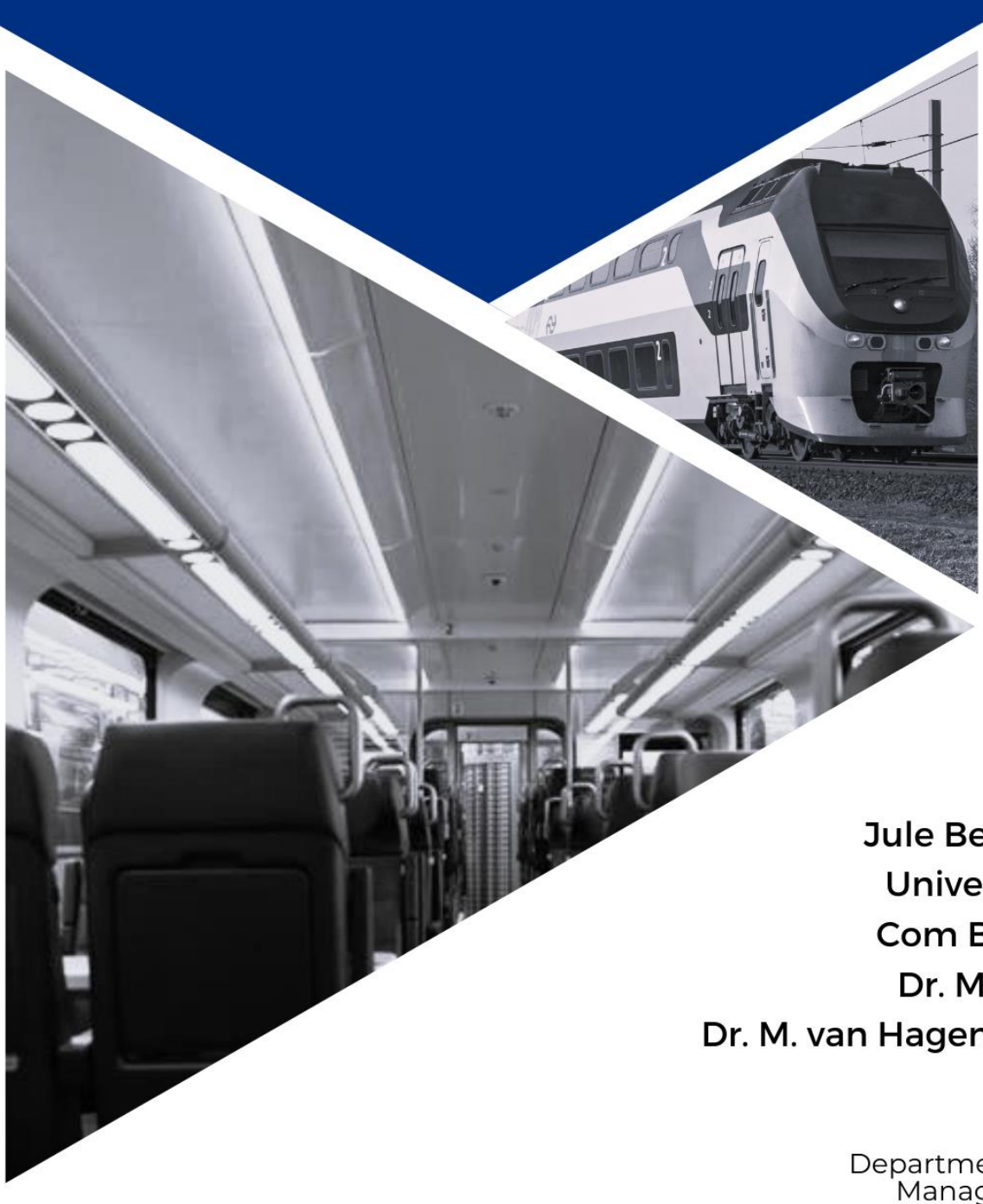
Nederlandse Spoorwegen (NS)

The Impact of in Train Lighting Characteristics on Passengers' Perceptions of Social Safety and Travel Experience during Nighttime

An Analysis of Intensity and Colour Temperature in VR



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Abstract

Aim: Passenger comfort on public transport is deeply influenced by social safety. Improving these impressions can be greatly assisted by thoughtful lighting design. The objective of this study was to examine the impact of different lighting conditions on passengers' perceptions of social safety and overall travel experience during nighttime. **Methods:** This study employed virtual reality (VR) glasses to simulate a train journey with 50 participants, after which a self-reported questionnaire was administered. Secondly, an online questionnaire was distributed to a sample of 819 participants, comprising similar sets of questions and images of the virtual reality environments. The research design was a 2 (bright/soft lighting) by 2 (cool/warm light) and a control condition with normal lighting that can be found currently in trains. By conducting both a VR-based study and an online questionnaire study, a balance is struck between controlled realism and wider generalisability, thereby improving the overall validity and applicability of the findings. A one-way ANOVAs was conducted to determine the effect of lighting conditions on perceived social safety and overall travel experience, followed by Tukey HSD post hoc tests to identify specific differences between the conditions. **Results:** The one-way ANOVA revealed a marginally significant effect of lighting conditions on the perceived social safety scale. Post hoc comparisons indicated no statistically significant differences between the conditions due to the lack of immersion. The results suggested a trend towards an effect of lighting conditions on perceived social safety, but the differences did not reach conventional levels of statistical significance. **Conclusion:** The study found not definitive evidence that different lighting conditions influence feelings of social safety among passengers. The results of this study provide insights for NS that can enhance social safety and experience in the train environment.

Keywords: Perceived social safety, travel experience, in train lighting, Netherlands Railways (NS)

Contents

1. Introduction

It is becoming increasingly important for customers to experience not only outstanding service but also an excellent experience when travelling by train. Service providers must prioritize the delivery of excellent customer experiences, as research by (Roozen & Katidis, 2019) highlights the significant impact of such experiences on customer satisfaction and loyalty, even in cases of weak service. An essential aspect of this experience is social safety, especially during nighttime travel, where safety concerns can significantly impact passenger comfort and perception of the service. This study is appointed by the NS (Netherlands Railways), one of the main train system providers in the Netherlands.. From 2021 to 2022, general customer satisfaction went down from 7.9 to 7.3, and customer satisfaction with social safety went down from 8.1 to 7.7 (*NS Annual Report 2022*, n.d.). NS is the biggest passenger rail transport operator in the Netherlands, handling over 1 million passengers a day on its 2,100 km of railways (*Responsibilities | About NS | NS*, n.d.).

Rail-based public transportation offers advantages like reducing traffic and pollution. However, its adoption is hindered by commuters preferring cars over public transport, and dissatisfaction with service quality (Ibrahim et al., 2020). Increasing customer satisfaction boosts ridership and fosters an environmentally friendly transportation network, with a preference for effective, safe, pleasant, and punctual service (Ibrahim et al., 2020; Mokhtar et al., 2023). Addressing reliability, service quality, and customer preferences is crucial for enhancing overall travel experience.

The safety of passengers is of fundamental importance to the creation of an appealing and easily accessible public transportation system. Social safety is a significant factor in customer satisfaction, particularly at night. According to Stjernborg (2024), 10% of participants have frequently or extremely frequently avoided public transportation due to feelings of unease. The study's findings also indicate that a variety of avoidance behaviours

are a result of insecure feelings of social safety. Furthermore, during the nighttime, people's mobility can be limited (Johansson et al., 2011). Ceccato et al. (2023) additionally found that avoiding certain places and times is a common individual preventive measure that is employed far more often for railway transit than for bus transportation. Passenger safety is crucial for public transportation. Therefore, it is important to provide optimal lighting during nighttime travel.

The level of indoor lighting affects both mental and physical states (Kong et al., 2022). Lighting is a tool to improve a travellers' experience and perception of safety during a nighttime train ride. For instance, Masullo et al. (2022) indicated that lighting systems' low lighting levels contribute to a calming effect, considerably lessening the anxiety that comes with high lighting levels. Custers et al. (2010) found that bright lighting enhances liveliness in people. Indoor lighting plays a crucial role in shaping both the atmosphere and interactions within a space, significantly impacting travellers' experiences during train rides.

Custers et al. (2010) have brought attention to the effects of lighting on ambience, spatial perception, emotions, mood, and cognitive processes. According to Winzen et al. (2014), coloured light can even affect how warm something feels on the skin. Yellow light produces a warmer feeling than blue light. Essentially, human emotions and cognitive capacities are greatly influenced by the colour temperature of the lighting.

The effect of lighting characteristics, specifically intensity and colour, temperature, (Custers et al., 2010; Johansson et al., 2011; Masullo et al., 2022; Tantanatewin & Inkarojrit, 2016) have all been studied. Studies have shown that soft lighting can have a calming effect and reduce anxiety, while bright lighting is associated with a greater sense of control, self-awareness and feeling of social safety, as indicated by Steidle & Werth (2014) and Johansson et al. (2011). Additionally, warm lighting has been found to have superior effects on cognitive performance compared to cool lighting, as suggested by Masullo et al. (2022) and

Tantanatewin & Inkarojrit (2016). However, there is still a need for further research to fully address the topic.

The research gap lies in the lack of comprehensive studies specifically focusing on the combined impact of lighting intensity and colour on passengers' perceptions of social safety and overall travel experience, especially during nighttime train journeys. To address this gap, this study investigates how different combinations of lighting intensity (soft vs. bright) and colour temperature (warm vs. cool) interact to shape passengers' perceptions of social safety and overall travel experience, particularly during nighttime train rides. To improve safety and encourage the use of trains as a sustainable mode of transportation, in train lighting systems can be designed with an awareness of how lighting affects passenger comfort and well-being. This study is conducted for NS (Netherlands Railways) to improve passenger's travel experience and feeling of social safety. Hence, the research question for this study is:

RQ: How do lighting characteristics, specifically intensity (soft vs. bright) and colour temperature (warm vs. cool), impact passengers' perceptions of social safety and overall travel experience, especially during nighttime?

To address the research question, two studies will be conducted. The first study will be conducted using virtual reality (VR) glasses to simulate a train journey with a questionnaire administered afterwards. The use of VR provides an immersive and controlled environment that can closely replicate real-life scenarios. Secondly, an online questionnaire will be sent to participants with similar sets of questions and images of the VR environments. The online questionnaire allows for a larger and more diverse sample size.

The next section presents the theoretical framework, which provides a clear picture of the research. It defines and presents the key ideas related to lighting intensity and colour, social safety, and customer experience. The first topic is customer experience and overall travel experiences. Furthermore, the concept of social safety is assessed. Afterwards, lighting

intensity and colour are discussed. After discussing the research methodology of Study 1 and how virtual reality glasses are being used to answer the research question, the findings of Study 1 are presented. Afterwards, the research methodology and findings of Study 2 will be presented. Lastly, a discussion finalises the research where both studies will be compared.

