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RESEARCH ARTICLE

Late Roman Villas and Cognitive Science

John Stephenson

Without the benefit of cognitive or evolutionary theory, late Roman villa patrons and designers intuited their way toward houses that engaged and strongly affected the emotions of inhabitants and visitor participants. Through the lens of their unique cultural moment, they discovered and deployed strategies that respond to certain innate and universal human needs. These were the aspects of a formal language of design that arose from a competitive 'architectural arms race' among a newly minted elite in the era of the late empire, which left a heritage that echoes through the history of architecture. Through the application of methods in cognitive science we can recover some of those strategies and understand their effects with a new specificity. Cognitive science confirms, continues, and elucidates earlier discoveries in phenomenology and psychology, placing the embodied and active human agent into the center of the experience of ancient architecture.

> If you look at the Baths of Caracalla … we all know that we can bathe just as well under an 8-foot ceiling as we can under a 150-foot ceiling … but I believe there's something about a 150-foot ceiling that makes a man a different kind of man.
> — Louis Khan on the Baths of Caracalla at Rome (Kahn 1960: 150)

Introduction

Roman villas of the elite in the late Roman empire, from approximately the 3rd to 5th centuries AD, comprise one of the largest and richest bodies of material culture of the era. Some 1,000 aristocratic houses of the period have been discovered in the region of the former empire, while over 1,100 citations of villa remains are recorded for Spain alone, in situ or in textual references, many of them dating to the late period (Bowes 2010; Gorges 1979).[1] If the great 4th-century Sicilian villa of Pizza Armerina remains the most renowned example of a luxury villa of the late empire, important new discoveries continue to be made that rival even that spectacular find, such as the recently excavated palatial villa of Cercadilla at Cordoba (Hidalgo Prieto 1996) (**Figure 1**), or the Spanish villa of Maternus at Carranque in central Spain, with its domed and apsidal reception halls, extensive mosaics, private basilica, hypocaust heating, and imported marbles, and its own separate Christian basilica (Fernández-Galiano 2001) (**Figure 2**). Roman villas, freestanding rural estates incorporating both a residence (*pars urbana*) and agricultural and other production facilities (*pars rustica*), are a distinctive feature of Roman culture.[2] The villa as an idea and architectural type is a Roman invention that has inspired revivals and interpretations throughout history up to today.

Appalachian State University, US
stephensonjw@appstate.edu

While the earliest villas in Italy date to the later 2nd century BC (Marzano and Métraux 2018; Ackerman 1985), villas arrived a bit later in the provinces. In Spain they began to replace modest farmhouses during the 1st century AD, and numerous luxurious *latifundia* (large villa estates) became widespread in the countryside in the course of the 2nd century (Kulikowski 2004). The appearance of Roman-style peristyle houses and villas in the provinces is considered one of the most significant indexes of the adoption of a Roman lifestyle among the provincial elite.[3] Over the subsequent centuries and in tandem with social change in the empire, villa designers would develop an architectural language which itself 'became an agent of Roman cultural identity' (Zarmakoupi 2014: 13). The ideology of the Roman villa centered around its provision of a setting for *otium*, or educated leisure, in the countryside, but always in relation to the city, and incorporating 'public' activities revolving around *patrocinium*, or the face-to-face patron-client relationship that was central to Roman civic life. For a half millennium, Roman villa owners, from Pliny the Younger in the 1st to 2nd century to Sidonius Apollinaris in the 5th century, eulogized their manifold villa holdings in letters among themselves, and visited each other's villas in a circuit of mobile *otium* among *amici*. During those centuries, the villa became the site of intense competition among the elite in Italy and the provinces.

Especially during the early and mid-4th century and continuing into the 5th, a veritable explosion of wealth and creativity was expended on luxury villas (Ellis 1989). According to varied evidence, including data from recent urban and villa excavation, this late burst of villa expansion was part of a surge in general prosperity that included still vital if changing cities (Kulikowski 2004; Bowes 2010). This late period of vibrant prosperity was fueled by elite competition for new honors and positions, especially in the hothouse political atmosphere initiated by governmental expansion and reforms during the

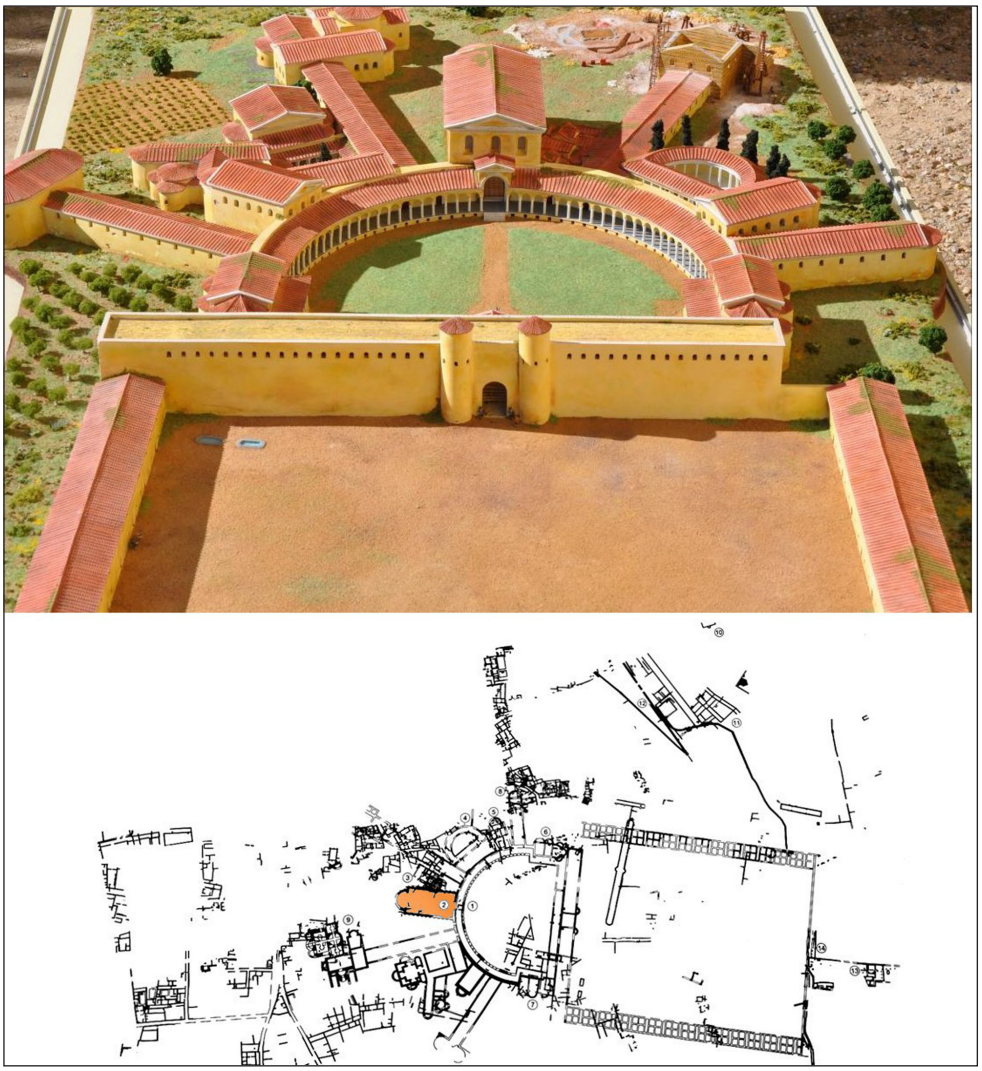

Figure 1: The 'Palacio' of Cercadilla (Cordoba, Spain), plan and reconstruction. Plan by permission of Alexandra Chavarria Arnau; reconstruction model photograph by John Stephenson.

Figure 2: Villa of Maternus at Carranque (Toledo, Spain), general view. Photo by John Stephenson.

reigns of Diocletian and Constantine, circa 284 to 337 AD (Heather 1998).[4] These newly competing elites deployed vast resources and a new aesthetic language in a kind of domestic arms race, aimed at staking out positions in the new social order of the late empire:

> 'By employing an iconography of civic architecture and a sophisticated aesthetic language based on curving, apsidal forms, these houses enabled their owners to claw their way up the social ladder' (Bowes 2010: 95).

Much of the work of this competition must have been enacted through person to person visits by members of a provincial elite; in certain regions we can even distinguish clusters or 'neighborhoods' of competing villas (Marzano and Métraux 2018: 22–23), though villa-owning aristocrats often speak of traveling substantial distances to visit other estates.[5]

The scale of villa holdings among the highest elite in this period is suggested by a couple of notable examples: the pagan aristocrat Symmachus owned four houses in Rome and the region in addition to 19 villas in several provinces, and the Christian lady Melania the Younger owned estates in Italy, Sicily, Spain, Africa, Mauretania, Britain, 'and other countries', including one property that included 400 *coloni*, or land-tied workers.[6] Villa design in the late empire is striking in its innovations, such as in the design of curving and domical and other non-orthogonal forms, revealing its importance to architectural history in the domestic, palatial, and sacred architecture of later cultures, including Christianity and Islam. This article examines the formal innovations of the late villas and outlines an approach to the reception of those forms that asks *how*, on an individual, bodily, and cognitive level, they performed a role in the competitive environment of this era, impressing and even overwhelming participants among a new class of aristocrats.

