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Architectural Solar Control Assessment: The Impact of Four Strategies on Building and Occupant Factors on the East and West Facades of Offices

“While the most valuable asset of daylight is its free availability, the most difficult aspect is its controllability, as daylight changes during the course of the day. Daylighting is more of an art than a science...” (ASHRAE, 2011. p. 37).

ABSTRACT

There is currently limited knowledge on the effectiveness of solar control techniques on east- and west-facing facades, and there is limited agreement on when and how they should be used. Authoritative sources recommend using the less effective techniques on these sides or to decrease the amount of glazing, but evidence suggests that people prefer having windows for access to daylight and nature, so decreasing glazing amount is also not an ideal solution. Designers need a better understanding of the performance of solar control techniques on the east and west of buildings. **The purpose of this research study is to assess the effectiveness of shading techniques on those facades of buildings, taking into account both benefits to the building functionality and benefits to the occupants.** Using Ecological Psychology’s Theory of Affordances, building-focused and occupant-focused affordances are explored through a mixed methods explanatory sequential methodology consisting of an experiment, survey, and in-depth interviews. Shading techniques assessed in this study include horizontal louvers, vertical louvers, eggcrate system, and vegetative configurations. The experimental and survey data will be collected in the Rotating Daylighting Laboratory at North Carolina State University in Raleigh, NC. This lab allows for the examination of every solar altitude and azimuth angle for an entire year, in one day, drastically extending the applicability of the data. This study can provide a baseline for future research in this topic area, contribute methodologically to the exploration of this topic, and offer a more holistic understanding of the benefits and drawbacks of solar control techniques on the east- and west-facing facades of buildings by including both instrument measurements and direct perceptions, preferences, and opinions of occupants.

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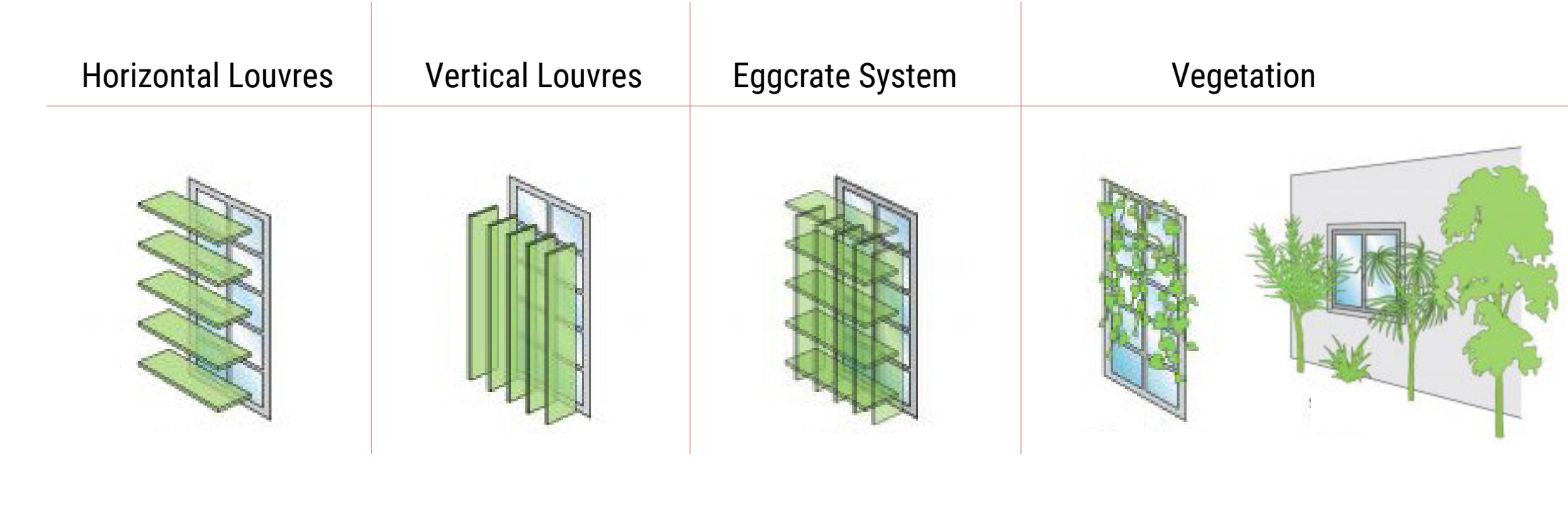
1. Background + Literature Review

The effects of sunlight on buildings include **illumination (visual light)** and **solar radiation (thermal)**, which together effect the **energy** use of buildings. Sunlight effects occupant **visual and thermal comfort, circadian rhythm, and biophilic connection** through views.

