Doctoral Dissertation

Study on Restorativeness in Home Environment for Interior Design: Investigation of Materials Choice by Design Background Participants

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Abstract

In recent years, the development of our economy and society has brought to the forefront a range of mental health issues that individuals are grappling with on a global scale. Stress, depression, and anxiety, among other mental health challenges, have become increasingly prevalent in modern society. Notably, the COVID-19 pandemic served as a significant trigger, people felt more stressed and insomnia because of the outbreak of the pandemic and isolation indoors. Therefore, there is an increasing concern about the emotional reactions of individuals to their environments, particularly in the context of creating restorative environments to relieve the adverse impacts of various mental health issues.

Given that humans live a significant portion of their lives in the home, the home environment presents an ideal quality for the implementation of restorative design, such as applying nature elements, to enhance well-being in everyday life. Moreover, the home environment has shown its impacts on restorativeness, such as releasing stress, attention restoration, and evoking positive emotions. Regarding home restorativeness, several aspects have shown their impacts in terms of restorativeness, such as greenness, window, furniture, and material.

However, as a crucial aspect of influencing perceived restorativeness in the home environment, limited research has explored the connections between specific interior materials and restorativeness in home environments. To bridge this gap, this study investigated the restorative potential of commonly used interior materials in home environments. After examining a comprehensive textbook about interior materials, several interior materials including interior wall paint, textile, wood, plastic, glass, metal, tile, brick, stone, and concrete were identified and selected as the experimental targets. To assess the restorativeness of these materials in interior design, a questionnaire which was adapted from the semantic differential method was employed for evaluation in the experiment. As the advantages of designer's thinking, 85 participants who were professionals with backgrounds of interior design-related majors were recruited to attend the data collection. Thereafter, cross-sectional data of subjective perceptions and

reactions to these ten materials were obtained. After the analysis by the Wilcoxon signed-rank test, the comparison results of each two interior materials were analyzed.

Combining with the material rankings of mean values by all restorative features, they concluded that glass material emerged as a strong candidate for enhancing the restorative qualities of living spaces. Doubts and the necessity of in-depth discussion were raised regarding specific wood's attribute/design and their impacts on restorative environments. Conversely, it also hinted that metal may not be the ideal choice for creating a restorative atmosphere in home environments. There also remained a need for more accurate and robust evidence to comprehensively understand the emotional reactions to brick material in various design contexts. These findings may contribute to the knowledge of creating a restorative home environment for interior design. Moreover, this study indicated some gaps between the emotional reaction to interior materials and restorativeness in the literature. Future research could expand on these findings by exploring other environmental contexts and considering additional variables.

Keywords: Mental health, Restorative environment; Restorative factor; Interior material; Semantic differential (SD) method.

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List of abbreviations

WHO: World Health Organization

DALY: Disability-Adjusted Life Years

PVC: Polyvinyl Chloride

DIBP: Di-iso-butyl Phthalate

DEHP: Di-2-ethylhexyl Phthalate

DINP: Di-iso-nonyl Phthalate

ART: Attention Restoration Theory

VOC: Volatile Organic Compound

CO_2: Carbon dioxide

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Preface

Author’s declaration

I hereby declare that the contents in my dissertation are my original idea and work, created in accordance with the Japan Advanced Institute of Science and Technology (JAIST)'s regulations. I take full responsibility for the content, except where I have explicitly cited references within the text. I conducted this research with idea conceptualization, methodology, data analysis, entire paper/dissertation writing, and project administration independently. The views expressed herein are my own, and this work has been submitted only for applying for the JAIST degree of Doctor of Philosophy in School of Knowledge Science.

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Chapter 1
Introduction

1.1 Serious mental health problems

In contemporary times, the progress of our economy and society has brought to the forefront a range of mental health issues that individuals are grappling with on a global scale. Stress (Koolhaas et al., 2011), depression (Smith, 2014), and anxiety (Marks & Lader, 1973), among other mental health challenges, have become increasingly prevalent in modern society. These issues have not only gained recognition but have also raised significant concerns due to their widespread impacts on individuals and communities.

Stress, typically originating from the demands of daily life and work, is recognized as a prominent factor contributing to mental health issues. Depression, as a major mental health concern, is described as a complex condition with various underlying causes, and it affects individuals across diverse age groups and backgrounds. Anxiety, involving excessive worry and apprehension, also is a significant mental health challenge that affects many individuals.

Mental health problems have now taken center stage as a significant global health challenge and the ubiquity of its crisis is evident in the staggering statistics. According to the World Health Organization (WHO) (Brundtland, 2000), it showed that a serious condition of mental health problems around the world:

- In 1998, mental health issues accounted for about 12% of all disability-adjusted life years (DALY) lost globally (high-income countries: 23%, low- and middle-incomes: 11%).
- The fifth leading factor of global disease was major depression.
- In the top 10 leading factors of disability worldwide, five of them were mental problems, for instance, major depression, alcohol use, and obsessive-compulsive disorders.

The magnitude of these mental health issues was underscored by global statistics collected by the WHO. These statistics revealed the widespread nature of mental health problems worldwide. It is evident that mental health challenges are not confined to specific regions or populations, instead, they represent a significant global health crisis that affects people from all walks of life.

Notably, the COVID-19 pandemic served as a significant trigger for a host of mental health issues, as revealed by a comprehensive review study. It had caused a widespread increase in mental health issues like depression, anxiety, and stress, and this had been extensively documented (Hossain et al., 2020). Particularly, the pandemic's adverse impacts exacerbated an already challenging situation, resulting in elevated stress levels (Burtscher et al., 2020) and more severe insomnia (Sun et al., 2021) among individuals during this period. According to the summarized data from a study in Nature Publishing Group, it shed light on the far-reaching implications of the pandemic on mental health, revealing the substantial toll it has taken on individuals worldwide (Liu et al., 2021). It underscored the urgent need for proactive measures to address the mental health crisis brought about or exacerbated by the pandemic. The detailed morbidity of each mental disease, investigated area, and participant number are shown in Table 1-1.

Table 1-1: Mental diseases morbidity during COIVD-19

Anxiety	32.60%
Depression	27.60%
Insomnia	30.30%
Post-traumatic stress disorder	16.70%
Anxiety (Subpopulation of suspected and infected people)	63.90%
Depression (Subpopulation of suspected and infected people)	55.40%

Data was collected in 9 countries, which belong to Asia, Europe, and North America. Participant number: 146,139

Note. data from Liu, Xuerong, Mengyin Zhu, Rong Zhang, Jingxuan Zhang, Chenyan Zhang, Peiwei Liu, Zhengzhi Feng, and Zhiyi Chen. "Public mental health problems during COVID-19 pandemic: a large-scale meta-analysis of the evidence." Translational psychiatry 11, no. 1 (2021): 384.

The world has witnessed a concerning rise in mental health issues that transcend geographical, cultural, and socioeconomic boundaries. The ubiquity of mental health problems has turned this silent epidemic into a global concern, demanding immediate attention and action.

1.2 Restorative environment

On account of severe mental health problems situation, there is growing scientific interest in how emotional reactions to environments because there is a category of environment, namely restorative environments, can alleviate mental problems (Bornioli & Subiza-Pérez, 2023). The restorative environment can be defined as a substantive branch of environmental psychology related to recovery from mental fatigue (Kaplan, 1992). They stand as a testament to the profound connection between our surroundings and our mental, emotional, and physical status. Several studies have found that a restorative environment can benefit human mental health and proved the connections (Collado et al., 2017; Herzog et al., 1997; Kaplan, 1995). More solid evidence and detailed information were found and shown in Table 1-2. For instance, a post-visiting investigation found that people would feel calm, relaxed, and thoughtful after experiencing a restorative environment (museum) owing to the aesthetic and fascination of their collections (Kaplan et al., 1993). In another study, it compared different environmental categories (Part 1: wilderness backpacking condition, vacation condition without wilderness, and control condition of daily routine. Part 2: building environment,

nature environment, relaxation but passive environment) and found that participants felt less anger and sadness in the nature environment (Hartig et al., 1991). Meanwhile, Cho et al. (2016) found cognitive functioning of cultural heritage sites and revealed the connections between emotional healing and tourist spot. In addition, similar attention restorative effects were found in the context of religious part in home environment (Herzog et al., 2010).

In summary, in an ever-changing world where mental health challenges have become increasingly common, the idea of a restorative environment shines as a potential source of strategy, capable of imparting positive effects on mental well-being. The importance of restorative environments extends beyond individual well-being as its impacts on urban public space (Polajnar Horvat & Ribeiro, 2023) and the long-term effect of built environment. It also can serve as a catalyst for community engagement and collective well-being. Therefore, it is incumbent upon us to put our concerns to these spaces, ensuring that they continue to provide positive effects (restorativeness) for us.

Table 1-2: Specific restorative environments and restorative effects

Restorative environment	**Restorative effect aspect**	**Reference**
Museum	Calm, relaxed, and thoughtful	(Kaplan et al., 1993)
Natural environment	Feeling less anger and sadness	(Hartig et al., 1991)
Cultural heritage sites	Emotional healing	(Cho et al., 2016)
Religion-related room	Attention restoration	(Herzog et al., 2010)
Urban Public Spaces	Attentional restoration	(Polajnar Horvat & Ribeiro, 2023)

1.3 Home environment

1.3.1 Topics related home environment

The key roles of home environment have been highlighted for years in research area. On the one hand, it serves as a place of residence, providing shelter and a physical space for individuals or families to live. On the other hand, it is a subject of extensive studies within various research fields. The topic related to home environment has been ongoing for many years, indicating its significance in both practical and academic fields (Graham et al., 2015):

- **Restorativeness.** The physical aspects and layout of a space have a significant impact on the activities and social interactions that occur within it, influencing the cognitive and emotional state of its occupants. For instance, it can induce a sense of relaxation. Moreover, environmental factors like lighting/daylighting, temperature, humidity, sound, color, and spatial arrangement can affect people's mood, attention, and stress levels. For instance, excessive exposure to sunlight might reduce relaxation. These characteristics of a space can shape individuals' thoughts and emotions while they are in that space. Personal keepsakes may evoke pleasant memories of the past. Additionally, the presence of personal and cultural items, such as artwork, photographs, and furniture, can contribute to feelings of well-being and social support.
- **Kinship.** In the home, kinship is the cornerstone of a thriving community. It's within these walls that family bonds are nurtured, and a sense of togetherness flourishes. The very essence of kinship brings warmth to a household, as shared moments and experiences create lasting memories. Sophistication in the context of kinship is about the refinement of these connections. It's the art of cultivating relationships with care and respect. The sophistication of kinship lies in the ability to navigate the complexities of family dynamics with grace and empathy, fostering an environment where everyone feels valued and heard.
- **Storage.** Storage is an indispensable element of a home that embodies a

multitude of essential qualities. When designed with abundance, it ensures that every item has its place, preventing clutter and chaos. A cozy home integrates storage seamlessly into its decor, creating a sense of warmth and comfort. Furthermore, storage can be a symbol of friendship, offering space for cherished mementos and shared possessions that strengthen the bonds of those living together. An inviting home incorporates storage solutions that not only serve a practical purpose but also enhance the aesthetics of the space, encouraging guests to feel at ease. Effective organization, facilitated by well-thought-out storage, simplifies daily life, making it easier to find what you need when you need it. Additionally, storage contributes to a sense of safety by keeping potentially hazardous items out of reach, promoting a secure environment for all residents. In essence, storage in the home is not merely a functional necessity but a reflection of the values and qualities that make a living space truly complete.

- **Stimulation**. Stimulation in the home is the vibrant pulse that infuses life with entertaining moments, excitement, and boundless fun. Entertainment takes center stage, with the home becoming a stage for endless possibilities. The excitement of trying new things, pursuing hobbies, and embarking on creative projects all unfolds within these familiar walls. Every room becomes a source of potential delight, where every corner holds the promise of a new adventure. In a stimulating home, each day brings with it the opportunity for laughter, learning, and cherished memories. It's a place where excitement and fun are not just occasional visitors but cherished residents, making every day an extraordinary journey.

- **Intimacy**. Intimacy often takes place within a home setting where couples share a living space. This context can provide insights into how homes mirror the dynamics of these relationships and how the design of a home can impact the way people interact, subsequently influencing the course and endurance of romantic partnerships. For instance, one might consider how the layout of a living space either supports or hinders a couple's desire for both closeness and personal space. Similarly, this extends to family dynamics, particularly parent-

child relationships.

- **Productivity.** Home also could be a workplace, it may foster productivity, where empowers individuals to achieve their goals, be it personal or professional. It may be a tranquil space where can inspire deep focus, creativity, and self-expression. In the midst of quietude, one finds the mental clarity to complete tasks efficiently and bring innovative ideas to life. In a productive home, every room serves as a sanctuary for self-expression, allowing personal passions to flourish. Quietude, both in terms of physical space and mental tranquility, is the cornerstone of productivity. It's a place where distractions are minimized.

Meanwhile, some studies underscored the significance of the home environment in various aspects of society and research. It highlighted several research areas of concern and interest: **Aging society** (Gitlin, 2003): It suggested that researchers should recognize the importance of home environments, especially in the context of societies with an aging population. It involved making homes more accessible and accommodating for older individuals. **Disease treatment strategies** (Gitlin & Corcoran, 1996; Hussain et al., 2015): They highlighted the significance of home environments in shaping novel approaches for addressing various health conditions, with a particular focus on dementia and chronic diseases. This implied that the designs and features of homes can have a significant impact on the well-being of individuals dealing with these health challenges. **Smart home technologies** (Sovacool & Del Rio, 2020): It recognized the increasing enthusiasm for integrating smart home technologies to elevate the overall quality of life for inhabitants. This suggested that technology-driven solutions can improve various aspects of daily living within a home.

1.3.2 Restorativeness in home environment

According to the findings from Mody et al. (2020), the frequency of experiencing a restorative environment could result in different health, working, and emotional satisfaction levels. Since humans spend much of their time in their homes (Brasche & Bischof, 2005), the home environment may be ideal for restorativeness. As a result,

applying restorative factors to the home, such as natural elements (Craig et al., 2022), is an effective design strategy for creating a restorative environment for our daily lives. In this previous study, under the impact of measures like keeping physical distancing, stay-at-home order, and city shutdown implemented in response to the COVID-19 pandemic, it proposed that integrating restorative environments can be instrumental in enhancing people's mental well-being, such as exposure to nature through green breaks or green spaces within the home workspace, can help mitigate the negative effects of isolation and enhance cognitive performance, mood, and overall well-being. It reviewed various studies and outlined two main approaches to incorporate restorative environments: "green breaks" involve immersing oneself in nature, either physically or virtually, while "green spaces" involve adding indoor plants or creating window views of nature within the workspace. That review pointed out that physical immersion in nature appears to have a more robust positive effect, but options like nature videos and sounds can also be beneficial. It emphasized that these interventions may not solve all the challenges posed by prolonged isolation and remote work but can provide meaningful relief from stressors.

Other strategies like home environment modification (Carnemolla & Bridge, 2016): a study involved making changes to the home environment in 157 cases. After these modifications, the occupants reported a significant 40% improvement in health-related quality compared to their situation before the changes. It implied that making changes to the living environment can exert a favorable impact on the general well-being of inhabitants. It also emphasized the importance of home design for a better emotional reaction and health.

Restorative experiences in home: some research observed restorative experiences associated with specific types of home environments. For instance, individuals living in second-home cabins (Bjerke et al., 2006) had reported experiencing restorative effects. And the similar experience was found in second-home which is located in rural areas (Pitkänen et al., 2020). This implied that certain home settings can promote feelings of relaxation and restorativeness. And showed a solid connection between home environment/home design and restorativeness. The summarized information is shown in the following table 1-3.

Table 1-3: The connections of home environment and restorativeness.

