

24 exploiting awe, RMA promotes and regulates prosocial behavior among religious followers and
25 creates in them an openness to adopt supernatural beliefs.

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28 *Keywords:* religious monumental architecture, sensory exploitation, costly signaling, awe,
29 supernatural beliefs

30

31 **Introduction**

32 Monumental architecture has been independently expressed across many large-scale civilizations
33 belonging to different eras and situated in different geographical regions. Well-known monumental
34 structures are – for example – the *Giza Pyramids* in Egypt, *Angkor Wat* in Cambodia or the
35 *Teotihuacan Pyramids* in Mexico (Trigger, 1990). It is commonly assumed that the defining feature
36 of such monumental constructions is their large scale, which vastly exceeds the scale of the everyday
37 buildings and built structures of the epoch in which they were built. Very probably, experiencing a
38 particular edifice as monumental depends on the particular timeframe or the culture in which one
39 lives, as well as on one's previous exposure to built monumental structures. For example, while for a
40 21st century urbanite, accustomed to massive modern skyscraper buildings, Neolithic ashmounds
41 might not look particularly spectacular, these structures probably felt as considerably more
42 impressive for Neolithic people, for whom they were amongst the biggest built structures of their era
43 (Johansen, 2004).

44 Throughout architectural history different types of monumental architecture have been
45 constructed. In early civilizations, fortifications, palaces, temples and tombs were among the most
46 common types, whereas in classical Rome and Greece, public buildings such as arenas, theatres or

47 public baths also often exhibited monumental aspects (Trigger, 1993, 75). In this article we will
48 concentrate on monumental architecture that was built to fulfill particular functions related to
49 religious doctrines, i.e., *religious monumental architecture* (henceforth abbreviated as RMA). While
50 the possible roles of monumental architecture for religions have already been briefly hinted at in
51 evolutionary accounts of religions and religious behavior (e.g., Gervais & Henrich, 2009; Atran &
52 Henrich, 2010), in this article we aim to give an in-depth and tentative analysis of the potential
53 function(s) of this type of architecture for religious doctrines.

54 The theoretical backdrop of our analysis is the view that religions are complex “devices” that
55 help(ed) creating, regulating and enacting (large-scale) community living (e.g., Wilson, 2002;
56 Graham & Haidt, 2010). In agreement with Graham and Haidt (2010) we see religion as “... a
57 complex system with many social functions, one of which is to bind people together into
58 cooperative communities organized around deities” (140). This perspective on religion has received
59 much attention in recent evolutionary approaches to religion and has bolstered research into the
60 relation between religiousness and cooperative, prosocial behavior (e.g., Shariff & Norenzayan,
61 2007). The question as to whether religions’ social function has come about as a result of selection
62 pressures at the level of the individual, the group, or both (cfr., Wilson, 2002) is still unsettled. Rather
63 than choosing sides of either one of these positions, we aim to shed light on the mechanism(s)
64 through which RMA supported religions’ social function.

65 Within the field of archaeology, monumental architecture is sometimes interpreted as a costly
66 signal that evolved to deter rival (religious) elites (Neiman, 1998). In this paper we will argue that in
67 order to fully understand the cultural and temporal pervasiveness of RMA, this costly signaling
68 account needs to be complemented with insights from sensory exploitation theory (Ryan, 1998).
69 Sensory exploitation is a concept from biological signaling theory that grasps how in animal

70 communication particular sensory sensitivities can be exapted. In this paper we will argue that not
71 only the costliness underlying RMA supports the social function(s) of religion, but also the fact that
72 such architecture seems to taps into an adaptive “sensitivity for bigness”. In so doing, RMA exploits
73 a particular emotional response (i.e., awe), which – we hope to demonstrate – supports the process of
74 religious community building.