The Villa as a Cognitive Experiment

In this article I examine the unique formal qualities of the late Roman villas with reference to new discoveries concerning human cognition – 'the many processes by which people understand, interpret, and organize sensory, social and internally generated data' (Goldhagen 2017: 46) — in order to appreciate just how these ancient houses delivered their competitive emotional punch and visual appeal. Such an approach places the active human mind and body at the center of architecture as experience, and carries forward the phenomenological work of earlier generations of theorists, making the object of study an interactive event between the created setting and a sentient participant able to move in space. The approach can inform our understanding in new detail regarding the connections between the intentions of designers of built environments from the past and the reception of users, and may offer objective criteria for identifying successful architecture. Jelić et al. write that 'it is possible to construct a strong frame of reference for comparing neuroscientific results with examples of well-designed spaces, like in the case of documented experiential quality of architectural masterpieces' (Jelić et al. 2016: 481). Cognitive approaches cannot answer all questions in the study of architecture, and are no replacement for the humanities but a complementary means of approaching the same phenomena (Gallese and Gattara 2017).[7]

If humanistic studies have shown that late Roman villas were 'machines for competition' (Bowes 2010: 97), and have identified innovative formal aspects of villas that played this role, cognitive approaches can help to explain *how* they made their impressions on participants at a bodily level. A focus on aesthetics in villa design shifts the discussion away from a well-worn debate over the social and political motives of late Roman patrons — the *why* — and toward a complementary understanding of how formal choices were conceived and interpreted to achieve patrons' competitive goals. My argument is this: Without the benefit of cognitive or evolutionary theory, late Roman villa designers intuited their way toward houses that engaged and strongly affected the emotions of inhabitants and visitor participants, by discovering and deploying, through the lens of their unique cultural moment, strategies that respond to innate and universal human needs. These were the aspects of a formal language that succeeded in their time, and left an architectural heritage that echoed through later periods of history. Through methods of cognitive and evolutionary science we can recover some of those strategies, and understand more clearly their effects with a new specificity. While the observations are generally applicable to late villas across the empire, my primary examples derive chiefly from the Iberian peninsula: modern Spain and Portugal, or ancient Hispania (Stephenson 2006; 2014; 2016).

The Material: Novel Features of the Late Roman Villa

Villa design and decor in the late Roman Empire involved both continuity and novelty in relation to earlier periods (Ellis 1989; Stephenson 2006). Villas continued to be organized as freestanding estates, as they had long been, often dominating their surroundings through scale and height, and composed of a conglomerate of independently roofed suites presenting a pyramidal pile to the viewer, and featuring external features such as towers and winged entry courts. The main residential sector of the 4th-century villa of Almenara de Adaja (Valladolid, Spain) covers over 2,500 square meters, behind two projecting arms framing the entry façade and extending some 70 meters (García Merino and Sánchez Simón 2001) (**Figures 3** and **4**).

The reconstruction image shows the villa situated next to a lake and with peripheral land given over to agricultural activities. The villa's main entry faces the winged exterior court; two open peristyle courts are visible within the complex, which are connected by a series of corridors revealed by low-slung roof lines. Around these courts are clustered five eccentrically shaped reception halls with raised rooflines, such as the octagon hall at left, and the triple-apsed triconch hall rising above the others at the right. The interiors of late villas were most often organized according to a familiar plan, with living spaces grouped around one or more peristyles: open spaces ringed by covered galleries supported by colonnades and giving access to principle rooms. Late villas often featured multiple

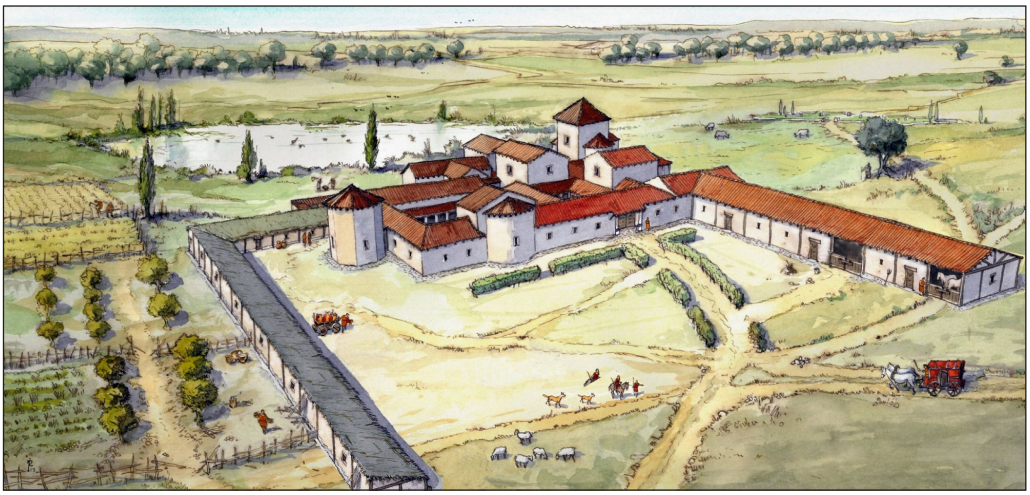

Figure 3: Villa of Almenara de Adaja (Valladolid, Spain) reconstruction drawing. By permission of the artist, José Ramón Almeida.

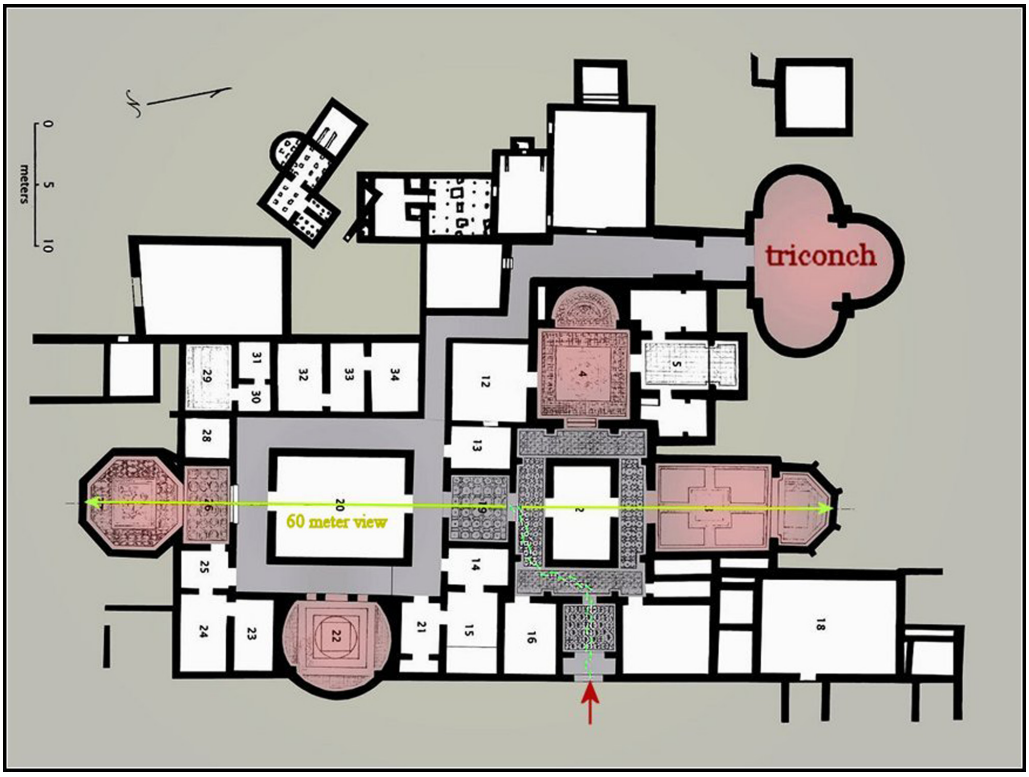

Figure 4: Villa of Almenara de Adaja (Valladolid, Spain), plan. Drawn by John Stephenson.

peristyles, and their dimensions grew to truly monumental and civic scales: the recently discovered 'Palacio' de Cercadilla (Cordoba) covers some 80,000 square meters (Hidalgo Prieto 2006) (**Figure 1**). In some villas the overall layout sometimes broke out of the traditional orthogonal plan to exhibit new forms, such as circles, hemicycles, and octagons. The villa of Baños de la Reina (Calpe, Spain) is organized around a circular court (García Entero 2006) (**Figure 5**), while the villa of Rabaçal (Coimbra, Portugal) features an octagonal court (Pessoa et al. 1993) (**Figure 6**).

Water features such as pools, canals, and fountains in peristyles and elsewhere also continued to be prevalent, though they often became larger and more complex (Stephenson 2009). At the villa of São Cucufate (Vidigueira, Portugal) two vast rectangular pools, each around 40 meters in length, flank the front and rear exterior of the residence (Alarcão et al. 1990) (**Figure 7**). Late villas incorporated towers and viewing platforms; impressive galleried façades, some with arcuated triple bay entrances; hemicycle entry courts; and freestanding temples and basilicas. The 'Palacio' de Cercadilla features a 100-meter-wide hemicycle court behind an entry court formed by two projecting arms, around 200 meters in length, and centers on the second largest apsidal basilica of the era after the Constantinian basilica at Trier (**Figure 1**). Interior rooms in the late villas also took on familiar orthogonal forms, though these could grow to vast proportions, such as in the 15-meter salon at La Olmeda (Palencia, Spain) (Nozal Calvo et al. 2000) (**Figure 8**).

Figure 5: Villa of Baños de la Reina (Calpe, Spain), reconstruction. By permission of the Ajuntament de Calpe.

Figure 6: Villa of Rabaçal (Coimbra, Portugal), aerial view. By permission of Otium Country House.

While many features from the past persisted, new types of structures began to appear in late villa interiors, such as private basilicas, elaborate thermal bath complexes, and oversized dining and reception suites, and these were the sites of newly intensive experimentation with curving and other non-orthogonal forms, including the apse and dome, domed octagons, apsidal halls, and multi-apsed triconchs and tetraconchs. The villa of Almenara de Adaja contains a collection of five apsidal and radially planned rooms (**Figure 4**), while the villa of Maternus at Carranque (Madrid) displays a series of round, domical spaces on its main axis, culminating in a domed triclinium (Fernández-Galiano 2001) (**Figure 9**). A bath building at the villa of Torre Cardeira (Quintos, Portugal) demonstrates this spirit of eccentric deployment of apses and domes in its anthropomorphic tree plan featuring 12 apsidal spaces with a domed head crowned by three smaller domes, with a hexagon room appended for good measure (**Figure 10**).