Home environment	Restorative effect aspect	Reference
Applying nature element	Relief from stressors	(Craig et al., 2022)
Home modification	Health and wellbeing	(Carnemolla & Bridge, 2016)
Second home of cabin	Attentional restoration and positive emotion	(Bjerke et al., 2006)
Rural second home	Health and Well-being	(Pitkänen et al., 2020)

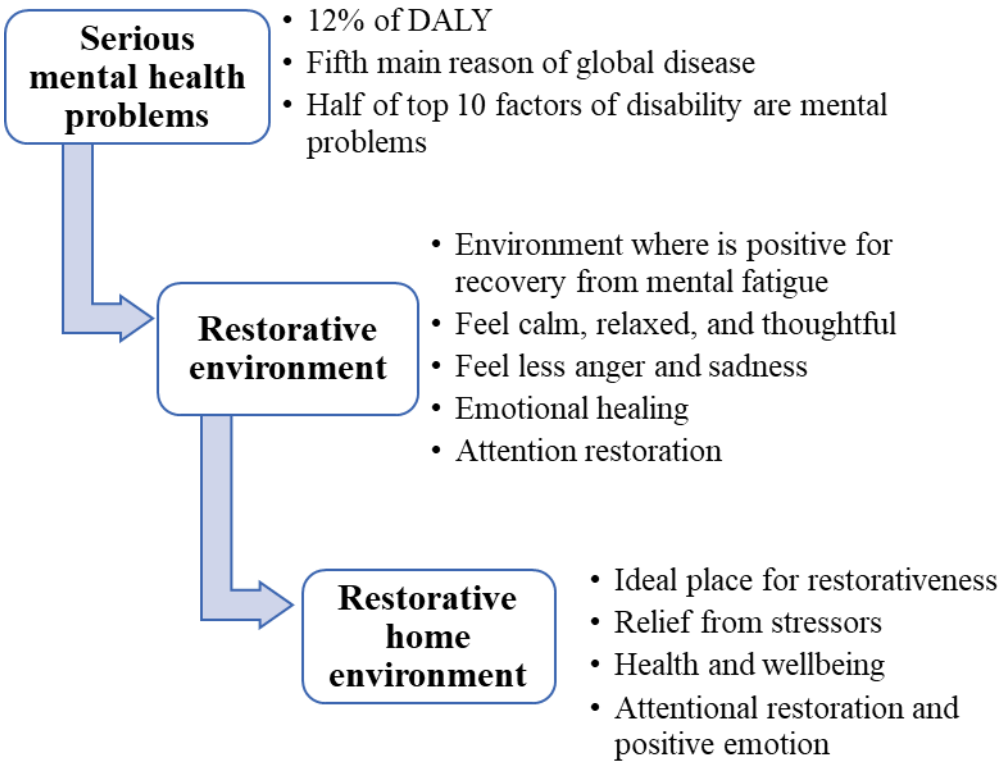


Figure 1-1: Outline of chapter 1

Chapter 2
Literature review

2.1 Home characteristic and restorativeness

Home restorativeness doesn't just refer to the overall ambiance of a home environment, it also includes specific environmental features and qualities within the home. In a home environment, several specific elements have been identified as being associated with restorativeness:

Greenness (Shibata & Suzuki, 2001). Researchers examined how the presence of foliage bonsai influenced occupants' experimental results, levels of emotional burden, and overall evaluation. They conducted two separate room conditions: one with plants arranged in the room and another without any plants. The conclusion indicated that having plants in the room may have contributed to the recovery from mental fatigue, as evidenced by the improved task scores in the second session when plants were present.

Window view (Kaplan, 2001). The study focused on the impacts of what people see when looking out of their windows on their overall well-being and satisfaction with their neighborhood. After comparing within six low-rise apartment communities, it found that having natural elements or natural views visible from windows played a significant role in enhancing degree of satisfaction with their community environment and various facets of their well-being. In contrast, views of built elements influenced satisfaction but not well-being, and views of the sky and weather did not substantially affect either outcome. These findings emphasize the importance of incorporating natural elements into the views from homes to enhance residents' satisfaction and overall well-being. It suggests that urban planning and design should prioritize nature content in residential views to promote the well-being and happiness of residents.

Furniture type (Dazkir & Read, 2012). Simulated interior settings, including both curvilinear (rounded) and rectilinear (straight-lined) forms. The results showed that the curvilinear designs elicited stronger feelings of pleasure and approach (a desire to approach or interact with the setting) compared to the rectilinear designs. The emotions

associated with curvilinear settings were more pleasant and calming. This research highlights the impact of furniture forms in interior design on people's emotions and preferences.

Interior material (Fell, 2010). How the presence of wood and indoor plants within an office setting can mitigate stress was examined. Researchers monitored the autonomic nervous system of 119 university undergraduate students in four different office conditions: categorized as follows: offices with wood elements and indoor plants, offices with wood but no plants, offices with plants but no wood, and offices with neither wood nor plants. Stress levels were assessed using the two objective indicator categories of skin conductance responses, both of which reflect the activation of the sympathetic nervous system. The findings revealed that wood exposure led to a reduction in the two objective indicator categories of skin conductance responses, suggesting a lower level of sympathetic system activation. However, there was no significant effect of plants on sympathetic activation, and no interaction between wood and plants was observed. The study suggests that wood can have similar stress-reducing effects with exposure to nature, making it a potential element for stress reduction in indoor environments like homes and offices.

2.2 Interior materials and their impacts

Considering the material, it possesses a diverse set of attributes that exert a profound and multifaceted influence on various aspects of occupants' physical, psychological, and physiological well-being, rendering it a pivotal component in shaping the overall comfort, health, and quality of life experienced within a given living environment. These attributes encompass various factors, all of which combine to create a holistic sensory and functional experience for individuals inhabiting the space. Some of them are summarized in Table 2-1.

Physical health

Health risk of phthalate level and interior material (Ait Bamai et al., 2014). A study

focused on phthalates, which are commonly used in various products and have raised concerns about their potential health effects (endocrine disruption). It conducted an analysis of phthalate concentrations detected in surface dust from various interior materials. In particular, homes that were furnished with wooden flooring found significantly greater concentration values of di-iso-butyl phthalate (DIBP), while the rooms with polyvinyl chloride (PVC) flooring showed increased levels of di-2-ethylhexyl phthalate (DEHP). Significantly, when it came to multi-surface dust, residences adorned with PVC wallpaper exhibited elevated concentrations of DEHP and di-iso-nonyl phthalate (DINP). Moreover, an interesting positive relationship was noted between the extent of PVC-based interior materials used and the concentration degrees of DEHP and DINP detected in surface dust of various materials. This study underscored a crucial takeaway: the choice of interior materials within homes, encompassing elements like flooring and wallpaper, wields a substantial influence on the presence of phthalates in dust.

PVC plastics and bronchial obstruction (Jaakkola et al., 1999). One study investigated the factors contributing to bronchial obstruction in infants during their first two years of life. It involved a group of newborns in Oslo born between 1992 and 1993. The researchers found that children, who were more likely to develop bronchial obstruction (the case group), were more likely to live in a place that contained PVC products and textile wall materials. While the healthy children (control group) were living in a place that had wooden products and no PVC/textile wall material. In statistical terms, the existence of PVC flooring was found its connection with a 1.89 times higher risk of bronchial obstruction, and textile wall materials were bridged to a 1.58 times higher risk of bronchial obstruction when compared with the living environment of healthy children. Furthermore, the study uncovered a dose-response relationship, suggesting that the plasticizers, which are contained in PVC and other materials in the living space, could be the significant risk factor of bronchial obstruction for the age group of young children.

Psychological well-being

Wood material and positive psychological impacts (e.g., bright, pleasant, and warm) (Watchman et al., 2017). This study focused on the mental impacts of material from indoor finishes, particularly wood, on the emotional benefits of satisfaction and comfort

of occupants indoors. Wood, as a natural building material, is known for its ability to create warm and pleasant atmospheres, potentially showing the positive result of restorative potential for occupants' mental health. It tried to detect how people view or feel about the use of wood indoors and their level of contentment with having wood/wooden materials indoors. After finishing an investigation to assess their view or feel in two spaces with distinct settings (one adorned with abundant wooden surface material and the another possessing comparable environmental conditions but no wood), the findings suggested that people in the experimental setting that was adorned with abundant wooden surface material reported higher contentment levels regarding attributes of illumination, acoustics, and thermal feeling compared to the no wood setting. Words like "bright," "pleasant," "modern," and "warm" were frequently used by participants to describe the room with wood.

Wood material and stress-reducing potential (Burnard & Kutnar, 2015). The review literature discussed focuses on the relationship between the applying wood material indoor and its potential ability of stress-reducing, aligning with the principles of restorative environmental design. It summarized previous research on how wood affects psychophysiological responses and outlined methods for testing efficacy of mental restorativeness in experimental environments. The existing studies indicated that incorporating wood material indoors led to diminished subconscious stress responses in comparison to spaces with minimal or no wooden elements. Consequently, by integrating the element of wood into design strategies that intend to introduce the favorable mental well-being effects of nature into indoor settings, such as restorative environmental design.

White steel and impressions of being unhealthy and closed or even depressed (Sakuragawa et al., 2005). Compared to the positive result of wood, visual stimulation from the white steel conveyed an adverse effect, creating an amplifying feeling of negative emotions. The significantly increased blood pressure of white steel environmental occupants supported this point of view.

Physiological impacts

Wooden materials and autonomic nervous system (Tsunetsugu et al., 2007). In this previous study, researchers aimed to understand the impact of room interiors with varying

proportions of wooden materials on the autonomic nervous system reactions of individuals. Some modeled rooms with progressive proportions of wood material were applied to conduct the comparison experiment and three levels of wood material quantity (no wood, middle quantity of wood, almost all wood) were compared. The measurements were the heart rate, systolic and diastolic blood pressure, reaction of neuro system, gathered subjective evaluations during exposure to these distinct visual settings. In the no-wood condition, there was a significant decline in blood pressure, while the reactions in neuro system were minor alterations. In the middle quantity of wood condition, it was found that the blood pressure had a notable drop, number of heart rate had a significant raise, and received a best subjective evaluation of “comfort”. In almost-all-wood condition, two categories of blood pressure were both reduced substantially and significantly. However, the great amount of wood utilization appeared to lead to a rapid decline in reaction of neuro system and an upsurge in heart rate. Overall, these findings provide insights into how interior design choices, such as the use of wood, can influence the human autonomic nervous system reactions in real-world settings.

Material of Japanese cedar and blood pressure levels (Sun et al., 2020). Researchers investigated the connection between bodily reactions and personal assessments of residential areas featuring various wooden elements, particularly a wood category of Japanese cedar and manufactured wooden panel. They conducted experiments with 83 subjects, where each subject spent 30 minutes in each type of room. The study assessed various factors, including stress biomarkers, systolic and diastolic blood pressure, emotional measures, and subjective feelings using questionnaires with the semantic differential method. Subjective evaluations of the rooms were heavily influenced by the subjects' preferences. Subjects tended to evaluate a room more positively if they preferred it. Interestingly, even subjects who generally disliked the experimental setting which was modeled by Japanese cedar didn’t evaluate any adverse emotions. Physiological responses, such as blood pressure, were found to be independent of the subjects' preferences. In the setting of Japanese cedar, subjects experienced a decrease in blood pressure, indicating a potential relaxation effect. Reactions of stress biomarkers were repressed in both experimental settings, suggesting a reduction in stress levels, regardless of the wood material. Overall, it indicated that Japanese cedar interiors may have a

calming effect on individuals, irrespective of their personal preferences.

Other emotional-related experience

Visual comfort quality (Zanon et al., 2019). This previous study focused on the importance of visual comfort in indoor environments, particularly in residential buildings. Notably, it found that some settings, such as window which related to interior material use, are the index for visual quality. Other emotional-related experiences exist in literature connected with material in home environment, such as safety perception (Pisello et al., 2016) and acoustic experience (Mohanty, 2016; Yu & Kang, 2009), the characteristic of which can also be considered as an effective source of restorativeness, such as noise isolation (Chung, 2018).

Together, these findings (table 2-1) have not only underscored the significance of interior materials but have also illuminated their pivotal role in not just creating functional spaces but in supporting the holistic health and well-being of individuals inhabiting these environments. Moreover, there is an increasing wealth of data underscoring that interior materials are not mere passive elements of design but active contributors to the physical, psychological, and emotional dimensions of human health. As we spend the majority of our lives indoors, understanding the profound impact of interior materials becomes increasingly critical for architects, designers, and policymakers striving to create spaces that promote vitality, productivity, and contentment among occupants.

Table 2-1: Interior material and physical, psychological, and physiological effects

Material	Effect aspect	Reference
Surfaces of materials	Health risk (Phthalates concentration)	(Ait Bamai et al., 2014)
Polyvinyl chloride plastics	Bronchial obstruction	(Jaakkola et al., 1999)
Wood	Positive psychological impacts, stress-reducing potential	(Watchman et al., 2017)
White steel	Evoking impression of unhealthy, closed or even depressed	(Sakuragawa et al., 2005)

Wooden material quantity	Disparate autonomic nervous system reactions	(Tsunetsugu et al., 2007)
Japanese cedar	Blood pressure levels	(Sun et al., 2020)
Holistic interior materials	Visual comfort quality	(Zanon et al., 2019)
	Safety perception	(Pisello et al., 2016)
	Acoustic experience	(Mohanty, 2016; Yu & Kang, 2009)
	Noise isolation	(Chung, 2018)

2.3 Research gap

Although interior material plays a pivotal role in enhancing home restorativeness, and significant connections have been established between them, it's worth noting that this topic remains relatively underexplored, with much-untapped potential for further investigation. While existing research has illuminated the influences of interior materials on factors like well-being, mood, and physiological responses, it's apparent that we're just scratching the surface of this intricate relationship. Regarding the material and restorativeness, it is still limited to three important research gaps.

- First, many previous studies have examined the positive restorative effects of wood materials in home environments. However, there is a lack of studies exploring the restorative effects of other materials in homes, such as textiles, glass, and brick. Is there any other material that may have good restorative potential in the home environment?
- Second, although the benefits of using natural materials instead of artificial materials in home environments have been stated by a previous study (Nousiainen et al., 2016)(pp. 78–80), the restorative effects of non-wood natural materials such as stone and soil are unknown.
- Third, there are so many commonly used materials in interior environment, that we could not know what their restorative potential is. Systematic research about

interior materials and emotion is still deficient, and it is needed to find more evidence-based information about interior materials.

2.4 Hypotheses

According to the positive results of wood from the wood literature review study (Watchman et al., 2017) and significant blood pressure reduction result of Japanese cedar panel (Sun et al., 2020) mentioned in the section of "Interior materials and their impacts", we got the first positive hypothesis of wood material. Moreover, as the adverse impact of steel (Sakuragawa et al., 2005) was found in the previous study, we hypothesized the negative result of metal. In addition, as the positive effects of natural material of wood and the human nature of closing to nature, we had another hypothesis of the better restorative potential of natural material. In total, 3 hypotheses were set:

H1: the interior material of wood could convey the positive effects of restorativeness and ranks a better restorative potential among all the interior materials.

H2: the material of metal might convey the negative effects on restorativeness and rank a low restorative potential among all the interior materials.

H3: the natural materials could convey the positive effects on restorativeness and were ranked a better restorative potential than artificial materials.

2.5 Research aim

To verify these hypotheses, this study planned to investigate humans' subjective perceptions and reactions to primary materials in interior design regarding restorativeness and discuss the potential of these interior materials for a restorative home environment. The main aim was to investigate the restorative potential of material in the home environment for interior design. Based on this aim, several subsidiary research aims were addressed:

- To find the potential interior materials, which can show a positive effect on restorativeness, such as metal.
- To learn the restorative potential of other natural interior materials by comparing wood and other natural interior materials.
- To systematically compare commonly used interior materials for restorative home environments.

