	6	4	6	4	3	4	5	3	5
O4	6	4	5	6	2	7	6	3	5	6	2	6	7	3	5	6	4	6	5	4	7
O5	2	4	6	4	4	7	3	5	6	5	3	6	4	2	7	3	6	6	3	2	6
O6	5	4	6	6	4	6	5	4	5	5	4	6	5	4	5	5	4	6	4	4	5
O7	5	3	5	4	3	5	5	2	3	6	2	5	5	3	4	2	3	6	6	3	5
O8	3	4	5	4	4	5	3	3	3	5	3	5	6	2	5	3	2	6	5	4	5
O9	6	1	5	6	1	7	6	1	6	5	1	6	6	1	6	7	1	3	6	1	6
O10	3	3	6	4	4	4	3	4	6	4	4	5	4	2	5	4	4	4	3	2	6
Avg	4,5	3,2	5,2	4,8	2,9	6,0	4,3	3,5	4,7	5,1	3,0	5,5	5,4	2,5	5,6	4,5	3,4	5,2	4,7	2,9	5,7
Std	1,65	1,23	1,23	1,14	1,29	1,05	1,42	1,27	1,49	1,10	1,05	0,53	0,97	0,97	0,97	1,58	1,51	1,14	1,06	0,99	0,67
p-value	0,061		0,002	0,003		0,000	0,200		0,069	0,000		0,000	0,000		0,000	0,129		0,007	0,001		0,000
p(W/H)	0,2962			0,0248			0,5469			0,3136			0,6490			0,2704			0,0215		

	Space Perception																	
	Size of Space			Perceived Width			Perceived Height			Openness			Claustrophobia			Small or Large		
	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH	CW	O	CH
O1	2	4	6	3	4	5	5	4	7	5	2	6	3	6	2	5	3	6
O2	5	2	6	7	4	3	4	4	7	7	2	4	2	7	5	6	2	4
O3	2	4	6	6	4	4	2	5	7	5	4	6	2	1	1	6	4	5
O4	5	4	6	6	5	3	3	3	7	5	3	5	3	4	2	5	4	7
O5	3	2	6	5	4	4	3	3	7	3	1	6	3	5	2	5	4	6
O6	5	4	7	6	4	5	4	4	7	4	4	7	1	7	1	5	3	7
O7	5	2	6	6	3	5	4	4	7	5	2	6	3	6	4	6	5	5
O8	3	4	6	4	4	5	3	4	7	5	2	6	3	5	3	4	6	4
O9	4	2	6	5	2	6	3	2	7	4	1	6	3	7	1	5	2	6
O10	4	3	6	6	4	4	4	4	7	5	4	7	4	4	1	5	4	6
Avg	3,8	3,1	6,1	5,4	3,8	4,4	3,5	3,7	7,0	4,8	2,5	5,9	2,7	5,2	2,2	5,2	3,7	5,6
Std	1,23	0,99	0,32	1,17	0,79	0,97	0,85	0,82	0,03	1,03	1,18	0,88	0,82	1,87	1,40	0,63	1,25	1,07
p-value	0,179		0,000	0,002		0,146	0,600		0,000	0,000		0,000	0,001		0,001	0,003		0,002
p(W/H)	0,0000			0,0521			0,0000			0,0193			0,3428			0,3239		

Functionality									
	Brightness			Walking Aid			Walking Speed		
	CW	O	CH	CW	O	CH	CW	O	CH
O1	5	3	6	6	4	5	3	6	2
O2	5	6	3	6	4	3	6	4	3
O3	4	4	6	3	3	5	7	6	5
O4	4	4	6	5	4	6	2	6	4
O5	4	2	6	4	4	5	6	7	5
O6	5	6	5	5	6	6	6	7	6
O7	4	5	3	6	3	5	2	4	3
O8	5	4	6	3	5	2	3	5	3
O9	6	3	6	6	4	3	3	6	2
O10	6	3	6	4	5	7	5	6	4
Avg	4,8	4,0	5,3	4,8	4,2	4,7	4,3	5,7	3,7
Std	0,75	1,26	1,19	1,17	0,87	1,49	1,79	1,00	1,27
p-value	0,120		0,037	0,232		0,396	0,056		0,002
(H/D		0,2993			0,8756			0,4230	

	CW	O	CH
Brightness	4,8	4	5,3
Walking Aid	4,8	4,2	4,7
Walking Speed	4,3	5,7	3,7



Appendix L: The evaluation form for mirrors as the light splasher

Section I Visual Features

Please score the **Perceived Size of the Space** for each tunnel

Left	Cramped	1	2	3	4	5	6	7	Spacious
Middle	Cramped	1	2	3	4	5	6	7	Spacious
Right	Cramped	1	2	3	4	5	6	7	Spacious

To you, how **High** do you perceive these tunnels?

