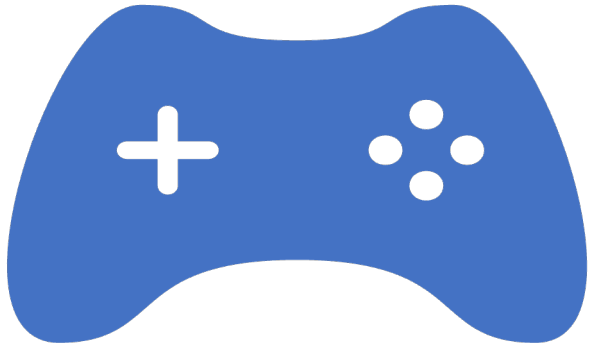
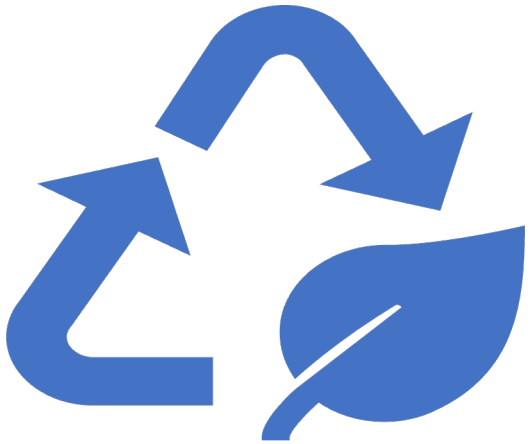
What my study is about

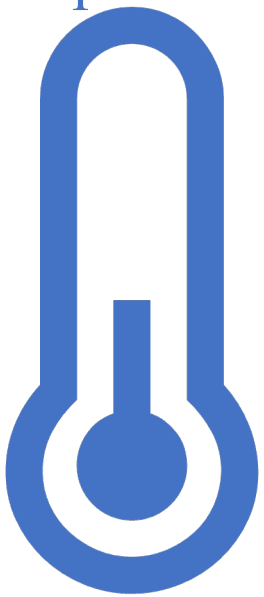
Virtual Reality



Retail Greenery



Lighting
Temperature



What is Virtual Reality ?

VR is a mediated environment which creates the sensation in a user of being present in a (physical) surrounding (Steuer, 1992)

Immersive VR

- Integrated body movement with the simulated environment (Wu et al., 2021)
- Wireless controller, Walking (Park et al., 2018)
- Projected in the headset (Park et al., 2018)
- Oculus Rift S
- User awareness of the world is low (Park et al., 2018)

Non-Immersive VR

- The 360° representations of three-dimensional (3D) environments (Wu et al., 2021)
- Keyboard, Mouse (Park et al., 2018)
- Displayed on desktop computer monitors (Park et al., 2018)
- Mockshop
- User awareness of the world is high (Park et al., 2018)

Variables to define Virtual Reality

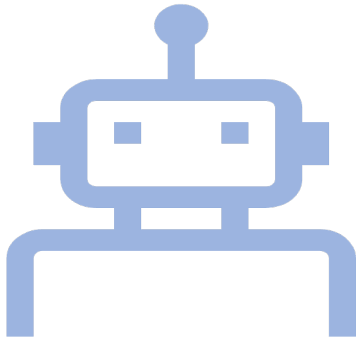
Vividness (Steuer, 1992)

(richness of an environments representation)

Interactivity

(extend to which a user can modify form and content of a mediated environment)

Telepresence (Park et al., 2016)



Perceived realism

Simulator sickness

What are VR atmospheric elements

Design elements (Hassouneh and Brengman, 2015)

- functional elements, layout, comfort, signage
- search speed, organization of website, aesthetic elements, color

Ambient elements

- lighting, music, smells, temperature
- brightness, sounds, enhanced zoom features, entertainment aspect

Social presence

- number of others, appearance, and behavior of others

Trialability

- sampling, augmented reality, and virtual reality

Apparel retailers that are using Virtual Reality

1. The Fabricant
2. Happy99
3. Carlings
4. Amazon
5. Dior
6. Tommy Hilfiger
7. Coach
8. Etsy
9. Walmart
10. Target

Radin, 2020

3D Virtual environments

Tommy Hilfiger

Shah, 2019

Dior

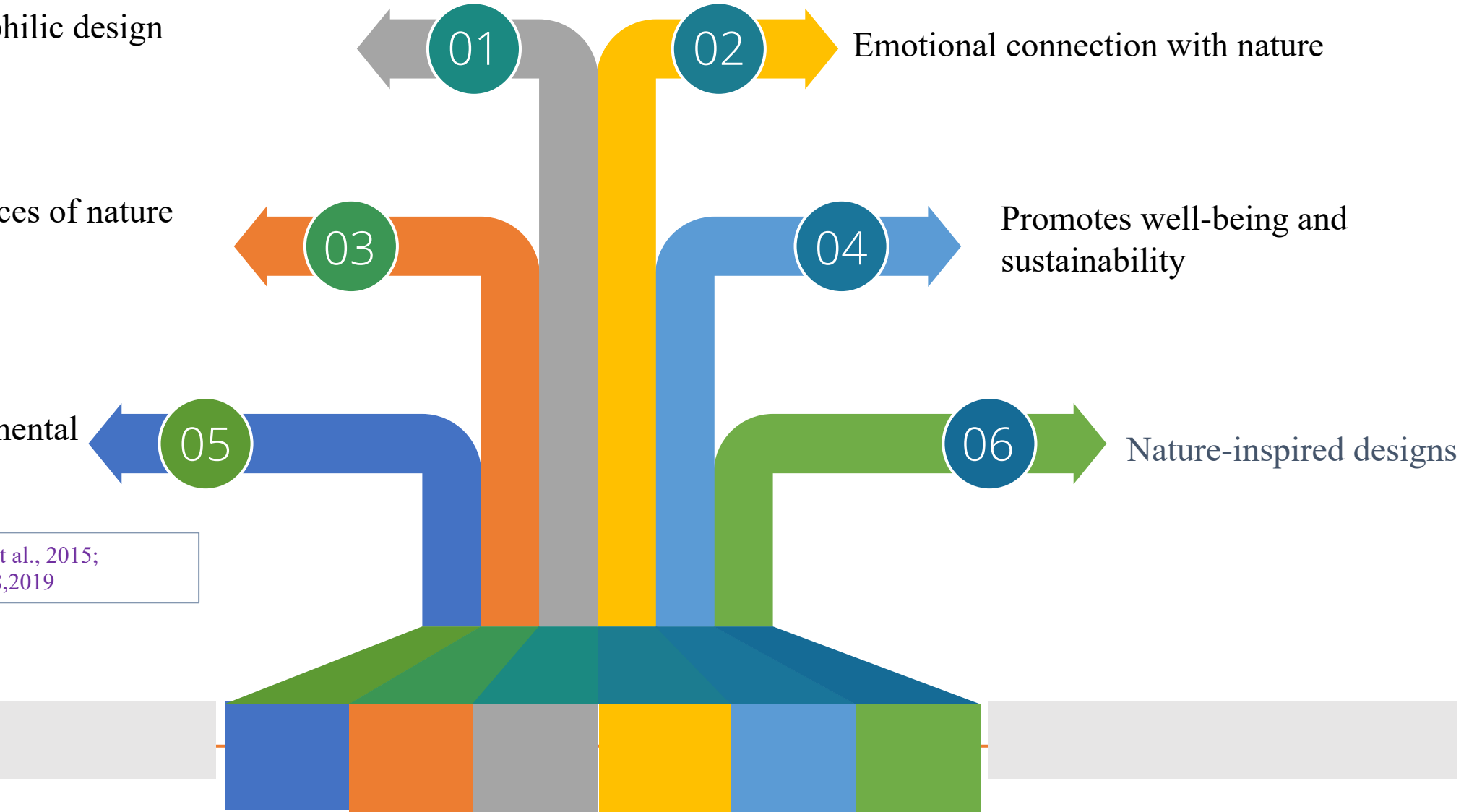
Cao, 2017

Walmart

Newman, 2017

What is Retail Greenery ?

Attributes of biophilic design



Emotional connection with nature

Direct experiences of nature

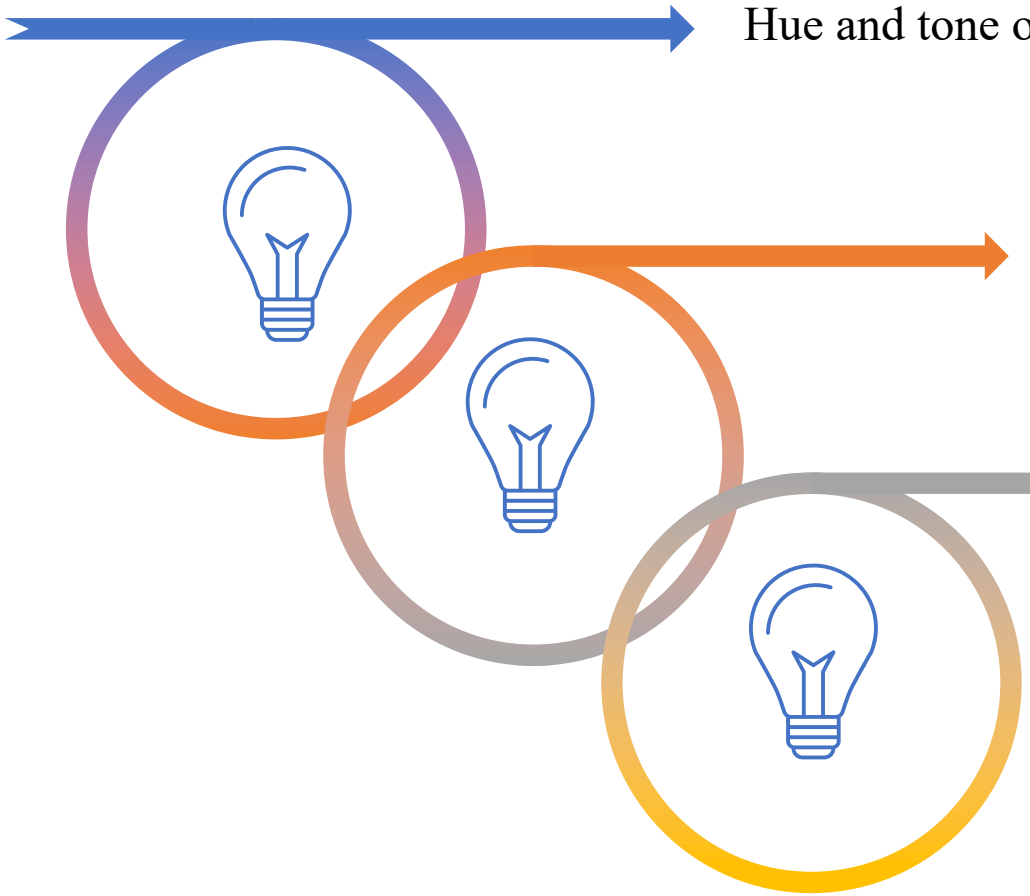
Promotes well-being and sustainability

Restorative environmental design

Nature-inspired designs

Kellert, 2008; Kellert et al., 2015; Rosenbaum et al., 2018,2019

Lighting Temperature



Hue and tone of white light, measured in Kelvins

Warm-white light- 2500-3500K, Bluish white light- 3600-5100K

Warm lighting- Pleasure and Relaxation, Cool lighting- arousal, visual clarity, and visual attention