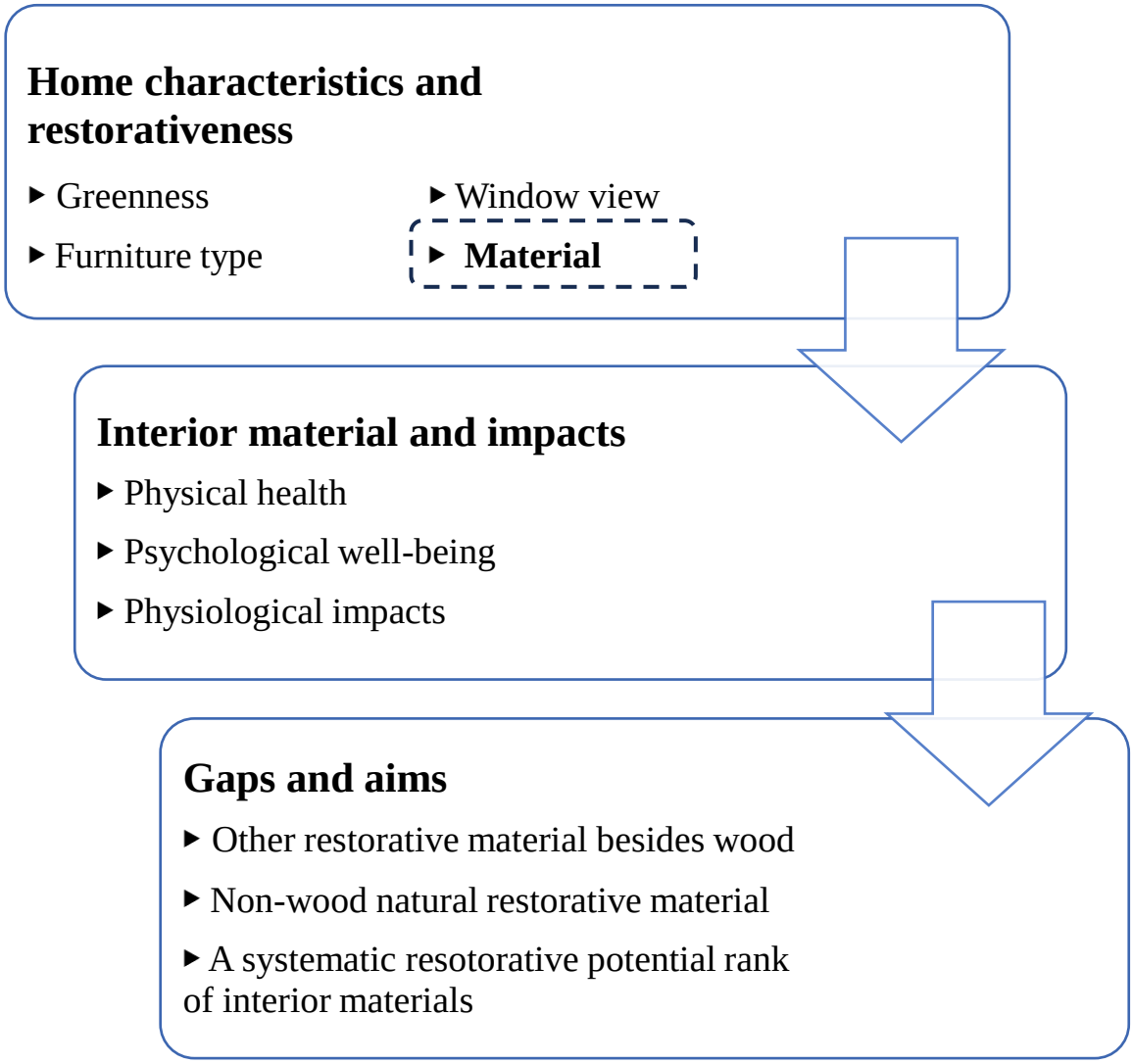


Figure 2-1: Outline of chapter 2

Chapter 3
Methodology

3.1 Study design

3.1.1 Experimental materials

To investigate humans' subjective perceptions and reactions to materials in home environment and discuss the restorative potential of these materials for a restorative home, the primary materials in interior design were the targets for experiment. Based on a professional and required textbook that comprehensively introduces materials and specifications, the categories and introductions of mainly used materials in the interior design field could be found (Godsey, 2012). Material is the key point that each interior designer or student is required to have a good command of knowledge during their professional experience. The main concept of that textbook was to provide new practical knowledge about different surface materials and a logical foundation for evaluating aspects of performance, making selections, and providing specifications for designers. The book incorporated discussions on globalization, sustainability, and toxicity, which were crucial topics in the realm of materials. The discussions inside were woven into chapters to help interior designers or students establish connections between the materials and these broader issues. The book also emphasized emerging technologies and significant developments within the industry. Throughout each chapter, the standardized specification format used in the building and design industry is applied. This approach allows interior designers or students to understand how this format is adapted for every material covered in the book. Additionally, there are dedicated sections on each commonly used material to address the needs of interior designers or students in work where these materials are not offered as a standalone course or elective. That book imparts practical knowledge about the commonly used materials and the various characteristics that influence their performance. It serves as a foundation for specialists who may want to explore materials more extensively in a separate material-focused topic.

Regarding the materials used for this research, we used the content analysis of the

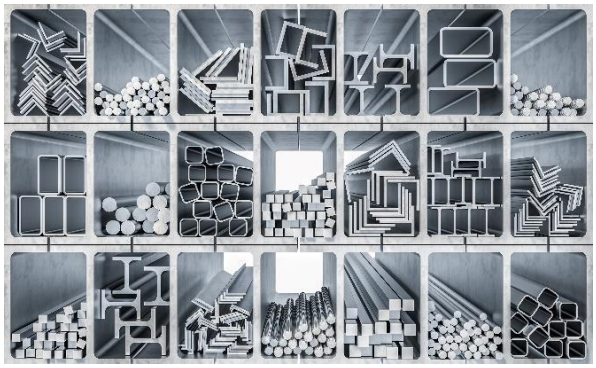
literature, removing materials that are rarely used and small in the interior home environment like wallpaper, sand, and soil. We categorized interior materials into ten different categories as the investigating target. They were interior wall paint, textile, wood, plastic, glass, metal, tile, brick, stone, and concrete. The picture of each material was searched from the picture serving website of free license (Freepik: www.freepik.com) to show their image for experiment, and they are shown in Figure 3-1. A sample picture of each material category was chosen by the author to show the typical example. During the experimental process, all the participants would search for more comprehensive information about each material from different websites and different perspectives.

(a)

(b)

(c)

(d)



(e) (f)

(g) (h)

(i) (j)

Figure 3-1: Ten different categories of interior materials for investigation: (a) interior wall paint; (b) textile; (c) wood; (d) plastic; (e) glass; (f) metal; (g) tile; (h) brick; (i) stone; (j) concrete

Note: Picture source from the free and premium license of Freepik: https://www.freepik.com/ (Accessed in Oct. 2022).

According to the information from textbook of interior materials (Godsey, 2012), here is brief introduction for each selected material.

- **Interior wall paint.** It is the name of some materials and techniques for surface treatment, such as the materials of paints and coatings. The interior wall paint was used as the example for this category as it is the surface material for wall that we see and touch in interior environment.

- **Textile.** It is a general term for all the textile materials, such as curtains, carpeting, and area rugs. The textile uses fibers originally, which can either come from natural sources or be created synthetically. Natural fibers include cotton and wool. Cotton is a type of natural fiber made from cellulose, while wool is derived from proteins. Apart from these, other sources of natural cellulose fibers are wood and bamboo.
- **Wood.** Wood can be many parts of an interior environment, such as pillars, furniture, and floor. Because of its brilliant properties, it is widely used in the interior environment, encompassing solid wood, veneer, and engineered wood. When used appropriately, wood can contribute to sustainable design practices and play a role in mitigating environmental impact by sequestering carbon dioxide (CO_2), a greenhouse gas. This means that the CO_2 becomes part of the wood's structure, where it remains until the wood naturally decomposes or is burned. This natural process of trees absorbing CO_2 and releasing oxygen is referred to as the carbon cycle. Consequently, the industry is organized to maintain efficient carbon cycles by managing forests. Harvesting mature trees is acceptable, provided they are consistently replaced with new trees to maintain this cycle. By preserving wood and ensuring the proper upkeep of wooden surfaces, the CO_2 remains locked within the wood itself, rather than being released into the atmosphere. This emphasis on responsible management and utilization of wood resources serves to both benefit sustainable design and contribute to environmental well-being.
- **Plastic.** It is a petrochemical material traditionally, and also could be used as some parts of interior environment, such as floor, partition wall, and thermal insulation material, etc. Although plastic has convenient advantages and obvious disadvantages, it pervasively appears in the interior environment. Plastic materials, which can convincingly imitate natural substances to the extent that they are being substituted for traditional building materials. Plastic is often referred to as a synthetic material, which sometimes leads to the perception that it lacks authenticity. While the chemistry behind plastics is complex and intriguing, interior designers do not necessarily need a deep understanding of chemistry to work with these materials. Plastics are composed of ingredients that create

extended chains of polymers. Different arrangements of these polymer chains result in distinct characteristics for each type of plastic, which then determine their optimal applications. Examples of such plastics include nylon, polypropylene, and vinyl. Although most plastics are derived from petroleum, the increasing costs of fuel are making bio-based plastics, sourced from plants, more economically viable. The term "bioplastics" refers to resins originating from plant sources like cashew shells, sugar cane, pea starch, and corn. In addition to factors like recyclability, recycled content, and biodegradability, designers prioritize the performance attributes of plastics when selecting materials for their projects. Notably, a key differentiation exists between thermoset plastics, which cannot be reshaped after production, and thermoplastic plastics, which can be softened and molded using heat. Acrylic is a commonly used example of a thermoplastic material with such characteristics.

- **Glass.** Various applications of glass, both as a surface material and as a component of standalone structures such as partition walls and staircases, are applied in design and construction. Different types of glass are chosen based on specific situations, and several processes are applied to alter its performance and appearance. Glass primarily consists of quartz sand that is heated to the point of fusion. The inclusion of other minerals, as specified by interior designers, introduces slight variations in their properties. While basic glass possesses transparency due to its non-crystalline nature, further modifications are made to enhance its characteristics for particular purposes. Glass is often combined with various technologies to create functional and decorative items. It has the unique property of being a solid yet non-crystalline, which grants it transparency. Glass is resistant to staining, durable against scratches, and infamous for breaking into sharp fragments when shattered. Nevertheless, the glass can become suitable for use in safety glazing applications when they are tempered or laminated. Several factors come into play when choosing glass for a design. These include: (1) The extent of light transmission, (2) Strength, (3) Energy efficiency, (4) Fire resistance. These considerations guide the selection process, ensuring that the appropriate type of glass is chosen for each specific project, taking into account its intended

function and desired attributes.

- **Metal.** Although there is an impression that metal in interior design is used as concrete bar, it also could be used as decoration, wall, furniture, etc. in a room. The factors that influence the performance of metals, stemming from their inherent properties as well as the unique attributes that emerge when metals are combined to form alloys. Fortunately, a deep understanding of metallurgy is not essential for interior designers, as the metals commonly specified are readily available and well-known. The majority of metals encountered during the search for materials for design projects are utilized as part of larger assemblies or as components within constructions. In this context, the focus is primarily on the overall performance specifications of the entire assembly. It's crucial to acknowledge that not all metal types find common usage in interior design settings. Designers simply need a sufficient amount of information about metals to assess their suitability for their intended purposes.
- **Tile.** Tiles can be crafted from various materials, with clay being the most prevalent, ranging from soft terracotta to robust porcelain. The various properties of tiles, including characteristics like rigidity and resistance to water penetration, are well-known to all designers. By comparing the sensation of touching an unglazed terra-cotta tile with that of a glazed clay tile or a glass tile, you can discern that the unglazed terra-cotta tile is more prone to getting soiled and stained. A lot of qualities that are important in the tile selection process can be sensed directly. When evaluating a tile surface for your design project, you need to consider multiple factors related to the installation, which include material composition, method of formation, quality of the surface, size, etc. It should consider a range of factors when selecting tiles for a design project, from tactile qualities to installation components, in order to make informed decisions that align with the desired aesthetic and functional outcomes.
- **Brick.** Brick, often called "burned mud," undergoes a firing process in a kiln and its original material is mud. The brick specified for construction is a specialized type of fine mud containing additional minerals, frequently including shale. Brick is commonly employed for accent walls and fireplace surrounds due to its

noncombustible nature. The rise in popularity of urban loft living has led to a distinctive design trend, where the presence of brick walls holds a pivotal role in achieving the desired aesthetic in home or hospitality design. When used as an interior surfacing material, brick necessitates careful planning due to its dimensions. It is thicker compared to most other interior surfacing materials. For new construction projects, designers can create details that account for this thickness, allowing them to specify dimensional brick (full brick). Alternatively, if dimensional brick isn't feasible for the site, veneer brick can be used. Veneer brick resembles dimensional brick in appearance but is thinner and can be applied in a manner similar to tiles. The color of brick is influenced by its composition and the conditions of firing. For instance, clay containing iron oxides (a common characteristic of clay) will result in a red color when fired in an oxidizing atmosphere and a purple hue when fired in a reducing atmosphere (with limited oxygen intake). This paragraph underscores the multifaceted considerations interior designers must weigh when selecting and working with brick as a surface material, encompassing dimensions, appearance, and firing conditions.

- **Stone.** Stones are generally known for being tough and durable materials. However, it's crucial to highlight that the attributes of stones can vary significantly from one type of stone to another. This means that not all stones share the same level of toughness and durability. Stones are typically composed of minerals, and minerals have specific melting points. Most stones are naturally occurring combinations of different minerals. However, in some cases, it's possible to find natural stones that are primarily made up of a single mineral. For example, certain basalt formations can consist of a single mineral. These formations can be melted at specific temperatures, such as 2372°F or 1300°C. When a natural stone is composed primarily of a single mineral, it can be melted and cast into new forms. This process is an efficient way to utilize the material and create new structures. This technique allows for the exploitation of the inherent characteristics of the material in innovative ways. Stones can be categorized into general groups, and they often exhibit visual characteristics that are specific to those groups. For instance: Granite tends to have a pronounced speckled texture. Marble commonly

displays veins in its appearance. Limestone generally appears smoother visually. Stones have a long history of being used as architectural materials. Although there are many materials in place of it to become the main materials of a building now, this ancient material can still reflect some characteristics and charm of the environment. And the stone buildings still exist around the world.

- **Concrete.** Concrete is described as a versatile and sustainable material. "Versatile" suggests that it can be used in a wide range of applications due to its adaptability and flexibility. "Sustainable" implies that it's environmentally friendly and has a lower negative impact compared to other materials. This combination of versatility and sustainability makes concrete an attractive choice for various uses and has led to its widespread use in interior design. It's not limited to functional or utilitarian spaces; instead, it's being used across different types of interiors. This trend is partly driven by current fashion trends, indicating that concrete is not only chosen for its practicality but also for its aesthetic appeal. Concrete is likened to a "chameleon" due to its ability to display visual variety. This means that concrete can be manipulated and designed in different ways to achieve various visual effects. It can be altered to match different styles and aesthetics, providing designers and architects with creative freedom. While there are formulations that can alter the characteristics of concrete, it's generally known for being a rigid and hard surface. It shares many qualities with stone, suggesting that its texture, durability, and appearance can resemble those of natural stone materials. This similarity with stone makes concrete suitable for applications where stone might be used but with added versatility in design.

3.1.2 Method

To find a valid tool to measure psychological opinion or attitude for this study, the Semantic Differential (SD) method, which was introduced by famous researcher Dr. Osgood, would be applied (Osgood, 1952). This method aims to quantify the subjective meanings attributed to various things or concepts by individuals. Rather than relying on vague qualitative descriptions, the SD method sought to provide a more precise and

structured way of understanding how people perceive and evaluate different items. The core idea of SD method involves using bipolar adjective pairs to capture the nuances of perception. These bipolar adjective pairs consist of pairs of adjectives that represent opposite meanings. For instance, "good" and "bad," "active" and "passive," or "strong" and "weak". Participants are asked to rate the items being studied on a scale defined by these pairs. By assigning ratings along these adjective pairs, individuals' perceptions are transformed into quantitative data. The resulting data are then used to create a semantic space where the positions of the adjectives represent the subjective meanings attributed to the items being studied. Imagine this space as a graph where each item is plotted based on its scores on different adjective pairs. This graphical representation helps to visualize and compare the perceived meanings of various items. An important feature of SD method is that it offers more than just magnitude estimation. Instead of simply assigning scores to items, the SD method provides a comprehensive picture of how individuals perceive and evaluate those items. This enables researchers to understand not only the degree of preference but also the underlying dimensions of perception that contribute to those preferences. For example, it used to evaluate participants' impressions for motions related to creativity and mood (Yamada et al., 2011) and used as the subjective indicator for evaluating comfort (Georgiev et al., 2013).