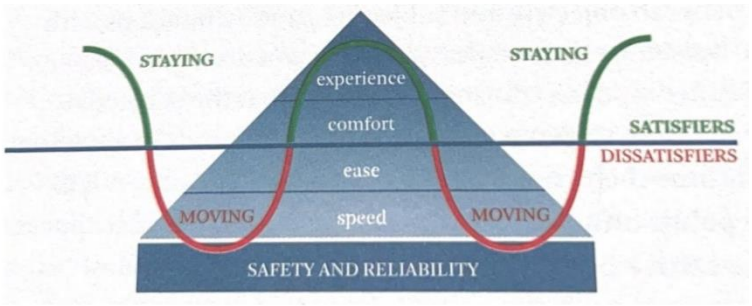
2. Theoretical Framework

2.1 Overall Travel Experience

Customer needs and expectations must be met to ensure an outstanding experience. To make the most of people's time when they are travelling by train, businesses must make sure that they have a positive experience (Van Hagen, 2020). Van Hagen (2011) identified the pyramid of customer needs (Figure 1) with five levels. The bottom of the pyramid identifies basic needs such as safety and reliability. If a customer does not feel safe in the service environment, they will avoid it. Similarly, if the service is not reliable, the customer will be dissatisfied. The following two levels, speed and ease, are closely connected. The bottom levels, comfort and overall experience, are also important factors. Customers want to reach their destination as quickly as possible, while also having a seamless experience. The train journey should be comfortable and provide a positive experience for the customer to be satisfied (Van Hagen, 2011).

Figure 1

Pyramid of Customer Needs



From. “Waiting experience at train stations”, by M. Van Hagen 2011, Eburon Academic Publisher, p.10.

Peek & van Hagen (2002) state that a station will only be considered a pleasant place to change trains by travellers once all requirements at each level of the pyramid have been satisfied. The total worth of the station is impacted if one level of the pyramid's standards is not met, therefore the station will be avoided by people. That can also be applied to in-train experience. If the bottom requirements of the pyramid are not met in a train setting, people will likewise avoid taking the train. To ensure that the top requirements of the pyramid are met, the atmosphere within the train must be satisfactory and comfortable, as it has a great influence on these requirements. The trip is assessed far more favourably when a pleasant atmosphere is created than when this is not given (van Hagen et al., 2017). In addition to the passengers themselves, who can enjoy their journey in the present, they also post about their satisfying travel experiences on social media. In this way, many others have discovered that NS makes train travel enjoyable (van Hagen et al., 2017). The satisfaction of all customers not only enhances the individual travel experience but also fosters a positive reputation for train services, which in turn encourages greater usage and customer satisfaction.

2.2 Social Safety during Nighttime

When it comes to train rides, one important aspect is social safety and the feeling of safety especially during nighttime. Traveller’s safety primarily refers to social safety, which is necessary for a train to operate as a public area. The idea of social safety encompasses the protection from real or imagined risks posed by other people in public spaces, as well as the constant inclusion, connection, and protection that are basic human needs (Boomsma & Steg, 2014; Diamond & Alley, 2022). Passengers will avoid locations that feel unsafe because they will not visit a station if they think it to be unsafe (Van Hagen, 2022). Safety is furthermore, the base of the customer needs pyramid and without fulfilling the baseline of the pyramid (Figure 1), the higher levels cannot be reached (Van Hagen, 2011). The capacity of individuals to benefit from urban opportunities for employment, education, and recreation is

significantly enhanced by the presence of public spaces. Such spaces serve as focal points for social interaction, collective celebration, and the articulation of discontent. Furthermore, public spaces are of great importance for the well-being of individuals and social interaction (Navarrete-Hernandez & Afarin, 2023). It can be argued that a train is a public space, given that it is a place where people meet and interact with one another. Mehta (2014) defines a public space as one that is accessible to all members of society, encourages both active and passive social behaviour, and is governed by general rules regarding usage. Daytime travelling can be different in many ways from nighttime travelling. Nighttime trip planning and organization may be impacted and complicated by several factors, including inadequate lighting, a decrease in the availability of public transportation, and a greater awareness of exposure (Kapitza, 2022). Especially for women, darkness can mean that their mobility is limited (Blöbaum & Hunecke, 2005; Johansson et al., 2011) since they feel unsafe, which can also mean that they do not feel comfortable taking the train at these hours. A study in Canada found that 67% of women, especially younger women, are worried about leaving their house after darkness because they feel unsafe (Keane, 1998). It is not only important for people to be able to walk in the darkness to get to their designated destination, but also for their mental health and well-being (Johansson et al., 2011). Travelling at night greatly increased the probability of selecting the car over other forms of transportation. According to Gilbert et al. (2008), negative affect and positive affect associated with social safety can be categorized. Based on this theory, negative emotions act as alerts that tell us to avoid unpleasant and possibly harmful stimuli. On the other hand, positive affect serves as a source of motivation, pushing us to seek out resources or improve our situation. Moreover, social safety theory by Slavich (2020) indicates that the primary function of the immune system and the human brain is to maintain the body's safety, which they accomplish by continuously identifying and

addressing social, physical and environmental threats. These feelings of unsafety and environmental threats can potentially appear on a train during nighttime.

2.3 Lighting

Lighting can have a positive effect on the sense of social security (lower level of the customer needs pyramid), creating a pleasant atmosphere at night by improving passengers' overview of the train. As illustrated in Figure 1, according to Van Hagen (2011), comfort is situated at the top half of the customer needs pyramid. Consequently, lighting can contribute to the bottom line of the pyramid, namely social safety. However, social safety is merely the bottom of the pyramid and, although important, is insufficient for an optimal experience. Research by (Blöbaum & Hunecke, 2005) and (Johansson et al., 2011) on perceived danger in public places and outdoor lighting shows that lighting has the potential to increase feelings of safety, while also affecting productivity and mood. Furthermore, nighttime light exposure could likely throw off circadian rhythms and mood. Recent research indicates that exposure to light at night also has a detrimental effect on mood (Bedrosian & Nelson, 2013). In the context of rail transport, for instance, lighting can enhance the perception of social safety for some passengers, while potentially causing discomfort for others. Furthermore, lighting can not only increase the feeling of safety but also the mood of people (Maier et al., 2017). Travelers need to have appropriate lighting for nighttime travel to ensure their safety, comfort, and overall travel experience.

2.3.1 Lighting Intensity

The interaction between bright and soft lighting has a profound influence on human experiences and behaviours. Soft lighting has been demonstrated to have both negative and positive effects on human behaviour. As observed by Masullo et al. (2022), high lighting levels can worsen nervousness while soft lighting has a calming effect that reduces nervousness. Despite potential negative impacts in the absence of perceived social safety, soft

lighting can increase freedom from limitations and foster creativity (Steidle & Werth, 2013). Additionally, the study shows that soft lighting increases the perceived freedom from constraints. Steidle & Werth (2014), indicated soft lighting is set at around 150 lux (lumen per square meter) while bright lighting is around 1500 lux. When the lighting was perceived as being just right, the mood then improved and reached its peak however, when it became too bright, the mood fell once more. (Küller et al., 2006). Furthermore, it was discovered that brightness elicited more reflective and controlled forms of self-regulation. Ultimately, bright lighting has been linked to a greater sense of control (Johansson et al., 2011). Moreover, participants' liveliness and brightness had a positive correlation (Custers et al., 2010; Steidle & Werth, 2014). The perception of the brightness of a lighting source is influenced by the colour temperature of the light source (Tantanatewin & Inkarojrit, 2016). The application of appropriate lighting can positively influence the experience of travellers on trains.

H1a: Bright lighting more positively influences passengers' feeling of social safety during nighttime than soft lighting.

H1b: Bright lighting more positively influences passengers' overall travel experiences during nighttime than soft lighting.

2.3.2 Lighting Colour Temperature

Not just the presence of bright and soft lighting can support specific feelings or behaviours of people, but also the colour temperature of the light can positively influence the atmosphere in a train. Variations in the lighting colour temperature appeared to affect the participant's emotions (Kim & Hong, 2023). Furthermore, it was found that the primary effects of lighting colour temperature on short-term memory and problem-solving revealed that subjects had superior performance under "warm" lighting as opposed to "cool" lighting (Knez, 2001). Cool lighting can enhance negative emotions and make people nervous (Masullo et al., 2022). According to Winzen et al. (2014) on the other hand, participants

reported feeling more alert when seated in blue light as opposed to yellow light. It is evident that the colour of the light, not its brightness, is what causes this effect. Park & Farr (2007) study demonstrates that a light source's colour temperature influences an individual's emotional state of arousal, with 5000K (Kelvin) being more arousing and cool than 3000K being warmer. Thus, in a retail setting, the level of arousal on an emotional level may be related to the brightness and colour temperature of the light source. These results imply that people generally find warmer lighting in retail establishments more enjoyable (Park & Farr, 2007). Ambience and lighting are closely linked; lighting affects the atmosphere, spatial perceptions, emotions, mood, and thought processes (Custers et al., 2010). Coloured light may give the impression that the surrounding temperature is warmer or colder than it is. The temperature was perceived warmer in the yellow light than it did in the blue light (Winzen et al., 2014). Lighting colour temperature plays a vital role in shaping human emotions and cognitive abilities, with warmer tones often associated with positive experiences.

H2a: Warm coloured lighting more positively influences passengers' feeling of social safety during nighttime than cool lighting.

H2b: Warm coloured lighting more positively influences passengers' overall travel experiences during nighttime than cool lighting.

2.4 Combined Effects of Lighting Intensity and Colour Temperature

Based on the literature mentioned above, it is expected that bright lighting enhances a greater sense of control and soft lighting can reduce anxiety. Furthermore, it is expected that warm-coloured lighting is preferred over cool-coloured lighting. Thus, when both manipulations are combined, they might have a stronger effect on passengers' overall travel experiences and passengers perception of social safety. According to Maier et al. (2017), preferences for brightness and warm light are significantly correlated.