75 This article is organized as follows. In the first section, we offer a discussion of Darwinian
76 approaches to monumental architecture. We complement and extend the view that such edifices are
77 costly signals, and claim that sensory exploitation theory has additional explanatory value to explain
78 the occurrence of RMA. We conjecture that, while being a costly signal, RMA also plays on the
79 adaptive tendency to associate size cues with dominance/power, both of which may trigger awe in
80 spectators. The two following sections aim to demonstrate how experiencing awe supports the social
81 function of religions. Specifically, in the second section it is argued that awe-provoking instances of
82 RMA contribute to vertical stratification within religious communities, to bonding between
83 (religious) community members and to monitoring social life. The third part discusses the
84 relationship between RMA and religious beliefs. Specifically, such edifices are deemed to be
85 commitment signals, whose specific emotional charging creates in religious followers openness to
86 religious/supernatural beliefs. The fourth section suggests that RMA’s social function can only be
87 fully grasped if seen as being intimately intertwined with religious ritual behavior and activities.

88

89 **1. Darwinian approaches to (religious) monumental architecture**

90 A number of (archeological) researchers have attempted to shed light on the origin and function(s) of
91 monumental architecture from a Darwinian perspective. In the following sections we consider the
92 specific evolutionary model that is commonly invoked by these researchers, i.e., costly signaling

93 theory, and complement it with sensory exploitation theory. We further discuss one particular
94 sensitivity which we think is exploited by RMA, and dwell on a typical emotional response that can
95 derive from this exploitation process and from observing the costliness underlying cases of RMA,
96 namely awe. For our discussion of awe we mainly rely on Keltner and Haidt's prototypical account
97 of awe (Keltner & Haidt, 2003)

98

99

100 **1.1. Monumental architecture as a costly signal**

101 The archeological record shows that there is a correlation between the emergence of monumental
102 architecture and the rise of stratified communities (e.g., Trigger, 1990; Kolb, 1994; De Marrais,
103 Castillo & Earle, 1996). Based on this, some authors presume that building monumental architecture
104 actively contributed to vertical social stratification. But by which mechanism could this have
105 happened? One view which has received considerable attention in the literature on monumental
106 architecture is that monumentality is a non-ambiguous and reliable signal of power. Trigger (1990),
107 for example, argues that building monumental architecture required massive amounts of energy, and
108 only those who actually had power and controlled it could have been capable of recruiting and
109 managing the energy and labor necessary for building such edifices. Monumental buildings thus "...
110 symbolize the ability of those for whom they were made to control ... energy to an unusual
111 degree" (Trigger, 1990, 125). By participating in constructing such power symbols, commoners
112 acknowledged their lower ranking with regard to the leading elites, which further underlined their
113 social inferiority. As embodying vast amounts of labor and energy, and the elites' ability to control
114 these, monumental architecture became one of the instruments for achieving social
115 organization/stratification.

116 While Neiman (1998) also recognizes the social organizational role of monumental
117 architecture, his main interest lies in elucidating, from a Darwinian perspective, how wasting energy
118 on non-utilitarian monumental architecture could have conveyed an adaptive benefit to the elite
119 builders. There are different indications that such buildings actually did have little pragmatic, i.e.
120 non-signaling use. For example, monumental structures could oftentimes not be accessed, or only by
121 a small religious elite. When such type of architecture could be entered by the public (cfr., churches
122 or cathedrals), the roofing of the interior space often surpassed the height that was strictly necessary
123 for the events and activities taking place there (e.g., religious services, marketplace). The fact that, at
124 times, this increased the risk of collapse suggests that the shape of the building surpassed its specific
125 utilitarian/pragmatic requirements. Also the use of visual illusions in religious monumental
126 architecture, which further augments the apparent grandeur of the structure, illustrates that, over and
127 above possible pragmatic functions, such architecture was also built to impress its viewers (for a
128 further discussion of this issue, see section 1.2.4).

129 By relating the occurrence of monumental architecture to Zahavi's handicap principle
130 (Zahavi, 1975) Neiman (1998) attempts to theoretically extend Triggers (1990) account. Specifically,
131 building on a case study of Classic Mayan monumental architecture, he contends that such "wasteful"
132 constructions illustrate costly signaling. Such edifices are analogous to non-human animal threat
133 displays, like costly nest decorations of black kites (Sergio et al., 2011). They reliably signal that the
134 elites who have built them had an energy surplus over competing elites and signaled to the latter that
135 engaging in competition would be futile. To non-elites they provided an opportunity to accurately
136 assess the elites' qualities as potential leaders (Aranyosi, 1999). Monumental architecture can thus be
137 considered as '... a form of "smart advertising," wherein the signaler accrues the benefits of
138 increased access to labor and resources as a result of paying the cost of construction, and non-

139 signalers can benefit from associating with more capable elites' (Aranyosi, 1999, 357). Because
140 monumental architecture thus signaled superior competitive ability, the elites who built these
141 structures had privileged access to resources and mates, which ultimately increased their reproductive
142 fitness.