We used the SD method to investigate participants' subjective perceptions and reactions to these ten materials. The reliability of the SD method in measuring peoples' subjective attitude to interior material has been reported elsewhere. For example, to understand how decorative veneer patterns are perceived both visually and psychologically, a study investigated 28 patterns through the perspectives of 300 college students by SD method. The results shed light on how decorative veneer patterns were perceived by individuals, encompassing sensory, emotional, and evaluative dimensions (Wang & Zhang, 2015). Another study focused on analyzing the various materials commonly used in living spaces and understanding their semantic roles in shaping people's perceptions of these spaces. The SD method was employed to measure the characteristics of these materials and their impacts (Hatami Zade et al., 2022). Moreover, a study used SD method to demonstrate that exposure to wood in a working place could lead to more positive initial perceptions of the office worker across various attributes

without discrimination and highlighted the potential positive impacts of wood in office interiors on interpersonal perception (Ridoutt et al., 2002).

Regarding the adjectives in this study, a developed material attribution evaluation system, which was developed by Bhise et al. (2005), was applied to select the adjective pairs for the SD method in measuring the perception of interior material quality. The primary purpose of this previous study was to create a methodology for measuring how people perceive things. Psychophysics, a specialized area in psychology, deals with understanding how the physical traits of objects relate to the psychological responses or reactions of individuals based on how they perceive these objects. However, there was a notable absence of comprehensive studies in the public domain that systematically explore, measure, and establish connections between the physical attributes of products and various aspects of how people perceive them. The gap in research was likely due to the challenges involved in quantifying psychosomatic factors in the highly competitive consumer industry. Some existing research had already employed semantic differential scaling to gauge people's perceptions of products and then correlated these perceptions with specific physical features of the products, such as the beam patterns of headlights (Jack et al., 1995).

In this material attribution evaluation system, three classes of variables were defined. They are physical, attribute, and evaluative classes, each with multiple variables to express the material properties.

- **Physical Variables**: These are quantifiable attributes of materials that can be precisely and objectively measured through the use of specialized physical instruments and tools, allowing for accurate and data-driven assessments of various material properties, such as hardness (durometer), slipperiness (friction gauge), temperature sensation (Therma esthesiometer), and visual characteristics (photometric and colorimetric properties measured using a radiometer).
- **Attribute Variables**: It pertains to the subjective assessment of different qualities or aspects of interior materials. In this context, individuals acted as the tools for measurement, and they were tasked with evaluating their

perceptions of these materials using attribute scales. These scales were constructed by establishing pairs of opposing adjectives, with each pair serving as two endpoints on the scale. These adjective pairs provided a clear reference for participants to rate and expressed their perceptions of the materials' various attributes or dimensions. In this category adjective system, it provides an extensive compilation of attribute-based adjective pairs tailored for the nuanced evaluation of interior materials. These adjective pairs are meticulously categorized across distinct attributes that encompass visual characteristics, tactile sensations, absorption properties, acoustic attributes, and olfactory qualities. Under the category of visual characteristics, each adjective pair ingeniously contrasts facets like lightness, shininess, and glossiness. And it provides a comprehensive canvas for evaluating the visual aesthetics of interior materials. In the realm of tactile sensations, these adjective pairs afford a rich description, exploring the contrasts between sensations like smoothness, silkiness, and slipperiness. This diverse spectrum enables a thorough tactile assessment of interior materials. The absorption properties focus on differentiating between materials that are absorbent and those that are repellant, catering to an essential aspect of material performance. In the dimension of acoustic attributes, the distinction of solidness and hollowness is highlighted, providing a means to gauge the acoustic qualities of materials. Last but not least, the olfactory qualities encompass a range of sensory experiences, differentiating materials based on whether they evoke pleasant smells, and what kinds of scent they spread (woody, leathery, etc.). These olfactory descriptors allow for a holistic assessment of the sensory impact of interior materials.

- **Evaluative Variables**: It encompasses a range of factors that are essential in shaping and determining overall judgments related to desirability, preferences, or assessments of a particular subject or context. By employing these evaluative pairs, interior material evaluators can derive a multifaceted understanding of the suitability and performance of materials within the

context of interior design. For example, Under the "Quality" variable, the adjective pair "Quality-Shoddy" serves to distinguish between occupant's feelings about high-quality or low-quality materials. This is crucial in assessing the overall excellence of interior materials.

According to restoration theory, four features of a restorative environment, including 'being away', 'extent', 'fascination', and 'compatibility', were chosen based on a previous study (Kaplan & Kaplan, 1989). And several previous studies have reported the reliability of these items in measuring the restorative potential (Hartig et al., 1997; Laumann et al., 2001). According to the expounding on these four features from Herzog et al. (2003), it explained the details related to these four features.

The feature of "**being away**" as a factor of environmental setting evokes mental states different from the usual ones. It suggested that individuals can bypass the need for focused mental effort to engage with that content by steering clear of familiar mental patterns and content. As a result, when people are in these settings, their exhausted intentional focus may take a break. This concept is the fundamental explanation for the positive impact of "getting away from everything all." For individuals immersed in urban environments and preoccupied with urban-related thoughts, natural settings serve as a means to achieve this mental shift or "being away." Essentially, it's a way to recharge and find mental relief by immersing oneself in a different mental state through a change in surroundings.

The second aspect of restorative settings, which is "**extent**." In this context, extent implies the capacity of a surroundings to captivate and occupy a person's mind for an extended period, giving their directed attention a chance to relax. Settings with ample content and structure, often described as "totally different worlds," are excellent examples of those with high extent. Even smaller settings, if rich in content and structure, can offer extent. Japanese gardens are provided as an illustration of such settings. According to the theory of Attention Restoration Theory (ART) which was discussed by Kaplan (1995), Green spaces are generally well-suited in terms of providing extent. In essence, extent signifies the ability of a place to fully engage and immerse one's mind.

"**Fascination**" is the third feature mentioned in a restorative setting from the theory.

It describes the capacity of an environmental setting to capture occupant's attention with ease. A setting with fascination can hold your focus without requiring conscious effort. It allows for both mental relaxation and appreciation of the environment's aesthetics, fostering a sense of peace and well-being.

The last element of a restorative feature is "**compatibility**." The surroundings are considered compatible when it aligns well with an individual's goals or supports, encourages, or accommodates the types of activities the individual wants to engage in. While these kinds of goals or supports, encourages, or accommodates the types of activities can vary widely from general to very specific.

The concept of compatibility becomes complex as individual goals and inclinations vary widely and can be conceptualized along a continuum. On one hand, these goals may be very general, such as the desire to move freely or have clear visibility. On the other hand, they can be highly specific, like the intention to refuel a vehicle or engage in a game of basketball. The dynamic nature of human preferences and objectives adds layers of complexity, making it possible for a setting to be compatible on one level and incompatible on another. Moreover, individuals may have multiple inclinations, possibly at similar levels of specificity. In such cases, a setting could be compatible for some of these inclinations but incompatible for others. This intricacy highlights the need for a nuanced understanding of compatibility, considering the diversity and variability in individual preferences and goals.

Despite these complexities, natural settings stand out for their distinctive feature of supporting a wide range of activities that align with the inclinations of people who visit them. Natural environments, such as parks or wilderness areas, often provide a harmonious blend of opportunities for various activities, accommodating the diverse needs and inclinations of individuals seeking restoration.

Combining these explanations with material attribution, we selected adjective words for four features' evaluation from the material evaluation attribution system. Being away means the environmental contents could elicit different mental conditions from ordinary. This feature refers to the atmosphere that is posed by the environment. Therefore, we selected the adjectives that best related to the atmosphere feeling from the evaluative

variables (Ordinary–Special, Harmony–Clash). Extent means that the environmental contents are sufficient to occupy the mind. From the point of the material, this feature can be found in the appearance. We selected some adjectives from the appearance variables (Textured–Untextured, Colorful–Dull, Finished–Unfinished, Patterned–Random). Fascination is the environmental ability to hold an occupant's attention without effort. And three adjective pairs were selected for this feature (Luxury–Cheap, Pleasing–Repelling, Attractive–Unattractive). Attractive–Unattractive was the adjective that adjusted from like-dislike. Compatibility is the range of support the materials provide. We used three adjective pairs (Durable–Nondurable, Solid–Flimsy, Changeable–Unchangeable) from the physical variables to express this feature. Regarding the word of changeable-unchangeable, it is the plasticity of the material, whether it is very easy or difficult to shape it into various shapes from the material to the finished product to adapt to daily life because of the feature of compatibility. In total, all of the features and adjective pairs are shown in Table 3-1.

Table 3-1: Restorative environmental features and adjective pairs

Being away	Ordinary–Special
	Harmony–Clash
Extent	Textured–Untextured
	Colorful–Dull
	Finished–Unfinished
	Patterned–Random
Fascination	Luxury–Cheap
	Pleasing–Repelling
	Attractive–Unattractive
Compatibility	Durable–Nondurable
	Solid–Flimsy

Changeable–Unchangeable

3.1.3 Contents of questionnaire

A named “An attitude investigation to interior materials” questionnaire was created to investigate the data from participants. As the first paragraph, it was an introduction to this investigation, which contented as “this is an attitude investigation to interior materials. It used the components of restorative environment to evaluate the 10 categories of interior materials (coatings, textiles, wood, plastic, glass, metals, tile, brick, stone, and concrete). We designed 12 adjective pairs with 1-7 scales to show the level of attitude to materials. Here, 1 represents the weakest feeling about this item; and 7 represents the strongest feeling about this item. Material is an abstract term for evaluating the component of environmental restorativeness. The same material can be used for various areas and purposes, which may express different properties. You are asked to see the picture of materials and search the information on the internet about this material, rate it after getting the image of this material. Materials are in different states when they are in different designs, they may be showing in different colors and shapes. The quality of the design is not related to the evaluation of this material. Please refer to and feel it in your most ideal environment, or in what you think is the most ideal situation for this material. It may be the common consciousness of each material in your experience.”

Prior to delving into the questionnaire, participants were provided with a consent form that outlined the contents and purpose of the investigation. This form served as an important preliminary step, ensuring that participants were fully notified about the experiment's content and objectives. The consent form explicitly conveyed that participating in the questionnaire posed no risk to the respondents. It reassured them that their involvement would be entirely safe and free from any potential harm. This transparency and assurance were crucial in creating a comfortable and secure environment for participants to engage in the research process. Additionally, participants were made aware that all the data collected would be handled with the utmost care and used exclusively for the purposes of this research. This commitment to data privacy and confidentiality was a fundamental aspect of ethical research practice, and it reinforced the

trust between the researchers and the participants. Furthermore, to safeguard the autonomy and comfort of the participants throughout the experiment process, they were granted the flexibility to log out or discontinue their participation at any stage.

To get a good understanding about each adjective for each material, the meaning of each adjective was explained (Table 3-2). For the questionnaire allocation, an internet platform (https://www.wjx.cn/, Accessed from Dec. 2022–Jan. 2023) was applied.

Table 3-2: Explanation of each adjective

Ordinary–Special	In the interior, this material gives people a common feeling or a special feeling.
Harmony–Clash	Is this material well integrated into the environment and harmonious indoors, or cannot it be integrated into the environment and clashing?
Textured–Untextured	In interior design, the surface of this material often has a concave-convex texture or is smooth without concave-convex. Roughness.
Colorful–Dull	Is the color of this material bright with color or dull without any color in interior design?
Finished–Unfinished	This material appears indoors, whether it needs to be reprocessed or has been completed.
Patterned–Random	Does this material appear in interior design with its own pattern (the texture is regular) or random?
Luxury–Cheap	A sense of luxury or cheap.
Pleasing–Repelling	People feel pleased to like to be close to or feel repelled and stay away from.
Attractive–Unattractive	The finished product of this material is attractive or unattractive for you.
Durable–Nondurable	whether the material is durable and how long it will be used
Solid–Flimsy	Is the material solid and flimsy?

Changeable–Unchangeable	The plasticity of the material, whether it is very easy or difficult to shape it into various shapes to adapt to daily life.

3.2. Experimental procedures

3.2.1 Pilot test

After selection of experimental materials and designing questionnaire, a pilot test was conducted to check the experiment details. As the professional skills or knowledge of material-related were needed, 6 participants of interior design-related background (landscape design, environment design, architecture, interior design) participants who had finished the courses of “Building Material” and “Design Basic”, were recruited to attend this section, their experimental processes were summarized in Table 3-3. Because the information that participants searched from the internet included so many samples and design work that we cannot publicize it for this dissertation, therefore, we only summarized the processes to show their rationale for searching for information from the internet.

When the participant arrived at the experiment place (laboratory seminar room with a computer which connected to the internet), the explanation of experimental contents would be introduced by the host. After their evaluation, they were asked to the comments related to all processes of the experiment to help us with the quality of questionnaire. The experiment coordinator recorded their processes of how to find the information of each material from the internet to understand the material attributes for evaluation.

Table 3-3: Process of pilot test

01	Female, 30 years old, landscape design PhD student.
	1. Searched the introduction of “interior wall paint” to know the material’s attributes, usage, advantages, disadvantages, etc. from the search engine Baidu.

	2. Used the filter of Baidu image search to enter the keywords “image room of interior wall paint” to review the designed image of this material. 3. Searched the material name from the online sale platform of “Alibaba” and others to find more images and explanations about it, including customer evaluations. 4. According to the information found from the process before, searched for more detailed key sentences like “how to clean the smell of wall paint”, and “what are the impacts of interior wall paints”.
02	Female, 27 years old, environment design PhD student.
	1. Based on her own experiences, the image of material in home was directly searched from the online interior design platform, such as www.zhuangyi.com, which contains numerous design images. 2. Searched the design images of each material from different search engines or picture-serving websites, for example, Baidu image, Google images, iStock, and Flickr. 3. Searched the information related to the materials’ advantages and disadvantages from the Baidu searching engine.
03	Male, 49 years old, landscape designer & associate professor in landscape design.
	1. Searched the introduction of each material’s attributes, usage, categories, ingredients, advantages, disadvantages, etc. from the search engine of Baidu. 2. Browsed through online design magazines and publications where features of high-quality images of homes and interior spaces, for instance, “INTERIOR DESIGN+CONSTRUCTION”. 3. Checked some material’s Kansei evaluations, advantages, and disadvantages from Google Scholar. 4. Searched the design images of each material from Baidu image.

04	Male, 32 years old, architect.
	1. Accessed the Baidu Baike to find the introduction about this material, which related to the material attributes, categories, commonly used color, etc. 2. Explored virtual showrooms and exhibitions hosted by manufacturers and design events. These platforms showcased the latest materials and their applications in home design. 3. Join interior design forums and communities (Moxingyun.com) where members share their home design projects. There are images and discussions about specific materials. 4. Searched the design images of each material from Baidu image.
05	Female, 26 years old, architect.
	1. Used the filter of Baidu image search to enter the keywords of "image room of each material" to review the designed image of this material. 2. Searched all the colors and attributes of material itself from Baidu. 3. Search the material with a certain atmosphere of design image of material, like "warm design of wood", "open feeling of living room", and "relax bedroom". 4. Checking the design company website (NIKKEN) to view the different styles of design.
06	Female, 37 years old, interior designer & associate professor in interior design.
	1. Accessed Google to find the information about this material, such as material attributes, categories, and commonly used colors. 2. Accessed some textbooks related to the interior material online and checked some illustrations in some books. 3. Searched the design images of each material from Baidu image and Google image.

3.2.2 Participants

For this study, it planned to investigate the human perception to support the design of a restorative home environment. It involved several fields of knowledge that were needed, such as interior design, material, and perception investigation (research-related knowledge). According to a study of design thinking (de Souza, 2012), it showed a recognized need for designers to play a more active role in proposing information to support design decision-making. Building-related design is seen as a process of constructing and solving problems, emphasizing the importance of scientific experimentation in addressing new design challenges. And the designers have the ability to propose relevant information because they are qualified to these two conditions: 1) designers have knowledge of physics concepts relevant to their design decisions; 2) they are in a situation where they can experiment with these concepts in a design task tailored for their application. Since the professional designer possesses an understanding of pertinent concepts that may impact decisions during design process, it appears reasonable for designers to put forth their considerations for facilitating design decision-making (de Souza, 2012). To show the material properties and obtain accurate impressions when they appear in home environment, we selected participants with interior design-related majors or careers.