(Boray et al., 1989)

Atmospherics factors in Virtual Reality

Authors	Independent variables	Dependent variables	Main effects of Retail Greenery
Bogicevic et al. (2019)	Static images vs. VR vs. 360 tour	Pleasure, stress, and approach/avoidance responses	✓ VR increases higher elaboration than static images
Liu et al. (2019)	Layout types (grid, centralization, radiation, and line), types of spatial information display: “area allocation map” and “actual scene view”),	Presence, spatial identification	✓ Radiation type including area allocation map
Shim et al. (2012)	Level of social presence (virtual sales associates vs no sales associates)	Social support from a retail website, attitude toward the website, and patronage intentions	✓ Apparel retail website with a virtual sales associate
Liu and Uang (2011)	Level of depth cues (low vs high), mode of display (HMD vs general display) vs 3D monitor	Cybersickness	● Cybersickness
Shim et al. (2012)	Control, color vividness, graphics vividness	Hedonic value, utilitarian value, engagement, enjoyment, satisfaction, and purchase intention	✓ Control, color vividness, graphics vividness

Justification for the study

1

Brand differentiation

Retailers still fail to differentiate their store as a brand from competitors as retailers, consider the atmospheric factors individually, and set a standard for customers (Foster and Mclelland, 2014)

2

Atmospheric factors

Limited research has been conducted to investigate the interactive effects of atmospheric elements (Roggeveen et al., 2020).

3

Retail Greenery

Previous studies did not discuss much about the combined effects of retail greenery (non-retail greenery) and lighting temperature (warm vs cool) in VR environments

4

Lighting temperature

The conceptual fit between lighting temperature and other atmospheric factors is highly important to influence consumers' perceptions and responses (Lin and Yoon, 2015).

5

VR/AR as the future of shopping

The global VR market is expected to reach USD 49.7 billion by 2023 (Xi and Hameri, 2021). Limited research has been done to understand the atmospheric factors in VR environments (Park et al., 2018)

6

3D VR environments

Many retailers are currently using 3D VW sites. However, questions still arise about how we can effectively use 3D VW sites to engage consumers and increase brand value (Nah et al., 2011)

Justification for the study

7

Shopping orientations in a VR setting

Very few studies have discussed the effects of shopping orientations in a VR setting (Pizzi et al., 2019).

8

Shopping orientations and atmospheric factors

Few studies have considered the relationships between utilitarian and hedonic shopping orientations in conjunction with retail greenery and lighting temperature

9

Atmospheric factors in VR environments

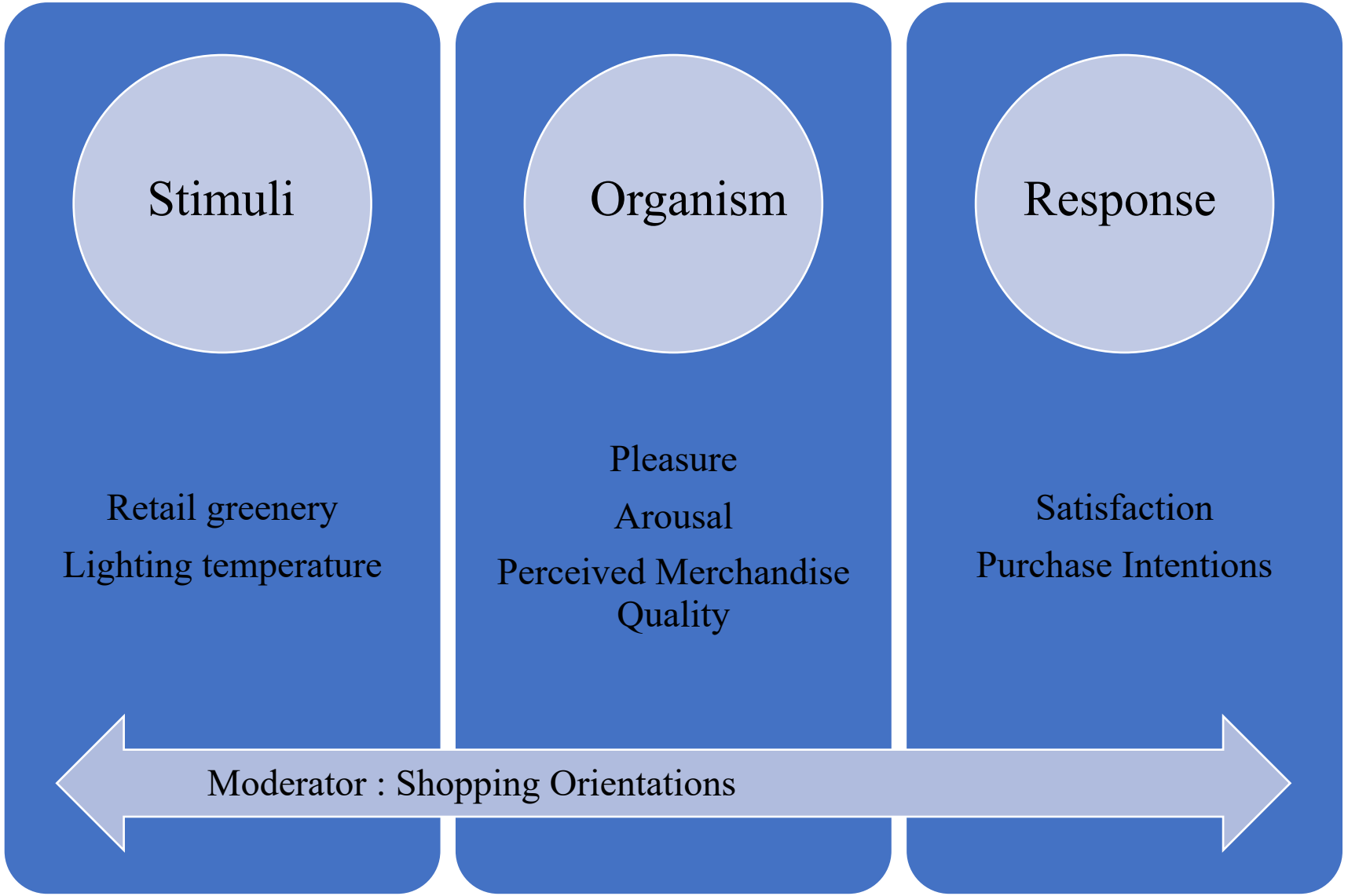
Prior studies often compared 3D VR with 2D environments. However, the impacts of the retail atmospheric factors need to be tested in VR environments (Park et al., 2018)

10

Shopping process

Shopping process is considered as a tiring activity, and retailers need to increase consumers' pleasure, arousal, perceived merchandise quality, satisfaction, and purchase intention.

Conceptual Framework



Mehrabrian and Russell, 1974

Theory behind retail greenery

Ulrich et al., 1991

Attention Restoration Theory

Stress Recovery Theory

A two-dimensional view of arousal

Kaplan, 1995

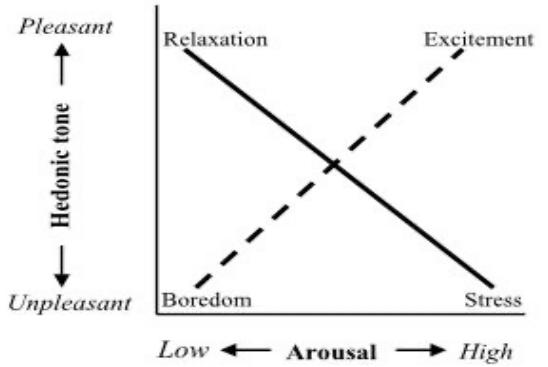
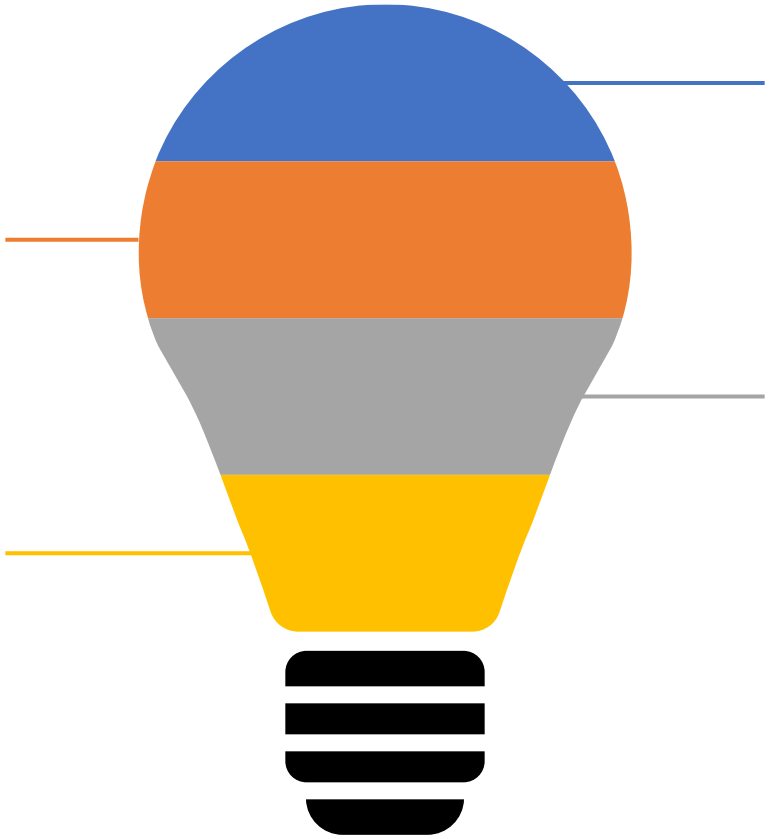


Figure 1. A two-dimensional view of arousal.