A. There are strategies that have historically been used for solar control on buildings.

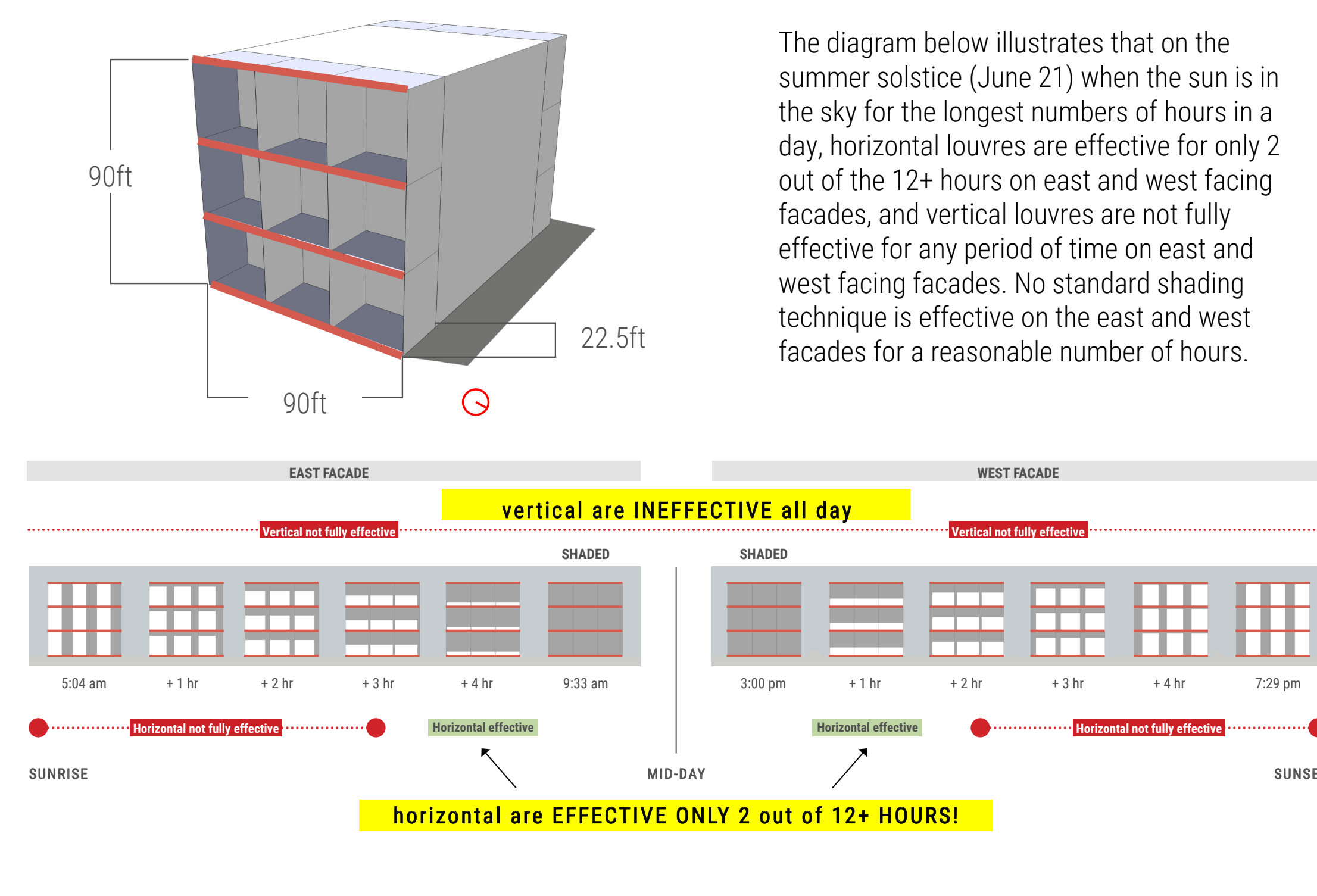
SCT [Solar Control Technique] = Architectural design elements used to manage unwanted daylight while maximizing “useful” daylight

Exclusion Criteria: Kinetic/moveable or temporary
Inclusion Criteria: Static/non-moveable* and permanent



B. Typical static, permanent architectural SCTs are virtually ineffective on the east and west facades of buildings.

Lack of Effectiveness of Horizontal, Vertical, and Eggcrate SCTs on East and West Facades