- First, interior design-relevant participants are experts who are familiar with the properties of each material when used in home environment. These experts possess in-depth knowledge about the properties of various materials when used in home environments. Their familiarity with the characteristics of materials allows them to make informed decisions about which materials are in the best situation for their designed ideal environmental atmosphere. This expertise ensures that the chosen materials not only meet functional requirements but also enhance the overall aesthetics and atmosphere of the space.

- Second, they are experienced in the treatments and expressions of each material from the material to a home environmental design. These experts bring valuable experience in translating materials into practical design elements within home environments. They understand how to treat and express these materials to achieve desired design outcomes. This involves considering factors such as texture, color, lighting, and arrangement to create a harmonious and visually appealing living space. Their experience enables them to seamlessly integrate materials into the overall design, ensuring that the final result of material evaluation in design is appropriate.

As the study targeted the design-background persons as the participants, the convenient sampling method was applied. The author asked his network to find the design-background participants, which involves two universities' design-related major students and some design-related company employees. The whole experiment continued for around two months, starting from December 2022, and closing on till January 2023.

In total, an impressive 85 answer sheets were collected, indicating a robust and diverse pool of responses. They were 44 female and 41 male participants with an average age of 23 (range: 19-49 years old). The demographic data are shown in Table 3-4. The participants who contributed to this dataset hailed from several interior design-related educational and professional backgrounds, including environmental design students, interior design students, and architects associated with Chinese universities or design companies. This diversity in participants not only enriched the data but also provided a multifaceted perspective on the materials being evaluated, reflecting the real-world context of interior design.

Table 3-4: Participants' demographic data

Total	85
Gender	44: female, 41: male
Age	Average: 23, range: 19-49 years old
Major	Architecture: 13, landscape design: 5, environment design: 41, interior

	design: 26

3.2.3 Flow of the experiment

During the questionnaire process, participants engaged in a comprehensive evaluation of various materials used in interior design. They were presented with pictures representing these materials and provided with relevant information sourced from the internet or drawn from their own extensive experience in the field. While answering the questionnaire, participants were asked to view the pictures and utilize information about the materials from the internet and their own professional experience to fill in the 12 adjective items they perceived about the material's properties. There were 10 materials, each with 12 adjective items to evaluate. Given the complexity of the task and the diversity of materials involved, participants dedicated approximately 60 minutes to complete the questionnaire. This timeframe allowed them to thoroughly assess and provide meaningful insights into the properties and attributes of each material, contributing to a comprehensive understanding of how these materials can be effectively utilized in interior design for a restorative home environment.

1. Firstly, participants were asked to read the introduction of the questionnaire, then, carefully checked the consent form. If the participant was willing to attend the experiment, he/she would fill it in with “Yes”. If the participant was unwilling to attend the experiment, he/she would directly quit the fill and log out the questionnaire link.
2. Secondly, participants were asked to view the material picture, check this material-related information/knowledge from the internet, and summarize all the information to get an impression to this material. They could check the material attributes, design process, design image, and everything from the internet.
3. Thirdly, the participants would utilize the information and their own experience to fill in the 12 adjective items, which could show their perceived evaluations of the material's properties.

4. Lastly, the participants would repeat the last two steps to finish all 10 materials' evaluations and submit the answers.

3.3. Statistical analysis

To systematically assess the restorativeness for all selected materials, including all four dimensions "being away," "extent," "fascination," and "compatibility," a calculated index was employed for each feature. This index was derived from the mean values of the relevant adjective items associated with each restorative feature. With a comprehensive set of 10 interior material categories at hand (encompassing interior wall paint, textile, wood, plastic, glass, metal, tile, brick, stone, and concrete), the researchers embarked on an extensive comparative analysis. A total of 45 ($C_{10}^{2} = \frac{10!}{(10-2)!2!} = \frac{10\times9}{2}$) material comparative pairs were meticulously calculated, each pair representing a distinct combination of two interior materials. This thorough examination aimed to uncover nuanced differences in the restorative properties of these materials, shedding light on their potential impact on the perception of restorativeness within interior environments. To maintain rigorous statistical integrity throughout the analysis, all tests were meticulously conducted using the widely recognized statistical software SPSS (Statistical Package for the Social Sciences). SPSS is renowned for its versatility and reliability in handling complex data analyses (https://www.ibm.com/products/spss-statistics, accessed in Feb. 2023). To ascertain the statistical significance of the findings, this study adhered to a stringent significance level, setting it at $p < 0.05$ (two-tailed). This level of significance ensures that the observed effects and differences in the data are sufficiently robust and unlikely to have occurred by chance, reinforcing the credibility of the study's outcomes and conclusions. All the statistical analysis applied this significant level as standard.

3.3.1 Normality

Before embarking on the comprehensive analysis of the distinctions among these interior materials, an important statistical step was taken to ensure the robustness and validity of the subsequent comparisons. Specifically, the normality of the data distribution

between every pair of materials was diligently assessed. To achieve this, the Kolmogorov-Smirnov test was employed, a widely recognized statistical method for assessing the normality of data distributions.

The outcome of these tests revealed that the p-values were consistently below the set stringent significance level (0.05). This key point had a significant implication: it indicated that the hypothesis of normality for the data distribution was not met for the pairs of material. As a result, this rendered the use of the paired sample T-test, a common statistical tool for analyzing variances for paired data, unsuitable in this context. Based on these results, the Wilcoxon signed-rank test was selected to analyze the matched-pair variances (Woolson, 2007) since it could ignore the condition of normality distribution to analyze the paired samples.

3.3.2 Evaluation criteria

Incorporating a more comprehensive perspective into our analysis, we extended our investigation to include additional dimensions of restorative potential. In addition to restorative potential of these 4 features, drawing from the insightful work of Laumann et al. (2001), who identified the features of compatibility and fascination could predict a self-rating aspect of preference, being away and compatibility could predict aspect of relaxation. Therefore, we added these two aspects (preference and relaxation) as supplementary indicators of restorative potential to show the difference. In total, we compared three aspects of each pair of materials:

- Preference: calculated by the total value of fascination and compatibility.
- Relaxation: calculated by the total value of being away and compatibility.
- Restorative potential: calculated by the total value of being away, extent, fascination, and compatibility.

Upon thorough analysis and interpretation of the Wilcoxon signed-rank test results, we were able to pinpoint the material pairs that exhibited statistically significant differences in terms of preference, relaxation, and overall restorative potential. By integrating these statistical findings with the descriptive data, such as means and medians,

we were able to shed light on how these interior material categories compare in the psychological opinions of our participants. This meticulous examination allowed us to unravel the potential of restorativeness for 10 mainly used material categories. It not only provides a detailed understanding of the “special” materials but also facilitates more informed decisions in interior design and material selection.

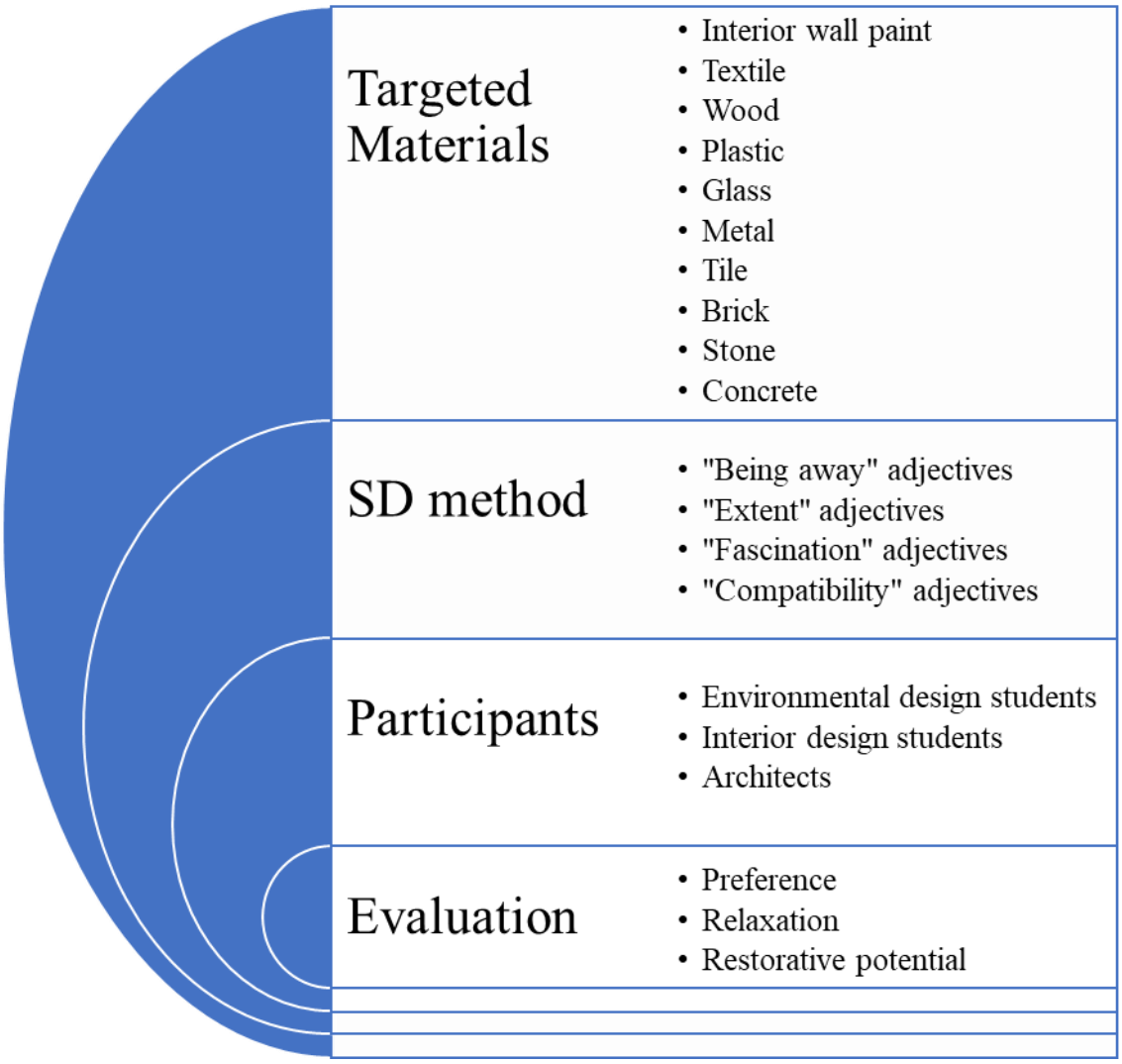


Figure 3-2: Outline of chapter 3

Chapter 4
Results of the experiments

4.1 Description results

In the context of our questionnaire, it's important to clarify the scoring system and how it relates to the restorative features we were assessing. According to the questionnaire setting of being away, the high score represents the properties of ordinary and harmony. However, for the "being away" feature, it's essential to understand that a low score in this category actually signifies that the material's design image deviates significantly from what individuals consider their ordinary environment. In other words, the lower the score, the more pronounced the "being away" feature of the material. This feature is all about creating a sense of distinctiveness and novelty, allowing individuals to mentally escape from their usual surroundings. Conversely, when evaluating the other three features—extent, fascination, and compatibility— a big value of score signifies an elevated degree of these respective attributes. In these cases, a higher score aligns with the material exhibiting a greater feature of extent, a higher feature degree of fascination, or increased feature of compatibility with the individual's inclinations.

After obtaining scores of being away, extent, fascination, and compatibility, the mean and median values were calculated to determine materials' preliminary ranks for each restorative potential feature. In the feature of being away (Table 4-1), wood and glass showed excellent scores, while metal was ranked last (score ranked from small to big). In the feature of extent (Table 4-2), the rank from best to worst was concrete, metal, stone, brick, plastic, glass, interior wall paint, wood, tile, and textile. For fascination (Table 4-3), the highest score was plastic and the lowest was wood. The compatibility feature (Table 4-4) ranked glass, plastic, textile, tile, brick, concrete, stone, interior wall paint, metal, and wood.

Table 4-1: Rank of mean and median in the feature of being away

	Being away	
	Mean	Median
Wood	2.95	3.00
Glass	3.07	3.50
Interior wall paint	3.25	3.50
Tile	3.39	3.50
Concrete	3.42	3.50
Textiles	3.48	3.50
Plastic	3.51	4.00
Stone	3.53	3.50
Brick	3.58	3.50
Metal	3.64	3.50

Table 4-2: Rank of mean and median in the feature of extent

	Extent	
	Mean	Median
Concrete	4.48	4.25
Metal	4.18	4.00
Stone	4.04	4.00
Brick	3.92	4.00
Plastic	3.92	4.00
Glass	3.84	4.00
Interior wall paint	3.83	4.00
Wood	3.66	3.75
Tile	3.54	3.75
Textiles	3.45	3.75

Table 4-3: Rank of mean and median in the feature of fascination

	Fascination	
	Mean	Median
Plastic	4.24	4.33
Brick	4.20	4.33
Concrete	4.18	4.33
Metal	3.79	4.00
Stone	3.73	4.00
Tile	3.65	4.00
Glass	3.47	3.67
Interior wall paint	3.35	3.67
Textiles	3.29	3.33
Wood	3.10	3.33

Table 4-4: Rank of mean and median in the feature of compatibility

	Compatibility	
	Mean	Median
Glass	3.90	3.67
Plastic	3.75	4.00
Textiles	3.70	4.00
Tile	3.39	3.67
Brick	3.39	3.33
Concrete	3.27	3.33
Stone	3.18	3.33
Interior wall paint	3.05	3.00
Metal	3.03	3.00
Wood	2.94	3.00

4.2 Verification of the results

The results of the Wilcoxon signed-rank test have yielded the comparative performance of various material pairs across the four restorative features. From the results of the Wilcoxon signed-rank test, the details of two materials with statistically significant differences could be obtained based on p-values. We calculated four features of 45 material pairs and summarized the results in Table 4-5. Table cells with bold font of Z-value and an asterisk (*) indicate statistically significant differences between the material pairs. These differences are essential because they highlight which materials excel in specific restorative features compared to others.