Lighting Temperature

DAST framework
D=Design
A= Ambient
S=social presence
T=trialability
Roggeveen et al. (2020)

Inherent consideration of Biophilic Design
(Kellert et al., 2008)



Stimulus-Organism-Response
(Mehrabrian and Russell, 1974)

Cognitive fit/misfit and fluent processing (Kang et al., 2019)

Retail Greenery

Authors	Independent variables	Dependent variables	Main effects of Retail Greenery
Brengman et al. 2012	In-store greenery and perceived complexity	Pleasure, stress, and approach/avoidance responses	✓ Store greenery
Rosenbaum et al., 2018	Lifestyle shopping center vs non-lifestyle shopping center	Restoration potential	✓ Lifestyle shopping center
Rosenbaum et al., 2019	Social presence in a lifestyle shopping center	Interest, excitement, relaxation	✓ Social presence
Purani and Kumar (2018)	Biophilic vs. non-biophilic stimuli	Affective responses and preferences	✓ Biophilic stimuli
Kristjansson, 2017	Greenery settings	Willingness to spend money	✓ Greenery settings
Demir et al., 2019	Greenery	Nature connectedness, emotional, cognition	✓ Greenery

Interaction effects of Retail Greenery

Authors	Independent variables	Dependent variables	Interaction effects of Retail Greenery
Brengman et al. 2012	In-store greenery and perceived complexity	Pleasure, stress, and approach/avoidance responses	✓ Retail Greenery X High Complexity ○ Retail Greenery X Low Complexity
Tyrvaienen et al., 2014	Greenery places and Time of the experiment (in the beginning vs after seating vs after walking)	Restoration potential	✓ Greenery places X Time spent
Berman et al., 2012	Location (urban vs nature) and time (pre-walk vs post-walk)	Positive affect	✓ Nature X Post-walk ○ Urban X Post-Walk
Berman et al., 2008	Picture type (nature vs urban) and the time of the test (before vs after picture viewing)	Attention performance	✓ Nature X After picture viewing ○ Urban X After picture viewing
Chung et al., 2020	Greenery settings and road views	Noise annoyance	○ 30% greenery X close distance ✓ 30% greenery X Far distance

Lighting Temperature

Authors	Independent variables	Dependent variables	Main effects of lighting temperature
Tantanatewin and Inkarojrit (2016)	Lighting temperature and color	Overall retail impression and identity	✓ Warm lighting ○ Cool lighting
Yang, (2015)	Lighting temperature and Level of complexity	Perceived value and Behavioral intentions	✓ Warm lighting ○ Cool lighting
Park and Farr (2007)	Lighting temperature and Color Rendering Index (CRI)	Pleasure and Arousal →	✓ Warm lighting ○ Cool lighting
		Visual Clarity →	✓ Cool lighting ○ Warm lighting
Lin and Yoon (2015)	Lighting temperature and contrast	Arousal → Pleasure Attention	✓ Cool lighting ○ Warm lighting
Mouhoubi (2014)	Lighting temperature, shelf height, and lighting intensity	Pleasure, Arousal, and feeling of safety	✓ Cool lighting ○ Warm lighting

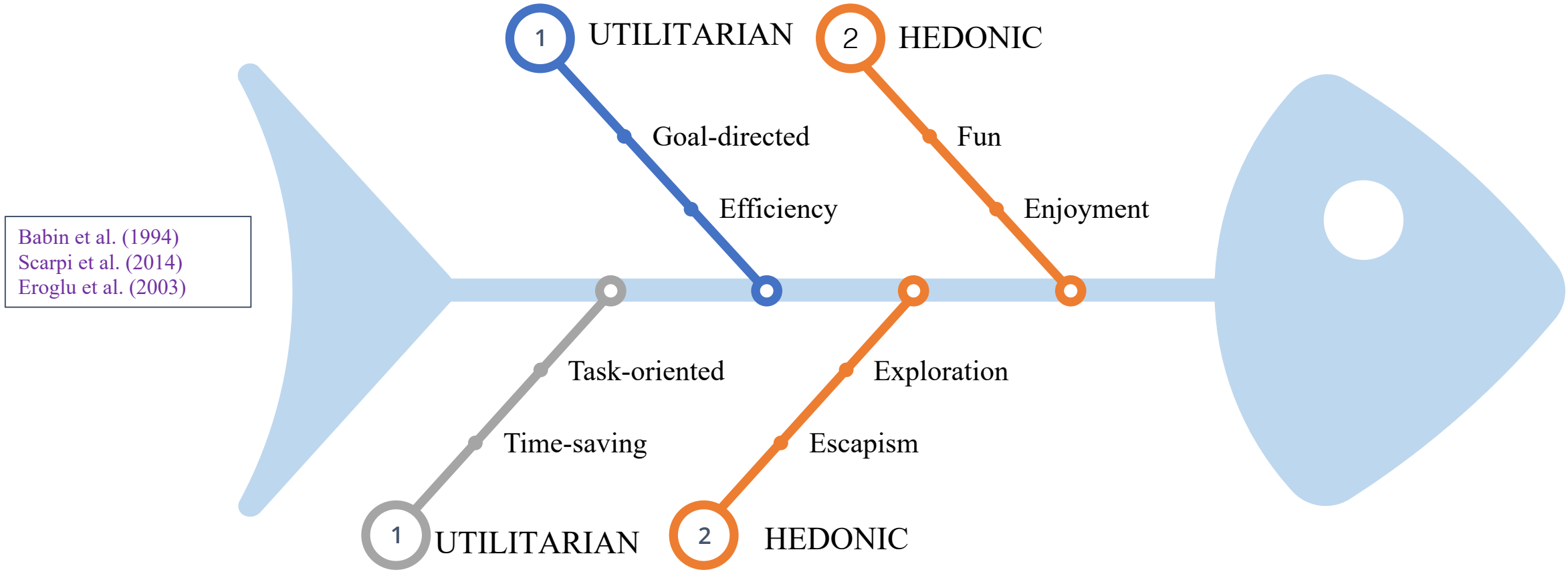
Interaction effects of Lighting Temperature

Authors	Independent variables	Dependent variables	Interaction effects of lighting temperature
Kang et al. (2019)	Lighting temperature Brightness of light	Cognitive states Fluency-mediator	✓ Warm X Bright Cool X Bright ✓ Cool X Dim Warm X Dim
Lin and Yoon (2015)	Lighting temperature Lighting types	Arousal Attention	✓ Cool lighting X High contrast Warm lighting X Low contrast
Wardono et al. (2012)	Colors Lighting Decor	Perceived sociability	✓ Monochromatic color X Dim lighting X Plain Decor
Manen (2018)	Lighting temperature Human crowding (High vs Low) Shopping motivation as a moderator	Attractiveness	✓ Warm lighting and low-human crowding Warm lighting and high-human crowding
Zhu er al. (2019)	Lighting temperature, illuminance, and	Cognitive performance Subjective mood	✓ Three-way interaction effects

Some findings are exceptional

Authors	Independent variables	Dependent variables	Interaction effects
Demir et al. (2019)	Greenery Perceptual sensitivity	Natural connectedness, cognitive function, and emotional regulation	
Yang (2015)	Lighting temperature Level of complexity	Perceived value and behavioral intentions	
Tantanatewin and Inkarojrit (2016)	Lighting temperature and color	Overall retail impression Retail identity	
Knez and Hygge (2002)	Lighting temperature and irrelevant sound effects	Cognitive performance and self-reported affect	

Utilitarian and Hedonic Shopping Orientations



Moderating effects of Shopping Orientations

Authors	Independent variables	Dependent variables	Moderating effects of shopping orientations
Purani and Kumar (2018)	Biophilic stimuli vs. non-biophilic stimuli	Pleasure and excitement	Hedonic value X Biophilic stimuli Utilitarian value X Biophilic stimuli
Luk et al. (2013)	Sacrifice, value, satisfaction	Behavioral intentions	Sacrifice X value X satisfaction → Behavioral intention Utilitarian value
Wenzel and Benkenstein (2018)	Shopping companions	Shopping experience	Shopping motivations X Shopping companions (partial)
Tsaur et al. (2014)	Selling orientation	Service outcomes	Shopping orientation X Selling orientation
Lunardo and Mbengue (2009)	Perceived control	Pleasure, stress, and return intent	Utilitarian motivational orientation X perceived control X pleasure/stress

Hypotheses development

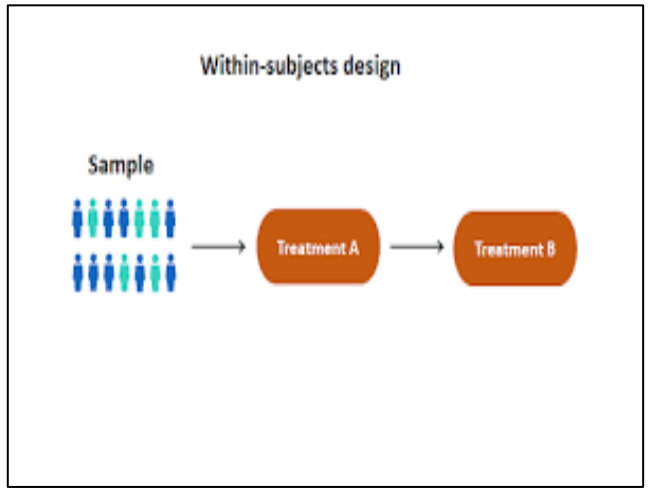
H1: Retail greenery will produce higher (a) pleasure, (b) arousal, (c) perceived merchandise quality, (d) satisfaction, and (e) purchase intention than non-retail greenery.