Moreover, villas now featured a greater specialization of spaces; extended, circuitous routes; view blocking and manipulation; increased control of visitors movements; and greater privacy for inhabitants. The villa of Almenara de Adaja incorporates nearly 200 meters of passageways in its connective armature, providing numerous

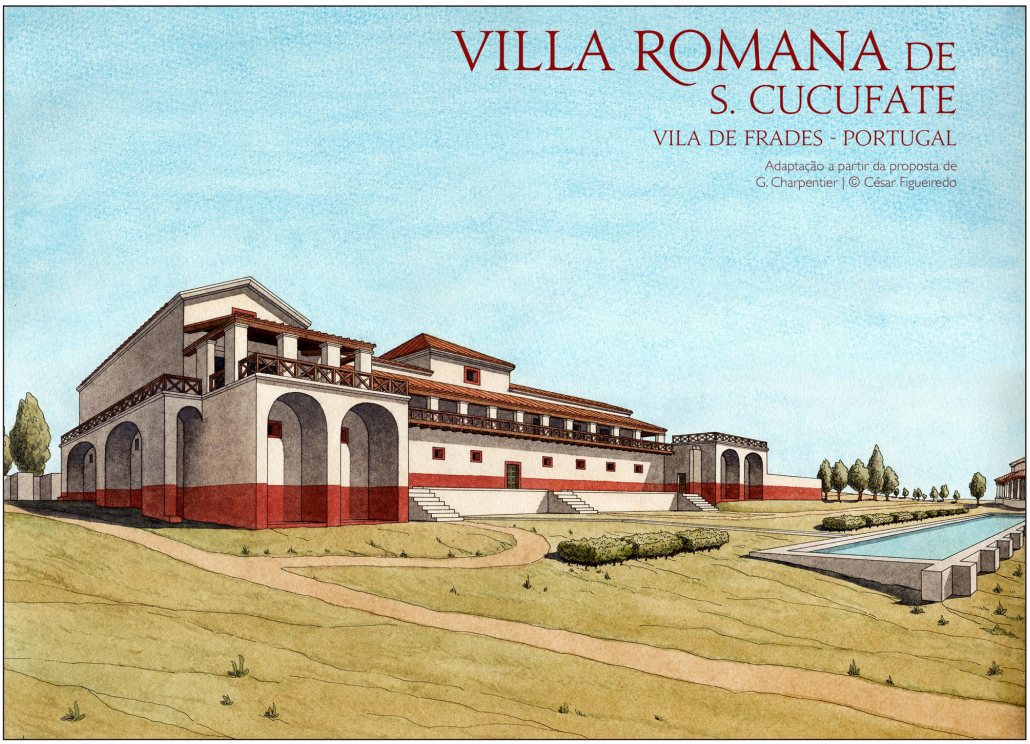

Figure 7: Villa of São Cucufate (Vidigueira, Portugal), reconstruction based on G. Charpentier. By permission of the artist César Figueiredo.

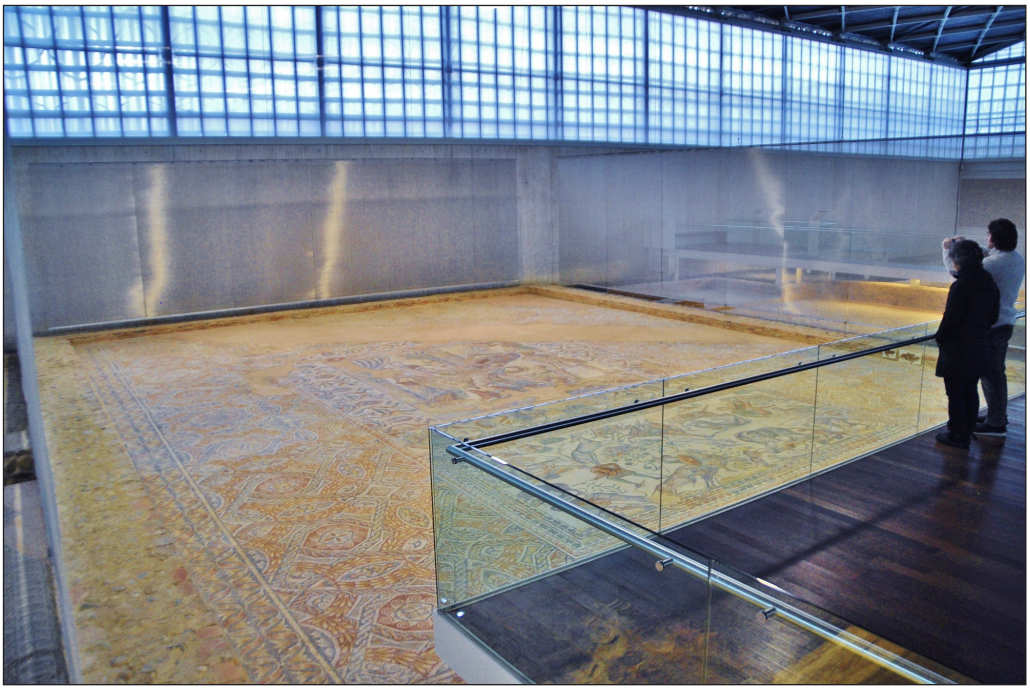

Figure 8: Villa of La Olmeda (Palencia, Spain), view of the grand salon. Photo by John Stephenson.

turns, steps, thresholds, and strongly manipulated views (**Figure 4**). Floor decoration included mosaic pavements in extremely bright colors and eye-catching geometric patterns (**Figure 11**), as well as figurative scenes; the total area of mosaic pavement as well as hypocaust floor heating tended to increase as villas grew larger.

The overall arrangements of villa complexes included some new layouts, from collections of independently grouped blocks reaching into the landscape and joined by long halls and cryptoportici (covered pathways) (**Figure 1**), including what can be called radial villas that spin out their parts from a center, like spokes on a wheel (**Figure 12**), to wide-view villas that featured wraparound loggias and towers designed to exploit outward views (**Figure 13**).

In these respects, villa architecture in Hispania paralleled most of the evolutionary patterns discovered in the late empire. However, villa design in late Roman Hispania in particular was remarkable for a spirit of creative experimentation that led to exuberant and sometimes truly

Figure 9: Villa of Maternus at Carranque (Toledo, Spain), view of circular hall. Photo by John Stephenson.

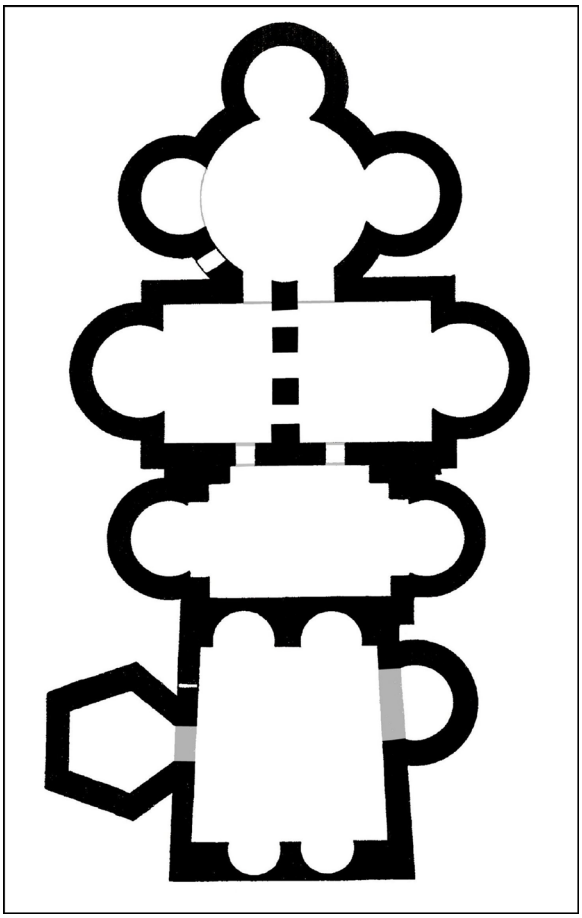

Figure 10: Villa of Torre Cardeira (Beja, Portugal), plan of the baths. Plan by John Stephenson.

eccentric designs. In no other province that I know of have round villas been discovered, for instance (Baños de la Reina, **Figure 5**), or domed circular dining rooms (round hall of Maternus, **Figure 9**), or radial villas springing from octagonal or hexagonal courtyards (Rabaçal, **Figure 6**).[8] The experiential effects of these innovations of form in the late villas are susceptible to interpretation using cognitive theory and discoveries. While introducing several discoveries in the cognitive study of architecture, I propose the application of these findings in enriching our understanding of the reception of these buildings in general, as well as their application in the interpretation of specific villas.

The Cognitive Revolution

The study of man's relationship to the built environment has in recent years been augmented by a penetration of research in the behavioral sciences, evolutionary biology, and animal behavior studies into the realm of applied design. Originating in a cognitive turn in psychological research from the 1960s, discoveries in this field have increased exponentially since the 1990s with the advent of new technologies and models. An outline of this work was published in 2015 by cognitive neuroscientist Colin Ellard, titled *Places of the Heart: The Psychogeography of Everyday Life* (Ellard 2015). Defining psychogeography initially as 'how our surroundings influence us',[9] Ellard surveys a vast emerging literature derived from methods such as functional MRIs, body feedback data, and animal behavior studies. More recently, Sarah Williams Goldhagen (2017) writes on advances in cognitive neuroscience and their role in explaining how we respond to buildings and landscapes. Much of this scholarship shares the belief that our preference for and behavior toward particular environments is in no small part innate and adaptive, as the enduring outcome of our millennia of human evolution. This emerging model reveals how our interactions with the environment 'structure and provide the framework for not only *what* but *how* we think' (Goldhagen 2017: 46; emphasis in original).