Table 4-5: The Wilcoxon signed-rank test results of material pairs

		Textiles	**Wood**	**Plastic**	**Glass**	**Metal**
Interior wall paint	Being away	-1.32	**-2.29***	-1.60	-1.35	**-2.55***
	Extent	**-2.75***	-1.48	-0.61	-0.04	**-2.78***
	Fascination	-0.40	-1.72	**-5.83***	-1.40	**-3.30***
	Compatibility	**-4.32***	-0.77	**-4.36***	**-5.03***	-0.09
Textiles	Being away		**-3.59***	-0.25	**-2.40***	-0.96
	Extent		-1.48	**-3.11***	**-2.95***	**-4.35***
	Fascination		**-2.02***	**-6.19***	-1.73	**-3.65***
	Compatibility		**-5.64***	-0.38	-1.32	**-4.34***
Wood	Being away			**-4.38***	-1.21	**-4.77***
	Extent			**-2.29***	-1.78	**-3.76***
	Fascination			**-6.88***	**-3.81***	**-5.23***
	Compatibility			**-5.49***	**-6.18***	**-0.81**
Plastic	Being away				**-2.75***	-0.83
	Extent				-0.81	**-2.32***
	Fascination				**-5.36***	**-4.02***

	Compatibility		**-0.78**	**-4.68***
Glass	Being away			**-4.13***
	Extent			**-2.81***
	Fascination			**-2.54***
	Compatibility			**-5.48***
Metal	Being away			
	Extent			
	Fascination			
	Compatibility			
Tile	Being away			
	Extent			
	Fascination			
	Compatibility			
Brick	Being away			
	Extent			
	Fascination			
	Compatibility			
Stone	Being away			
	Extent			
	Fascination			
	Compatibility			

Table 4-5 (continued)

		Tile	Brick	Stone	Concrete
Interior wall paint	Being away	-1.18	**-2.23***	-1.69	-1.10
	Extent	**-2.74***	-0.61	-0.88	**-4.69***
	Fascination	**-3.08***	**-5.78***	**-2.97***	**-5.14***
	Compatibility	**-2.48***	**-2.27***	-1.14	-1.44
Textiles	Being away	-0.59	-0.78	-0.23	-0.40
	Extent	-0.96	**-3.57***	**-3.87***	**-5.41***
	Fascination	**-3.28***	**-5.72***	**-3.53***	**-5.50***
	Compatibility	**-2.66***	**-2.92***	**-3.46***	**-2.74***
Wood	Being away	**-4.16***	**-4.80***	**-3.83***	**-3.22***
	Extent	-1.21	**-2.72***	**-3.03***	**-5.64***
	Fascination	**-4.70***	**-6.55***	**-5.40***	**-6.25***
	Compatibility	**-3.72***	**-3.38***	**-2.29***	**-2.18***
Plastic	Being away	-1.26	-0.69	0.00	-0.86
	Extent	**-3.42***	-0.03	-1.09	**-4.42***
	Fascination	**-4.62***	-0.45	**-3.97***	-1.03
	Compatibility	**-2.66***	**-2.63***	**-4.08***	**-3.16***
Glass	Being away	**-2.59***	**-3.83***	**-2.47***	**-2.42***
	Extent	**-3.06***	-0.82	**-1.99***	**-5.33***
	Fascination	-1.63	**-5.31***	**-2.55***	**-5.81***
	Compatibility	**-4.47***	**-3.54***	**-5.04***	**-4.11***
Metal	Being away	**-2.14***	-0.36	-1.01	**-2.10***
	Extent	**-4.46***	-1.77	-0.95	**-2.45***
	Fascination	-1.23	**-3.63***	-0.24	**-3.95***
	Compatibility	**-3.28***	**-3.37***	-1.58	**-2.36***
Tile	Being away		**-2.18***	-0.86	-0.01

	Extent		**-3.02***	**-3.81***	**-5.98***
	Fascination		**-4.45***	-0.55	**-4.11***
	Compatibility		-0.23	**-2.05***	-1.27
Brick	Being away			-0.67	-1.84
	Extent			-0.95	**-4.11***
	Fascination			**-3.85***	-0.56
	Compatibility			**-2.03***	-0.89
Stone	Being away				-0.54
	Extent				**-3.76***
	Fascination				**-4.02***
	Compatibility				-0.85

*$p < 0.05$.

The results described the materials that indicate statistically significant differences for each of the four restorative features:

Being Away:

- Interior wall paint: Statistically significant difference with wood, metal, and brick.
- Textiles: Statistically significant difference with wood, and glass.
- Wood: Statistically significant difference with plastic, metal, tile, brick, stone, and concrete.
- Plastic: Statistically significant difference with glass.
- Glass: Statistically significant difference with metal, tile, brick, stone, and concrete.
- Metal: Statistically significant difference with tile and concrete.
- Tile: Statistically significant difference with brick.

Extent:

- Interior wall paint: Statistically significant difference with textile, metal, tile, and concrete.
- Textiles: Statistically significant difference with plastic, glass, metal, brick, stone, and concrete.
- Wood: Statistically significant difference with plastic, metal, brick, stone, and concrete.
- Plastic: Statistically significant difference with metal, tile, and concrete.
- Glass: Statistically significant difference with metal, tile, stone, and concrete.
- Metal: Statistically significant difference with tile and concrete.
- Tile: Statistically significant difference with brick, stone, and concrete.
- Brick: Statistically significant difference with concrete.
- Stone: Statistically significant difference with concrete.

Fascination:

- Interior wall paint: Statistically significant difference with plastic, metal, tile, brick, stone, and concrete.
- Textiles: Statistically significant difference with wood, plastic, metal, tile, brick, stone, and concrete.
- Wood: Statistically significant difference with plastic, glass, metal, tile, brick, stone, and concrete.
- Plastic: Statistically significant difference with glass, metal, tile, and stone.
- Glass: Statistically significant difference with metal, brick, stone, and concrete.
- Metal: Statistically significant difference with brick and concrete.
- Tile: Statistically significant difference with brick and concrete.
- Brick: Statistically significant difference with stone.

- Stone: Statistically significant difference with concrete.

Compatibility:

- Interior wall paint: Statistically significant difference with textile, plastic, glass, tile, and brick.
- Textiles: Statistically significant difference with wood, metal, tile, brick, stone, and concrete.
- Wood: Statistically significant difference with plastic, glass, tile, brick, stone, and concrete.
- Plastic: Statistically significant difference with glass, metal, tile, brick, stone, and concrete.
- Glass: Statistically significant difference with metal, tile, brick, stone, and concrete.
- Metal: Statistically significant difference with tile, brick, and concrete.
- Tile: Statistically significant difference with stone.
- Brick: Statistically significant difference with stone.

Combining the mean values of each material and the results of the Wilcoxon signed-rank test, we found statistical comparison rank relationship in restorative potential features of each material pair. This comprehensive analysis allowed us to elucidate the unique characteristics of each material in relation to relaxation, preference, and overall restorative potential. By summarizing these results, we were able to establish clear ranking relationships among the materials, shedding light on their relative performance in creating restorative environment (Table 4-6).

Relaxation:

Glass had a better level than tile, brick, stone, concrete, and metal, and metal had a lower level than tile. In addition, the score of concrete was better than metal.

Preference:

The score of plastic was better than metal, tile, interior wall paint, stone, and wood.

The score of brick was better than interior wall paint, metal, stone, and wood. The level of wood was lower than plastic, stone, glass, tile, brick, concrete, and textile. While other ranks also indicated, score of tile was better than interior wall paint, score of stone was better than wood. Moreover, it also indicated the level of metal was lower than plastic, brick, and concrete.

Restorative potential:

The score of concrete was better than metal.

Table 4-6: Ranking relationships of interior materials which have statistical difference

Relaxation (Being away, compatibility)	Glass > Tile > Metal Glass > Brick Glass > Stone Glass > Concrete	Concrete > Metal
Preference (Fascination, compatibility)	Plastic > Metal Plastic > Tile > Interior wall paint Plastic > Stone > Wood Brick > Interior wall paint Brick > Metal Brick > Stone	Glass > Wood Tile > Wood Brick > Wood Concrete > Wood Textile > Wood Concrete > Metal
Restorative potential	Concrete > Metal	

Desciption — Rank of mean and median

- **Being away**: Wood, Glass, Interior wall paint, Tile, Concrete, Textiles, Plastic, Stone, Brick, Metal.
- **Extent**: Concrete, Metal, Stone, Brick, Plastic, Glass, Interior wall paint, Wood, Tile, Textiles.
- **Fascination**: Plastic, Brick, Concrete, Metal, Stone, Tile, Glass, Interior wall paint, Textiles, Wood.
- **Compatibility**: Glass, Plastic, Textiles, Tile, Brick, Concrete, Stone, Interior wall paint, Metal, Wood

Comparison — Wilcoxon signed-rank test

• Material pairs that indicate statistically significant differences for each of the four restorative features were obtained.

Results — Rank in restorative potential

• **Relaxation**: Glass > tile, brick, stone, concrete, metal.

• **Preference**: Plastic > metal, tile, interior wall paint, stone, wood.

Brick > interior wall paint, metal, stone, wood.

Wood < plastic, stone, glass, tile, brick, concrete, textile.

Metal < plastic, brick, concrete.

• **Restorative potential**: Concrete > Metal

Figure 4-1: Outline of chapter 4

Chapter 5
Discussions

Based on the data summarizing results, this investigation had several significant points that led to discussion of implications, such as glass, wood, and metal, which may make contributions to the research topic of restorative environment for interior design. They may help designers (interior designer, architect, or environment designer) to create a restorative home environment.

5.1 Glass

Expanding upon the outcomes of the study, the data revealed some compelling insights. Notably, glass emerged as the frontrunner, demonstrating statistically superior attributes when it came to inducing relaxation. In fact, glass outperformed tile, brick, stone, concrete, and metal materials significantly in this regard. This was underscored by its exceptional "being away" feature, which contributed to its top-notch ranking in terms of relaxation. Moreover, glass exhibited remarkable compatibility, achieving the highest score in this dimension. In the realm of preference, while glass didn't statistically surpass all materials, it notably stood out by surpassing wood. Importantly, it didn't lag significantly behind any other materials in terms of preference and restorative potential. This compelling data highlighted that the glass material indeed presents a positive profile for fostering restorativeness, positioning it as a promising choice for interior design that prioritizes the well-being and preferences of occupants comparing other main materials in interior design.

5.1.1 Glass in interior design

Actually, the material of glass is related to many environmental components in our daily lives (Rajaramakrishna & Kaewkhao, 2019). Glass, a material with a rich history, plays a pivotal role in various contemporary technologies. It has emerged as a transformative material in modern interior design, offering a unique blend of versatility, transparency, and adaptability. From its traditional use in windows and doors to

innovative applications like smart glasses, glass has redefined the boundaries of interior design. The glass has already found a multifaceted role in interior design, emphasizing its diverse applications and eco-friendly attributes.

- **Versatility**. The primary feature that sets glass apart as a material in interior design is its remarkable versatility. Designers are often attracted to glass because of its unique capacity to assume different shapes and conform to diverse design styles. Glass is incredibly flexible and can be manipulated, molded, and crafted to align with the creative concepts and visions of interior designers. This remarkable adaptability renders it well-suited for an extensive array of applications, ranging from practical and functional elements such as windows (Figure 5-1) and doors to more artistic and visually striking uses, like decorative displays and architectural features. In essence, glass offers designers an open source, allowing them to explore their creativity while simultaneously fulfilling both utilitarian and aesthetic design requirements in a variety of interior spaces.
- **Key products**. Within the glass industry, several key products stand out for their importance in interior design. Container glass and flat glass are among the most prominent. Container glass finds its place in everyday items such as glass bottles for decoration (Figure 5-2). In contrast, flat glass is employed in window panels, glass chandeliers, glass doors, and wide-neck jars.
- **Cost-Effectiveness and Eco-Friendliness**. Glass is favored in interior design for its cost-effectiveness, eco-friendly nature, and recyclability. It aligns with the growing emphasis on sustainable design practices. Glass is a material that can be used with a clear conscience, as it is not only aesthetically pleasing but also environmentally responsible. Its recyclability reduces waste and promotes the efficient use of resources, making it an attractive choice for interior designers who prioritize sustainability.

Figure 5-1: Glass windows for sunroom

Note:

Picture source: https://flic.kr/p/88AwiQ (Accessed on Oct. 25, 2023)

Picture credit: Clarkston SCAMP on Flickr

License type: Attribution (CC BY 2.0)

Figure 5-2: Glass decoration

Note:

Picture source: https://flic.kr/p/Npij99 (Accessed on Oct. 25, 2023)

Picture credit: Bennilover on Flickr

License type: Attribution-NoDerivs (CC BY-ND 2.0)

5.1.2 Glass and restorative effects

Recent evidence suggested a compelling connection between glass and restorative effects within interior spaces. This phenomenon underscored the vital role glass plays in promoting occupants' satisfaction, psychological well-being, and cognitive restoration. For example, one compelling facet of glass's restorative potential is its ability of

transparency to offer residents a glimpse of nature's beauty (Kaplan, 2001). Having a window view of nature significantly enhances apartment residents' overall satisfaction and well-being. This connection to the outdoors, facilitated by the transparency of glass, infuses interior spaces with the soothing presence of nature, promoting relaxation and contentment; In densely populated urban environments, glass windows that open up to the sky serve as more than architectural features and become instruments of attention restoration (Masoudinejad & Hartig, 2020). Residents in such settings can seek refuge from the urban commotion, discovering tranquility in the calm openness of the sky visible through their windowpanes.

Additionally, the advantages of glass in interior design extend beyond visual access to the external environment. Glass windows provide a conduit for natural daylight to permeate indoor spaces. In the case of daylight, often regarded as the finest source of illumination, is intrinsically linked to the psychophysiological well-being of occupants (Mahmoud et al., 2023). However, it facilitated by glass, not only illuminates rooms but also invigorates the mental and emotional states of those within.

5.1.3 Glass and other advantages

Glass, with its transcendent features, has left an indelible mark on the world of architecture and interior design. It is not just a construction material; it is a statement of elegance and an embodiment of modernity. Several studies underscore the high aesthetic impacts of glass in architectural and interior applications, revealing its power to captivate and elevate human experience. Hefnawy (2022) illuminated the profound aesthetic impact of glass materials. It has been widely acknowledged that glass possesses a unique allure, capable of transforming ordinary spaces into captivating environments. Its sleek, transparent appearance, combined with the interplay of light and reflections, adds a touch of timeless sophistication to any structure. The building industry has discussed glass as an attractive building material (Gulnick, 2019) and structure (Deriu, 2018) that has been used daily for decades. An intriguing facet of glass's aesthetic impact emerges from the facial micro-reaction analysis found that participants felt positive when facing glass structures of walls, facades, and roofs (Bedon & Mattei, 2021).

Glass structures in modern architecture have always intrigued and divided opinions. They evoke both awe and apprehension, pushing the boundaries of design and challenging our perceptions of space and height. While some associate glass structures with vertigo-inducing sensations, others actively seek out these designs as sources of exhilaration and inspiration. This duality in the perception of glass structures highlights their unique and complex nature in the architectural world. Although glass structures are sometimes connected with an image of building vertigo because of their properties and the rise of high-rise buildings (Butt, 2018), plenty of places actively produced a desire to experience the building of vertigo (Deriu, 2018). Many individuals actively seek experiences that elicit this sensation (Figure 5-3). It is a testament to the allure of glass structures that people are drawn to spaces and buildings that challenge their sense of balance and perspective. These spaces offer a unique opportunity to confront and embrace the exhilarating feeling of height and transparency.

Moreover, the quest for comfort within glass environments has also been a subject of exploration (Bedon, 2022). It had discussed various criteria for designing glass spaces that prioritize comfort and illuminated the potential of glass to create environments that are not only visually stunning but also conducive to well-being. In Bedon (2022)'s study, it described the significance of pilot experiments conducted to study the relationship between human comfort and the traditional mechanical aspects used in the design of structural glass. The preliminary experiments introduced had highlighted the necessity for extensive datasets, which could encompass a wide range of measurements. The aim was to understand and establish connections between human comfort preferences and the classical mechanical parameters that are typically considered in the design of glass structures. In essence, these pilot experiments served as a starting point for more comprehensive investigations, helping to bridge the gap between the human experience and the mechanical aspects of structural glass design.

Figure 5-3: Glass and building vertigo

Note:

Picture source: https://flic.kr/p/Hkxueb (Accessed on Oct. 28, 2023)

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5.2 Wood

The secondary finding of this study was that wood might not be the best material for restorative potential in a home environment. From the aspect of preference, wood scored less than plastic, stone, glass, tile, brick, concrete, and textile. Although wood received the best score in the feature of being away, the scores of extent, fascination, and compatibility were not good.

This was in contrast with some previous studies. For example, Watchman et al. (2017) found that a wood room often conveys the impression of bright, pleasant, and warm compared with a no-wood room. Sakuragawa et al. (2005) delved into the connection between wooden walls and our innate affinity for nature. Their findings suggested that incorporating wooden elements into interior spaces can serve as a bridge, connecting occupants to the natural world. Wood's organic qualities, which might evoke images of forests and the great outdoors, could instill a sense of tranquility and a deeper connection to the environment. This connection to nature is a theme that resonates with many, as it offers a respite from the hustle and bustle of urban living.

Based on the positive result of wood from previous study that mentioned before, hypothesis 1 that the wood material may rank a better restorative potential among all the interior materials was set. However, the wood material of comparison results rejected this hypothesis. The reason could be explained by the following description that we found the weakness of wood material when it is used in home environment.

5.2.1 Weakness of wood material

Although the allure of wood in interior design is undeniable, as it brings warmth and a connection to nature. However, this enchanting material also presents a complex set of challenges and potential negative impacts that must be carefully considered in its application:

- **Health Risks**: emitting volatile organic compounds (VOCs). Alapieti et al. (2020) have cast a spotlight on the less glamorous aspects of wood-related topics. One significant concern lies in the emission of VOCs, formaldehyde,

and acrolein from certain wood products. These emissions can have adverse health effects on indoor occupants. VOCs, in particular, are known to contribute to indoor air pollution and can cause a series of physical health risks, for example, breathing-related diseases and allergens. The need for proper ventilation and the use of low-VOC wood finishes are strategies employed to mitigate these risks. Thus, while wood may bring a sense of natural beauty, it also demands responsible handling and product selection to ensure the health of those who inhabit the space.