H2: There will be a significant difference between cool and warm lighting on (a) pleasure, (b) arousal, (c) perceived merchandise quality, (d) satisfaction, and (e) purchase intention.

H3: There are significant interaction effects between retail greenery and lighting temperature on (a) pleasure, (b) arousal, (c) perceived merchandise quality, (d) satisfaction, and (e) purchase intention

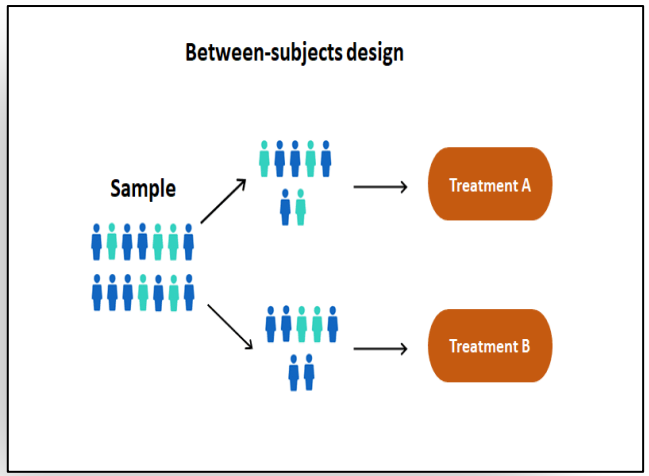
H4: Utilitarian and hedonic shopping orientations will moderate the relationship between lighting temperature and retail greenery in biophilic design on consumers' (a) pleasure, (b) arousal, (c) perceived merchandise quality, (d) satisfaction, and (e) purchase intention.

Methodology



Retail Greenery X Non-Retail Greenery

- ✓ Increases statistical power
- ✓ Biophilic- Within-subjects (Brengman et al., 2019)
- ✓ Minimizes random noise
- ✓ Increases the chances of discovering a true differences among the conditions (Nachimos, 2015)

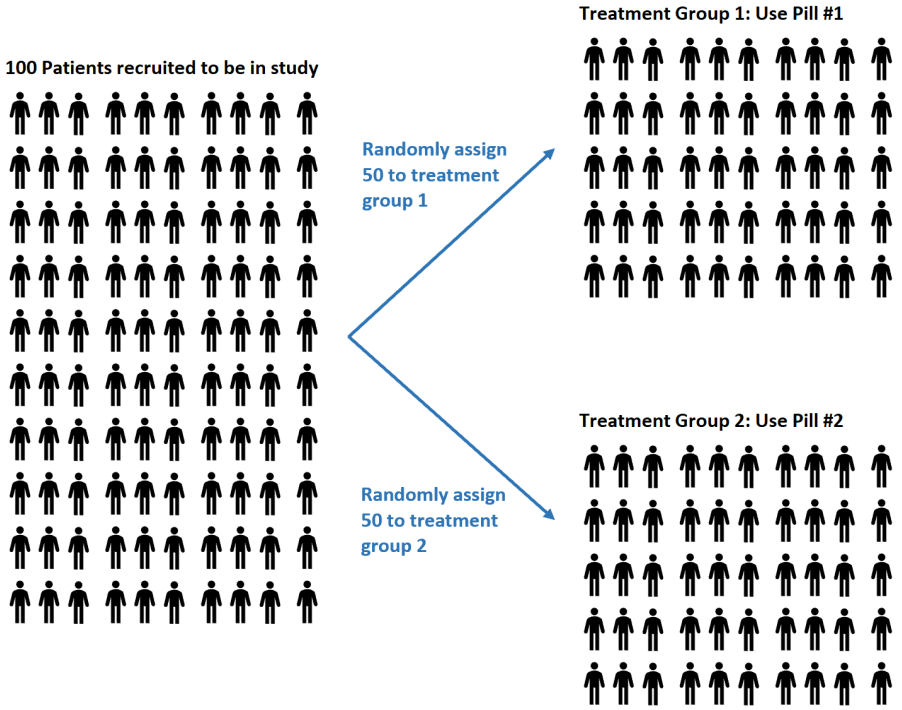


Warm lighting X Cool lighting

- ✓ Shorter time sessions
- ✓ Each participant score is independent
- ✓ No carry over effect

Bhandari (2021)

Randomization

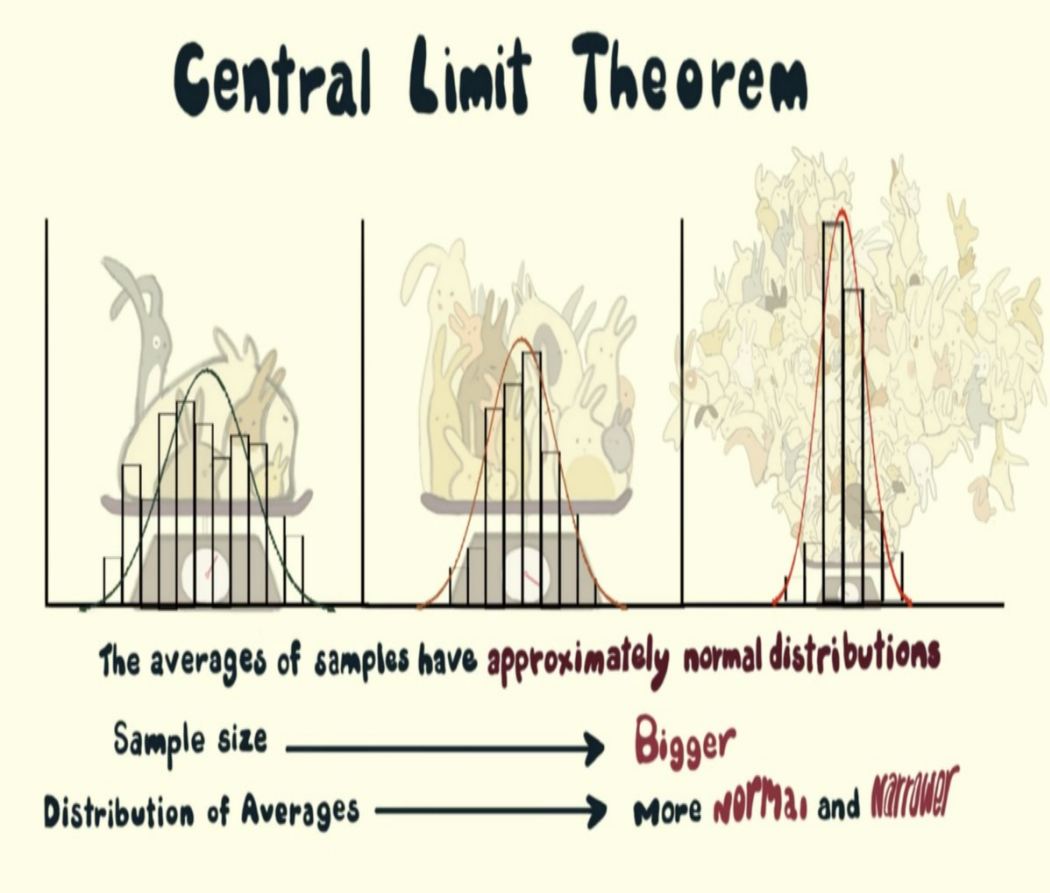


Zach, 2021

- It reduces the possibility of order effects
- Participant assignment will not affect the outcomes
- Produces the comparable groups
- Controls the confounding variable
- Facilitates true causal and effect relationship

Moffitt, 2003

Sample Size

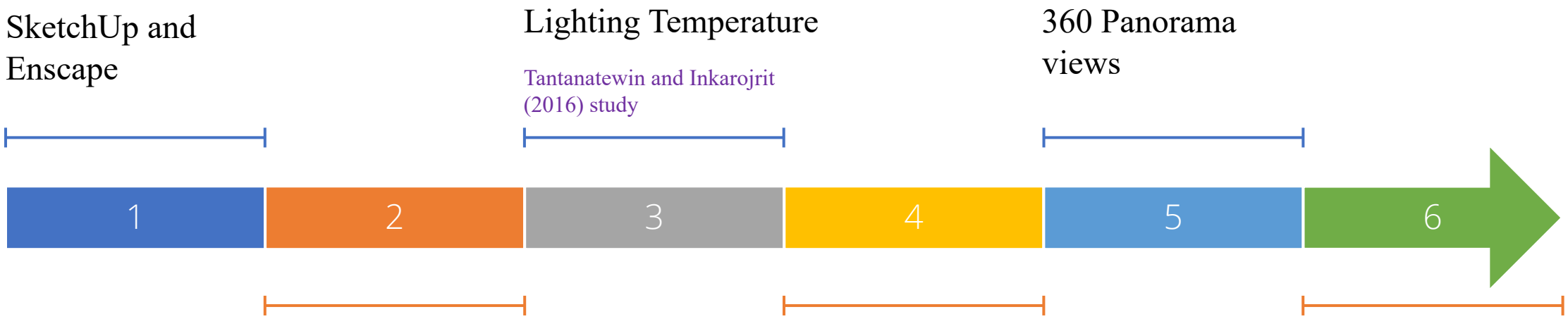


Lyim (2020)

- 295 participants participated in this study
- Sample size >=30 Central Limit Theorem
- A sufficiently large sample size can predict the characteristics of a population correctly
- 73 participants for the cool lighting and retail greenery condition and 74 participants for remaining three conditions

