

# Semiotic and Phenomenological Study of Sacred Architecture Using Last-Generation Eye-Tracking Instrumentation in Real Conditions vs. AI-based Predictions

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Sacred buildings work as pedagogic devices to transmit religious understanding and access spiritual reality. It is this double function that guarantees communal and personal spiritual continuity and growth. In this process, aesthetics has always played a decisive role. Long ago, builders of hallowed structures learned and applied the simple truth that, as Plato articulated 2,500 years ago, we are attracted to, fall in love with, and want to know more about and share that which we find beautiful. If, on the one hand, most scholars and architects would agree with these insights, on the other hand, there is much less agreement about how architecture manages to deliver such results.

For example, among the many competing explanations are those from Theological aesthetics. [1] Scholars in this area have been examining and offering insights about the communicational (semiotic) and experiential (phenomenological) power of the sacred arts for a long time, often focusing on architecture as the writings of Abbot Suger (1140s), Thomas Aquinas (1260s), Rudolf Otto (1970), John Paul II (1999), and Ratzinger (2019) attest.[2] Over the last two decades, this inquiry has been enriched by work coming from other disciplines.[3] Yet, these studies provide little information about what and how concrete architectural features enable the communication of spiritual understanding.[4] Arguably, architects have gone the furthest in this regard. Using case studies, architectural history, and typological analysis, they have identified architectural properties that effectively transmit spiritual understanding.[5] The problem is how one decides which one(s) of these alternative explanations is correct or, at least, closer to what is really happening. Moving forward necessitates some “objective” method to evaluate any given claim; and for this, there is arguably no better path than a reasonable and cautioned deployment of empirically-grounded means of investigation. In fact, it is because all the existing explanations have been based on indirect means to support their claims (e.g., surveys and behavioral observations at best – see [6]), making it difficult to move forward. Similar limitations afflicted the semiotic investigations of architecture of the 1970s and 80s [7] and more recent narrative/phenomenological studies of buildings.[8] At the same time, not all empirical work with relevance to sacred architecture has been helpful as the efforts have fallen short because they are too narrow,[9] too general,[10] or too focused on effects and not causes.[11] In other words, a carefully designed research agenda is necessary for real progress. The good news is that there have been significant developments in mobile eye-tracking technology and AI (Artificial Intelligence) that open unprecedented opportunities to gain an empirical understanding of how sacred architecture engages people and communicates.

This paper reports on research intending to address this whole situation by mapping the aesthetic interactions between architecture and human behavior/cognition by applying those cutting-edge instruments to:

1. identify how architectural features encode aesthetic quality and facilitate both aesthetic reaction and spiritual insights;
2. determine how this process occurs both semiotically and phenomenologically;
3. gauge the kinds and levels of cognitive-aesthetic outcomes; and
4. elucidate the special aesthetic/cognitive dimensions of architecture.

We are guided by a theoretical framework that establishes sacred buildings as (a) *utilizing specific architectural features* to (b) *encode and communicate spiritual reality and understandings (as information, orientation, and rituals [12])* and that postulates that those features and how we engage them are grounded (c) on “pre-cognitive” mental structures that foreshadow our conscious aesthetic and cognitive response. [13]

Specifically, we deployed ambulatory eye-tracking (ViewPoint System, VPS 19), AI-based scene analysis (3M VAS, Visual Attention Software), biosensors (Empatica E4 wristband), and questionnaires to gauge, document, and analyze how two different buildings (one religious and one secular) communicated spiritual and other understandings to 32 individuals of Catholic faith. Whereas eye-tracking has been used in laboratory settings to study architecture and urbanism in the past, to our knowledge, this is the first time that an ecological experimental paradigm (i.e., one situated in real life conditions) has been deployed on sacred architecture and one of very few in architecture and urbanism in general. Our presentation will share this unique scientific effort and study methodology as well as its results. Of particular interest will be the comparison between AI-based predictions of how people “should” perceive the architectural scenes and the actual, ecologically situated results from actual people visiting the buildings. Lastly, since this interdisciplinary work is related to another study using neuroscience and biometrics to measure the architectural effects of the same two buildings on devoted Catholics, [14] we will be able to explore the correspondence between architectural causes and effects at an unprecedented empirical level.



Figure 1: one of the research subjects wearing the mobile eye-tracking system while visiting the sacred space.



Figure 2: Mobile eye-tracking results inside the sacred building. Colors map high (red), medium (yellow), and lower (green) levels of visual attention that were statistically calculated across the 32 subjects that visited the building.

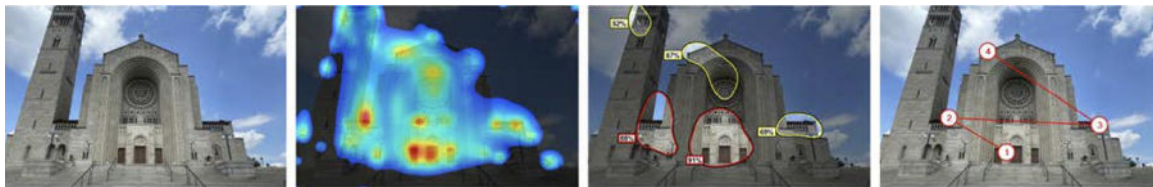


Figure 3: AI-based scene analysis. Color mapping is similar to the above, with blue standing for the lowest levels of attention. This study uses no subjects but is purely algorithmic.

### Full References

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- [2] Aquinas, c.1260s; John Paul II, 1999; Suger, c.1140s; Otto, 1970; Ratzinger, 2019.
- [3] Bergmann, 2012; Bermudez, 2015; Hejduk & Williamson, 2011; Jaeger 2010.
- [4] Daelemans, 2015; Kieckhefer, 2004; Lukken & Searle, 1993; Thomas, 1994; Wuerl & Aquilina, 2013.
- [5] Alexander, 1977, 1979; Ardalan et al., 2014; Lawlor, 1994; Mann, 1993; Schwarz, 1958; Stegers, 2008.
- [6] Bermudez, 2009, 2011; Levi & Kocher 2012; Ouellette et al., 2005.
- [7] Broadbent et al., 1980; Eco, 1986; Hillier & Hanson, 1984; Preziosi, 1979; Williams Robinson, 2006.
- [8] Austin, 2020; Lawson, 2001; Psarra, 2009.
- [9] Arnheim, 2009; Goh et al., 2010; Vartanian et al., 2015.
- [10] Arbib, 2022; Manzo & Devine-Wright, 2013; Ritchie, 2020.
- [11] Bermudez et al., 2017; Herzog et al., 2010; Hollander & Anderson, 2020.
- [12] Jones, 2000.
- [13] Cosmides & Tooby, 1997; Hildebrand, 1999; Kellert, 2018; Sussman & Hollander, 2021. This claim is also supported in Chomskyan linguistics, Jungian psychoanalysis, and Wilberian integral psychology.
- [14] Bermudez & Nakamura, 2023.

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