- **Weathering and Hygroscopic Challenges**: Feist (1983) emphasized another aspect of wood's complexity: its susceptibility to weathering (Figure 5-4). Wood, when exposed to the elements, can undergo various forms of deterioration, such as warping, rot, and decay. This poses challenges when wood is used in exterior applications, where it must withstand rain, sun, and temperature fluctuations. Protective coatings and regular maintenance are vital in preserving the integrity and aesthetic appeal of wood surfaces outdoors. Furthermore, Brischke and Alfredsen (2020) shed light on the hygroscopic nature of wood (Figure 5-5)— a quality that makes it prone to absorbing and releasing moisture based on environmental conditions. This dynamic behavior can lead to dimensional changes, affecting the stability and structural integrity of wood components. In interior settings with fluctuating humidity levels, such as bathrooms or kitchens, managing wood's hygroscopic properties becomes crucial to prevent issues like warping, cracking, or mold growth.

These weaknesses may be the reasons that Strobel et al. (2017) noted the challenge of maintaining interior wood materials is a recurring concern in their study. Wood demands ongoing care to preserve its appearance and structural integrity. Neglecting this maintenance can lead to issues such as warping, discoloration, and degradation of the material. As a result, the perceived difficulty of wood upkeep has deterred some from embracing it in interior design.

Figure 5-4: Weathered wood

Note:

Picture source: https://flic.kr/p/2a9MP8A (Accessed on Oct. 28, 2023)

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Figure 5-5: Hygroscopic nature of wood

Note:

Picture source: https://flic.kr/p/qVzfHL (Accessed on Oct. 28, 2023)

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5.2.2 Diverse Factors Shaping Wood Design

Song et al. (2016) brought attention to the multifaceted nature of wood design and preferences. Their study demonstrated that different genders, cultural backgrounds, and individual perspectives can significantly influence the use of wood in interior design. This suggests that wood's application is not a one-size-fits-all approach. Instead, it may be

driven by a multitude of criteria, including personal preferences, cultural significance, and even gender-specific inclinations. Understanding and accommodating these diverse factors is essential for creating interior spaces that resonate with occupants.

Moreover, a comprehensive review of interior wood materials was conducted and raised thought-provoking questions (Burnard & Kutnar, 2015). They pointed out that while wood is often associated with restorative effects, the specifics of wood types and attributes that truly contribute to these effects remain uncertain. What makes one wood species more conducive to creating a restorative environment than another? Are there particular features of wood, such as grain patterns or colors, that play a pivotal role in enhancing well-being? More restorative environmental tests with strong wooden material designs and specific criteria are needed to discuss this gap. These kinds of reasons may also influence the wood material's adoption and the extent to which it can contribute to restorative effects in interior design.

In summary, the utilization of wood in interior design is a nuanced endeavor. Health risks, maintenance challenges, and diverse factors influencing design choices all contribute to the complexity of this material's use. It is clear that a deeper exploration of wood's attributes and their impact on restorative environments is needed. Further research and environmental testing, incorporating well-designed wood categories and specific criteria, are essential to fill this knowledge gap. Only through such investigations can we unlock the full potential of wood as a transformative element in interior spaces, bridging the gap between wood material and well-being.

5.3 Metal

From the relaxation aspect, metal had the worst mean score and was statistically less than glass, tile, and concrete. Moreover, its score was less than plastic, brick, and concrete in preference. Furthermore, metal was worse than concrete in all features of restorative potential, it received the worst score in being away and a low score in compatibility. The image of metal in interior design appears to evoke consistent perceptions across various studies, aligning with previous findings that shed light on the emotional and

psychological associations linked to this material.

These results strongly supported the hypothesis that this study set for metal material (H2), suggesting that the material of metal indeed conveys negative effects on restorativeness and ranks low in restorative potential among all interior materials. While metal is a commonly used material in the home environment, its low potential of restorativeness should not be overlooked. The impacts of metal on psychology indicated its implications and they are shown in the following.

5.3.1 Impacts of metal on psychology

Metal tends to convey images of being unhealthy, closed, and even depressed, which is consistent with prior research completed by Sakuragawa et al. (2005). Their study suggested that certain forms of metal, particularly white steel, are often associated with unfavorable attributes, including a sense of unhealthiness and an environment that feels closed off and gloomy. Another study's observation that stimuli from metal materials could evoke a stress response and create an impression of coldness, hardness, and artificiality resonates with the results of a stress reaction (Koga & Iwasaki, 2013). Their research revealed that exposure to metal elements had a notable impact on participants' stress levels. This suggests that metal-rich interior environments may induce a physiological stress response in occupants, which could, in turn, affect their overall well-being and comfort.

Metal materials in interior design not only impact the psychological and emotional experiences of occupants but also play a role in shaping consumer perceptions and preferences. A study has revealed metal packs could convey an image of a lower price to change the consumer’s perception of willingness to buy (Maleki et al., 2020). These may be why a finding from building materials’ visual and tactile evaluation showed that steel’s sensory descriptions and expressive meanings are cold, industrial, and unpleasant (Wastiels et al., 2013). These sensory associations with steel materials have implications for the overall ambiance and user experience within spaces where steel is prevalent. Therefore, the metal was described as “while simplicity, solitude, and stress-induced demonstrated the tangle of metal that can affect the application and achievement of

desired living space" from a semantic investigation of metal (Hatami Zade et al., 2022).

5.3.2 Implications of using metal

These consistent findings underscore the significance of carefully considering the choice and placement of metal materials in interior design. While metal has its advantages, such as enhancing the visual appeal through its reflective properties (Alfadda, 2016) and durability, its potential to create an atmosphere that is perceived as cold, hard, and stressful should not be underestimated. Designers and architects should be cognizant of these psychological associations. The image of metal in interior design appears to be characterized by recurring themes of negativity, including associations with closed and depressive spaces. Moreover, physiological responses such as stress can be triggered by metal-rich environments. These insights underscore the importance of considering not only the physical attributes but also the emotional and psychological implications of metal materials in interior design, with the goal of creating spaces for restorativeness.

5.4 Brick

According to ranking relationships among all the materials, it could be found that the score of brick was better than interior wall paint, metal, stone, and wood in the terms of preference. Although it ranked lower than the glass in terms of relaxation, its ranks were second place in the feather of fascination and middle place in the feathers of extent and compatibility. Some advantages related to feathers of restorative potential were found in the results.

Hatami Zade et al. (2022) found that drawing attention to the material of living space, the emotional and sensory impacts of brick as a building material in various settings had been discussed. Through their research, valuable insights into the way people perceive brick within the realm of buildings and indoors were collected. It highlighted how brick has the remarkable ability to evoke feelings of warmth, comfort, and nostalgia. According

to interview contents based on grounded theory, some emotional and sensory adjectives were mentioned in their research related to brick.

- Invitation: Brick was described as inviting, suggesting that it draws people in and encourages exploration.
- Tranquility: Being around brick was said to create a sense of calm and serenity, making it an ideal choice for creating peaceful spaces.
- Warmth: Brick, especially when used near a fireplace (Figure 5-6), was described its associations with physical warmth and a cozy, homely atmosphere.

Figure 5-6: Brick and fireplace

Note:

Picture source: https://flic.kr/p/24jhAeM (Accessed on Oct. 30, 2023)

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- Tactile Experience: Some participants highlighted the tactile nature of brick, emphasizing how it invites people to touch and interact with it.
- Nostalgia and Tradition: Brick's rough texture and opacity evoke feelings of nostalgia and tradition, grounding spaces with a sense of history.
- Strength and Durability: Brick is seen as a symbol of strength and durability, providing a solid foundation for interaction and relaxation.
- Eco-Friendly: In industrial structures, brick is recognized as an eco-friendly choice that seamlessly integrates with natural elements.
- Motivation and Inspiration: Brick serves as a motivator, inspiring people with its timeless beauty and unique character.

Ultimately, brick is more than just a building material; it may be a catalyst for emotion. It may motivate and inspire, drawing us closer to its extraordinary features. It is a material that not only withstands the test of time but also transforms spaces, infusing them with its unique blend of nostalgia, strength, and tranquility. Brick, in all its rugged elegance, is a true cornerstone of architectural and emotional design. While the study conducted by Hatami Zade et al. (2022) presented a constructive understanding into the emotional and sensory impacts of brick as a building material, it's important to acknowledge that these insights were based on subjective descriptions from individual participants. While such qualitative data is incredibly valuable, there remains a need for more accurate and robust evidence, both subjective and objective, to comprehensively understand the emotional reactions people have to brick in various architectural and interior design contexts.

To fill this gap, future research endeavors should aim to combine subjective responses with objective data collection methods. Objective data could include physiological measurements which can provide quantifiable insights into emotional

responses. Additionally, advanced technologies like eye-tracking devices can help monitor where individuals focus their attention when exposed to brick environments.

By integrating both subjective and objective data, researchers can acquire a deeper and more intricate comprehension of how brick impacts emotions and sensory experiences. This multifaceted approach would not only provide a deeper insight into the emotional reactions to brick but also offer a more scientifically rigorous foundation for architects and designers to make informed decisions when incorporating brick into their projects.

5.5 Limitations, strengths, and future studies

5.5.1 Limitations

The study discussed herein, while providing valuable insights into the perceptions and reactions of individuals towards various interior materials, is not without its limitations, which should be considered for a more comprehensive understanding of the findings.

- Firstly, the study's focus was on materials themselves rather than their specific applications in design. This could pose challenges in accurately capturing participants' impressions, as translating a material into a design concept can be subjective and context-dependent. Furthermore, while the participants were related to interior design, including students, the diversity in their design experiences might have influenced their perceptions differently.
- Secondly, the study was conducted in China, and the design styles and preferences can vary significantly across different regions and cultures globally. The findings may be reflective of the design styles prevalent in China but might not be universally applicable. This regional specificity can limit the generalizability of the results to a broader international context. Additionally, relying on participants to search for material information online introduces the possibility of bias based on the search results they

encounter.

- Thirdly, increasing the number of participants could have provided more transparent and robust results. And the participant group was only the design-related background, it might lead to bias from the perceptions of designer group. A more extensive and varied sample might have allowed for a broader range of perspectives and more statistically significant findings.
- Lastly, while the study explored participants' responses and attitudes toward indoor materials, it did not delve into a detailed analysis of each material, leaving room for future research to explore this aspect more comprehensively. The detailed restorative potential of interior wall paint, textile, plastic, tile, brick, stone, and concrete could not be found.

Based on the last limitation, the results only found some significant differences for 3 main materials (glass, wood, metal), statistical differences between the rest materials were not found. Therefore, the material groups of nature and artificial couldn't be discussed from the results (H3). Future studies can follow this direction to do some comparison experiments to discuss these two materials' relationships. In the realm of design and construction, the choice between natural and artificial materials is a decision that significantly shapes the form, function, and environmental impact of a structure. While both natural and artificial materials have their own attributes, the choice between natural and artificial materials in design is a nuanced decision that requires a thoughtful evaluation of various criteria, such as environmental impact, cultural context, and functional requirements. Designers should carefully consider their complex situations.

5.5.2 Strengths

Despite the noted limitations, this study's strengths lie in its attempt to delve into the restorative effects of commonly used interior materials, particularly within the context of professional interior design. By engaging with a sample of individuals well-versed in interior design, the research offered a unique perspective on how these materials impact the restorative potential of a space.

One of the study's commendable aspects is its comparative approach, pitting various interior materials against each other in terms of their restorative potential. This comparative analysis not only sheds light on the materials that excel in this aspect but also highlights opportunities for enhancing residential interior design through material selection. Such insights can prove invaluable to interior designers and homeowners alike, as they seek to create environments that promote well-being and restoration.

The findings of this study hold promise for providing guidelines to those involved in the design of homes and interior spaces. With a clearer understanding of how different materials impact individuals' restorative experiences, designers can make informed choices that align with the desired emotional and sensory outcomes of a space. This could lead to the creation of living environments that better support occupants' well-being and relaxation from the aspect of restorativeness.

Furthermore, this study underscored the importance of considering emotional reactions to materials in the topic of environmental design. Emotions act a significant function in how individuals perceive and interact with their surroundings, and acknowledging these factors can lead to more human-centric and emotionally engaging designs.

5.5.3 Future studies

Future research endeavors in this field hold the potential to provide even deeper insights into the restorative potential of interior materials. One avenue for such studies could involve narrowing the scope to focus on one or two material comparisons in more intricate detail. For instance, delving into the realm of wooden interior design with a more specific analysis of various wood categories or attributes could yield valuable findings (e.g., comparison of wood material color, a light color of wood material design (Figure 5-7) and a Dark brown color of wood material design (Figure 5-8)). By honing in on the unique qualities of different woods, researchers can better understand how specific wooden materials contribute to the restorative qualities of a home environment.

Figure 5-7: Light color of wood material design

Note:

Picture source: https://flic.kr/p/f2jv6A (Accessed on Oct. 30, 2023)

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Moreover, building on the intriguing results that suggest emotional associations with certain materials, such as brick evoking nostalgia, traditionality, and warmth (Hatami Zade et al., 2022), and some textile materials showed smoothness, softness, and elegance (Kim & Na, 2009), there is a rich landscape to explore. Future investigations could delve deeper into the emotional reactions elicited by materials like brick or textiles and compare these reactions to those triggered by other materials. Such studies would serve to elucidate the precise emotional and sensory impacts of these materials, thereby allowing for a more nuanced understanding of their potential in creating restorative home environments.

Figure 5-8: Dark brown color of wood material design

Note:

Picture source: https://flic.kr/p/af7zuD (Accessed on Oct. 30, 2023)

Picture credit: Sherwood CC on Flickr

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Although some topics and directions were described for future studies, the combination of both subjective and objective data is needed when verifying perception of environmental effects. Such as some physiological measurements (skin conductance, salivary alpha-amylase, heart rate, blood pressure). Additionally, advanced technologies like eye-tracking devices can help monitor where individuals focus their attention when exposed to an environment. Collecting data through systematic and unbiased methods ensures the accuracy and precision of environmental assessments. It allows researchers to draw informed conclusions about the state of the environment or the design.

By refining the focus of future research and delving into the intricacies of specific

materials, the field of interior design can continue to advance its understanding of how material selection can profoundly affect the restorative experiences of individuals within their living spaces. These insights can not only inform design practices but also contribute to the creation of living environments that truly enhance psychological health and quality of life.

Chapter 6
Conclusion

According to the data results and discussion in this study, they shed light on the significant role that interior materials play in shaping the restorativeness of a home environment. This study stands as one of the pioneering endeavors that delved into the profound impact of interior materials on restorative potential. It's worth noting that this investigation uniquely engaged a cohort of interior-design-relevant participants, ensuring a specialized perspective on the subject matter. In doing so, we have contributed valuable insights to the field, shedding light on the intricate relationship between interior materials and their ability to facilitate restoration and well-being within Chinese interior design settings. The findings from this research carry significant implications for interior design practices, emphasizing the importance of material selection in creating environments that promote restorativeness.

- Notably, glass material emerged as a strong candidate for enhancing the restorative qualities of living spaces. This insight is of particular value to restorative environmental designers who aim to create homes that promote well-being and relaxation. Designers and architects can now consider incorporating more glass elements into their designs, leveraging the positive effects associated with this material.
- While the result pointed to the restorative potential of wood materials, it also underscored the need for more in-depth discussions and considerations regarding specific wood categories and designs. This suggests that designers should be selective in their use of wood, taking into account the unique attributes and types of wood to maximize its restorative impact.
- Conversely, the study raised questions about the suitability of metal materials in restorative home environment designs, hinting that they may not be the ideal choice. These findings encourage designers to exercise caution when integrating metal into residential spaces, especially if the goal is to create a restorative atmosphere.

- Some advantages of brick material related to feathers of restorative potential were found in the results. Also, there remains a need for more accurate and robust evidence, both subjective and objective, to comprehensively understand the emotional reactions people have to brick in various architectural and interior design contexts.