143 In both Trigger (1990) and Neiman's (1998) account it is mainly by wasting energy through
144 labor and resources that monumental architecture plays its social organizational role. We suspect,
145 however, that a mere focus on wastefulness cannot fully capture the characteristics of RMA. The
146 reason is that while a costly signaling perspective focuses on the effort/energy that has gone into
147 creating the architectural form, it remains silent on the question of how these structures' particular
148 aesthetic appearance might also have contributed to some of the proposed functions of RMA, such as
149 social organization/stratification.

150 In our framework, we bring together two theoretical perspectives to explain the functions of
151 RMA. We agree with Neiman (1998) that many instances of RMA are costly signals, illustrating
152 wastefulness of – among other things – time, material, or labor. However, claiming that RMA
153 merely embodies wastefulness greatly under-constrains the precise form of these edifices. The history
154 of architecture shows us that during different epochs and among different cultures wasteful
155 advertising through monumentality mainly occurred by erecting structures whose most constant and
156 distinctive feature is their very large *size*, most often expressed through height (cfr., towers,
157 pyramids, ziggurats). This historically constant feature is not addressed by signaling accounts.

158 There is little doubt that concentrating the waste of energy and material into one massive
159 structure that stands out from the environment allows observers to fairly easily estimate the effort that
160 has gone into building the structure. We are however convinced that something more than signal
161 efficiency is operating here (Endler, 1992). In our dual account of RMA, Neiman's costly signaling

162 account is complemented with another theoretical perspective on signal evolution, namely sensory
163 exploitation theory. In so doing, we hope to further address the question of why exactly size, and
164 specifically height, have become attractors for wasteful monumental building activities. In the
165 following sections we explain the basic principles of sensory exploitation theory and try to
166 demonstrate that the primary sensorial sensitivity which is being exploited in RMA is an adaptive
167 “sensitivity to bigness”.

168

169 **1.2. RMA involves sensory exploitation**

170 **1.2.1. The mechanism of sensory exploitation**

171 In a costly signaling system, receivers’ responses to senders’ signals are determined by the extent to
172 which these signals indicate underlying (genetic) quality of the sender (Zahavi, 1975). Although
173 being an influential perspective, in animal communication research costly signaling is only one of the
174 many models which biologists use to explain how signals evolve. Another model that has received
175 much attention is *sensory exploitation* (SE) (e.g., Ryan, 1998; Arnqvist, 2006). Central to SE is that
176 senders evolve display traits to exploit pre-existing sensitivities of receivers¹, or sensitivities that are
177 under strong selective pressure in another context than the SE system. These traits may often be
178 costly, but that does not necessarily mean that they reliably correlate with quality, which is a
179 requirement to regard the trait as a costly signal. In recent years, theoretical (e.g., Fuller, Houle &
180 Travis, 2005) and empirical evidence (e.g., Rodriguez & Snedden, 2004) for the role of SE in sexual
181 selection has been steadily accumulating, establishing it as a valuable alternative to traditional
182 indirect benefit models, such as costly signaling.

¹ Usually the term “Sensory Exploitation” is interpreted quite broadly, referring not only to the exploitation of sensory sensitivities, but also to the exploitation of receivers’ emotional and cognitive sensitivities. Moreover, these sensitivities do not need to be innate, but can be learned as well, given that they are maintained by strong functionality outside the signaling context. Therefore, sometimes the more inclusive term “receiver psychology” is used.