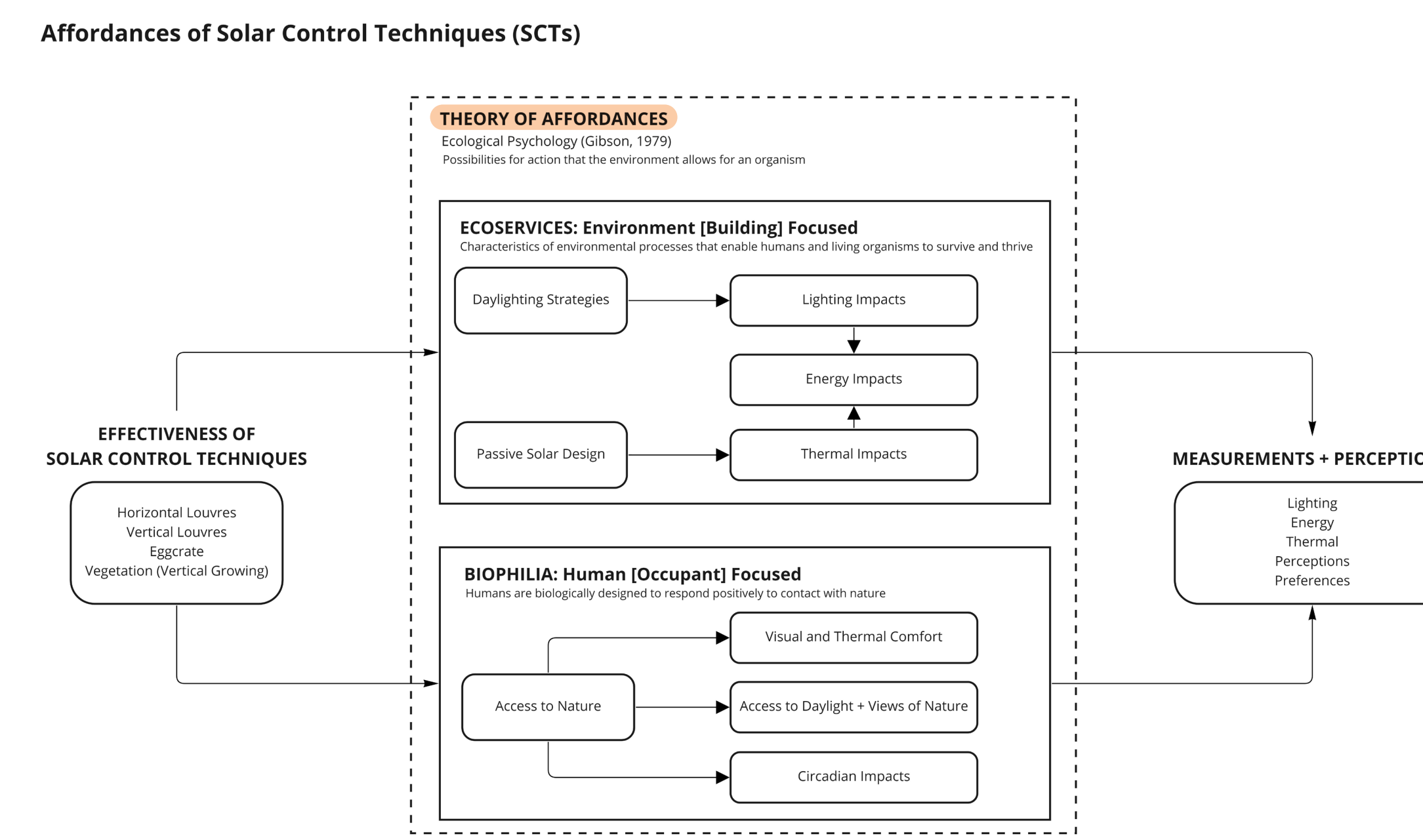
C. There is a lack of agreement on the effectiveness of SCTs on the east and west facades in seminal works on solar control.