Three precepts underlie the study of cognition in the environment: first, our minds and bodies (and our

Figure 11: Villa of Maternus at Carranque (Toledo, Spain), mosaic pavement detail. Photo by John Stephenson.

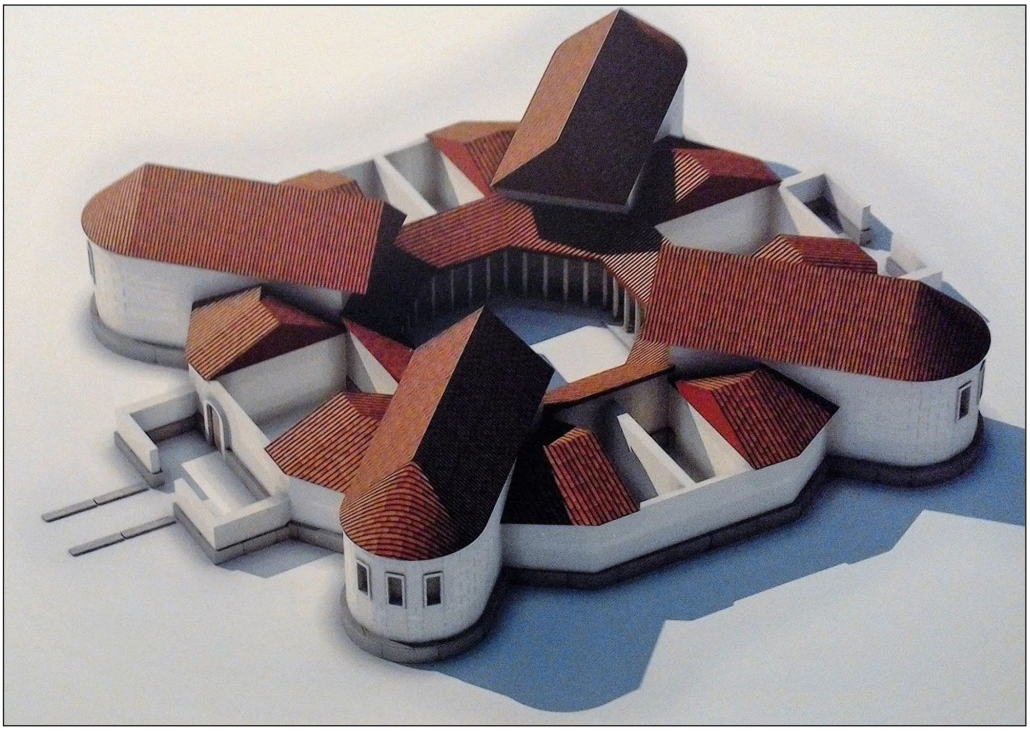

Figure 12: Villa of Valdetorres de Jarama (Madrid, Spain), reconstruction after J. Arce. By permission of the Museo Arqueológico Nacional, Madrid.

rational and emotional selves) are not separated in the traditional Cartesian sense but act in constant relation; second, much of our cognitive activity occurs below the level of consciousness; and third, these factors make us less autonomous agents in the world and more embedded participants in response to our surroundings, in a collaboration of mind, body and environment (Goldhagen 2017: 46–47). This cognitive paradigm was anticipated in the phenomenological studies of Maurice Merleau-Ponty in *Phenomenology of Perception* (Merleau-Ponty 1962) and Martin Heidegger in *Sein und Zeit* (*Being and Time*) of 1927 (Heidegger 1996). Merleau-Ponty rejected a Cartesian mind-body duality, placing the body's interaction with the world at the center of our perceptions, asserting that 'the body is our general medium for having the world' (Merleau-Ponty 1962: 129). Heidegger argued similarly that our understanding of the world and objects within it arises through being actively 'in the world'. Perception is never passive, but is action oriented: psychologist James Gibson, notably in *The Ecological*

Figure 13: Villa of São Cucufate (Vidigueira, Portugal), general view. Photo by John Stephenson.

Approach to Visual Perception (Gibson 1986) argued in his theory of 'affordances' that humans and other creatures relentlessly monitor and seek to modify their environments to better suit them and to make sense of the world. Recent neuroscientific studies have now corroborated and articulated this 'enactive account' of our engagement with environments, finding a primal 'lack of indifference' to the world among all creatures (Colombetti 2014; Jelić et al. 2016, 481). In this model, all beings are ultimately 'vehicles of meaning', as they perceive the world in combination with emotions to create meaning and value for themselves, in what has been called a 'bodily cognitive-emotional' form of apprehending the world. Cognitive science confirms, continues, and elucidates earlier discoveries in phenomenology and psychology with a new specificity. This is the historical framework and overall value of the current approach.

In our 'enactive' bodily engagement with the environment we constantly sense, decode, and incorporate information of varied types, including perceptions of spatial and surface patterns; visual assessments of tactile qualities (haptic impressions); perceptions of our body in space (proprioception), monitored for peripersonal space (within our imagined reach) versus extrapersonal space; tactile information; aural sensations; and impressions of temperature (thermoception),[10] all interacting with our sensorimotor systems for movement, and in concert with spontaneous emotions and patterns of associations built up over a lifetime (cognitive schemas or 'primes'). These latter constructs include metaphorical associations learned through living and maturing in an embodied mind, such as the universal equation of large scale with power and importance (Yannick and Verpooten 2013), and the equation of altitude and upward orientation with positive and transcendent affects (Henderson and Wakslak 2010; Meyers-Levy and Zhu 2007). In assessing and filling in gaps in our perception, such as imagery barely scanned in our peripheral vision, or the expected tactile feel of a visually perceived surface, we constantly call up and utilize stored memories and also emotions from earlier experiences. This largely unconscious activity has evolved within a system of adaptive behaviors and rewards acquired during millennia of living in an immediate relationship with our surroundings, often under conditions different from today.

New Discoveries in Cognition: Canonical Neurons and Empathic Interactions with the Environment

Cognitive research has generated a series of discoveries, many of them quite recent, that have begun to illuminate how we interact with environments as minds and bodies on a cellular level. The discovery of two types of neurons involved in motor cognition, called *canonical neurons* and *mirror neurons*, holds implications for the active experience of ancient visitors to late Roman villas (Acharya and Shukla 2012; Goldhagen 2017). These cells are located in the frontal and parietal lobes of the brain, and are triggered when we manipulate an object in close peripersonal space (such as painting a fresco or turning a door knob). But they also fire when we watch another person take the same action, or if we even look at an object that implies a potential to manipulate: we unconsciously mirror that action, 'creating' a mosaic, for instance, in our unconscious mind. In this manner canonical and mirror neurons are essential to how we learn through observation and emulation. Art historian David Freedberg argues that the empathic responses arising from this system are central to the human experience of art and architecture, independent of cultural and temporal contexts.[11] The architect Richard Neutra observed this dynamic long before the discovery of its neural basis, writing, 'Viewing hand-formed pottery, or the lines of a draughtsman, or the lettering of

a calligraphist, we unconsciously identify ourselves with their makers: we seem to follow vicariously the imagined muscular exertion in the nervous experience of the craftsman, as if experiencing it ourselves' (Neutra 1969: 74).

The role of canonical neurons and mirror neurons ensures that any environment in which are visible many human traces of its construction by human hands will trigger this kind of active engagement by a participant. Thus, every object and every interior and exterior surface of an ancient villa was rich in such stimuli, constantly generating unconscious responses to their cues. In contrast to our visual perception of overall architectural form, which runs through our parietal lobe and does not spontaneously call up or require reference to memories, our perception of surface qualities engages these neural pathways that call up memories of surfaces in varied ways — including texture, sound, color, and also past emotions — so that our perception of surfaces actually provides a richer and more complex constellation of active responses (Cant and Goodale 2007).

In this light, the more opulent late Roman villas deployed an unprecedented wealth of varied materials, textures, and colors. In a richly appointed villa such as the 4th-century villa of Maternus at Carranque (Madrid) is a superabundance of hand-wrought materials, including Egyptian red porphyry (**Figure 14**), serpentine, Tunisian Chemtou yellow marble, speckled pavonazzetto, Thessalian green marble, Chian portasanta, brown marble from Skyros, verde antico, Afyon Turkish marble, white and veined marble, elephant ivory, mother of pearl, colored glass, limestone, and other materials (Fernández-Galiano 2001). Their visual beauty, bright colors and varied hand-wrought textures would be encountered by an activated witness participant, due in part to the recruitment of this especially richly connected neural system. Numerous studies in social cognition demonstrate that positive affect can arise from visual and bodily contact with soft surfaces in particular, such as textiles (Williams and Bargh 2008).[12] Goldhagen concludes that 'such data suggest that people metaphorically extend the schemas they construct of experiences with surfaces … into arenas of our lives that fall far from the embodied experiences in which they originate' (Goldhagen 2017: 163). I have written elsewhere about a marked increase in the use of textiles of varied kinds in domestic interiors of the late Roman period (Stephenson 2014). The effect of these once ubiquitous colorful objects in villas, with their haptic, thermoreceptive, acoustic, and extremely bright visual qualities, is an example of profound impressions on ancient visitors that are nearly completely lost to us today. Late Roman villas offered greater opportunities to engage this primal empathic system in minds and bodies, thus enhancing their competitive value in the architectural arms race of the late empire.