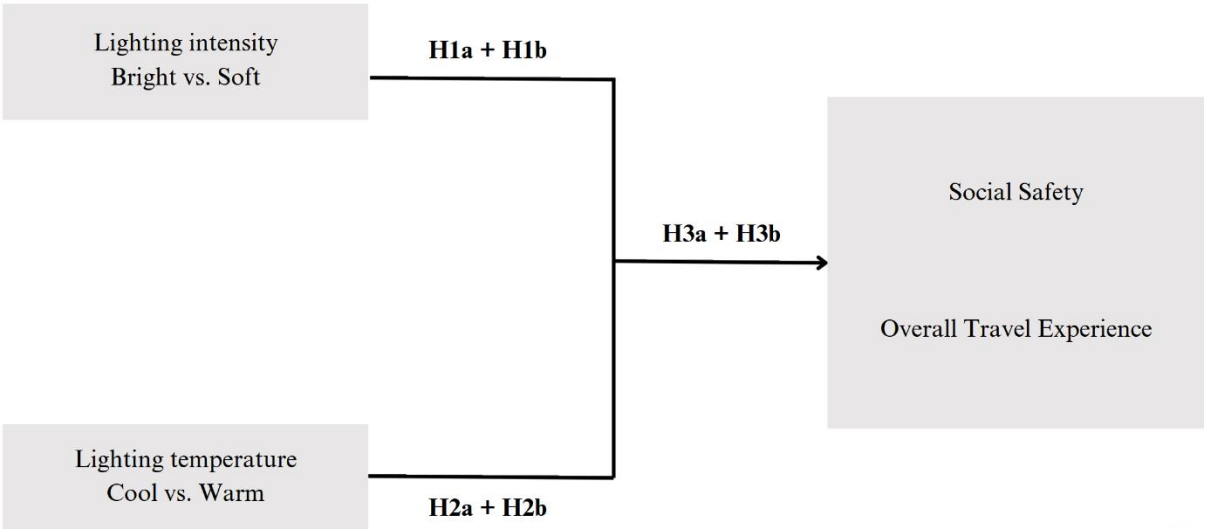
To test these hypotheses H3a: Bright lighting and warm coloured lighting combined significantly enhance passenger's feeling of social safety and overall travel experience during nighttime compared to soft lighting and warm coloured lighting; H3b: Soft lighting and cool coloured lighting combined significantly enhances passenger's feeling of social safety and overall travel experience during nighttime compared to bright lighting and cool coloured lighting, a between-subjects design was employed.

2.5 Conceptual Model

The current study examines the interaction between lighting intensity and lighting temperature on passengers' overall travel experience and feelings of social safety. It is anticipated that the congruence of environmental stimuli will enhance passengers' travel experience during their journey. This suggests that bright lighting and warm-coloured lighting might enhance passengers' overall travel experience and feeling of social safety. A similar congruence effect is anticipated for soft lighting and cool-coloured lighting (Figure 2).

Figure 2

Conceptual Model



Two studies will be conducted to test the conceptual model. The first study will utilise virtual reality glasses to simulate a train journey, after which a questionnaire will be administered. The creation of a controlled and immersive environment that closely resembles real-life situations through the use of VR can increase the realism of the study and potentially produce more accurate and dependable results. The sample of Study 1will mostly be comprised of university students. Furthermore, in Study 2 participants will be provided with an online questionnaire comprising comparable questions and images of the VR environments. A larger and more diverse sample size that accurately reflects NS's clientele can be obtained through the online survey. The NS participants panel will be used to reach participants.

3. Methods Study 1

3.1 Research design

In this VR study, a 2x2 design with a control condition was used for the dependent variables of overall travel experience and perception of social safety. The five conditions contain 2 (soft lighting vs. bright lighting) x 2 (warm colour vs. cool colour). These conditions are shown in Table 1. Furthermore, the control condition, in which no alterations were made to the lighting intensity or colour, was included to establish a baseline for comparison. This condition represented the standard lighting currently in use on the train and allowed for the assessment of any changes in the dependent variables as a result of the experimental manipulations. The inclusion of a control condition with a sample size of N=10 enabled the determination of whether the observed effects were attributable to the specific lighting alterations or simply a consequence of natural variation in the data.

Table 1

Research design / Independent Variables

	Warm colour (yellow)	Cool colour (blue)
Soft lighting	Condition: 1 N=10	Condition: 3 N=10
Bright lighting	Condition: 2 N=10	Condition: 4 N=10

After the simulated train ride in the VR environment provided by the NS, participants' opinions of their overall travel experience and social safety were assessed via a questionnaire. Virtual reality offers an experience that closely resembles the real-life target setting, as it preserves the majority of perceptual modalities, particularly 3D perception and movement sensation as a real-live setting. This suggests that it may enhance the external validity of the

findings (Meißner et al., 2019). As posited by (Bateson & Hui, 1992), the psychological and behavioural phenomena suggested by the simulated environment can be identical to those of the real environment. This design allows for the examination of the primary effects of lighting characteristics on passengers' perceptions of social safety and overall travel experience, as well as any potential interactions between these variables.

3.2 Pre-test

Pre-testing was done to ensure that the experimental conditions were appropriate and effective before the main study was conducted. A sample group of 10 participants was exposed to the five conditions during the pre-testing stage. They were instructed to wear VR glasses and imagine themselves as if they were on a real train. Following a period of approximately two minutes, the headset was removed and the participants were presented with a questionnaire designed for the main study. This questionnaire was used to evaluate the participants' immersion in the virtual reality environment and to assess the manipulation check. The pre-test was designed to determine participant's initial responses and perceptions of various lighting conditions (soft vs. bright, cool vs. warm). If the soft light was indeed perceived as soft and the bright light as bright and the cool light was perceived as cool and the warm light as warm. Refinements were made to the instructions given to the participants and the time they spent in the VR was reduced from 4-5 minutes to 2-3 minutes.

3.3 Study 1

3.3.1 Procedure

VR environments provided by NS were used for this study to represent the new generation of Sprinter trains. This approach allows participants to experience the feeling of being on a train and enables easier changes to the environment based on conditions. Participants were randomly assigned to one of the five conditions after being approached at the Utrecht Central station and the campus of the University of Twente. After the participants

agreed to take part in the study they were first asked to fill in the informed consent form before they were instructed to put on the VR glasses. The participants were instructed to take in the VR environment, have a look around in the train compartment that was presented to them and imagine themselves on a real train. Depending on the condition in which the participants were, the lighting was bright, soft or standard and the colour of the lighting was either warm (blue) or cool (yellow). The VR environment is simulating the inside of a train during the night. After experiencing the train ride on the VR glasses, which took about 2-3 minutes, participants were asked to complete a questionnaire regarding their overall travel experience and the level of social safety they felt during the experiment. Subsequently, the participants were thanked for their involvement and presented with some candy as a thank-you gesture.

3.3.2 Stimuli

3.3.3 Manipulation Lighting Intensity

A pre-test was carried out to determine the ideal lighting setup for the experiment. The pre-test results led to the selection of a soft and a bright lighting option. The settings for control condition, the standard lighting was intended to resemble the lighting environments that are frequently found in trains. Two conditions with bright lighting (Figure 3 and 4) and two with soft lighting (Figure 5 and 6) made up each set. One additional control condition was added, in which no particular lighting manipulation was done and the standard in train lighting was used (Figure 7).

3.3.4 Manipulation Lighting Colour Temperature

A pre-test was carried out to determine the ideal lighting setup of the ambient lighting for the experiment. The pre-test results led to the selection of a warm colour tone which is slightly yellow and a cool lighting tone which is slightly blue. A warm, lighting was indicated

and a cool lighting was chosen from the pre-test. Two conditions with cool lighting (Figure 3 and 5) and two conditions with warm lighting (Figure 4 and 6) made up each set.

Figure 3

Bright and cool lighting – condition 4

Figure 4

Bright and warm lighting – condition 2

Figure 5

Soft and cool lighting – condition 3

Figure 6

Soft and cool lighting – condition 3

Figure 7

Standard lighting – control condition

3.4 Questionnaire design

The questionnaire designed for this study aimed to assess self-reported passengers' perceptions of social safety and overall travel experience concerning the manipulated variables of lighting characteristics. The questionnaire included five parts, the full questionnaire that was used for this study is included in Appendix A . The questionnaire was available in English and Dutch to the participants.

3.4.1 VR Environment Immersion

The initial question asked if the participants had noticed that the train journey took place at night. The question was posed in the form of a multiple-choice item, with two possible responses: whether the train ride occurred during the day or night. Secondly, a rating was assigned to indicate the degree of immersion experienced by the participants in the virtual reality environment on a scale of 1 to 10, with 1 indicating a lack of immersion and 10 indicating a high degree of immersion. These questions were part of the manipulation check. The objective was to determine whether the participants perceived the environment as being at nighttime and whether they were able to immerse themselves in the experiment. Finally, participants were asked to indicate their experience of playing video games, specifying whether they played multiple times a week, a month, a few times a year or not at all. This information may be indicative of their immersion level in the VR environment.

3.4.2 Overall Travel Experience

Subsequently, participants were asked to evaluate various aspects of their travel experience, including their perceived stress levels, comfort, and satisfaction. A scale based on the 1974 work by Mehrabian & Russell was employed to assess the subjective experience of participants during the VR session. The construct of these questions comprises five pairs of opposing emotions, including happy and unhappy. On a five-point scale, participants were asked to indicate their emotional state, from one (very unhappy) to five (very happy). To

assess the reliability of each variable, Cronbach's alpha of the scale was examined (α = .82). The questions about their overall travel experience were based on questions provided by NS (2020). The scale consisted of seven statements, such as “I find the inside of this train looks appealing”. The statements were evaluated on a 5-point Likert scale ranging from strongly disagree to strongly agree. The Cronbach's alpha of the scale was examined (α = .75).

3.4.3 Social Safety

Subsequently, participants were requested to assess the level of social safety they believed the train journey would provide, taking into account factors such as perceived danger and visibility. The scale was based on the scale developed by Blöbaum & Hunecke (2005). The scale consists of six statements, such as “I feel calm on this train.” The statements were evaluated on a 5-point Likert scale, ranging from strongly disagree to strongly agree. The Cronbach's alpha of the scale was examined (α = .83).

3.4.4 Lighting Characteristics

The questionnaire was designed to gather data on the impact of lighting characteristics on passengers' perceptions of social safety and overall travel experience. To measure that, a manipulation check was included in the questionnaire. The construct of these questions comprises three pairs of opposing lighting characteristics, including soft and bright. Participants were asked to indicate their perception of the lighting in the VR environment on a 5-point scale, with 1 representing a very soft lighting condition and 5 representing a very bright lighting condition. The questions were based on a scale developed by Van Hagen et al. (2010). The second scale was designed to elicit a more profound understanding of how the participants perceived the lighting. The scale consists of four statements, such as “I find the lighting level pleasant on this train.” The statements were evaluated on a 5-point Likert scale, ranging from strongly disagree to strongly agree. The Cronbach's alpha of the scale was examined (α = .77).

3.4.5 Demographics

To establish a foundation for understanding the backgrounds of the participants, the questionnaire concluded with the gathering of demographic information, including nationality, age and gender. Furthermore, participants were asked to indicate the frequency with which they take the train, their preferred activities during a train journey, the destinations they typically travel to by train, with who they are normally travelling, and finally, their opinions of NS as a company.

3.5 Participants

It was reached out to people of all ages (16 and older) and genders. In total, 50 participants participated in the VR experiment and filled in the questionnaire. The distribution of the participants over the different conditions can be found in Table 1. The ages of the participants ranged from 19 to 26 years old. The mean age of the participants was 21.94.