Lack of Agreement on Effectiveness of SCTs on East and West Facades from Seminal Architectural Works on Solar Control

	Olgay/Olgay, 1957	AIA, 1981	Ching/Adams, 2001	ASHRAE, 2011	Kamal, 2011	Alshamrani/Mujeebu, 2016
Horizontal	Ineffective on EW	Not specified for EW	Not specified for EW	Not specified for EW	Ineffective on W, but more effective than vertical	More effective than vertical
Vertical	Ineffective on EW, but could decrease summer heat gain	Most successful on EW	Most effective on EW	Effective on EW, but most effective when slanted N and done together	Ineffective on EW	Ineffective on EW
Eggcrate	Ineffective on EW, but could decrease summer heat gain, especially in SW orientation	Effective in SE and SW orientations	Efficient in hot climates	Not mentioned	Not mentioned	Best performing on EW
Vegetation	Effective on EW, especially SE and SW orientations	Not mentioned	Most effective on SE and SW	Effective on EW	Effective on EW	Not mentioned

According to this source [columns headed] this SCT [row headed] is...
 ■ SCT is ineffective on EW ■ SCT is effective on EW under certain conditions ■ SCT is effective on EW ■ Not mentioned/specified for EW

2. Theoretical + Conceptual Framework



3. Research Objective + Questions

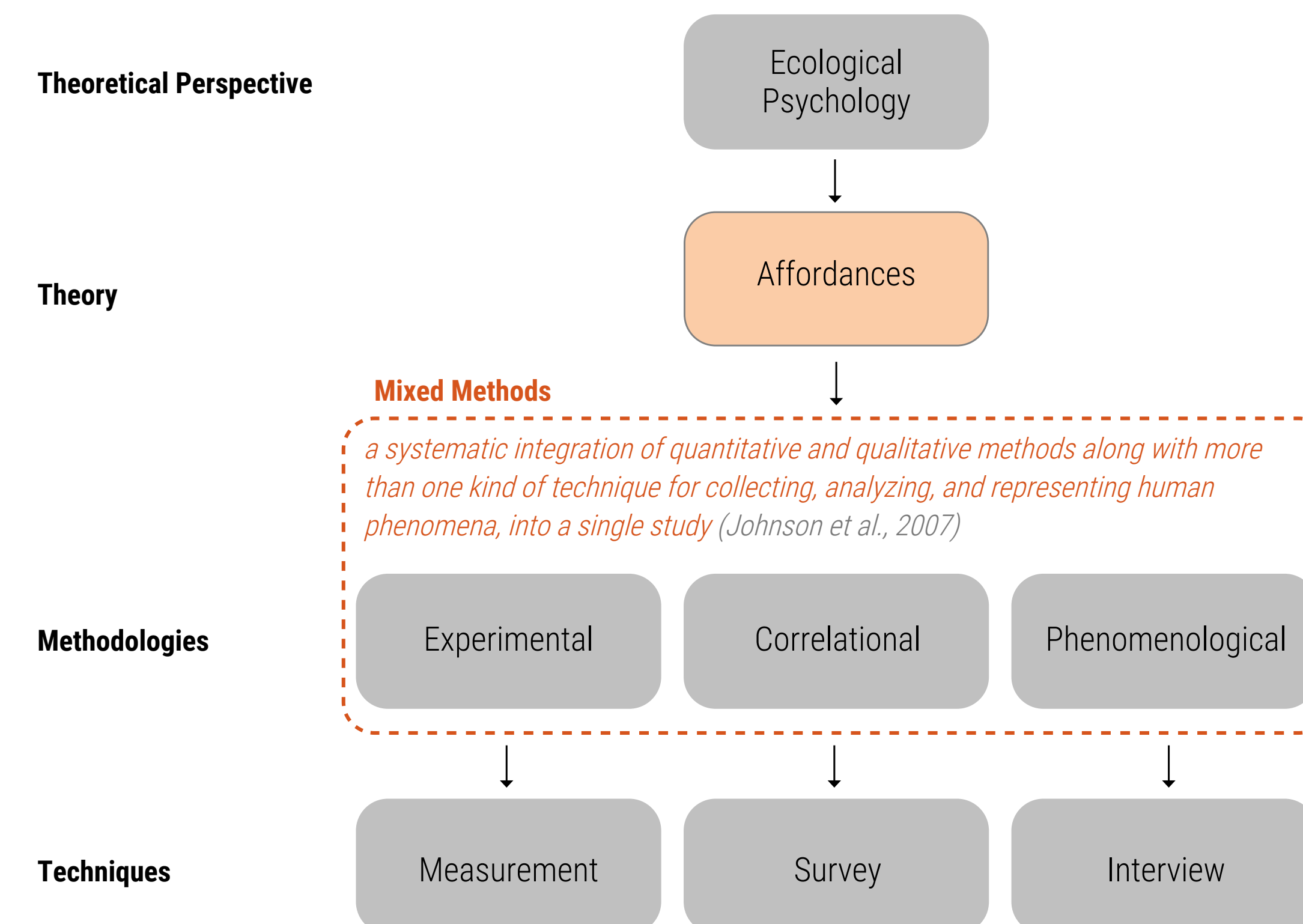
The aim of this research is to examine the effectiveness of solar control techniques on the east- and west-facing facades of offices in the southeastern United States. In framing ecoservices and biophilia as affordances, the effectiveness of SCTs will be assessed from the lenses of building-focused and occupant-focused affordances. Research question 1 (RQ1) is related to building-focused affordances, and Research questions 2 and 3 (RQ2, RQ3) are related to occupant-focused affordances.