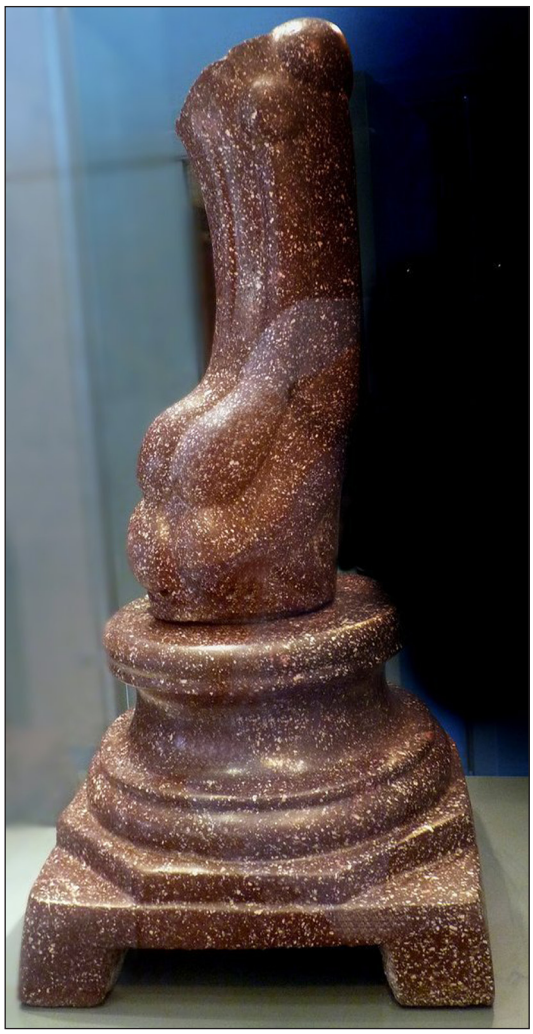

Figure 14: Villa of Maternus at Carranque (Toledo, Spain), porphyry table leg. Photo by John Stephenson.

Navigating in the Villa: Place Cells and Grid Cells

One of the greatest recent discoveries in cognitive science has been the central role our sensory system plays in movement and bodily position in an intermodal system of perception that reaches far beyond movement itself. Thompson and Varela write that 'what the organism senses is a function of how it moves, and how it moves is a function of what it senses' (Thompson and Varela 2001: 424; Jelić et al. 2016: 481). The neurological mechanism behind our sense of the location of our moving body in space (proprioception), was discovered by Edvard Moser, May-Britt Moser, and John O'Keefe, who won the Nobel Prize in Medicine for their work in 2014 (Fenton 2015). The brain's internal navigation system, dubbed a 'human GPS', involves nerve cells in the brain called *place cells* and *grid cells* that are activated with movement, and location is tracked by neurons firing in the shape of a hexagonal grid — creating a kind of miniature representation of the terrestrial spatial world. During navigation in space, our body constantly updates its location by visually estimating its distance to two surrounding points in peripersonal space. The resulting triangular form is mapped onto that hexagon, updating movement and direction in 60 degree increments of radiating triangles. The system is in a sense equivalent to cellular or satellite triangulation on the earth's surface.

A related discovery concerns the role of this internal navigation system in the formation of memories. The place and grid cells are found to reside in the hippocampus and parahippocampal region, a region of the brain now recognized as the key site for consolidating long-term memories for storage. The two processes — location

finding/body visualization and memory formation — are thus intimately connected, and show on a neurological level why we cannot recall a memory of an event without also consciously or unconsciously recalling its location. Goldhagen writes that 'what follows from this is that place-bound experiences constitute the very framework of our sense of self and perceived identity' (Goldhagen 2017: 85). The roles of place and grid cells in wayfinding and proprioception hold implications for understanding lived experience in the late Roman villas, and may be implicated in the competitive nature of the villa phenomenon itself. These would be highly active in the ancient experience of motion within the ambulatory spaces of the late villas, where processional movement through often extremely long, richly decorated, and articulated connective spaces will have triggered not only empathic responses to diverse objects and surfaces, but would call up a constellation of memories, while generating and cementing new ones, literally creating a memorable experience.

These discoveries in the sensorimotor system — tying place and grid cells to both motion and long-term memory — provide a neurological basis for an ancient art of memory that is both place and motion bound, called 'mnemotechnics'. Cicero, in *De Oratore*,[13] intuits this quality of memory when he advocates the 'memory palace' technique as a means for recalling information. In this system, each of a set of items to be recalled — Cicero gives the example of sections of a speech – is imagined to reside in a discreet space such as the rooms of a house; the items are committed to memory serially while concentrating on a visual image of each room, and later called up by 'walking' through each space on a chosen route.[14] Bergmann (1994) applies ancient mnemotechnics to the scholarship of Roman architecture and decor in a well-known article titled 'The Roman House as Memory Theater', which investigates movement and memory in the reception of domestic architecture and decoration. Bergmann argues that the fresco decoration in the Pompeian House of the Tragic Poet is only fully understood through a dynamic serial experience by an ambulatory viewer, one that calls up and layers associated memories in turn, rather than through only the reception of a collection of static images.

Frances Yates, in her important book *The Art Of Memory* (Yates 1966), explored the literary sources for this ancient art of mnemotechnics. Yates begins with the only complete treatise on the subject, the *Ad Herennium* by an anonymous author from the 80s BC (Caplan 1954), which was the basis for treatments by Cicero and later Latin writers, such as Quintillian.[15] The anonymous author lays out the method as dependent on visual memorization of a series of connected places, and images located in those places ('Constat igitur artificiosa memoria ex locis et imaginibus', *Ad Herennium* III, xvi.29), and offers specifics about the best kinds of places and images. The author refers repeatedly to places that include intercolumniations ('multa intercolumnia', III, xvi.29 and xix.31) and even recommends intervals of around thirty feet between stops ('plus aut minus pedum tricenum', III, xix.32), suggesting perhaps a circuit of rooms around the ambulatories of a peristyle. The layout of salons, basilicas, and triclinia in late villas as a series around one or more peristyles, or, as in the Spanish villas, radiating around circular or polygonal courtyards, seems to agree with advice for serial route placements in the *Ad Herennium*. Notably, the recommendation of providing serially apprehended visual scenes that can bind with 'imagines' (the image of a whole room, or another image within that room) should involve striking, colorful imagery in optimum light, and includes portraits and figural representations in violent, dramatic, or comic action ('imagines agentes', III, xxii.37), and even figures wearing purple cloaks or crowns. As the writer of the *Ad Herennium* notes, what imagery will be most memorable in this method will be up to the individual, at least in part: 'Things seem different to different persons. The same is true with respect to images: one that is well-defined to us appears relatively inconspicuous to others' (III, xxii.38).[16] Not only do different people value images differently, as the author notes, but the content of stimuli such as paintings and mosaics is specific to the culture in which they appear.

However, the discovery of the neural basis for the mingling of motion, proprioception, and wayfinding with memory formation confirms the validity of the concept and of the place of architecture in its functionality, and demonstrates on a neural level 'how it works'. If we read this ancient technique 'in reverse', it becomes evident that places, especially striking places, themselves were understood to enable the creation and calling up of memories, including memories completely independent of the setting, and this constellation of effects can be explained with reference to the new cognitive discoveries. It is noteworthy that features of late imperial villa decor such as mosaics, frescoes, and textiles are defined by extremely bright colors and strong, scintillating patterns, and human figures in vigorous and often violent theatrical scenes of action (Stephenson 2006; 2014), rather like the advice for *imagines agentes* and memorable imagery in the *Ad Herennium*. The 4th-century Spanish villa of La Olmeda (Palencia) preserves a series of colorful colossal figures in poses of high drama in its vast mosaic on the subjects of Achilles on Skyros and hunting (**Figure 15**), while at the recently discovered Spanish villa of Noheda (Cauca), in a vast triconch dining hall, measuring 31.3 meters on a side, are colorful, truly colossal mythological figures in action; a detail with bacchantes is just a part of a much larger scene (Valero Tévar 2013). According to ancient mnemotechnics, the apprehension of these kinds of images by a visitor in motion was best suited to cement memories; cognitive science confirms the connection.

The roles of place cells and grid cells in wayfinding, proprioception, and memory would be especially implicated in the perambulatory nature of the villa. The visitor to a late Roman villa was often engaged necessarily in a lot of scripted pedestrian movement through a large estate, which would engage a continuous act of cementing and updating memories — including memories of a striking and visually rich architectural experience (Jansen-Osmann and Wiedenbauer 2004). In many of the late Spanish villas, extraordinary resources were expended on their connective armatures — the pathways including corridors, loggias, and cryptoportici that together often created extremely long, circuitous, ascending, and

Figure 15: Villa of La Olmeda (Palencia, Spain), view of the mosaic with hunters and Achilles on Skyros, in the grand salon. Photo by John Stephenson.

articulated interior routes with numerous thresholds, often paved with brightly colored geometric mosaics and lined with mural decor, such as at the villa of Maternus at Carranque (**Figure 11**). At the 4th-century Spanish villa of Almenara de Adaja, the visitor would take at least seven turns from the entry, pass through numerous thresholds, and cover nearly 120 meters of alternately bright and dimly lit labyrinthine corridors before finally arriving at just one of the villa's prized apsidal suites, the triple-apsed triconch hall (García Merino and Sánchez Simón 2001) (**Figure 4**). On another route through the villa, visitors would make seven turns on an ascending path over geometric mosaics while passing four apsidal or radially planned halls, in order to reach the elevated octagonal hall, on the way discovering a 60-meter view through the entire long axis of the villa, from the octagonal room to the octagonal, apsed basilica. Rebecca Molholt writes about the effects of moving on and looking at such mosaics: 'The experience of [geometric] mosaics thus involves a sort of phenomenological vision, prompting a larger cognitive, perceptual, retinal, and epistemological effort toward understanding. As she actually treads on the images, the beholder is moved to become actively engaged in the narrative unfolding underfoot' (Molholt 2011: 287). These kinds of elaborate internal pathways could activate a host of motion- and vision-related mechanisms in a visitor's cognition while wayfinding in the house. Pedestrian motion was certainly an important feature of the late villa visit, and designers skillfully exploited its potential to engage the visitor.