Field (2005)

Stimuli Development

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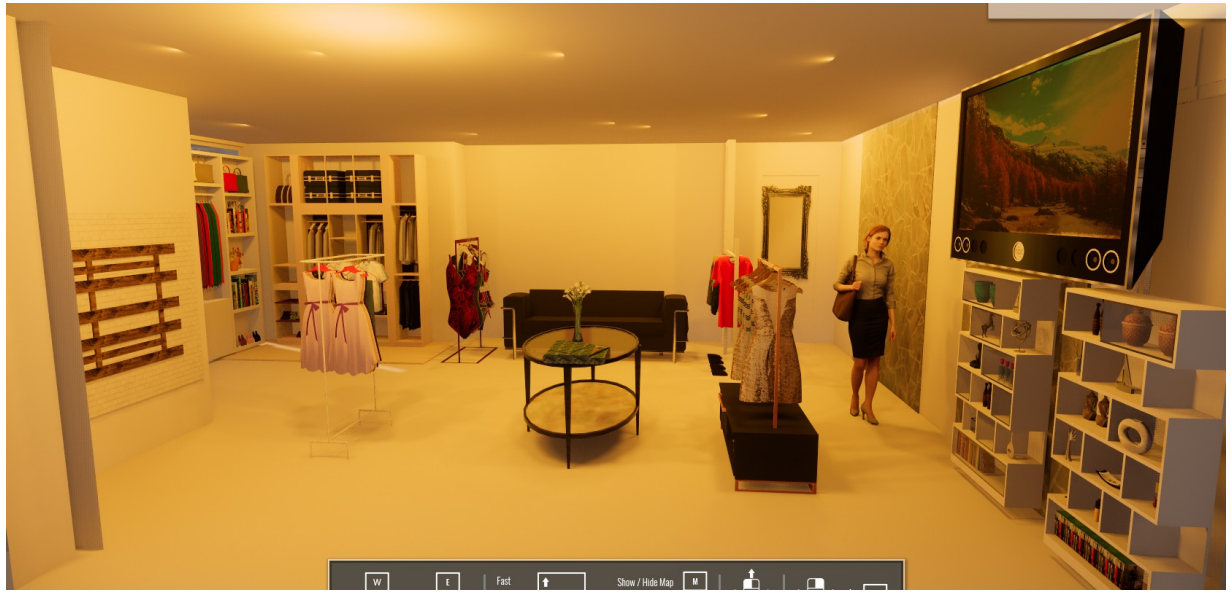


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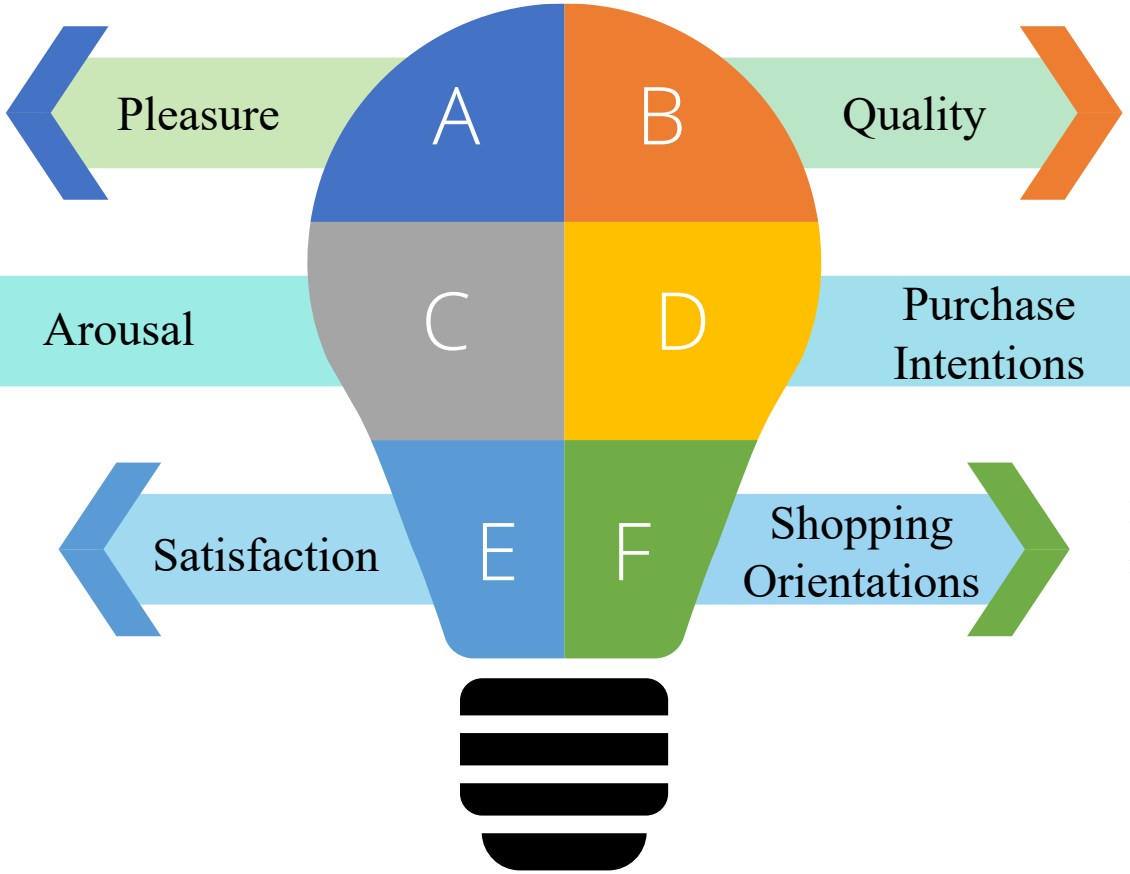
Instruments



Donovan and Rossiter, 1982

Depressed-Contended
Unhappy-Happy
Unsatisfied-Satisfied

High quality items
High workmanship

Meghan et al., 2017

Donovan and Rossiter, 1982

Relaxed-Stimulated
Calm-Excited
Dull-Jittery

Likelihood
Willingness to buy
Willingness to recommend

Baker et al, 2002

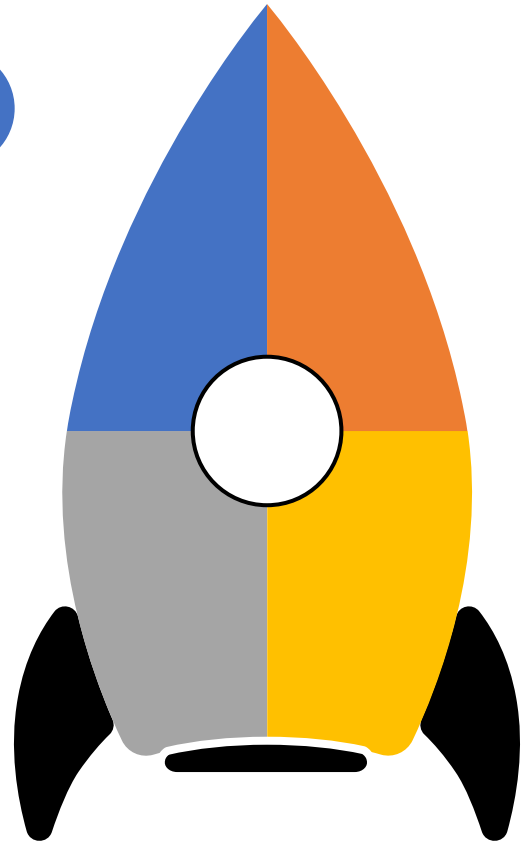
Liu et al., 2013

How satisfied ?
Expectations
How close to your visual store

Buying clothes at the most convenient place
Like an escape

Babin et al., 1994

Data Analysis



1 Data Cleaning

2 Exploratory Data Analysis

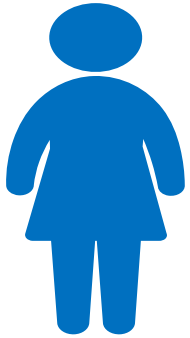
3 Mixed-ANOVA

4 Data Storytelling

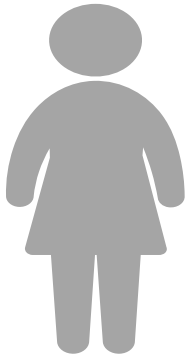
Data Collection Procedure

- Consent form
- Online Survey Questionnaire
- Randomizer
- 360 Panorama View

Sample Characteristics



VS



48.5%

- U of M participants
- Age: 18-23
- Extra credit

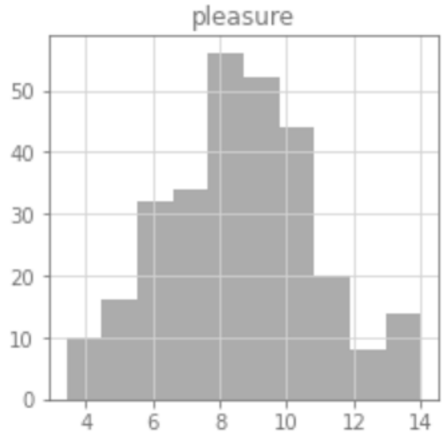
51.5%

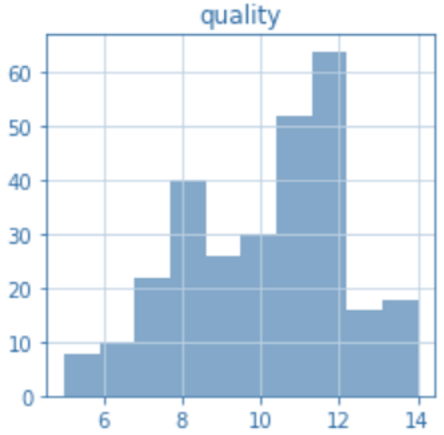
- Participants across US
- Age: 18-23
- 1 USD incentive

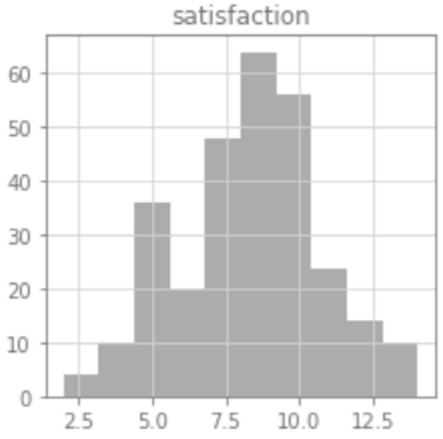
The normal distribution curve seems fine for pleasure, arousal, satisfaction and purchase intentions except quality. Cronbach's alpha for all variables is greater than 0.7.