Table 2

Participants Characteristics

Condition	Mean Age	Gender	Percentage
1	21.5	Male	40%
		Female	60%
2	22.4	Male	40%
		Female	60%
3	21.4	Male	30%
		Female	70%
4	22.9	Male	40%
		Female	60%
5	21.5	Male	10%
		Female	90%

Table 3

Train Travel Behaviour

Condition	Travel frequency	Percentage	Destination	Percentage
1	4 days or more a week	30%	To work	10%
	1-3 days a month	10%	HBO/University	30%
	1-10 days a year	0%	Leisure activity	30%
			Other	30%
2	4 days or more a week	10%	To work	20%
	1-3 days a month	40%	HBO/University	20%
	1-10 days a year	20%	Leisure activity	20%
			Other	40%
3	4 days or more a week	0%	To work	10%
	1-3 days a week	40%	To School	10%
	1-3 days a month	50%	HBO/University	20%
	1-10 days a year	10%	Leisure activity	40%
			Other	20%

4	4 days or more a week	10%	To work	10%
	1-3 days a week	60%	To School	10%
	1-3 days a month	20%	HBO/University	20%
	1-10 days a year	10%	Leisure activity	30%
			Other	30%
5	1-3 days a month	40%	HBO/University	20%
	1-10 days a year	10%	Leisure activity	50%
			Other	30%

4. Results Study 1

4.1 Manipulations Checks

4.1.1 Lighting Intensity

The soft/warm environment was perceived as neither soft nor bright (M = 3.2, SD = 1.03), and the soft/cool environment was similarly perceived as neither soft nor bright (M = 3.3, SD = 0.9). The bright/warm environment was moderately perceived as soft (M = 2.7, SD = 1.16), while the bright/cool environment was perceived as neither soft nor bright (M = 3.2, SD = 1.32). The control condition was perceived as mildly bright (M = 3.9, SD = 1.10). A one-way ANOVA showed no significant effect of lighting conditions on the perceived lighting scale, $F(4, 45) = 1.27$, $p = .296$, indicating that the different lighting conditions did not produce significant differences in the perceived lighting scale. Nevertheless, the analysis will be continued as intended.

4.1.2 Lighting Temperature

A one-way ANOVA revealed a significant effect of lighting conditions on the perceived lighting scale, $F(4, 45) = 6.899$, $p < .001$. Post hoc comparisons using the Tukey HSD test indicated that the mean score for bright/warm was significantly different from conditions soft/cool, bright/cool, and control ($p < .01$). Specifically, the difference between condition bright/warm and condition soft/cool was -1.60 ($p = .0027$), the difference between condition bright/warm and bright/cool was -1.60 ($p = .0027$), and the difference between condition bright/warm and condition control (normal) was -1.60 ($p = .0027$). No significant differences were found between conditions soft/warm and the other conditions or between conditions soft/cool, bright/cool, and control.

The descriptive statistics show that the soft/cool environment was moderately perceived as cool (M = 2.4, SD = 0.7) and the bright/cool environment was moderately perceived as cool (M = 2.4, SD = 0.7). The soft/warm environment was neither perceived as

cool or warm (M = 3.5, SD = 0.8) and the bright/warm was significantly perceived as warm (M = 4, SD = 0.8). The control condition (normal) was perceived as moderately cool (M = 2.4, SD = 1.35). Therefore, the manipulation check suggests that the different lighting conditions led to significant differences in the perceived lighting scale, particularly between warm light and cool light.

4.1.3 Lighting Colour

A one-way ANOVA revealed a significant effect of lighting conditions on the perceived lighting scale, $F(4, 45) = 5.235$, $p = .0015$. The Tukey post hoc test indicated that the mean score for condition bright/warm (yellow) was significantly different from conditions soft/cool (blue), bright/cool (blue), and control (normal). Specifically, the difference between condition bright/warm (yellow) and condition soft/cool (blue)was -1.3 ($p = .0167$), the difference between condition bright/warm (yellow)and condition 4 was -1.5 ($p = .0040$), and the difference between condition bright/warm (yellow) and condition bright/cool (blue) was -1.4 ($p = .0083$). No significant differences were found between condition 1 (yellow) and the other conditions or between conditions soft/cool (blue), bright/cool (blue), and control (normal).

The descriptive statistics show that the soft/cool environment was moderately perceived as blue (M = 2.8, SD = 0.8) and the bright/cool environment was moderately perceived as blue (M = 2.6, SD = 1.0). The soft/warm environment was neither perceived as blue or yellow (M = 3.5, SD = 1.0) and the bright/warm was significantly perceived as yellow (M = 4.1, SD = 0.3). The control condition was perceived as moderately blue (M = 2,7, SD = 1.16). These findings suggest that the different lighting conditions led to significant differences in the perceived lighting scale, particularly between yellow light and blue light or control normal light. The yellow light condition was perceived as significantly more yellow compared to the blue light conditions.

4.1.4 Immersion

A one-way ANOVA was conducted to compare the effect of lighting conditions on immersion levels in the VR environments. There was no significant effect of lighting conditions on the immersion scale at the $p < .05$ level for the five conditions [$F(4, 95) = 0.47$, $p = .76$]. Thus, the manipulation check indicates that the different lighting conditions did not produce significant differences in the perceived immersion levels.

4.2 Hypothesis Testing

4.2.1 Lighting Intensity

A one-way ANOVA revealed that the differences in perceived social safety across the different lighting conditions were not statistically significant, $F(4,45) = 1.316$, $p = .278$. The means and standard deviations for each condition were as follows: soft/warm lighting ($M = 4.07$, $SD = 0.459$), bright/warm lighting ($M = 4.30$, $SD = 0.554$), soft/cool lighting ($M = 4.02$, $SD = 0.123$), bright/cool lighting ($M = 3.98$, $SD = 0.547$), and normal lighting ($M = 3.75$, $SD = 0.798$). These results do not support the hypothesis (H1a) that bright lighting more positively influences passengers' feelings of social safety.

A one-way ANOVA revealed that the differences in perceived overall travel experience across the different lighting conditions were not statistically significant, $F(4, 45) = 1.572$, $p = .198$. The perceived overall travel experience scores for each condition were as follows: condition soft/warm ($M = 3.90$, $SD = 0.735$), condition bright/warm ($M = 4.01$, $SD = 0.449$), condition soft/cool ($M = 3.67$, $SD = 0.243$), condition bright/cool ($M = 3.79$, $SD = 0.664$), and condition normal ($M = 3.41$, $SD = 0.668$). These results are not in line with (H1b) that bright lighting more positively influences passengers' overall travel experience.

4.2.2 Lighting Colour Temperature

A one-way ANOVA revealed that the differences in perceived social safety across the different lighting conditions were not statistically significant, $F(4, 45) = 1.316$, $p = .278$. The perceived social safety scores for each condition were as follows: soft/warm lighting ($M =$

4.07, SD = 0.459), bright/warm lighting (M = 4.30, SD = 0.554), soft/cool lighting (M = 4.02, SD = 0.123), bright/cool lighting (M = 3.98, SD = 0.547), and normal lighting (M = 3.75, SD = 0.798). Contrary to the hypothesis (H2a), warm lighting did not significantly affect passengers' perceptions of social safety.

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4.2.3 Interaction

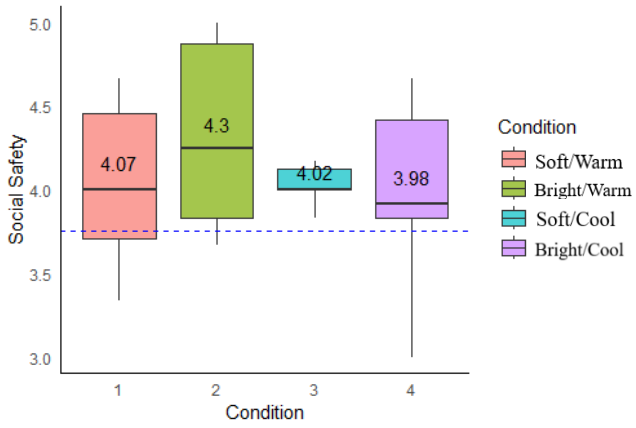
A two-way ANOVA was conducted to examine the effect of lighting conditions on perceived social safety. No significant main effect was found of brightness, F(1,36) = 0.48, MSE = 0.21, p = . 493, and no significant main effect of colour, F(1,36) = 1.61, MSE = 0.21, p = . 212. The interaction effect between brightness and colour was also not significant, F(1,36) = 0.85, MSE = 0.21, p = . 362. The descriptive statistics show that the perceived social safety scores for each condition were as follows: soft/warm light condition (M = 4.07, SD = 0.459), the mean score under bright/warm light condition (M = 4.30, SD = 0.554) (Figure 8). The evidence suggests that bright/warm lighting has a slight positive effect on perceived social safety. However, this difference is not statistically significant.

A two-way ANOVA was conducted to examine the effect of lighting conditions on passengers' overall travel experience. No significant main effect was found for brightness, F(1, 36) = 0.42, MSE = 0.31, p = .521, and no significant main effect of colour, F(1, 36) = 1.68, MSE = 0.31, p = .203. The interaction effect between brightness and colour was also

not significant, F(1, 36) = 0.00, MSE = 0.31, p = 1.000. Descriptive statistics indicate that the perceived overall travel experience scores for each condition were as follows: soft/warm light condition (M = 3.90, SD = 0.735) and bright/warm light condition (M = 4.01, SD = 0.449) (Figure 9). The evidence suggests that bright/warm lighting has a slight positive effect on the overall travel experience. However, this difference is not statistically significant. These results are not in line with (H3a) that bright lighting and warm coloured lighting combined significantly enhance passengers' feeling of social safety and overall travel experience during nighttime compared to soft lighting and warm coloured lighting.

Figure 8

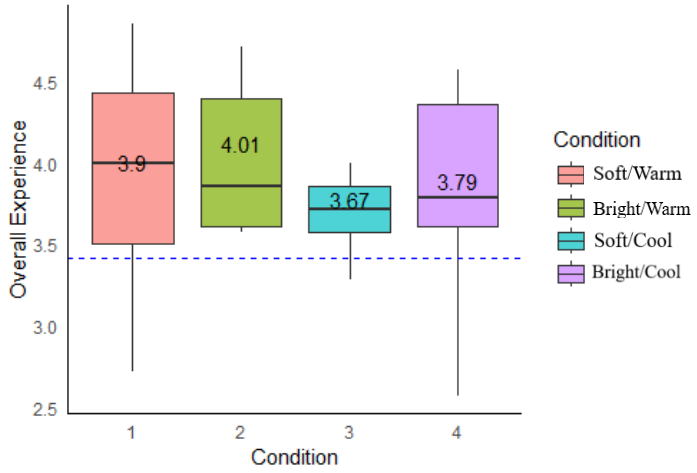
Social Safety per condition



Note. The blue line represents condition 5 (control/normal).