Future research could expand on these findings by exploring other environmental contexts and considering additional variables. This will help confirm and expand our understanding of how materials can be harnessed to create restorative environments, ultimately benefiting individuals seeking a good life quality within their homes.

In conclusion, this study has presented valuable understandings into the restorativeness of commonly used materials in home environment. Interior designers, architects, and environmental designers can leverage these findings to make informed decisions when selecting materials for creating restorative home environments. Whether it's choosing glass for its positive impact on relaxation or wood for its potential warmth and comfort, these insights can guide design choices to enhance the well-being of residents.

One noteworthy contribution of this research is the identification of gaps in the existing literature concerning the emotional reactions to interior materials and their restorative effects. This highlights a promising avenue for future research, where investigators can delve deeper into the emotional responses evoked by various materials and their implications for creating restorative spaces. Understanding these emotional reactions can offer a more comprehensive perspective on the restorative potential of materials, ultimately leading to more thoughtful and effective design choices.

In essence, this study not only informs current design practices but also paves the way for further exploration and innovation in the field of restorative environmental design. Ongoing exploration of the complex connection between materials used in living spaces and the health and happiness of individuals is needed. The ultimate aim is to design living spaces that not only fulfill practical needs but also promote the overall physical and mental wellness of the people residing in them.

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Appendix: Questionnaire

An attitude investigation to interior materials

This is a perception investigation into interior materials. It used the components of restorative environment to evaluate the 10 categories of interior materials (interior wall paint, textile, wood, plastic, glass, metals, tile, brick, stone, and concrete). We designed 12 adjective pairs with 1-7 scales to show the level of attitude to materials. You will be asked to see the picture of materials and search the information on the internet about this material, rate it after getting the design image of this material.

Informed consent for this investigation

This questionnaire is an investigation of the human's perception to interior materials. It used 12 adjective pairs with 1-7 scales to show the level of attitude to materials. 1 represents you get the weakest feeling about this item; 7 represents you get strongest feeling about this item. In the process of evaluation, you are asked to see the picture of the material and search the information about this material from the internet, after you find your perception of this material's properties, fill in the 12 adjective items. The whole investigation may continue for 60 mins. The result may help us to clarify the connections between interior materials and restorative potential and find the recommendation materials for restorative environment design. We promise this investigation will not involve your private information or physical data. Also, there is not any risk involved. We just hope you fill your name to mark your data and your major or occupation to show you are related to interior design. Regarding the investigation results, it will be kept confidential, and we promise that the analysis results will only be used for this research. If you feel uncomfortable or change your mind, you can quit at any time during the investigation. If you have any questions, please contact the investigator Zhao Jing (zhaojing@jaist.ac.jp). If you are willing to participate, please click the agree option below, and it represents you agree with the contents that we show you about this investigation. If you are not willing, please exit this link. Thank you.

○Agree

○Disagree

What is your name?

_____

What is your major or occupation?

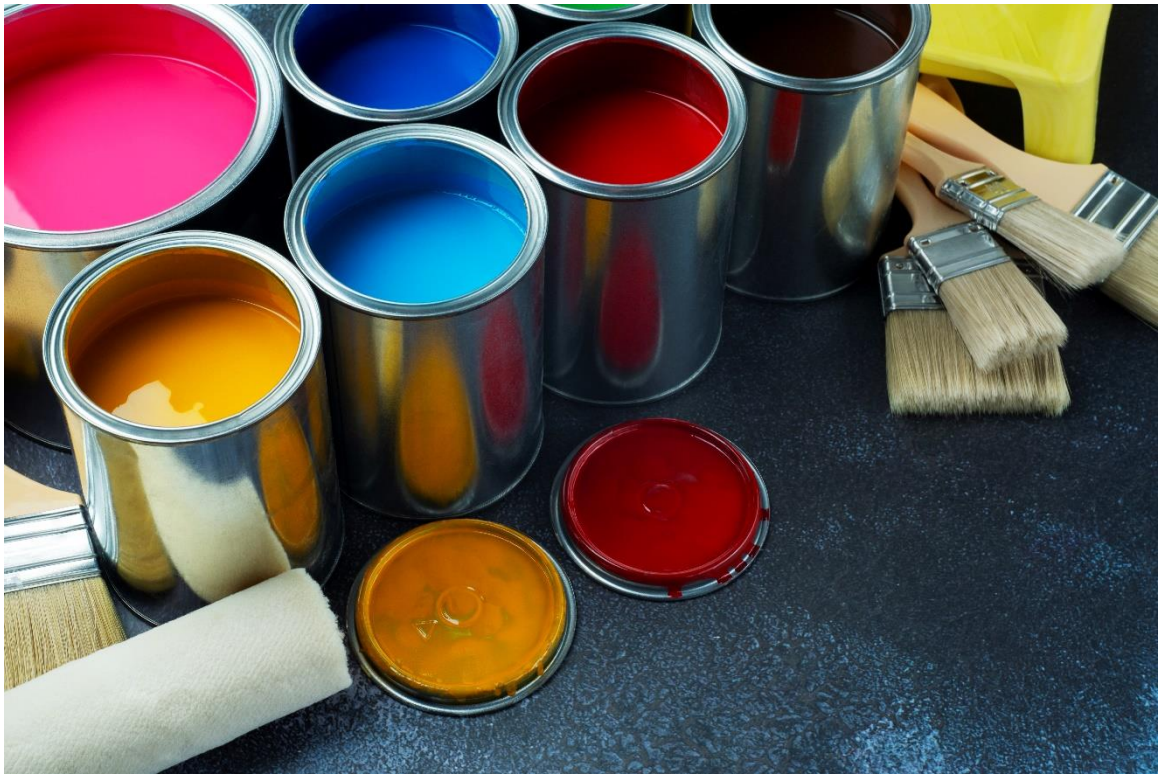
_____

Explanation of each adjective

Ordinary–Special	In the interior, this material gives people a common feeling or a special feeling.
Harmony–Clash	Is this material well integrated into the environment and harmonious indoors, or cannot it be integrated into the environment and clashing?
Textured–Untextured	In interior design, the surface of this material often has a concave-convex texture or is smooth without concave-convex. Roughness.
Colorful–Dull	Is the color of this material bright with color or dull without any color in interior design?
Finished–Unfinished	This material appears indoors, whether it needs to be reprocessed or has been completed.
Patterned–Random	Does this material appear in interior design with its own pattern (the texture is regular) or random?
Luxury–Cheap	A sense of luxury or cheap.
Pleasing–Repelling	People feel pleased to like to be close to or feel repelled and stay away from.
Attractive–Unattractive	The finished product of this material is attractive or unattractive for you.
Durable–Nondurable	whether the material is durable and how long it will be used
Solid–Flimsy	Is the material solid and flimsy?
Changeable–	The plasticity of the material, whether it is very easy

Unchangeable	or difficult to shape it into various shapes to adapt to daily life.

Material evaluation



What are your impressions of interior wall paint? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○

Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○

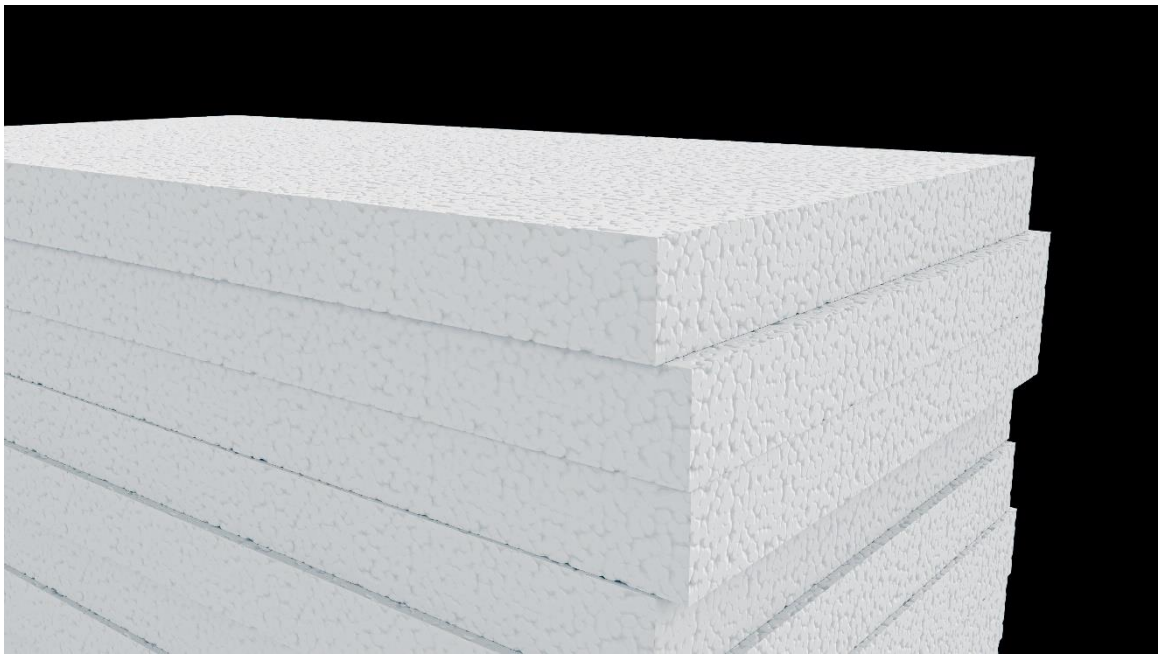
What are your impressions of textiles? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○

Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○

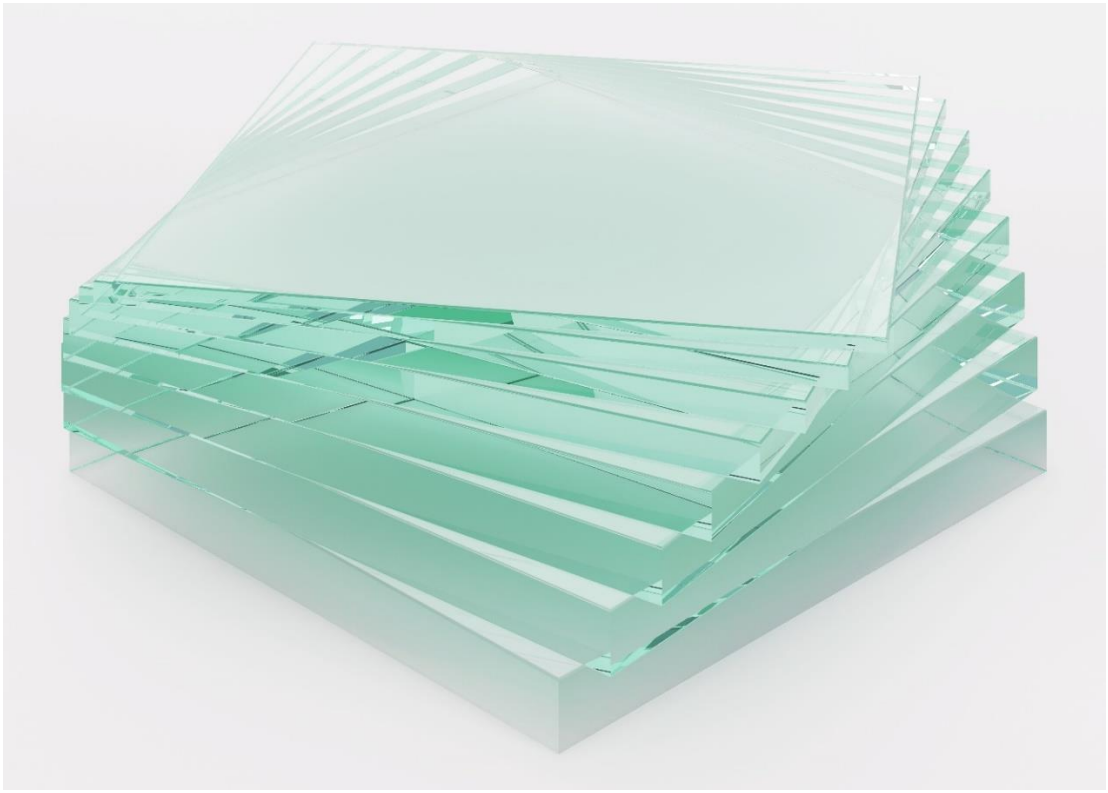
What are your impressions of wood? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○



What are your impressions of plastic? (Refer to the internet information to find your impression to this material)

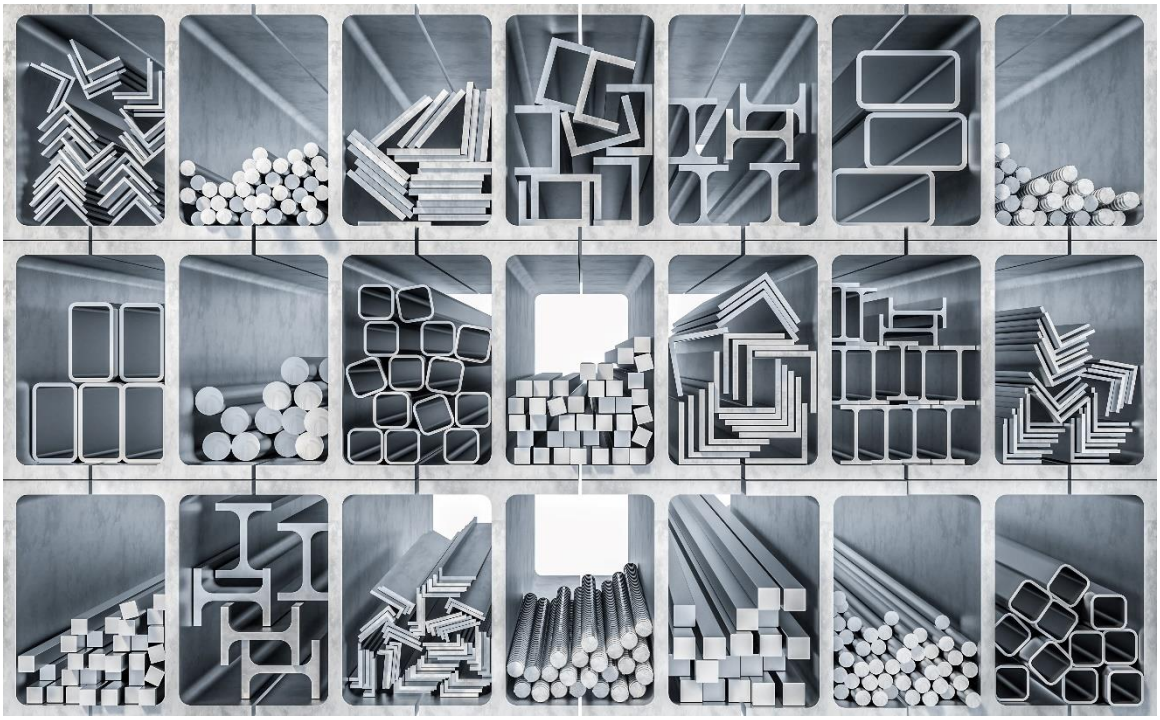
	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○



What are your impressions of glass? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○

Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○



What are your impressions of metal? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○

Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○

What are your impressions of tile? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○

Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○

What are your impressions of brick? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1

Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○

What are your impressions of stone? (Refer to the internet information to find your impression to this material)

	Strongest			Neutral			Weakest

	7	6	5	4	3	2	1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○

What are your impressions of concrete? (Refer to the internet information to find your impression to this material)

	Strongest 7	6	5	Neutral 4	3	2	Weakest 1
Ordinary-Special	○	○	○	○	○	○	○
Harmony-Clash	○	○	○	○	○	○	○
Textured-Untextured	○	○	○	○	○	○	○
Colorful-Dull	○	○	○	○	○	○	○
Finished-Unfinished	○	○	○	○	○	○	○
Patterned-Random	○	○	○	○	○	○	○
Luxury-Cheap	○	○	○	○	○	○	○
Pleasing-Repelling	○	○	○	○	○	○	○
Attractive-Unattractive	○	○	○	○	○	○	○
Durable-Nondurable	○	○	○	○	○	○	○
Solid-Flimsy	○	○	○	○	○	○	○
Changeable-Unchangeable	○	○	○	○	○	○	○