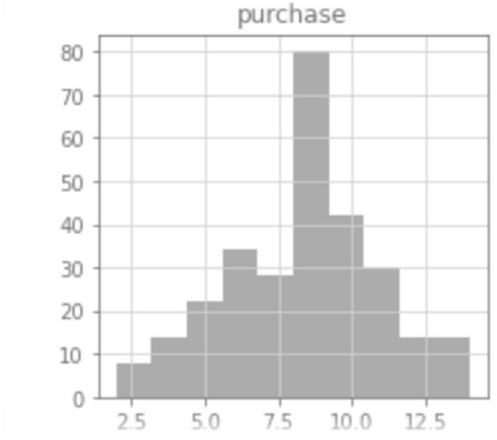
Reliability

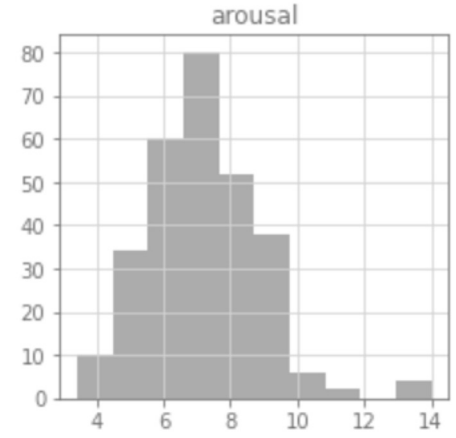
Arousal	★
Perceived Merchandise Quality	★
Pleasure	★
Purchase intention	★
Satisfaction	★











Using corr() function, I measured the correlation matrices for both M-turk and college participants.

The correlation matrix of M-Turk participants

Pleasure	1				
Arousal	0.7	1			
Satisfaction	0.78	0.59	1		
Quality	0.61	0.28	0.54	1	
Purchase Intention	0.73	0.56	0.77	0.58	1

The correlation matrix of college participants

Pleasure	1				
Arousal	0.62	1			
Satisfaction	0.78	0.59	1		
Quality	0.32	0.14	0.31	1	
Purchase Intention	0.71	0.55	0.83	0.33	1

Using correlation coefficient and sample sizes (M-turk and college participants) , I have measured z-score and p-value, which indicates that there are no significant differences in correlational matrices except Quality

Differences in correlation matrix for both Class and M-Turk participants

Soper (2021)

F1	Arousal	Pleasure	Purchase Intention	Quality	Satisfaction
Arousal	✚	✚	✚	✚	✚
Pleasure	✚	✚	✚	✚	✚
Purchase Intention	✚	✚	✚	✚	✚
Quality	✘	✘	✘	✘	✘
Satisfaction	✚	✚	✚	✚	✚

Not OK
OK

Findings related to Hypotheses

Results of Hypothesis testing	Supported?
Hypothesis One: Retail greenery vs Non-greenery	Fully supported
Hypothesis Two: Cool vs Warm lighting	Partially supported
Hypothesis Three: Interaction effects between greenery and lighting	Partially supported
Hypothesis Four: Moderating effects of shopping orientations	Partially supported

Retail greenery crates higher pleasure, arousal, perceived merchandise quality, satisfaction, perceived complexity and purchase intention than non-retail greenery

Independent variables	Dependent variables	F-statistic	p-value
	Pleasure	78.011	$p<0.000^{***}$
	Arousal	42.855	$p<0.000^{***}$
Greenery /Non-greenery	Perceived quality	22.319	$p<0.000^{***}$
	Satisfaction	79.520	$p<0.000^{***}$
	Purchase intentions	44.771	$p<0.000^{***}$
	Perceived complexity	32.46	$p<0.000^{***}$

	Greenery Mean value	Non-Greenery Mean value
Pleasure	4.79	3.85
Arousal	3.93	3.31
Perceived quality	5.33	4.85
Satisfaction	4.74	3.63
Purchase intentions	4.60	3.75
Perceived complexity	3.67	3.01

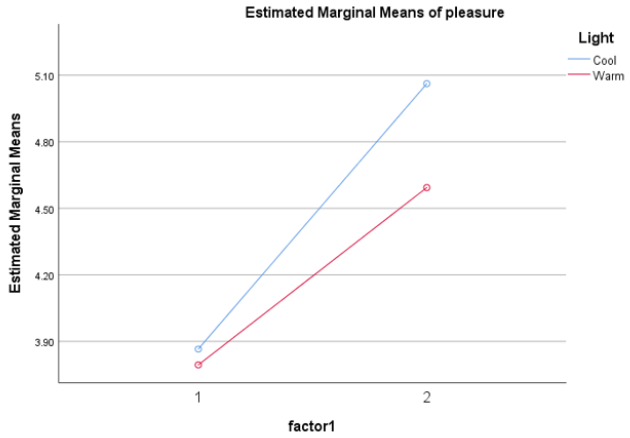
Cool lighting creates higher arousal than warm lighting. However, there were no significant differences between them on pleasure, perceived merchandise quality, satisfaction, and purchase intentions.

Independent variables	Dependent variables	F-statistic	p-value
	Pleasure	2.012	$p>0.05$
	Arousal	4.031	$p<0.05^{*}$
Cool/warm	Perceived quality	0.619	$p>0.05$
	Satisfaction	0.891	$p>0.05$
	Purchase intentions	0.15	$p>0.05$

	Cool Mean value	Warm Mean value
Pleasure	3.86	3.48
Arousal	3.93	3.31
Perceived quality	5.16	5.01
Satisfaction	3.69	3.54
Purchase intentions	4.22	4.13

Under the retail greenery condition, cool lighting creates higher pleasure and perceived merchandise quality than warm lighting. No other effects are evident.

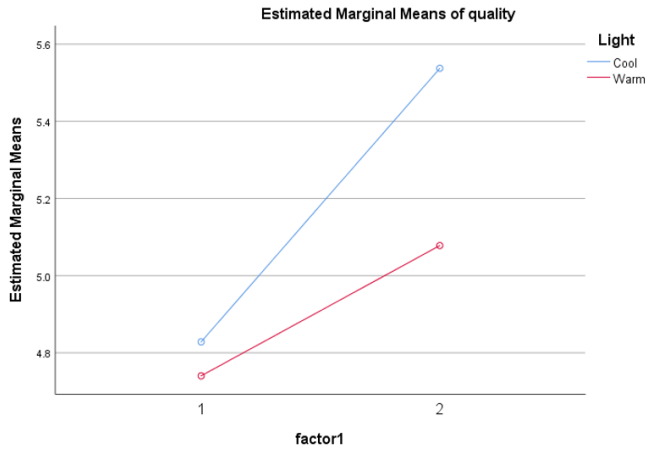
The interaction effects between retail/non-greenery and lighting temperature on pleasure



1. Retail Greenery
2. Non-retail greenery

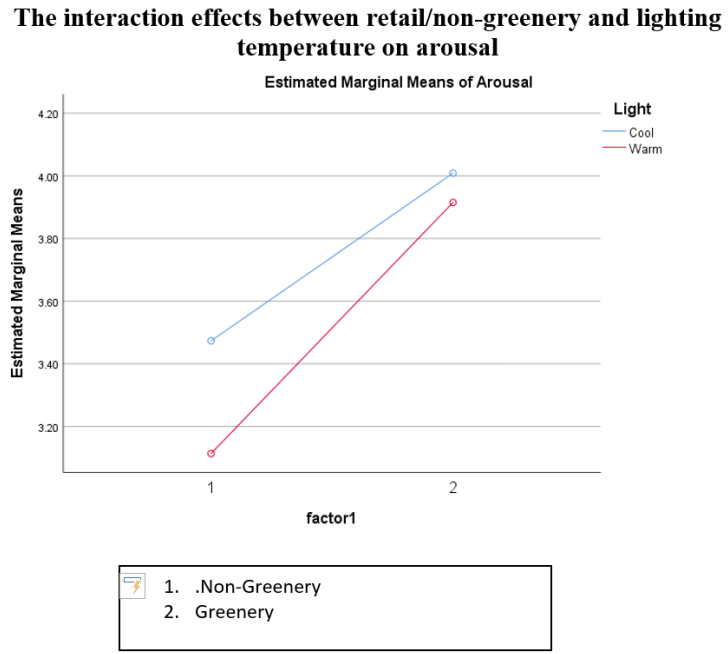
DV	β	t	*p*
Pleasure	0.468	2.324	<0.05
Arousal	0.094	0.541	>0.05
Perceived Merchandise Quality	0.459	2.524	<0.05
Satisfaction	0.411	1.739	>0.05
Purchase Intention	0.352	0.246	>0.05

The interaction effects between retail/non-greenery and lighting temperature on perceived merchandise quality



1. Retail Greenery
2. Non-retail greenery

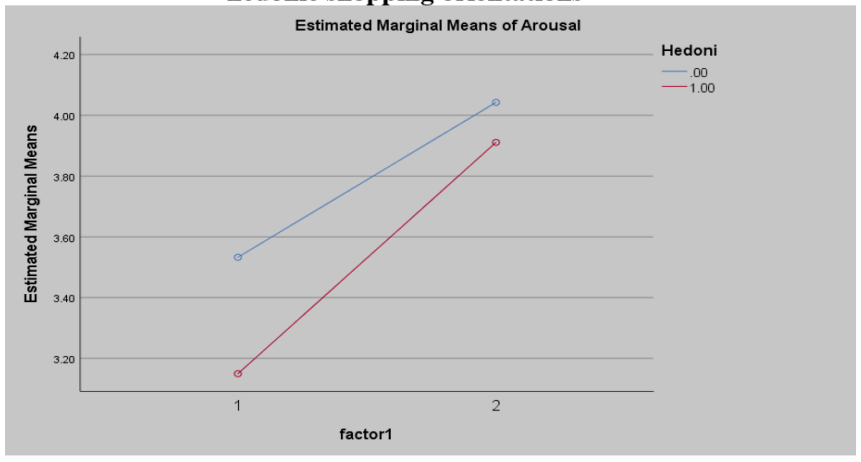
Under the non-retail greenery condition, cool lighting creates higher arousal than warm lighting. No other effects are evident.