Canonical and Mirror Neurons and Embodied Simulation in Villas

Canonical neurons and mirror neurons are recognized as an important neural basis of our active and goal-oriented thinking in environments: as humans and animals we continually if involuntarily search in our surroundings for opportunities or 'affordances' to act, and we prepare to respond by imagining how we might act. A doorway or a set of steps can become affordances, eliciting unconscious yet active responses from a viewer aware, even unconsciously, of their potential.[17] The discovery thus holds further implications for the study of the reception of ancient buildings: consider the effect of 14 thin steps inserted on the main processional path at the 4th-century villa Pisões (Beja, Portugal) in terms of affordances (**Figure 16**).

The seemingly gratuitous addition of these miniature steps (8 to 10 cm high) at Pisões appears designed to maximally activate these cognitive responses in a minimally rising vertical passage. Such affordances as ramps and stairways trigger engagement through mirror and canonical neurons, even before our leg muscles awaken other systems in an effort against gravity (Jansen-Osmann and Wiedenbauer 2004; for Roman cities, see MacDonald 1965). A number of late Iberian villas, such as the villas of Maternus (**Figure 2**) and Pisões, stage ascending routes from the entryway to principal halls through strategic placement on slopes, where an abundance of steps becomes a strategy of muscular and empathic engagement. Meanwhile, walking the ascending route itself will trigger our embodied metaphorical concepts equating elevation and upward motion with positive and even transcendent affects (Henderson and Wakslak 2010; Myers-Levy and Zhu 2007). Late Roman villas are known for their inclusion of such 'gratuitous' features of articulation and 'clutter', including numerous thresholds, doorways, steps, layering of multiple mural planes in the visual field, and shifting mosaic patterns, each of which would intensify the empathic system and experience of affordances.

Figure 16: Villa of Pisões (Beja, Portugal), view of 14 steps. Photo by John Stephenson.

This feature of affordances, representing the 'enactive' nature of our relationship with the environment, has been studied in the complementary fields of evolutionary science and information theory, which concern our human and animal heritage of exploration. Humans share an innate imperative essential in our hunt for ideal settings: the urge to explore, to wander intentionally, to seek out new information in our surroundings. We have been called *infovores* (Kaplan 1987); the possession of this urge has always been instrumental in the realization of the other goals of survival. This imperative keeps us moving forward in environments, seeking places that are rich in new opportunities, and lies in part behind our curiosity when viewing a curve in the path ahead, or a horizon that beckons and promises new discoveries — or walking a maze-like villa corridor.

In these kinds of situations, where opportunities are suggested but withheld, researchers have recognized a condition of enhanced attention and expectation they call 'mystery' (Kaplan 1987; Biederman and Vessel 2006). The neural mechanism rewarding such exploration has recently been discovered. In another case of intermodal sensing that combines vision with movement, the parahippocampal cortex and the rhinal cortex, where visual information is decoded and also our memories are engaged, is found to contain receptors that bind with pleasure inducing natural opiates (endomorphins) when we visually and physically seek and discover (Biederman and Vessel 2006). This reward system for exploration in conditions of 'mystery' would be activated when villa designers manipulated interior walking routes to include numerous blind turns, partially obscured vistas, layered and distant vistas, and vistas that are not immediately accessible by the pedestrian visitor (such as the 60-meter interior view at Almenara de Adaja). This urge to seek and discover and the other human imperatives regarding the environment are understood to be as fundamental to our survival as sex and food ingestion, and the reward systems that sustain them in the brain are of the same nature: registering as pleasure and positive affect when satisfied, or in anxiety and discomfort when withheld.

Time and Motion in an Intermodal Sensory System

More recently, researchers have revealed a mechanism in the brain relating to the cognition of time (Tsao and Moser 2018). In two regions of the brain's entorhinal cortex, they found a neural system that involves hundreds of thousands of cells continually firing in exceedingly varied patterns and that is thought to generate our episodic cognition of elapsed time. These 'chaotic' variations in firing activity are believed to be responsible on the neural level for the subjective nature of our experience of time, depending on conditions including emotional states and settings. This discovery aligns with others that find that aspects of the built environment, such as thresholds, turns, 'clutter', fenestration, and amount of decoration augment the estimation of time elapsed in moving through spaces, once more showing the integrated nature of our senses: we experience time in an embodied, metaphoric spatial relation within the environment (Jansen-Osmann and Wiedenbauer 2004). These discoveries and others support a new unified cognitive model joining sensory and bodily functions in an intermodal system, showing again how the mind and body are not separate, as four hundred years of Cartesian theory had led us to believe. A specific application of this finding to the late Roman villas relates again to their superabundance of mosaic decor, thresholds, and articulations in connective and ambulatory spaces. Studies regarding the subjective perception of time suggest that the late villa designers intuited how an amplified participant experi-

ence could be induced by drawing a visitor into processional movement through carefully designed and lengthy spaces, which would engage visitors' imagination and stimulate their naturally active role in the environment (Jansen-Osmann and Wiedenbauer 2004). The plan of Almenara de Adaja, with its 120-meter maze-like pathway to the triconch demonstrates this quality, as well as the numerous 'kaleidoscopic' mosaic pavements in villas such as the Villa of Maternus at Carranque (**Figures 4** and **11**).

New Kinds of Spaces: Effects of Radial and Curving Geometry

The discovery of grid cells has been further deployed to suggest their role in a human preference for nonorthogonal spaces: 'a persistent unease when faced with the grid's pervasiveness' (Goldhagen 2017: 66). Goldhagen offers the example of Frank Lloyd Wright's 1936 Hanna House in Stanford, California. The architect avoided a rectilinear plan in favor of a modular system of hexagonal honeycomb forms and equilateral triangles, which suggested to Goldhagen that Wright was able to intuit that 'people would be drawn to spaces arranged according to hexagonal geometries because they are consonant with the dictates of human visual perception, and might well facilitate a more effortless spatial experience' (68).[18] If we consider this more literal equation of the geometry of inner and outer spatial experience, it is worth noting again that late Roman villa design featured the deployment of hexagonal, octagonal, and other polygonal plans in a range of structures, including halls, peristyle courtyards, towers, bath halls, and other types, as well as decor motifs including mosaic pavements in repeating polygons. For example, the 4th-century villa of Abicada (Mexilhoeira Grande, Portugal) is organized around a hexagonal peristyle; the extraordinary villa at Rabaçal (Coimbra, Portugal), built in the late 4th or early 5th century, is organized around an octagonal peristyle (**Figure 6**), and the late 4th-century villa of Valdetorres de Jarama (Madrid) features an octagonal peristyle (**Figure 12**). These examples reveal a late Roman predilection, more evident in Spain than any other province, for creating polygonal and other eccentric domestic mural forms. Centrally planned, curving, and polygonal forms had already entered the architectural vocabulary of imperial palaces since the erection of Nero's Domus Aurea at Rome in the 1st century AD, and in the 2nd century at Hadrian's Villa at Tivoli. As Boethius observes, these designs were 'symptomatic of the breakdown of the tyranny of the right angle' already in the 1st century (Boethius and Ward-Perkins 1992: 249). However, the fruition of this protracted experiment in nonorthogonal forms only came with the advent of the late villas.

One of the most significant formal developments in the invention of nonorthogonal spaces in architecture, and of the late villa phenomenon itself, was a novel experimentation in this era with curving, arcuated, domical spaces and mural forms. These produced new effects in shaping seamless and all-encompassing environments around inhabitants, who could be found nestled in apsidal and domical dining halls, reclining upon embroidered coverlets and pillows on the newest innovation in dining furniture: the curving hemicyclical *stibadium* couch (Sidonius Apollinaris, *Epistle* 9.8; Stephenson 2014). A striking example of this new furnishing in masonry is preserved at the villa of El Ruedo (Cordoba) (Hidalgo Prieto 1990) (**Figure 17**).[19] A burgeoning psychological literature outlines how humans are exceptionally sensitive to curves in the built environment, registering strong preferences for them especially in contrast to sharp or jagged edges (Paul and Christopher 2009; Banaei et al. 2017; Bar and Neta 2006). In the new domical spaces of late villas, their seamlessness would give rise to significant cognitive effects, interrupting our usual ability to estimate the scale of an enclosing space by the parallax distortion of receding edges, while drawing the room into our register of encompassing peripersonal space, much like Leonardo's image of the Vitruvian Man. One point of interpretation of these

Figure 17: Villa of El Ruedo (Cordoba, Spain), dining room with stibadium couch. Photo by John Stephenson.

novel curving forms is in their service to a strong sense of *refuge* and shelter for participants — an evolutionary imperative in all creatures (Appleton 1975). The dining suite at the villa of El Ruedo near Cordoba plays on the symbolism of refuge in a room literally intended to evoke a dim and watery grotto (Stephenson 2009) (**Figure 17**).[20] The room, with its curving stibadum and fountain-pool, opened at the front to provide diners with views onto a light-filled exterior scene in the peristyle and beyond, thus combining a sense of refuge with a wide prospect in what seems a most satisfactory way.