Figure 9

Overall Travel Experience per Condition



Note. The blue line represents condition 5 (control/normal).

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lighting condition (M = 3.76, SD = 0.243) and bright/cool lighting condition (M = 3.79, SD = 0.664) (Figure 9). The evidence suggests that bright/cool lighting has a slight positive effect on the overall travel experience. However, this difference is not statistically significant. These results are not in line with (H3b) that soft lighting and cool coloured lighting combined significantly enhance passengers' feeling of social safety and overall travel experience during nighttime compared to bright lighting and cool coloured lighting.

5. Methods Study 2

5.1 Research design

In this study, a 2x2 design and a control condition were used for the dependent variables of overall travel experience and perception of social safety. The five conditions contain 2 (soft light vs. bright light) x 2 (warm colour vs. cool colour). These conditions are shown in Table 4. Furthermore, a control condition was applied in which no alterations were made to the lighting intensity or colour. This condition represented the standard lighting currently in use on the train. The control condition contained a sample of size N=166 enabled the determination of whether the observed effects were attributable to the specific lighting alterations or simply a consequence of natural variation in the data. The research design is equivalent to that of Study 1, with the exception that VR was employed in Study 1. In Study 2, participants were presented with images of the VR environment in an online questionnaire.

Table 4

Research design / Independent Variables

	Warm colour (yellow)	Cool colour (blue)
Soft lighting	Condition: 1 N=149	Condition: 3 N=168
Bright lighting	Condition: 2 N=164	Condition: 4 N=172

Participants' opinions of their overall travel experience and social safety were assessed via an online questionnaire. With this design, it is possible to examine the primary effects of lighting characteristics on passenger's perception of social safety and overall travel experience, as well as any potential interactions between these variables. By using an online survey, it is possible to obtain a larger and more diverse sample size that accurately reflects

NS's clientele. Furthermore, only two users could be in the VR seat at any given time. It is challenging to recruit a sufficient number of participants for the virtual reality study. An advantage of the online study is that it can be completed at any time and from any location. The participants enjoy greater flexibility, and the study is completed in a shorter period.

5.2 Study 2

5.2.1 Procedure

An online version of the questionnaire and virtual environment from Study 1 was created and presented to the NS panel. An email was sent to the panel members requesting their participation in the survey. Each respondent was randomly matched with one of the five conditions. The respondents were presented with an image of the virtual reality setting and were given the option of viewing it at any time during the survey. Upon completion of the survey, participants were thanked for their participation.

5.2.2 Stimuli

5.2.3 Manipulation Lighting Intensity

The manipulations of the environment were kept the same as in Study 1. Two conditions with bright lighting (Figure 3 and 4) and two with soft lighting (Figure 5 and 6) made up each set. One additional control condition was added, in which no particular lighting manipulation was done and the standard in train lighting was used (Figure 7). The difference from study one is that the environments are not presented to the participants through the VR glasses but in the form of an image.

5.2.4 Manipulation Lighting Colour Temperature

The manipulations of the environment were kept the same as in Study 1. Two conditions with bright lighting (Figure 3 and 4) and two with soft lighting (Figure 5 and 6) made up each set.

5.3 Questionnaire design

The questionnaire designed for this study aimed to assess passengers' perceptions of social safety and overall travel experience concerning the manipulated variables of lighting characteristics. The questionnaire included four parts, the full questionnaire that was used for this study is included in Appendix B. The questionnaire was only available in Dutch, as it was only distributed to customers of NS. In comparison to Study 1, participants were not asked whether they noticed that the train journey was at night, their perceived level of immersion and their experience with video games, as these questions were specifically designed for the VR approach. In addition, the demographic questions and the questions about their travel habits were left out, as this is information that is already known about the participants in the NS panel.

5.3.1 Overall Travel Experience

Subsequently, participants were asked to evaluate various aspects of their travel experience, including their perceived stress levels, comfort, and satisfaction. A scale based on the 1974 work by Mehrabian & Russell was employed to assess the subjective experience of participants. The construct of these questions comprises five emotions, including happiness, enjoyment and satisfaction. The emotions were evaluated on a 5-point Likert scale ranging from strongly disagree to strongly agree. To assess the reliability of each variable, Cronbach's alpha of the scale was examined ($\alpha = .93$). The questions about their overall travel experience were based on questions provided by NS (2020). The scale consisted of seven statements, such as “I find the inside of this train looks appealing” the statements were evaluated on a 5-point Likert scale ranging from strongly disagree to strongly agree. To assess the reliability of each variable, Cronbach's alpha of the scale was examined ($\alpha = .75$).

5.3.2 Social Safety

Subsequently, participants were requested to assess the level of social safety they believed the train journey would provide, taking into account factors such as perceived danger and visibility. The scale was based on the scale developed by Blöbaum & Hunecke (2005). The scale consists of six statements, such as “I feel calm on this train.” The statements were evaluated on a 5-point Likert scale, ranging from strongly disagree to strongly agree. To assess the reliability of each variable, Cronbach's alpha of the scale was examined ($\alpha = .86$).

5.3.3 Lighting Characteristics

The questionnaire was designed to gather data on the impact of lighting characteristics on passengers' perceptions of social safety and overall travel experience. To measure that a manipulation check was included in the questionnaire. The construct of these questions comprises three pairs of opposing lighting characteristics, including soft and bright. Participants were asked to indicate their perception of the lighting from the images on a 5-point scale, with 1 representing a very soft lighting condition and 5 representing a very bright lighting condition. The scale was based on a scale developed by Van Hagen et al. (2010). The second scale was designed to elicit a more profound understanding of how the participants perceived the lighting. The scale consists of four statements, such as “I find the lighting level pleasant on this train.” The statements were evaluated on a 5-point Likert scale, ranging from strongly disagree to strongly agree. To assess the reliability of each variable, Cronbach's alpha of the scale was examined ($\alpha = .62$).

5.3.4 Demographics

To establish a foundation for understanding the backgrounds of the participants, the NS provided information about the participants including nationality, age and gender. Lastly, participants were asked to indicate their preferred activities during a train journey, with who

they normally travel, their opinions of NS as a company and finally, they were asked if they had any recommendations regarding the questionnaire.

5.4 Participants

The survey was sent out to people of all ages (18 and older) and genders. In total, 819 participants participated in the online questionnaire. The distribution of the participants over the different conditions can be found in Table 4. The ages of the participants ranged from 20 to 74 years old. The mean age of the participants was 50.28.

Table 5

Participants

Condition	Mean Age	Gender	Percentage
1	47.4	Male	45.6%
		Female	52.3%
		Other	1.34%
		I prefer not to say	0.67%
2	48.8	Male	52.4%
		Female	47.6%
3	53.2	Male	48.8%
		Female	50.6%
		Other	0.59%
4	50.8	Male	45.9%
		Female	49.4%
		Other	3.49%
		I prefer not to say	1.16
5	50.9	Male	44.0%
		Female	55.4%
		Other	0.6%

6. Results Study 2

6.1 Manipulation Check

6.1.1 Lighting Intensity

A one-way ANOVA revealed a significant effect of lighting conditions on the perceived lighting scale, $F(4, 814) = 74.54$, $p < .001$. The Tukey post hoc test indicated several significant differences between conditions. The difference between condition bright/warm and conditions soft/cool was -0.948 ($p < .001$), the difference between condition bright/warm and condition bright/cool was 0.369 ($p = .003$), and the difference between condition bright/warm and the control condition was 0.047 ($p = .991$). No significant differences were found between condition soft/cool, condition bright/cool, and the control condition.

The descriptive statistics show that the soft/warm environment was moderately perceived as soft ($M = 2.52$, $SD = 0.990$) and the bright/warm was neither perceived as soft nor bright ($M = 3.57$, $SD = 0.979$). The soft/cool environment was moderately perceived as soft ($M = 2.62$, $SD = 0.996$) and the bright/cool environment was neither perceived as soft nor bright ($M = 3.94$, $SD = 0.853$). The control condition was neither perceived as soft nor bright ($M = 3.61$, $SD = 0.892$). These findings suggest that the different lighting conditions led to significant differences in the perceived lighting scale. The bright light condition was perceived as significantly brighter compared to the soft light and control conditions.

6.1.2 Lighting Temperature

A one-way ANOVA revealed a significant effect of lighting conditions on the perceived lighting scale, $F(4, 814) = 28.64$, $p < .001$. The Tukey post hoc test indicated several significant differences between conditions. The difference between condition soft/warm and condition soft/cool was -0.839 ($p < .001$), the difference between condition soft/warm and condition bright/cool was -1.032 ($p < .001$), and the difference between

condition soft/warm and the control condition was -0.705 ($p < .001$). Additionally, a significant difference between condition bright/warm and condition soft/cool was -0.575 ($p < .001$), the difference between condition bright/warm and condition bright/cool was -0.769 ($p < .001$), and the difference between condition bright/warm and the control condition was -0.442 ($p < .001$). No significant differences were found between condition soft/warm and condition bright/warm, between conditions soft/cool and bright/cool, or between conditions soft/col and the control condition.

The descriptive statistics show that the warm light environment was perceived as neither warm nor cool in both conditions soft/warm ($M = 3.42$, $SD = 1.01$) and condition bright/warm ($M = 3.15$, $SD = 0.95$). The cool light environment was perceived as moderately cool in both condition soft/cool ($M = 2.58$, $SD = 1.00$) and condition bright/cool ($M = 2.38$, $SD = 1.07$). The control condition was perceived as slightly cool ($M = 2.71$, $SD = 0.985$). The cool light conditions were perceived as significantly cooler compared to the warm light and control conditions.

6.1.3 Lighting Colour

A one-way ANOVA revealed a significant effect of lighting conditions on the perceived lighting scale, $F(4, 814) = 31.52$, $p < .001$. The Tukey post hoc test indicated several significant differences between conditions. The difference between condition soft/warm (yellow) and condition soft/cool (blue) was -0.786 ($p < .001$), the difference between condition soft/warm (yellow) and condition bright/cool (blue) was -0.860 ($p < .001$), and the difference between condition soft/warm (yellow) and the control condition was -0.422 ($p = .002$). Additionally, significant differences were found between condition bright/warm (yellow) and conditions soft/cool (blue), bright/cool, and the control condition. The difference between condition bright/warm (yellow) and condition soft/cool (blue) was -0.901 ($p < .001$), the difference between condition bright/warm (yellow) and condition

bright/cool (blue) was -0.975 ($p < .001$), and the difference between condition bright/warm (yellow) and the control condition was -0.537 ($p < .001$). No significant differences were found between condition soft/warm (yellow) and condition bright/warm (yellow), or between conditions soft/cool (blue) and bright/cool (blue).