RQ1 What solar control techniques (SCTs) are most effective on the east and west facing facades of offices in the Southeast United States?

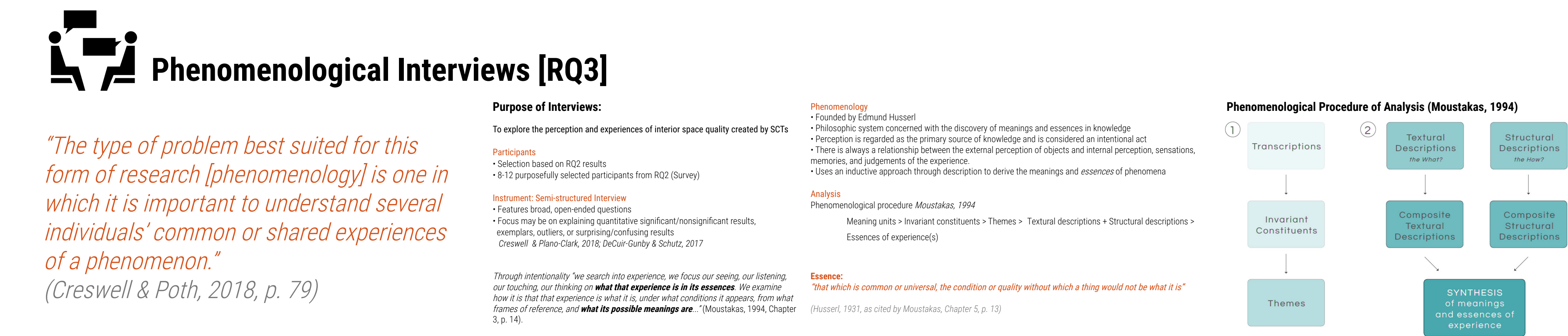
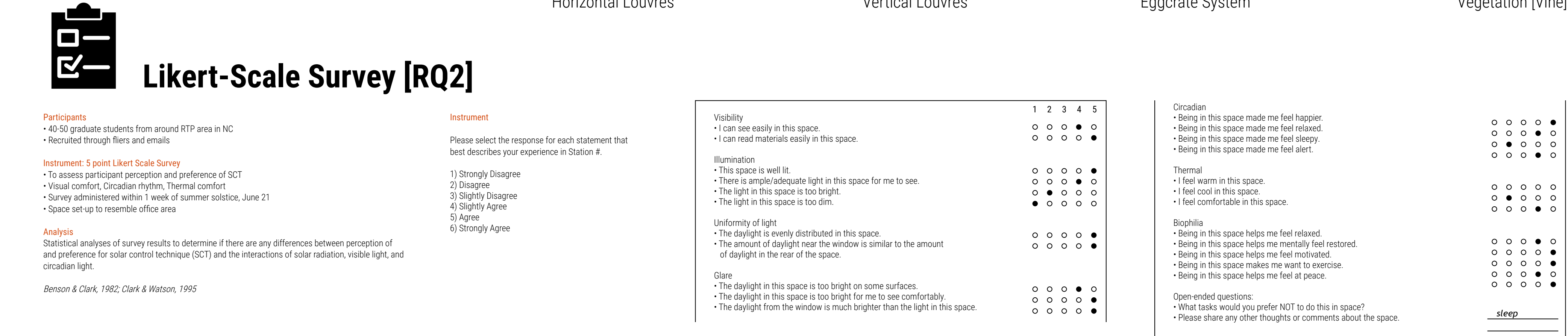
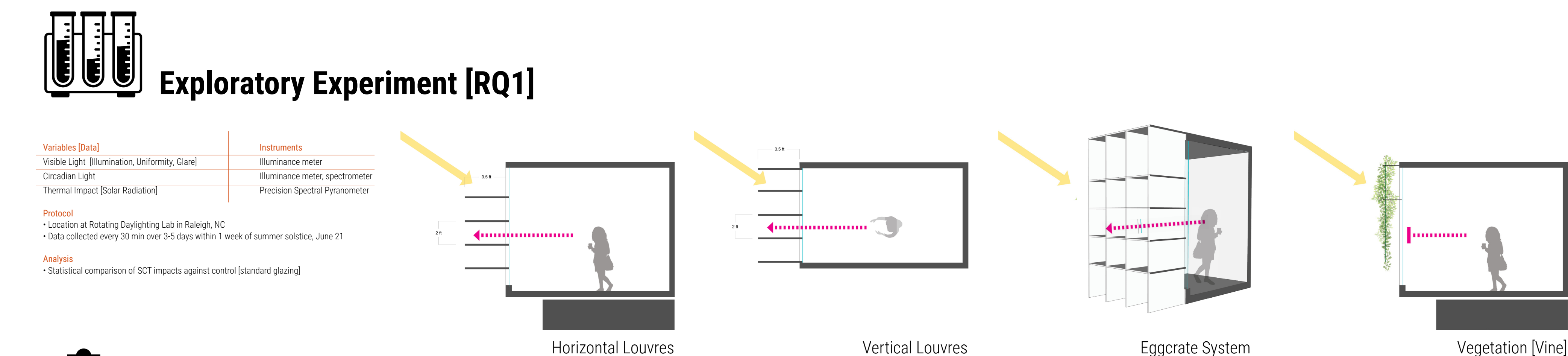
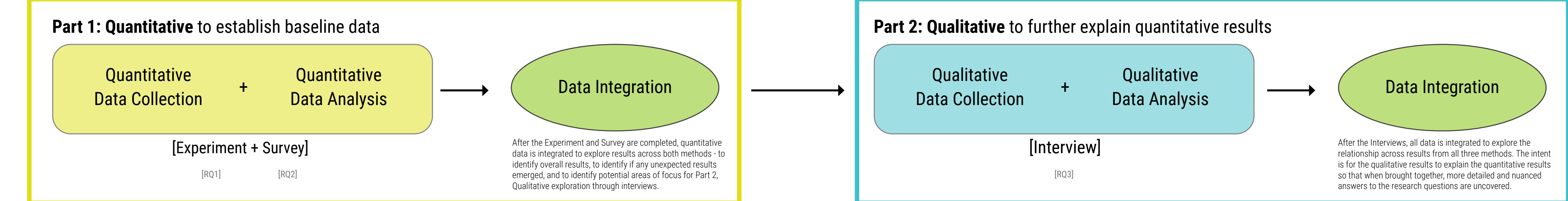
RQ2 What solar control techniques (SCTs) do users prefer on the east and west facing facades of offices in the Southeast United States?