Conclusion

This discussion has touched on only a small selection of the ongoing discoveries in the emerging field of cognitive science and the environment, in seeking to address some issues in the innovative and spectacular architecture of the late Roman villa phenomenon, from a perspective that departs from the traditional causal narrative. This material is particularly conducive to a focus on cognitive and emotional effects in reception, as the experiments of late Roman designers were clearly intended to impress and manipulate the human senses and emotions. A cognitive and evolutionary approach carries forward a tradition of environmental and architectural aesthetics that has asked questions about what attracts us to places and buildings and how they affect us. In many ways the new breakthroughs in the science of cognition serve as a bridge not only to the discoveries and theories of embodiment promoted by earlier generations of theorists, notably such phenomenologists as Merleau-Ponty, but also to the work of much earlier theorists like Cicero and the anonymous writer of the *Ad Herennium*. These ongoing discoveries in our intermodal cognitive systems, implicating the mind and body in marked contrast to a heritage of Cartesian theory, finally help us to recognize and confirm the brilliance and innovation of the late Roman designers themselves, and offer another window into the lived experience of their creations. Rather than viewing architecture as a bloodless intellectual object, we seek to define our subject as a living nexus between active, seeking human beings and their settings — to view and feel from within the body and buzzing brain and from behind scanning eyes, people reach out and interact with the world in a richness of complexity intuited by the ancients. As Goldhagen suggests, we could learn something today from such analysis of historic masterpieces of architecture that contributes to the design of our own buildings and cities. It is at this cognitive level that we can first recognize what we value and share.

Cognitive and evolutionary approaches to the study of architecture have been critiqued from various quarters, notably from within the humanities themselves. Seghers addresses 'the common hostility within humanities departments with regard to biological theorization concerning their subjects' (Seghers 2015).[21] Critical assertions from the humanities frequently argue that an account of our aesthetic responses to architecture must lie in a unique cultural period or individual realm (Newby 1991). Methods focused on other than historical contingencies risk eliding cultures to produce a reductive account that neglects the unique contribution of the culture and creator. However, these are not mutually exclusive avenues of inquiry but are complementary. In *The Wright Space*, Grant Hildebrand (1991) situates Frank Lloyd Wright in the cultural and period context of 20th-century architecture and as an innovator toward an indigenous American style, yet he finds in Wright's innovations a skilful deployment of motifs that engage with sensitivities, emotions, and cognitive sensoria enduring after millennia of shared human interaction with the environment. All creative acts must operate within these parameters: the artist creates something unique to self, culture, and period, but with a 'language' of form that must respond to a common, ancient, and largely unconscious human nature. If meaning in all cultural production hinged only on a singular personal and period moment, we would not value, study, and somehow individually respond to these Roman villas, more than 17 centuries old and in distant locales. It is why we still thrill to an eccentrically shaped hall, still enjoy a convoluted pathway leading to a panoramic view, why we could still appreciate the heat under our feet in a hypocaust hall, why a grand view from a high platform or tower thrills, why the sight of towering piles of villas would still impress us today.

Notes

[1] Monumental rural villas have been discovered in greatest concentrations in the former provinces of Hispania, Britain, Aquitane, Pannonia, and southern Italy (Sicily), and to a lesser extent in Africa (Sodini 1995).

[2] The Roman writer Columella, in his agricultural treatise *De re rustica*, (I, 6, 1) divides the parts of a typical villa into three parts, the *pars urbana*, or master's residence, *pars rustica*, or quarters for estate laborers, and *pars fructuaria*, the productive farm; other writers combine the latter two divisions under the *pars rustica*.

[3] Conversely, the late disappearance of peristyle houses is viewed as an indication of the eclipse of Roman culture in the provinces (Brogiolo and Ward-Perkins 1999; Christie 2004).

[4] The central government underwent a ten- to twenty-fold increase within the lifetime of Constantine alone (Kulikowski (2004), esp. 65–84).

[5] In the 4th century Ammianus Marcellinus jokingly compared their circuits between estates to Alexander the Great's marches on campaign, in *History* 28.4.18.

[6] *Life of Melania the Younger*, 11 and 18.

[7] Similarly, Bruce Trigger (1990: 119) writes, 'It is not my intention to defend a narrow cultural ecological approach which limits itself to explaining cross-cultural regularities and ignores the diversity that is evident in human behaviour. Yet rejecting ecological determinism as a valid explanation of all aspects of human behaviour does not prevent a case from being made for ecological constraints on such behaviour. Some of the more extreme versions of post-processualism appear to be so determined to affirm cultural particularities that they overlook or deny cross-cultural uniformities. In so doing, they appear to lose sight of a significant aspect of the ontological reality of what they are studying.'

[8] The emperors of Spanish origin, Trajan, Hadrian, and the Theodosian dynasty, must have contributed personally to this striking architectural dialog. Not only did each of these architectural innovators live for periods on Spanish soil; on their ascendancy to emperorship they likely inspired courtiers to emulation in the home province, mediating between the imperial centers and the 'periphery' of the western Empire. On the other hand, because Hadrian was a native of Spain, he probably brought an understanding of architecture drawn from innovative Spanish design to bear at his own groundbreaking estate at Tivoli near Rome. In this sense, Spain could also be a 'center' from which ideas and inspiration could emanate.

[9] This use of the term is to be distinguished from the avant-garde term and concept espoused by Guy Debord and the Situationist International.

[10] A fascinating overview of this topic is given in Heschong's book *Thermal Delight in Architecture* (1979).

[11] Freedberg argues that 'a crucial element of esthetic response consists of the activation of embodied mechanisms encompassing the simulation of actions, emotions and corporeal sensation, and that these mechanisms are universal' (Freedberg and Gallese 2007: 197).

[12] For instance, students in a study located in a classroom full of soft furniture, rugs, and pillows consistently engaged more actively in group discussions, while respondents in another study reported exchanges with new persons as 'rough' when they touched a rough textured object at the same time (Williams and Bargh 2008).

[13] Relevant passages in *De Oratore*: 2.74.299–300, 2.86.351–54, 2.87.357–58.

[14] Cicero said, 'Persons desiring to train this faculty (of memory) must select places and form mental images of the things they wish to remember and store those images in the places, so that the order of the places will preserve the order of the things, and the images of the things will denote the things themselves, and we shall employ the places and images respectively as a wax writing-tablet and the letters written on it' (*De oratore*, II, lxxxvi, trans. Yates (1999: 2)).

[15] The section on memory technique in the *Ad Herennium* appears in *Ad Herennium*, III, xvi–xxiv.

[16] 'Alii videtur aliud, item fit in imaginibus ut quae nobis diligenter notata sit, ea parum videatur insignis aliis'.

[17] The term and concept of affordance was developed by psychologist James Gibson, notably in his book *The Ecological Approach to Visual Perception* (Gibson 1986). Gibson studied human visual perception, establishing that motion must be taken into account in any theory of visual perception; his theory of affordances argued that humans and other creatures relentlessly seek to alter and modify their environments to better suit them. Gibson's theory varies with the stance of Merleau-Ponty in *Phenomenology of Perception* in that Gibson posits affordances in the environment as existing independent of human perception though activated with their recognition, while Merleau-Ponty proposed such interactions arising solely in a dialectical concept of consciousness mediated by the body in contact with the environment. The discovery of a neural basis for this imperative confirms and elucidates Gibson's theory.

[18] This comparison of examples across time and space is valid since the chief argument underlying this article and the cognitive approaches to architecture it treats is that humans share certain proclivities due to our shared biological heritage, regardless of temporal issues.

[19] The curving stibadium itself probably became so popular in the late empire as a response to the curving spaces of dining rooms (Author 2006).

[20] Adorning its darkened recesses were a series of statues that included a bronze Hypnos-Somnus, whose home in mythology is set deep within a cave with a central couch and outflowing water.

[21] Seghers concludes that 'such critiques are, however, more often than not a reflection of disciplinary conservatism, sparked by insufficient insight into the theoretical structure and explanatory intent of evolutionary theory' (Seghers 2015: 74).

Competing Interests

The author has no competing interests to declare.

References

Acharya, S and **Shukla, S.** 2012. Mirror Neurons: Enigma of the Metaphysical Modular Brain. *Journal of Natural Science, Biology, and Medicine*, 3(2): 118–24. DOI: https://doi.org/10.4103/0976-9668.101878

Ackerman, J. 1985. *The Villa: Form and Ideology of Country Houses*. Princeton: Princeton University Press.

Alarcão, J, Étienne, R and **Mayet, F.** 1990. *Les villas romaines de Sao Cucufate (Portugal)*. Paris: Les Éditions de Boccard. DOI: https://doi.org/10.3406/crai.1989.14719

Appleton, J. 1975. *The Experience of Landscape*. Hoboken, NJ: John Wiley & Sons.

Banaei, M, et al. 2017. Walking through Architectural Spaces: The Impact of Interior Forms on Human Brain Dynamics. *Frontiers of Human Neuroscience*, 11: 477. DOI: https://doi.org/10.3389/fnhum.2017.00477

Bar, M and **Neta, M.** 2006. Humans Prefer Curved Visual Objects. *Psychological Science*, 17(8): 645–48. DOI: https://doi.org/10.1111/j.1467-9280.2006.01759.x

Bergmann, B. 1994. The Roman House as Memory Theater: The House of the Tragic Poet in Pompeii. *Art Bulletin*, 76(2): 225–256. DOI: https://doi.org/10.1080/00043079.1994.10786585

Biederman, I and **Vessel, E.** 2006. Perceptual Pleasure and the Brain: A Novel Theory Explains Why the Brain Craves Information and Seeks It Through the Senses. *American Scientist*, 94(3): 247–53. DOI: https://doi.org/10.1511/2006.59.995

Boëthius, A and **Ward-Perkins, J.** 1992. *Etruscan and Roman Architecture*. New Haven: Yale University Press.

Bowes, K. 2010. *Houses and Society in the Later Roman Empire*. London: Duckworth Publishers.

Brogiolo, GP and **Ward-Perkins, J.** (eds.) 1999. The Idea and Ideal of the Town between Late Antiquity and the Middle Ages. Leiden: Brill.

Cant, J and **Goodale, M.** 2007. Attention to Form or Surface Properties Modulates Different Regions of Human Occipitotemporal Cortex. *Cerebral Cortex* 17(3): 713–31. DOI: https://doi.org/10.1093/cercor/bhk022

Caplan, H. 1954. *Cicero Ad C. Herrenium*. Trans. by H. Caplan. Cambridge, Mass.: Harvard University Press.