The descriptive statistics show that the warm light environment was perceived as neither yellow nor blue in both conditions soft/warm ($M = 3.48$, $SD = 0.997$) and condition bright/warm ($M = 3.59$, $SD = 0.952$). The blue light conditions were perceived as moderately blue in both conditions soft/cool ($M = 2.69$, $SD = 1.04$) and condition bright/cool ($M = 2.62$, $SD = 1.03$). These findings suggest that the different lighting conditions led to significant differences in the perceived lighting scale, particularly between yellow lighting and blue lighting.

6.2 Hypothesis Testing

6.2.1 Lighting intensity

A one-way ANOVA revealed a marginally significant effect of lighting conditions on the perceived social safety scale, $F(4, 814) = 1.954$, $p = .0997$. Post hoc comparisons using the Tukey HSD test showed no statistically significant differences between conditions. These findings suggest that while there was a trend towards an effect of lighting conditions on perceived social safety, the differences observed did not reach conventional levels of statistical significance. The means and standard deviations for each condition were as follows: soft/warm lighting ($M = 3.36$, $SD = 0.88$), bright/warm lighting ($M = 3.48$, $SD = 0.76$), soft/cool lighting ($M = 3.32$, $SD = 0.90$), bright/cool lighting bright light, $M = 3.46$, $SD = 0.80$), and normal lighting ($M = 3.53$, $SD = 0.78$). These results do not support the hypothesis (H1a) that bright lighting more positively influences passengers' feelings of social safety.

A one-way ANOVA revealed that the differences in perceived overall travel experience across the different lighting conditions were not statistically significant, F(4, 814) = 1.22, p = .301. The perceived overall travel experience scores for each condition were as follows: condition soft/warm (M = 2.88, SD = 0.87), condition bright/warm (M = 2.81, SD = 0.76), condition soft/cool (M = 2.93, SD = 0.86), condition bright/cool (M = 3.00, SD = 0.86), and condition normal (M = 2.95, SD = 0.84). These results are not in line with (H1b) that bright lighting more positively influences passengers' overall travel experience

6.2.2 Lighting Colour Temperature

A one-way ANOVA revealed a marginally significant effect of lighting conditions on the perceived social safety scale, F(4, 814) = 1.954, p = .0997. Post hoc comparisons using the Tukey HSD test showed no statistically significant differences between conditions. These findings suggest that while there was a trend towards an effect of lighting conditions on perceived social safety, the differences observed did not reach conventional levels of statistical significance. The means and standard deviations for each condition were as follows: soft/warm lighting (M = 3.36, SD = 0.88), bright/warm lighting (M = 3.48, SD = 0.76), soft/cool lighting (M = 3.32, SD = 0.90), bright/cool lighting bright light, M = 3.46, SD = 0.80), and normal lighting (M = 3.53, SD = 0.78). These results are not in line with (H2a) warm coloured lighting more positively influences passengers' feeling of social safety.

A one-way ANOVA revealed that the differences in perceived overall travel experience across the different lighting conditions were not statistically significant, F(4, 814) = 1.22, p = .301. The perceived overall travel experience scores for each condition were as follows: condition soft/warm (M = 2.88, SD = 0.87), condition bright/warm (M = 2.81, SD = 0.76), condition soft/cool (M = 2.93, SD = 0.86), condition bright/cool (M = 3.00, SD = 0.86), and condition normal (M = 2.95, SD = 0.84). These results are not in line with (H2b) warm coloured lighting more positively influences passengers' overall travel experiences.

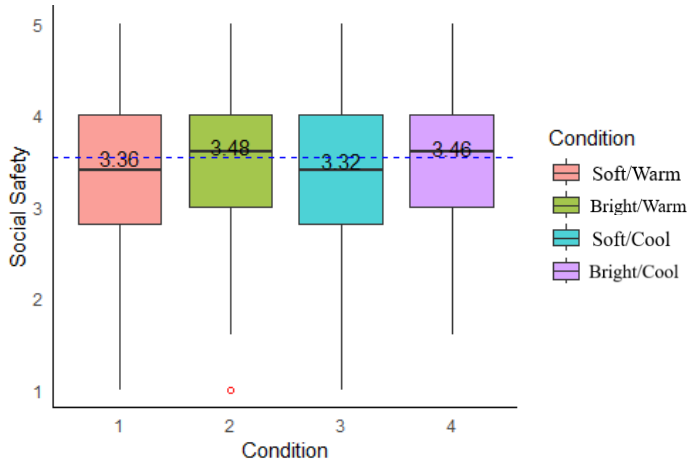
6.2.3 Interaction

A two-way ANOVA was conducted to examine the effect of lighting conditions on perceived social safety. A marginally significant effect was found for brightness, $F(1, 649) = 4.01$, $MSE = 0.70$, $p = 0.046$. There was no significant effect of colour, $F(1, 649) = 0.25$, $MSE = 0.70$, $p = 0.620$. The interaction effect between brightness and colour was also not significant, $F(1, 649) = 0.01$, $MSE = 0.70$, $p = 0.905$. The descriptive statistics show that the perceived social safety scores for each condition were as follows: soft/warm light condition ($M = 3.36$, $SD = 0.88$), the mean score under bright/warm light condition ($M = 3.48$, $SD = 0.76$) (Figure 10). These findings suggest that while there was a trend towards an effect of lighting conditions on perceived social safety, the differences observed did not reach conventional levels of statistical significance.

A one-way ANOVA was conducted to examine the influence of lighting conditions on passengers' overall travel experience. No significant effect was found for brightness, $F(1, 649) = 0.0019$, $MSE = 0.699$, $p = 0.965$. There was a marginally significant effect of colour, $F(1, 649) = 3.25$, $MSE = 0.699$, $p = 0.072$. The interaction effect between brightness and colour was also not significant, $F(1, 649) = 1.13$, $MSE = 0.699$, $p = 0.287$. The descriptive statistics show that the perceived social safety scores for each condition were as follows: soft/cool light condition ($M = 2.88$, $SD = 0.865$), the mean score under bright/cool light condition ($M = 2.81$, $SD = 0.755$) (Figure 11). These findings suggest that while there was a trend towards an effect of lighting conditions on perceived social safety, the differences observed did not reach conventional levels of statistical significance. These results are not in line with (H3) bright lighting and warm coloured lighting combined significantly enhance passengers' feeling of social safety and overall travel experience during nighttime compared to soft lighting and warm coloured lighting.

Figure 10

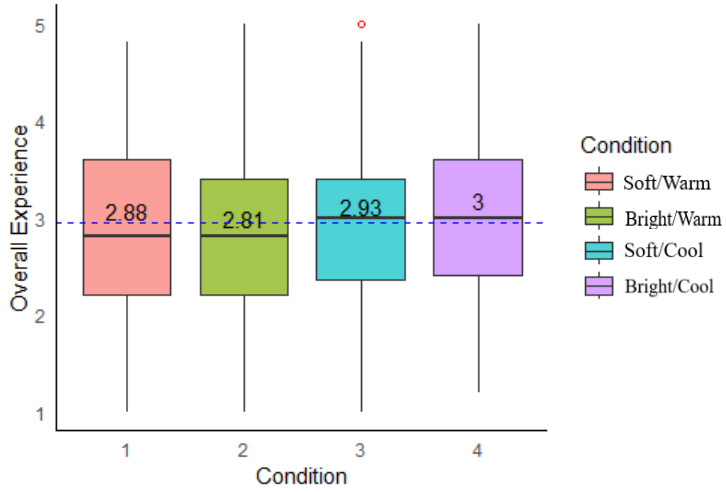
Social Safety



Note. The blue line represents condition 5 (control/normal).

Figure 11

Overall Travel Experience



Note. The blue line represents condition 5 (control/normal).

A two-way ANOVA was conducted to examine the effect of lighting conditions on perceived social safety. A marginally significant effect was found for brightness, $F(1, 649) = 4.01$, $MSE = 0.70$, $p = 0.046$. There was no significant effect of colour, $F(1, 649) = 0.25$, $MSE = 0.70$, $p = 0.620$. The interaction effect between brightness and colour was also not

significant, F(1, 649) = 0.01, MSE = 0.70, p = 0.905. The descriptive statistics show that the perceived social safety scores for each condition were as follows: soft/warm light condition (M = 3.32, SD = 0.904), the mean score under bright/warm light condition (M = 3.46, SD = 0.799) (Figure 10). These findings suggest that while there was a trend towards an effect of lighting conditions on perceived social safety, the differences observed did not reach conventional levels of statistical significance. These findings suggest that while there was a trend towards an effect of lighting conditions on perceived social safety, the differences observed did not reach conventional levels of statistical significance.

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Table 6

Findings of Study 1 and Study 2 in regards to the hypothesis.

	Hypothesis	Conclusion
H1a	Bright lighting more positively influences passengers' feeling of social safety during nighttime than soft lighting.	Study 1: Rejected Study 2: Rejected
H1b	Bright lighting more positively influences passengers' overall travel experiences during nighttime than soft lighting.	Study 1: Rejected Study 2: Rejected
H2a	Warm coloured lighting more positively influences passengers' feeling of social safety during nighttime than cool lighting.	Study 1: Rejected Study 2: Rejected
H2b	Warm coloured lighting more positively influences passengers' overall travel experiences during nighttime than cool lighting.	Study 1: Rejected Study 2: Rejected
H3a	Bright lighting and warm coloured lighting combined significantly enhance passengers' feeling of social safety and overall travel experience during nighttime compared to soft lighting and warm coloured lighting.	Study 1: Rejected Study 2: Rejected
H3b	Soft lighting and cool coloured lighting combined significantly enhance passengers' feeling of social safety and overall travel experience during nighttime compared to bright lighting and cool coloured lighting.	Study 1: Rejected Study 2: Rejected

7. Discussion

The goal of this study was to examine the effects of lighting characteristics during nighttime travel, specifically investigating intensity (soft vs. bright) and colour (warm vs. cool), impact on passengers' perceptions of social safety and overall travel experience. This was done using VR glasses to simulate a train journey with a questionnaire administered afterwards. Secondly, an online questionnaire was sent to participants with similar sets of questions and images of the VR environments. The results showed no significant impact of lighting characteristics on passenger perceptions of social safety or overall travel experience. In this chapter, the findings of Study 1 will be discussed first, followed by those of Study 2. Subsequently, the divergences between the studies will be outlined, followed by an examination of the limitations and the practical implications for NS. Finally, recommendations for further research will be presented.