Left	Low	1	2	3	4	5	6	7	High
Middle	Low	1	2	3	4	5	6	7	High
Right	Low	1	2	3	4	5	6	7	High

Please score the **Brightness** for each tunnel

Left	Dark	1	2	3	4	5	6	7	Bright
Middle	Dark	1	2	3	4	5	6	7	Bright
Right	Dark	1	2	3	4	5	6	7	Bright

Please score the **Complexity of Light** for each tunnel (You may focus on the ceiling)

Left	Simple	1	2	3	4	5	6	7	Complex
Middle	Simple	1	2	3	4	5	6	7	Complex
Right	Simple	1	2	3	4	5	6	7	Complex

Please score the **Cleanness** level for each tunnel

Left	Dirty	1	2	3	4	5	6	7	Clean
Middle	Dirty	1	2	3	4	5	6	7	Clean
Right	Dirty	1	2	3	4	5	6	7	Clean

Please score the **Aesthetics** for each tunnel

Left	Ugly	1	2	3	4	5	6	7	Beautiful
Middle	Ugly	1	2	3	4	5	6	7	Beautiful
Right	Ugly	1	2	3	4	5	6	7	Beautiful

Appendix L: The evaluation form for mirrors as the light splasher

Section II Aesthetic Values

How would you rate the **Attractiveness** of this tunnel design?

Left	Unattractive	1	2	3	4	5	6	7	Attractive
Middle	Unattractive	1	2	3	4	5	6	7	Attractive
Right	Unattractive	1	2	3	4	5	6	7	Attractive

How would you rate your **Stylishness** of such a tunnel design?

Left	Old-fashioned	1	2	3	4	5	6	7	Modern
Middle	Old-fashioned	1	2	3	4	5	6	7	Modern
Right	Old-fashioned	1	2	3	4	5	6	7	Modern

How would you rate the **Coherence** of such a tunnel design?

Left	Incoherent	1	2	3	4	5	6	7	Coherent
Middle	Incoherent	1	2	3	4	5	6	7	Coherent
Right	Incoherent	1	2	3	4	5	6	7	Coherent

How do you feel about the **Ornateness** of this tunnel design?

Left	Too little	1	2	3	4	5	6	7	Too much
Middle	Too little	1	2	3	4	5	6	7	Too much
Right	Too little	1	2	3	4	5	6	7	Too much

How do you feel about the **Luxuriousness** of this tunnel design?

Left	Poor	1	2	3	4	5	6	7	Luxurious
Middle	Poor	1	2	3	4	5	6	7	Luxurious
Right	Poor	1	2	3	4	5	6	7	Luxurious

Appendix L: The evaluation form for mirrors as the light splasher

Section III Open Comments

Do you have more thoughts to share?

Personal Info

Name ____

Gender	Female	Male	Others		
Age	<18	18-22	23-26	27-30	31-35
	36-45	46-60	61-70	71-80	>80

What is your culture background?

European	East Asian	Middle/South Asian	Latino	North American
African	Australian	Oceanian		

Other________________

Appendix M: Raw and processed data from experiment of using mirrors and the light splasher