Christie, N. (ed.) 2004. *Landscapes of Change: Rural Evolutions in Late Antiquity and the Early Middle Ages*. Aldershot: Ashgate Publishers.

Colombetti, G. 2014. *The Feeling Body: Affective Science Meets the Enactive Mind*. Cambridge: The MIT Press. DOI: https://doi.org/10.7551/mitpress/9780262019958.001.0001

Ellard, C. 2015. *Places of the Heart: The Psychogeography of Everyday Life*. New York: Bellevue Literary Press.

Ellis, S. 1989. An Archaeological Study of Urban Domestic Housing in the Mediterranean, A.D. 400–700. Unpublished thesis (PhD), Oxford University.

Fenton, A. 2015. Coordinating with the 'Inner GPS'. *Hippocampus*, 25(6): 763–69. DOI: https://doi.org/10.1002/hipo.22451

Fernández-Galiano, D. 2001. *Carranque: Centro de Hispania romana*. Madrid: Museo Arqueológico Regional, Alcalá de Henares.

Freedberg, D and **Gallese, V.** 2007. Motion, Emotion and Empathy in Esthetic Experience. *Trends in Cognitive Sciences*, 11(5): 197–203. DOI: https://doi.org/10.1016/j.tics.2007.02.003

Gallese, G and **Alessandro, G.** 2017. Embodied Simulation, Aesthetics, and Architecture: An Experimental Aesthetic Approach. In: Robinson, S and Pallasmaa, J (eds.), *Mind in Architecture: Neuroscience, Embodiment, and the Future of Design*. Cambridge, Mass.: The MIT Press. pp. 161–80.

García Entero, V. 2006. *Los balnea domésticos, ámbito rural y urbano, en la Hispania romana*. Madrid: Consejo Superior de Investigaciones Cientificas.

García Merino, C and **Sánchez Simón, M.** 2001. Excavaciones en la villa romana de Almenara-Puras (Valladolid): Avance de resultados (I). *Boletín del Seminario de Estudios de Arte y Arqueología*, 67: 99–124.

Gibson, J. 1986. *The Ecological Approach to Visual Perception*. London: Routledge.

Goldhagen, SW. 2017. *Welcome to Your World: How the Built Environment Shapes Our Lives*. New York: Harper Collins Publishers.

Gorges, JG. 1979. *Les villas Hispano-Romaines: Inventaire et problématique archéologiques*. Paris: Publications du Centre Pierre.

Heather, P. 1998. Senators and Senates. In: Cameron, A, and Garnsey, P, *Cambridge Ancient History*, vol. 13. Cambridge: Cambridge University Press. pp. 184–210. DOI: https://doi.org/10.1017/CHOL9780521302005.007

Heidegger, M. 1996. *Being and Time*. Trans. by J Stambaugh. Albany, NY: State University of New York Press.

Henderson, M and **Wakslak, C.** 2010. Over the Hills and Far Away: The Link Between Physical Distance and Abstraction. *Current Directions in Psychological Science*, 19(6): 390–94. DOI: https://doi.org/10.1177/0963721410390802

Heschong, L. 1979. *Thermal Delight in Architecture*. Cambridge: The MIT Press.

Hidalgo Prieto, R. 1996. *Espacio público y espacio privado en el conjunto palatino de Cercadilla (Córdoba)*. Seville, Junta de Andalucia.

Hidalgo Prieto, R. 1990. Esquemas Decorativos Pictoricos de la Villa Romana de El Ruedo. *Anales de Arqueología Cordobesa*, 1: 109–24. DOI: https://doi.org/10.21071/aac.v0i.11427

Hildebrand, G. 1991. *The Wright Space: Pattern and Meaning in Frank Lloyd Wright's Houses*. Seattle: University of Washington Press.

Jansen-Osmann, P and **Wiedenbauer, G.** 2004. The Influence of Turns on Distance Cognition: New Experimental Approaches to Clarify the Route-Angularity Effect. *Environment and Behavior*, 36(6): 790–813. DOI: https://doi.org/10.1177/0013916503262537

Jelić, A, et al. 2016. The Enactive Approach to Architectural Experience: A Neurophysiological Perspective on Embodiment, Motivation, and Affordances. *Frontiers in Psychology*, 7: 481. DOI: https://doi.org/10.3389/fpsyg.2016.00481

Kahn, L. 1960. Marin City Development. *Progressive Architecture*, 41: 149–53.

Kaplan, S. 1987. Aesthetics, Affect and Cognition: Environmental Preference from an Evolutionary Perspective. *Environment and Behavior*, 19(1): 3–32. DOI: https://doi.org/10.1177/0013916587191001

Kulikowski, M. 2004. *Late Roman Spain and Its Cities*. Baltimore and London: Johns Hopkins University Press.

MacDonald, W. 1965. *Architecture of the Roman Empire*. Vol. 1. New Haven: Yale University Press.

Marzano, A and **Métraux, G.** 2018. The Roman Villa: An Overview. In: Marzano, A and Métraux, G (eds.), *The Roman Villa in the Mediterranean Basin*. Cambridge, UK: Cambridge University Press. pp. 1–41. DOI: https://doi.org/10.1017/9781316687147.003

Merleau-Ponty, M. 1962. *Phenomenology of Perception*. London: Routledge & Kegan Paul.

Meyers-Levy, J and **Zhu, R.** 2007. The Influence of Ceiling Height: The Effect of Priming on the Type of Processing People Use. *Journal of Consumer Research*, 34(2): 174–86. DOI: https://doi.org/10.1086/519146

Molholt, R. 2011. Roman Labyrinth Mosaics and the Experience of Motion. *Art Bulletin*, 43(3): 287–303. DOI: https://doi.org/10.1080/00043079.2011.10786009

Neutra, R. 1969. *Survival Through Design*. Oxford, UK: Oxford University Press.

Newby, P. 1991. *The Symbolism of Habitat: An Interpretation of Landscape in the Arts*. Seattle: University of Washington Press.

Nozal Calvo, M, Cortes, J and **Abásolo, J.** 2000. Intervenciones arqueológicas en los baños de la Olmeda (Pedrosa de la Vega, Palencia). In: Fernández-Ochoa,

C and Garcia Entero, V (eds.), *Termas Romanas en el Occidente del Impero: II Coloquio Internacional de Arqueología en Gijón*. Gijón: Coloquio Internacional de Arqueología en Gijón. pp. 311–18.

Paul, S and **Christopher, B.** 2009. Do People Prefer Curved Objects? Angularity, Expertise, and Aesthetic Preference. *Empirical Studies of the Arts*, 27(1): 25–42. DOI: https://doi.org/10.2190/EM.27.1.b

Pessoa, M, et al. 1993. *Römische Villa Rabaçal*. Penela: Thomas G. Schattner.

Seghers, O. 2015. Of Darwin and Other Demons: the Evolutionary Turn in Aesthetics. *Kultura – Społeczeństwo – Edukacja*, 2(8): 73–90. DOI: https://doi.org/10.14746/kse.2015.2.5

Sodini, JP. 1995. Habitit de l'antiquité tardive. *Topoi: Orient-Occident*, 5: 151–218. DOI: https://doi.org/10.3406/topoi.1995.1563

Stephenson, J. 2006. A Social History of Late Roman Villas in Hispania. Unpublished thesis (PhD), Emory University.

Stephenson, J. 2009. Villas and Aquatic Culture in Late Roman Spain. In: Kosso, C and Scott, A (eds.), *Water, Baths, Bathing, and Hygiene from Antiquity through the Renaissance*. Leiden: Brill. pp. 337–60. DOI: https://doi.org/10.1163/ej.9789004173576.i-538.71

Stephenson, J. 2014. Veiling the Late Roman House. *Textile History*, 45(1): 3–31. DOI: https://doi.org/10.1179/0040496914Z.00000000035

Stephenson, J. 2016. Dining as Spectacle in late Roman Villas. *Bulletin of the Institute of Classical Studies*, 59(1): 54–71. DOI: https://doi.org/10.1111/j.2041-5370.2016.12019.x

Thompson, E and **Varela, F.** 2001. Radical Embodiment: Neural Dynamics and Consciousness. *Trends in Cognitive Science*, 5(10): 418–25. DOI: https://doi.org/10.1016/S1364-6613(00)01750-2

Trigger, B. 1990. Monumental Architecture: A Thermodynamic Explanation of Symbolic Behaviour. *World Archaeology*, 22(2): 119–32. DOI: https://doi.org/10.1080/00438243.1990.9980135

Tsao, A and **Moser, E.** 2018. Integrating Time from Experience in the Lateral Entorhinal Cortex. *Nature*, 561: 57–62. DOI: https://doi.org/10.1038/s41586-018-0459-6

Valero Tévar, MA. 2013. The Late-Antique Villa at Noheda (Villar de Domingo García) near Cuenca and its Mosaics. *Journal of Roman Archaeology*, 26: 307–30. DOI: https://doi.org/10.1017/S1047759413000172

Williams, L and **Bargh, J.** 2008. Experiencing Physical Warmth Promotes Interpersonal Warmth. *Science*, 322(5901): 606–7. DOI: https://doi.org/10.1126/science.1162548

Yannick, J and **Verpooten, J.** 2013. An Exploration of the Functions of Religious Monumental Architecture from a Darwinian Perspective. *Review of General Psychology*, 17(1), 2013: 53–68. DOI: https://doi.org/10.1037/a0029920

Yates, F. 1966. *The Art of Memory*. London: Routledge.

Zarmakoupi, M. 2014. *Designing for Luxury on the Bay of Naples: Villas and Landscapes (c. 100 BCE–79 CE)*. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:osobl/9780199678389.001.0001

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