7.1 Main Findings

The results of the manipulation check of Study 1 indicated that the participants did not perceive any discernible variations in lighting intensity between the conditions. However, significant differences were observed in how people perceived the colour and temperature of the lighting, particularly in distinguishing between blue and yellow tones, as well as warm and cool lighting. Nevertheless, the primary analyses showed that, despite these perceptual differences, neither colour temperature nor lighting intensity had a significant effect on passengers' perceptions of social safety or their overall travel experience. These findings contrast with earlier studies by Blöbaum & Hunecke (2005) and Johansson et al., (2011), which suggest that lighting can enhance feelings of safety and mood. This study found no significant effect of lighting colour or intensity on social safety perceptions or overall travel experience. The study was conducted in a simulated environment where participants may not have felt real feelings of fear or safety, which could explain this difference. This discrepancy

may be attributed to the specific context of rail transport, as highlighted by Van Hagen (2011), where lighting can influence the atmosphere but may not significantly impact passengers' perceptions of social safety. This may be because the sense of security in such environments is influenced by other factors than lighting alone. The mean scores for social safety and travel experience varied slightly depending on the type of lighting, but these differences were not statistically significant, This is in contrast to the findings of Custers et al. (2010) & Winzen et al. (2014), which suggest that people feel more alive and alert when they are in an environment with bright and cool lighting, which could ultimately enhance social safety. Similar results were obtained when looking at the combined effects of lighting intensity and colour temperature, which were not significant. In contrast to the findings of this study, Masullo et al. (2022) found that soft and warm lighting can have a calming effect on people. Although participants were able to distinguish between different lighting colour temperatures, these differences had a minimal impact on their perceptions of social safety and their overall travel experience.

Participants in Study 2 were able to correctly identify differences in temperature, colour and light intensity. The study found that lighting conditions had a marginally significant effect on perceived social safety, but the differences did not reach statistical significance. This was contrary to expectations that warm, bright lighting would improve passengers' perceptions of social safety. The lack of significant results suggests that lighting may have some effect on passenger perceptions of safety, but not a major one. The absence of compelling evidence regarding the impact of lighting intensity on social safety is at odds with the findings of Steidle & Werth (2013, 2014), who observed that soft lighting could enhance perceptions of freedom from constraints and reduce anxiety. Moreover, the findings of Kim & Hong (2023) & Winzen et al. (2014), who asserted that lighting colour temperature can significantly influence emotions and alertness, were not supported by the data. Furthermore,

the relationships between cool colours and soft lighting, as well as between warm colours and bright lighting, were also examined. Although there were indications of a potential correlation between certain combinations and enhanced perceptions of social safety and overall travel experience, these differences lacked statistical significance, contrary to the findings of Maier et al. (2017). Who stated that lighting brightness and colour are positively correlated, but these differences lacked statistical significance. Consequently, the hypotheses that lighting characteristics would enhance travellers' perceptions of social safety and their overall travel experience were not supported by the data.

7.2 Differences Study1 vs. Study 2

The biggest difference between the two studies was the perception of lighting. In Study 1, the VR study, it was particularly difficult for participants to indicate whether the lighting was bright or soft. This could be because participants had to get out of the VR environment to answer the question. Schwind et al. (2019) stated that participants may be influenced by real-world cues when answering the questionnaire outside of the virtual reality environment and that they may be more easily distracted. Additionally, the lower scores for the perception of lighting characteristics may be attributed to the lack of interactivity in the VR environment. Participants were not required to complete any tasks within the VR setting and were only permitted to observe the environment without the ability to move within it. This may have also contributed to the limited level of immersion. In Study 2, however, participants were on average accurate in indicating whether the lighting was bright or soft. This could be because in Study 2 participants could still see the image of the environment, whereas in Study 1 participants had already left the environment when answering the lighting question. Nevertheless, also in Study 2, there were no significant differences in perceived social safety or overall travel experience across different lighting conditions which could be because images are less immersive than VR and people could not imagine themselves as if

they were actually in the displayed train environment. A further significant distinction between the two studies is the demographic profile of the participants. The sample in Study 1 consisted exclusively of university students, who do not represent the full population of frequent train travellers. Conversely, in Study 2, the NS participants' panel was utilised, which accurately reflects the typical customer base of NS. Due to the fact that people are voluntarily in this panel, it could mean that they are more likely to be critical towards the service than average train travellers.

7.3 Limitations

This study has some limitations that should be acknowledged. Due to the time it takes to recruit participants for a VR study, only 50 participants were recruited, which may explain why the hypotheses had to be rejected. When people were in the VR, only the visuals of a train were simulated, not any sounds, which may have meant that people were not fully immersed in the VR. Immersion is identified by Agrawal et al. (2020) as when an individual is deeply engaged in an activity, their cognitive processes can result in a shift in their attentional state, which may lead to a disassociation from the physical world. In the VR environment, it was difficult for people to correctly identify the bright and the soft lighting conditions which can be a sign that people were not fully immersed. Another limitation of the VR study is that convenience sampling was used. The participants were all under 25 and students, which can affect the results as demographics such as age and education differ from the general population. With the online survey, it is less time-consuming to reach people and it is also easier to spread across all possible age groups and genders. However, it has one major disadvantage, which is that people only saw pictures of the VR environments, which is less immersive, it is more difficult to imagine being on the train, and depending on the quality of the device, the questionnaire participants filled out could look slightly different to the original. It is therefore unlikely that participants will feel insecure in the train environment or

that they will not enjoy the journey, given that they were not actually on a train. It has been demonstrated that high degrees of immersion can enhance the sense of presence, leading to more realistic experiences and more effective applications. A discernible enhancement in task performance and the accuracy of question responses was observed with increased immersion (Bowman & McMahan, 2007). In conclusion, while the study had limitations in terms of participant diversity and immersive elements, it does highlight the importance of full immersion in VR environments for accurate assessments.

7.4 Practical Implications for NS

These findings suggest that lighting may not have such a big impact on train travellers as assumed. Passengers could be influenced by several other factors that influence their feeling of perceived social safety and overall travel experience more than lighting characteristics. It is advised to further research this topic to find the underlying factors that influence these feelings. If individuals do not feel at ease using public transportation, they will elect not to do so (Van Hagen, 2011). The introduction of well-lit train environments still has the potential to enhance social safety and the overall travel experience. Moreover, lighting can enhance the communication of a brand's appearance, in addition to helping with the visual task of promoting a sense of well-being. Furthermore, the specific brand image can be enhanced through the use of lighting, with different lighting techniques allowing for the communication of distinct brand identities (Schielke, 2010). It is recommended that NS conducts further research into the impact of lighting on passengers' travel experience.

7.5 Future research

The study demonstrated the importance of the relationship between lighting, perceived social safety and overall travel experience. However, no firm conclusions could be drawn about this relationship due to the lack of significant results from the analysis. For future research, it is recommended that participants experience the environment of an actual

train under realistic conditions, or in the mock-ups provided by NS. This approach enables participants to gain a more realistic impression of an actual train journey, thereby increasing the likelihood that they will perceive the lighting as enhancing or as a valuable addition to the social safety or overall travel experience. This approach allows for the investigation of whether there is an impact of lighting characteristics on perceived social safety, and overall travel experience. It also allows for the examination of whether the lack of significant findings is due to the limitations of this study. Nevertheless, it is important to investigate further mediating and moderating factors that could impact the correlation between lighting and the sense of social safety as well as the overall travel experience. Furthermore, a qualitative research approach could bring a deeper understanding of the factors that influence passengers' perceptions of social safety and overall travel experience. It is crucial to combine a large sample size that represents all types of train travellers with a realistic approach to gain a deeper understanding of the participants' perspectives and to investigate other elements that could influence these relationships. Qualitative methods could be employed in this process.

7.6 Conclusion

While participants could distinguish between different lighting intensities and colour temperatures, these variations did not significantly impact their perceptions of social safety or overall travel experience. Lighting characteristics, such as intensity and colour temperature, did not enhance feelings of social safety or improve travel experiences in the context of rail transport. Future research should explore additional factors that might influence these perceptions and use more realistic and immersive experimental conditions.

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Appendix

During the preparation of this work the author used Grammarly, DeepL write, Quillbot and ChatGPT for a grammar, spelling and stylistic check of the paper. After using these tools/services, the author reviewed and edited the content as needed and takes full responsibility for the content of the work.

Appendix A: Questionnaire Stud 1/VR

Q1 What condition

- ○ Condition 1 - Soft/Warm
- ○ Condition 2 - Bright/Warm
- ○ Condition 3 - Soft/Cool
- ○ Condition 4 - Bright/Cool
- ○ Condition 5 - Control

End of Block: Questions for me

Start of Block: Informed consent

Q2 Dear participant, Thank you for participating in this study which is part of my bachelor thesis for Communication Science at the University of Twente. The NS contributes to this study, which takes place in a VR train environment and investigates the travelling experience. You will be asked to wear VR glasses and fill out a questionnaire in which you will indicate your impressions of the experience. The VR environment shows the interior of a train. Please imagine yourself that you are onboard of this train as if it is a real train. If you feel nauseous or experience discomfort while being in the virtual environment, you can stop at any time, simply by notifying the researcher and taking of the VR headset. The VR experience will be stopped immediately. In case you do not want to start or finish the questionnaire, you can always close the survey without any repercussions. Doing the experiment and filling out the

questionnaire will take about 10 minutes of your time. All your answers will be kept strictly confidential and anonymous. Thank you for your efforts!

For more information, please contact the researcher on this address.

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions or withdraw my participation at any time without providing a reason:

- ○ Yes, I consent
- ○ No, I don't consent

End of Block: Informed consent

Start of Block: stop

Q3 Please wait for instructions from the researcher to put on the VR headset!

End of Block: stop

Start of Block: VR environment check

Q4 What time of the day was it in the VR environment ?

- ○ The train journey was during the day
- ○ The train journey was during the night

Q5 I felt like I was on a real train (1 = not at all ; 10 = very much):

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10

Q6 I play video games:

- ○ 4 days a week or more
- ○ 1-3 days a week
- ○ 1-3 days a month
- ○ 5-10 days a year
- ○ Never

End of Block: VR environment check

Start of Block: General Travel Experience

Q7 On this train I would feel

	Very	Somewhat	Neither	Somewhat	Very	
	1	2	3	4	5	
Unhappy	○	○	○	○	○	Happy
Annoyed	○	○	○	○	○	Pleased
Unsatisfied	○	○	○	○	○	Satisfied
Stressed	○	○	○	○	○	Relaxed
Uncomfortable	○	○	○	○	○	Comfortable

Q8 Please indicate to what extent you agree with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I find the inside of this train looks appealing	○	○	○	○	○
I feel safe on this train	○	○	○	○	○
I feel comfortable on this train	○	○	○	○	○
I like the atmosphere on this train	○	○	○	○	○
I find the lighting on this train pleasant	○	○	○	○	○
I am enjoying this train journey	○	○	○	○	○
I have the feeling that I have to be quiet on this train	○	○	○	○	○

End of Block: General Travel Experience

Start of Block: Social safety

Q9 Please indicate to what extent you agree with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I feel calm on this train	○	○	○	○	○
I like to stay on this train	○	○	○	○	○
I have a pleasant feelingon this train	○	○	○	○	○
I have a good overviewfrom this place	○	○	○	○	○
I feel comfortable taking this train unaccompanied	○	○	○	○	○
I feel secure on this train	○	○	○	○	○

End of Block: Social safety

Start of Block: Lighting

Q10 The lighting in the train was:

	Very	Somewhat	Neither	Somewhat	Very	
	1	2	3	4	5	
Soft	○	○	○	○	○	Bright
Cool	○	○	○	○	○	Warm
Blue	○	○	○	○	○	Yellow

Q11 Please indicate to what extent you agree with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I find the lighting level pleasant on this train	○	○	○	○	○
I think the lighting level is sufficient on this train	○	○	○	○	○
I perceive this train as well lit	○	○	○	○	○
I find the lighting level too bright on this train	○	○	○	○	○

End of Block: Lighting

Start of Block: Demographics

Q12 What is your Nationality?