	Visual Features																	
	Perceived Size			Height			Brightness			Light Complexity			Cleanness			Aesthetics		
	RB	O	RD	RB	O	RD	RB	O	RD	RB	O	RD	RB	O	RD	RB	O	RD
O1	4	4	3	5	4	3	6	3	5	3	4	6	6	5	5	5	5	6
O2	5	4	3	5	4	3	5	4	5	4	3	5	6	4	3	6	4	4
O3	3	3	2	5	5	4	4	5	6	6	3	4	4	6	7	4	6	5
O4	6	4	3	6	4	3	5	5	4	4	4	6	5	5	4	6	4	3
O5	6	4	2	6	6	2	6	4	5	5	3	6	6	5	3	6	4	6
O6	3	3	3	4	3	2	5	4	6	4	2	5	5	4	2	6	4	3
O7	7	6	3	6	6	5	7	4	6	4	1	6	6	6	6	6	4	3
O8	3	4	7	1	3	4	3	4	5	2	2	7	6	2	5	5	4	6
O9	3	4	4	3	4	3	5	4	6	3	1	6	2	4	6	3	4	6
O10	5	4	4	6	4	2	6	4	2	2	3	5	4	5	2	6	4	5
O11	5	4	3	4	5	3	4	3	6	4	3	6	4	4	4	6	4	5
O12	7	5	2	7	4	1	5	3	7	7	2	4	6	6	3	7	4	2
O13	6	4	3	4	4	3	5	5	3	4	4	6	3	6	5	3	5	4
Avg	4.8	4.1	3.2	4.8	4.3	2.9	5.1	4.0	5.1	4.0	2.7	5.5	4.8	4.8	4.2	5.3	4.3	4.5
Std	1.46	0.73	1.25	1.53	0.91	1.00	1.00	0.68	1.33	1.36	0.99	0.84	1.29	1.12	1.53	1.20	0.61	1.34
p value	0.116		0.054	0.377		0.002	0.005		0.020	0.013		0.000	0.877		0.334	0.017		0.720
L/R		0.008			0.002			1.000			0.003			0.297			0.116	

	Aesthetic Values														
	Attractiveness			Stylishness			Coherence			Ornateness			Luxuriousness		
	RB	O	RD	RB	O	RD	RB	O	RD	RB	O	RD	RB	O	RD
O1	6	4	6	5	4	6	4	5	3	6	4	5	6	4	5
O2	5	3	4	5	2	5	5	4	3	4	2	5	3	1	4
O3	3	5	6	2	5	3	3	5	4	6	4	5	4	2	7
O4	6	4	3	6	2	5	6	6	4	5	2	6	5	2	4
O5	6	4	5	3	4	2	6	6	1	4	2	5	6	2	5
O6	6	3	4	6	3	3	2	4	2	6	4	5	4	2	6
O7	6	4	4	5	1	7	4	7	3	5	3	7	6	2	6
O8	5	3	6	7	2	5	6	5	2	4	1	6	6	1	6
O9	5	3	6	5	3	6	4	6	2	3	1	6	5	1	5
O10	6	4	5	5	4	6	4	4	3	2	1	5	6	2	6
O11	5	4	6	6	4	6	5	6	4	4	3	5	6	3	5
O12	7	2	1	6	1	5	3	6	1	4	1	7	7	1	4
O13	3	4	5	2	5	4	2	4	3	6	3	5	2	2	2
Avg	5.3	3.6	4.7	4.8	3.1	4.8	4.2	5.2	2.7	4.5	2.4	5.5	5.1	1.9	5.0
Std	1.14	0.74	1.43	1.51	1.33	1.41	1.35	0.97	0.99	1.22	1.15	0.75	1.38	0.83	1.24
p value	0.000		0.030	0.006		0.004	0.034		0.000	0.000		0.000	0.000		0.000
L/R		0.256			1.000			0.006			0.023			0.887	

	Average			Std		
	RB	O	RD	RB	O	RD
Perceived Size	4.8	4.1	3.2	1.46	0.73	1.25
Height	4.8	4.3	2.9	1.53	0.91	1.00
Brightness	5.1	4.0	5.1	1.00	0.68	1.33
Light Complexity	4.0	2.7	5.5	1.36	0.99	0.84
Cleanness	4.8	4.8	4.2	1.29	1.12	1.53
Aesthetics	5.3	4.3	4.5	1.20	0.61	1.34
Attractiveness	5.3	3.6	4.7	1.14	0.74	1.43
Stylishness	4.8	3.1	4.8	1.51	1.33	1.41
Coherence	4.2	5.2	2.7	1.35	0.97	0.99
Ornateness	4.5	2.4	5.5	1.22	1.15	0.75
Luxuriousness	5.1	1.9	5.0	1.38	0.83	1.24