DV	β	*p*	t
Pleasure	0.271	>0.05	0.305
Arousal	0.360	<0.05	2.097
Perceived Merchandise Quality	0.088	>0.05	0.374
Satisfaction	0.220	>0.05	0.879
Purchase Intention	-0.019	>0.05	-0.077

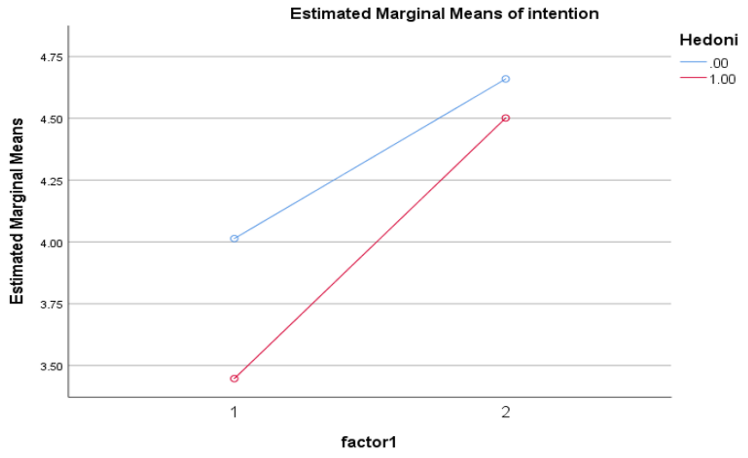
Under the non-retail greenery condition, utilitarian shopping orientation creates higher pleasure, satisfaction, purchase intention, and arousal than hedonic shopping orientation.

The interaction effects between non-greenery and shopping orientations (utilitarian/hedonic) for arousal. Here, blue line indicates utilitarian shopping orientations and red line indicates hedonic shopping orientations



1. Non Greenery
2. Greenery

The interaction effects between non-greenery and shopping orientations (utilitarian/hedonic) for purchase intention. Here, blue line indicates utilitarian shopping orientations and red line indicates hedonic shopping orientations

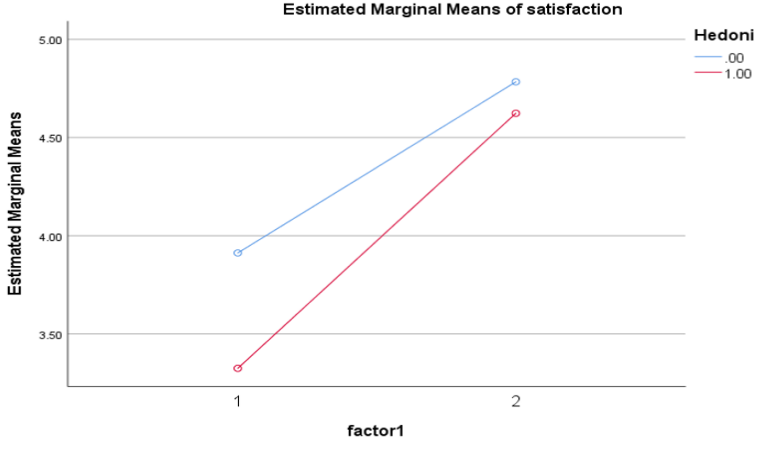


1. Non-Greenery
2. Greenery

The interaction effects between non-greenery and shopping orientations (utilitarian/hedonic) for pleasure. Here, blue line indicates utilitarian shopping orientations and red line indicates hedonic shopping orientations

1. Non Greenery
2. Greenery

The interaction effects between non-greenery and shopping orientations (utilitarian/hedonic) for satisfaction. Here, blue line indicates utilitarian shopping orientations and red line indicates hedonic shopping orientations



1. Non Greenery
2. Greenery

There are no statistically significant interaction effects between retail greenery and shopping orientations.

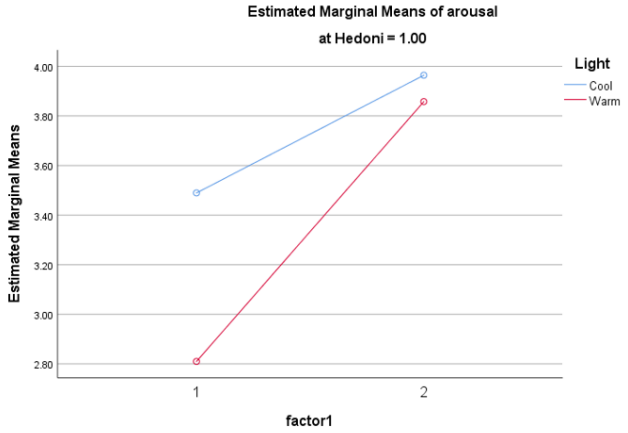
DV	β	*p*
Pleasure	-0.004	>0.05
Arousal	0.153	>0.05
Perceived Merchandise Quality	-0.263	>0.05
Satisfaction	-0.247	>0.05
Purchase Intention	0.385	>0.05

There are no statistically significant interaction effects between lighting temperature and shopping orientations.

DV	F	*p*
Pleasure	0.794	>0.05
Arousal	2.263	>0.05
Perceived Merchandise Quality	0.761	>0.05
Satisfaction	0.316	>0.05
Purchase Intention	0.007	>0.05

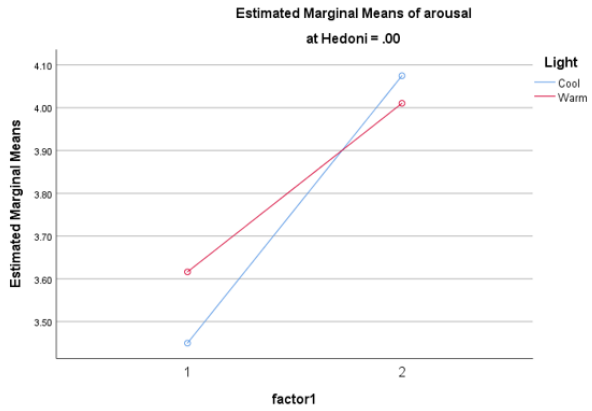
For both utilitarian and hedonic shopping orientations, under the retail greenery condition, both cool and warm lighting create higher arousal than the non-retail greenery condition.

The estimated margian means of arousal at utilitarian shopping orienation



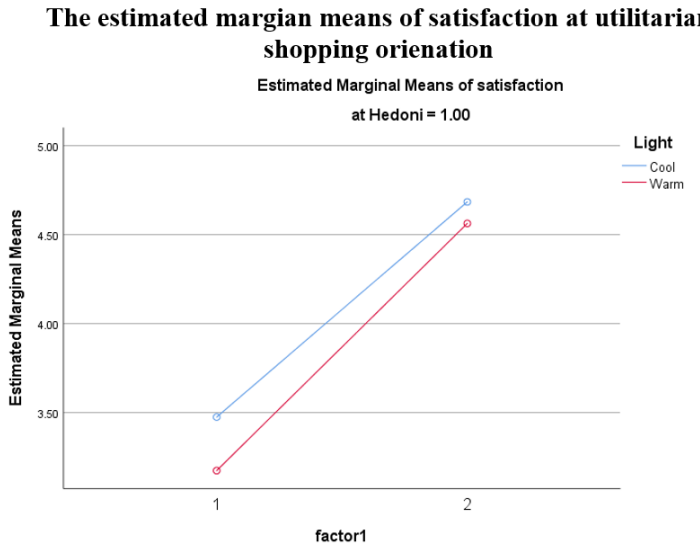
1. Non-Greenery
2. Greenery

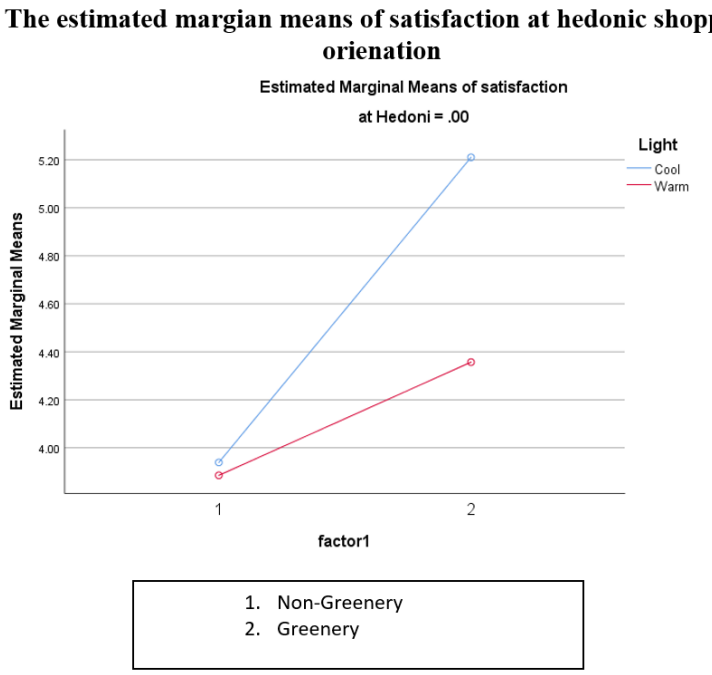
The estimated margian means of arousal at hedonic shopping orienation