○ Dutch

○ Other: _____

Q13 What is your age?

_____

Q14 What is your gender?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say

Q15 The questionnaire is almost finished, please answer the last questions about your regular train travel behavior:

How often do you take the train?

- ○ 4 days a week or more
- ○ 1-3 days a week
- ○ 1-3 days a month
- ○ 1-10 days a year

Q16 What do you normally do on the train?

	Never	Sometimes	About half the time	Most of the time	Always
Sleeping	○	○	○	○	○
Working	○	○	○	○	○
Reading	○	○	○	○	○
Talking / Socializing	○	○	○	○	○
Listen to music	○	○	○	○	○
Nothing	○	○	○	○	○

Q17 With who are you traveling normally?

	Never	Sometimes	About half the time	Most of the time	Always
Alone	○	○	○	○	○
In a group	○	○	○	○	○
With kids	○	○	○	○	○

Q18 What is the reason for taking the train mostly?

- ○ To go to work
- ○ To go to school
- ○ To go to HBO/ university
- ○ To get to my leisure activities
- ○ Other: _____

Q19 What is your opinion of NS as a company: (1 = extremely bad ; 10 = extremely good):

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10

End of Block: Demographics

Appendix B: Questionnaire Study 2/Online

1	**Dummy: te testen variant**	*Single-response*

- ○ 1 - LAGE INTENSITEIT, WARME KLEURTEMPERATUUR VOORWAARDE ACTIEF

  Variable column **Randomisatie** Gelijk aan **1**

- ○ 2 - HOGE INTENSITEIT, WARME KLEURTEMPERATUUR VOORWAARDE ACTIEF

  Variable column **Randomisatie** Gelijk aan **2**

- ○ 3 - LAGE INTENSITEIT, KOUDE KLEURTEMPERATUUR VOORWAARDE ACTIEF

  Variable column **Randomisatie** Gelijk aan **3**

- ○ 4 - HOGE INTENSITEIT, KOUDE KLEURTEMPERATUUR VOORWAARDE ACTIEF

  Variable column **Randomisatie** Gelijk aan **4**

- ○ 5 - NORMALE INTENSITEIT, GEMIDDELDE KLEURTEMPERATUUR VOORWAARDE ACTIEF

  Variable column **Randomisatie** Gelijk aan **5**

3	**Welkom!**	*Tussenpagina*

Je krijgt straks een afbeelding te zien van een treininterieur in een nachtsituatie. Over dit interieur stellen we een aantal vragen. Beeld je zo goed mogelijk in dat je aan boord bent van deze trein, alsof het een echte trein is.

Klik op 'Volgende' om te starten.

4 **[{Afbeelding}]** *Tabel(single response)*

In welke mate ben je het eens of oneens met de volgende stellingen over dit interieur?

	Zeer mee oneens	Enigszins mee oneens	Noch mee eens, noch mee oneens	Enigszins mee eens	Zeer mee eens
Ik zou mij blij voelen in deze trein	○	○	○	○	○
Ik zou mij plezierig voelen in deze trein	○	○	○	○	○
Ik zou mij tevreden voelen in deze trein	○	○	○	○	○
Ik zou mij ontspannen voelen in deze trein	○	○	○	○	○
Ik zou mij comfortabel voelen in deze trein	○	○	○	○	○

5 **[{Afbeelding}]** *Tabel(single response)*

In welke mate ben je het eens of oneens met de volgende stellingen over dit interieur?

	Zeer mee oneens	Enigszins mee oneens	Noch mee eens, noch mee oneens	Enigszins mee eens	Zeer mee eens
Ik vind het interieur van deze trein aantrekkelijk	○	○	○	○	○
Ik vind de sfeer in deze trein fijn	○	○	○	○	○
Ik vind de verlichting in deze trein prettig	○	○	○	○	○
Ik heb het gevoel dat ik stil moet zijn in deze trein	○	○	○	○	○
Ik ervaar deze trein als kleurrijk	○	○	○	○	○

6 **[{Afbeelding}]** *Tabel(single response)*

In welke mate ben je het eens of oneens met de volgende stellingen over dit interieur?

	Zeer mee oneens	Enigszins mee oneens	Noch mee eens, noch mee oneens	Enigszins mee eens	Zeer mee eens
Ik zou mij rustig voelen in deze trein	○	○	○	○	○
Ik zou graag in deze trein verblijven	○	○	○	○	○
Ik heb een goed overzicht vanaf deze plek	○	○	○	○	○
Ik zou het prettig	○	○	○	○	○

vinden om in deze trein alleen te reizen					
Ik zou mij veilig voelen in deze trein	○	○	○	○	○

7 **[{Afbeelding}]** *Single-response*

Wat is je totale oordeel over dit interieur, uitgedrukt in een rapportcijfer?

(1=extreem slecht; 10= extreem goed)

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10

8 **[{Afbeelding}]** *Slider*

We zijn nu benieuwd wat je vindt van de <u>verlichting</u> in deze trein.

De verlichting in deze trein vind ik...

Geef je antwoord op de schaal van 1 t/m 5. Plaats het schuifje op de gewenste positie.

Gedimd	◯	Helder
Koel	◯	Warm
Blauw	◯	Geel

9 **[{Afbeelding}]** *Tabel(single response)*

In welke mate ben je het eens of oneens met de volgende stellingen over dit interieur?

	Zeer mee oneens	Enigszins mee oneens	Noch mee eens, noch mee oneens	Enigszins mee eens	Zeer mee eens
Ik vind het verlichtingsniveau in deze trein aangenaam	◯	◯	◯	◯	◯
Ik vind het verlichtingsniveau in deze trein voldoende	◯	◯	◯	◯	◯
Ik vind dat deze trein goed verlicht is	◯	◯	◯	◯	◯
Ik vind de verlichting te fel in deze trein	◯	◯	◯	◯	◯

10 **Als laatste volgen nog enkele achtergrondvragen.** *Tabel(single response)*

Wat doe je doorgaans tijdens een treinreis?

	Nooit	Soms	Ongeveer de helft van de tijd	De meeste tijd	Altijd
Slapen	◯	◯	◯	◯	◯
Werken	◯	◯	◯	◯	◯
Lezen	◯	◯	◯	◯	◯
Praten/socialiseren	◯	◯	◯	◯	◯
Muziek luisteren	◯	◯	◯	◯	◯
Niets	◯	◯	◯	◯	◯

11 Met wie reis je normaal gesproken? *Tabel(single response)*

	Nooit	Soms	Ongeveer de helft van de tijd	De meeste tijd	Altijd
Alleen	◯	◯	◯	◯	◯
Met iemand anders	◯	◯	◯	◯	◯
In een groep	◯	◯	◯	◯	◯
Met kinderen	◯	◯	◯	◯	◯

12 Wat is je mening over NS als bedrijf? *Single-response*

(1=extreem slecht; 10= extreem goed)

◯ 1

◯ 2

◯ 3

◯ 4

◯ 5

◯ 6

◯ 7

◯ 8

○ 9

○ 10

13 **Dit was de vragenlijst over een mogelijk nieuw treininterieur. Heb je nog een opmerking? Laat het hieronder voor ons achter.**

Klik op 'Volgende' om de vragenlijst af te ronden.

Open (groot)

Appendix C: Search log

Date	Source type	Search terms	Amount of hits
06-04-24	Scopus	customer AND experience AND pyramid	39
06-04-24	Google scholar	Lighting AND aircraft AND cabin AND safety	30.3000
12-04-24	Google scholar	Actual safety AND objective safety	4.630.000
12-04-24	Google scholar	Public AND places AND social AND safety	5.070.000
12-04-24	Scopus	actual OR objective AND social AND safety	5
12-04-24	Google schooler	public AND places AND social AND safety	6
13-03-24	Google schooler	Effects and indoor lighting	602.000
13-03-24	Google schooler	Effects and indoor lighting AND performance	422.000
15-04-24	Google scholar	Nighttime AND social AND safety	185.000

15-04-24	Google scholar	Nighttime AND social AND safety AND public transport	67.900
17-03-24	Google scholar	Crowding AND train	223.000
18-04-24	Google scholar	Public AND transport AND night	953.000
18-03-24	Google scholar	Effects AND lighting AND emotions	320.000
18-03-24	Google scholar	Lighting AND mood	518.000
18-03-24	Google scholar	Lighting AND time of day	4.010.000
18-04-24	Scopus	public AND transport AND safety	20
18-04-24	Scopus	public AND transport AND night	4
21-03-24	Scopus	customers AND welcome	6
21-03-24	Scopus	customers AND feeling AND welcome	0
21-03-24	Google scholar	Customer feeling welcome	304.000
30-04-24	Google schooler	Lighting AND aircraft AND cabin	36.000
30-04-24	Google scholar	Lighting AND aircraft AND cabin	36.400
30-04-24	Scopus	social AND safety	1,748
30-04-24	Scopus	"social safety"	305
30-04-24	Google scholar	Social AND safety AND survey	5.360.000
30-04-24	Scopus	"social safety" scale	1
30-04-24	Scopus	social AND safety AND scale	11
30-04-24	Google scholar	lighting aircraft jetlag	4.590
30-04-24	Google scholar	lighting aircraft cabin	17.500
02-05-24	Google scholar	Arousal public transport	17.90
02-05-24	Scopus	social AND safety AND lighting	8.108
02-05-24	Scopus	"social safety" AND lighting	75
06-05-24	Scopus	"social safety" AND night	4
06-05-24	Scopus	"social safety"	305
06-05-24	Google scholar	perception safety	6.320.000
06-05-24	Google scholar	perception safety night	1.290.000
06-05-24	Google scholar	perception social safety	6.130.000
06-05-24	Google scholar	Nighttime AND social AND safety AND public transport	69.200

06-05-24	Scopus	customers AND welcome	6
06-05-24	Scopus	customer AND experience AND pyramid	39
07-05-24	Google scholar	aircraft cabin lighting intensity color	23.800
07-05-24	Google scholar	lighting impact mood	223.000
26-06-24	Google scholar	virtual reality research	3.950.000
26-06-24	Google scholar	virtual reality questionnaire	491.000
26-06-24	Google scholar	Image AND immersion	2.570.000