RQ3 Why do office users in the Southeast United States prefer certain solar control techniques (SCTs) more than others?

4. Research Strategy



5. Methodology: Explanatory Sequential Mixed Method Design



6. Next Steps

DATA COLLECTION + ANALYSIS | It is anticipated that data will be collected in spring and summer 2026 and analyzed in fall 2026 through spring of 2027.

SIGNIFICANCE | Findings will shed light on the effectiveness of vegetation as shading compared to three SCTs typically used in architectural design. This study has the potential to inform best practices or guidelines for built environment designers when selecting and designing SCTs on the east- and west-facing facades of buildings. The inclusion of participants’ views, opinions, and experiences through the phenomenological interviews will allow for occupant perceptions of and preferences for SCTs to be shared and included in the assessment of the SCT performance. Furthermore, the inclusion of this information will provide designers with a better understanding of how occupants benefit and perceive SCTs on the east- and west-facing facades of buildings. Lastly, this study can provide a baseline for future research on the effectiveness of SCTs in these orientations with a more holistic protocol; thus, this study can contribute methodologically to approaches used to explore this topic.

DISSEMINATION | Portions of the literature review, methodological organization, and findings may be disseminated at conferences (such as ARCC, EDRA, and ASHRAE Annual Conferences), in journals (such as Building and Environment, International Journal of Architectural Research, and Journal of Mixed Methods Research), and with industry practitioners (such as AIA and ASHRAE) through presentations and condensed guidelines.

NEXT STEPS | Next steps after concluding this research depends on findings, but includes investigating the efficacy of various vegetation types and species for shading, exploring the use of vegetation as shading within building envelopes, and integrating vegetation within other building systems.