1. Non-Greenery
2. Greenery

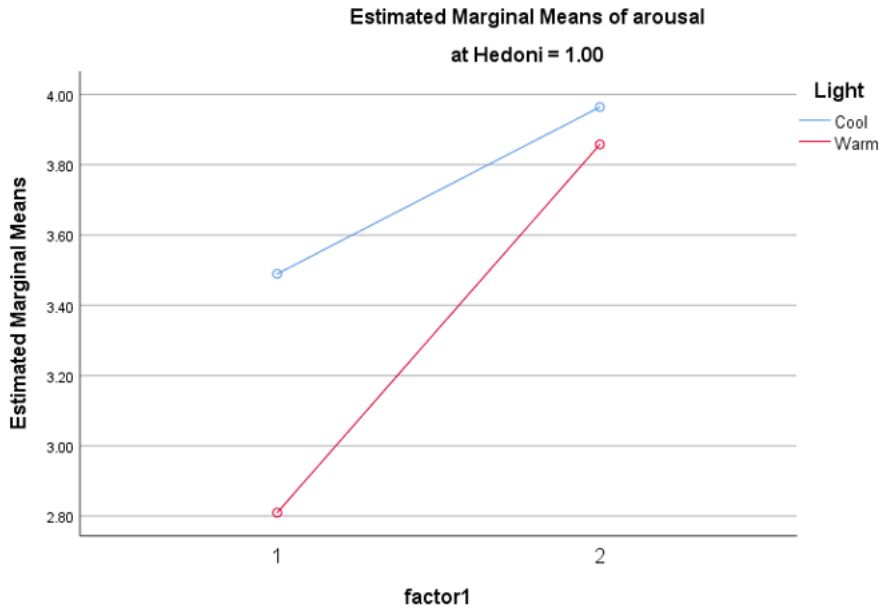
For hedonic shopping orientations, under the retail greenery condition, cool lighting creates higher satisfaction than warm lighting.





For utilitarian shopping orientations, under the non-retail greenery condition, cool lighting creates higher arousal than warm lighting.

The estimated margian means of arousal at utilitarian shopping orienation



1. Non-Greenery
2. Greenery

DISCUSSIONS AND CONCLUSIONS

Findings related to S-O-R framework

1. Partial support is the SOR link supported,

   Influence other states, S-O link, O-R link,

   S-R link supported.

2. Retail Greenery and Lighting temperature as stimuli

3. Influence affective and cognitive states and outcomes

4. Moderating effects of utilitarian and hedonic shopping orientations

5. Interaction effects between retail greenery and lighting temperature

6. Need to focus on other cognitive and affective states

Retail Greenery and Lighting Temperature

Potential Design

Retail greenery creates higher pleasure, arousal, perceived merchandise quality, satisfaction, and purchase intention than the non-retail greenery condition

01

Lifestyle shopping

The implementation of retail greenery in the biophilic design may provide consumers with lifestyle shopping experiences (Rosenbaum et al., 2019)

02

Seamless shopping

Integrating vegetation and biophilic attributes could facilitate consumers engaging in seamless shopping experiences

03

Interactive effects

The interaction effects are evident between retail greenery and lighting temperature

04

Retail Greenery and Lighting Temperature

Fluent Processing

The interactive effects between retail greenery and cool lighting may enhance fluent and ease processing of information

05

Cognitive fit

Cool lighting may conceptually fit with retail greenery application. Cool lighting increases visual clarity and brighter than warm lighting (Park and Farr, 2007).

06

Contradictory findings

Current findings are not consistent with findings in previous studies including Yang (2015), Mouhoubi (2014), Park and Farr (2007).

-Consumers treated differently in the virtual environment compared to the physical environment

07

Supportive findings

Findings from my study supported the Lin and Yoon (2015) study

08

Retail Greenery and Lighting Temperature

Sensory variability

Key difference between the retail greenery and non-retail greenery application is sensory variability

09

Perceived realism

Retail greenery could also enhance consumers' sense of presence in the 3D virtually mediated environment.

10

Cognitive overload

Retail greenery creates higher perceived complexity than non-retail greenery.

11

Interface and lighting

Consumers look for visual clarity and a sense of ease in processing information within the virtual environment. 3D dimension needs more research. They are not the exact copy of the physical environment

12

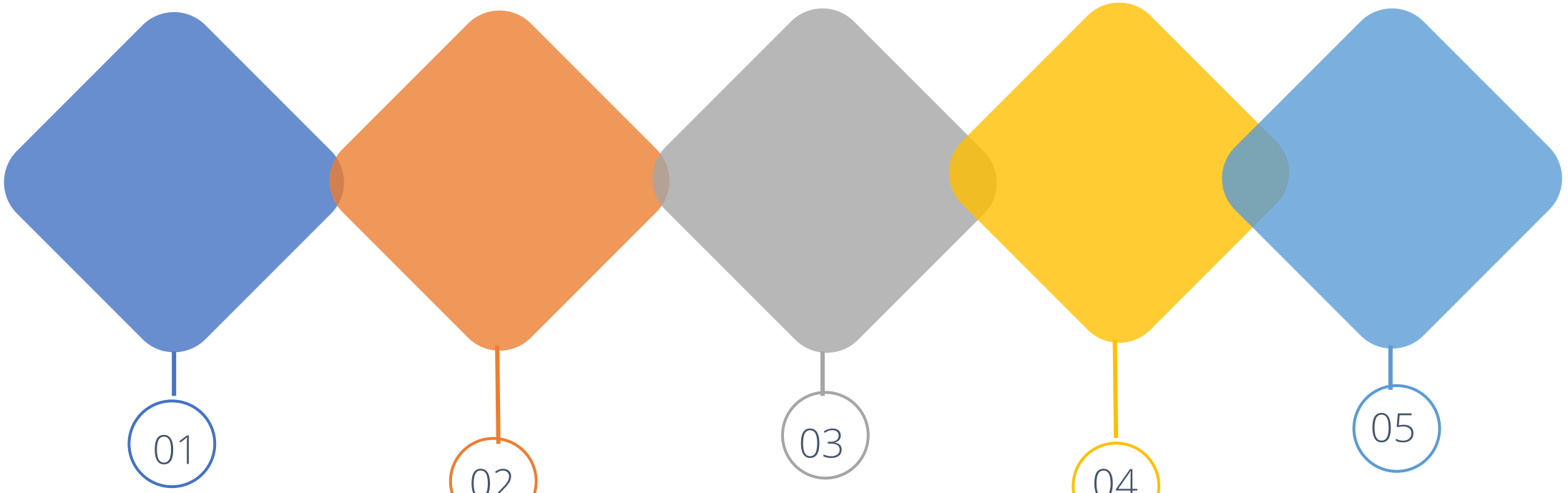
Shopping Orientations

Retail greenery and shopping orientations do not interact with each other. That is utilitarian and hedonic shopping orientations do not significant differences under the retail greenery condition. However, lighting matters. Findings suggest three -way interaction effects greenery, lighting temperature, and shopping orientations.

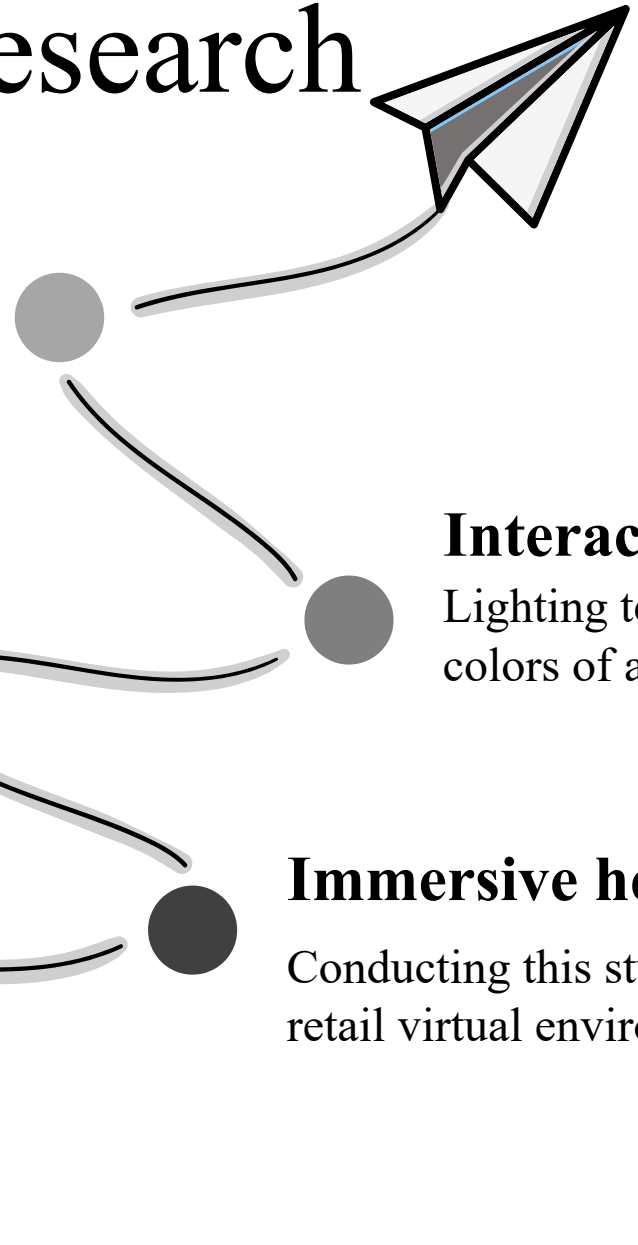
Lighting temperature does not interact with shopping orientations

There are interaction effects between non-retail greenery and shopping orientations. Non-greenery conditions might work better for utilitarian shopping orientations than hedonic shopping orientations

Limitations



Future Research



Environmental congruence

Congruence between product type and biophilic attributes

Interactive effects

Lighting temperature and colors of apparel items

Moderating role

Fashion involvement, need for cognition, age, gender.

Immersive headset

Conducting this study in the retail virtual environment

User centric design

User interviews, wireframes development, heuristic evaluation, usability testing .