183 Several empirical studies lend support to the plausibility of the SE mechanism as an
184 alternative account of signal evolution (for a review, see Fuller et al., 2005; Arnqvist, 2006). For
185 example, Rodd and colleagues (2002) suggest that male guppy color patterns are food mimics.
186 Specifically, they found that, among populations, variation in female mating preferences for males
187 with orange spots can be explained by the attraction to orange food objects. Given the fact that these
188 animals frequently eat orange food items, selection for easy detection of orange food items might
189 have resulted in selection for preferences for orange males.

190 Admittedly, demonstrating a correlation between attraction to orange food and orange males
191 by itself does not tell us anything about the direction of causation. It may be that the “orangeness” of
192 males is actually an adaptive indicator of male quality (because, for instance, producing the color
193 requires ingesting carotenoids), and that the preference for orange food is merely a by-product of
194 mate choice. It may also be that the preference for orange food and orange males evolved
195 independently in these guppies (Fuller et al., 2005). A final possibility is that costly signaling and SE
196 operate simultaneously and complement each other, and thus each explains a particular aspect of the
197 evolved display. In the case of the guppies example, it may be that, initially, females are attracted to
198 orange males because they mimic food. Because this orangeness is also hard to produce for males,
199 females can – secondarily – also be selecting for male quality (Arnqvist, 2006).

200 This last interpretation is a “weaker” version of SE, one that is not mutually exclusive with
201 costly signaling and that may even complement it. This account is commonly considered to explain
202 specific aspects of costly signal evolution, for example, why a costly signal takes on a specific
203 wasteful form rather than another one. This weaker version of SE is also called “sensory drive” and
204 often focuses on signal efficiency (Endler, 1992). It needs mention, however, that a clear distinction
205 between sensory drive and SE is unwarranted and usually these theoretical variants are lumped

206 together. The argument put forward in this paper is mainly based on this weaker version of SE. In
207 particular, we propose that in addition to costly signaling, SE has explanatory potential for RMA and
208 can uncover why in RMA costliness is perennially embodied in *high* structures.

209 Although both SE and costly signaling are usually applied to explain patterns in sexual
210 selection, they can also describe the interactions between senders and receivers of any signaling
211 system, even a cultural one. Whereas in sexual selection SE drives the evolution of male display
212 signals (e.g., ornaments, behaviors, sound production) in the signaling system we propose, SE drives
213 the evolution of particular features about RMA (i.e., increased size and height of built structures) to
214 reinforce religions' social function. SE operates because receivers have pre-existing sensory,
215 cognitive or emotional sensitivities for visual, aural or other perceptual stimuli/features. In our
216 signaling system RMA is supposed to exploit what we coin a "sensitivity for bigness".

217

218 **1.2.2. RMA exploits an adaptive sensitivity for bigness**

219 The primary sensory sensitivity which seems to be exploited by instances of RMA is the tendency to
220 consider large-sized objects or agents as powerful or dominant. This sensitivity seems to be
221 widespread in the animal kingdom. With regard to humans it has been suggested that it originates
222 from parent-child interactions, where the correlation between the parent's size and its influence over
223 the child becomes a benchmark for estimates about social power later on in life (Schwartz, Tesser &
224 Powell, 1982). Others, however, consider such a "sensitivity for bigness" to be a deeply homologous
225 trait, which might explain why it is shared among different animal species. Judge and Cable (2004),
226 for example, note that in the animal kingdom height and size are employed to assess the power and
227 strength of other animals, thus acting as a direct cue on the basis of which fight-or-flight decisions
228 are made. According to this view a sensorial sensitivity to bigness is basically adaptive perception.

229 Within groups of (social) animals this sensitivity for bigness seems to be exploited during dominance
230 displays, in an effort to establish or further consolidate social hierarchies (De Waal, 1982). For
231 example, during dominance displays of non-human primates dominant individuals try to make
232 themselves appear taller than they actually are (e.g., by extending arms and legs) and also exhibit
233 traits (e.g., pilo-erection) which increase their perceived size (De Waal, 1982). In captivity primates
234 have even been reported to intensify the power of their display by making high structures with some
235 of the objects available in their enclosures.

236 The association of size cues with power is also apparent from human behavior. For example,
237 bank directors' offices are often located in the uppermost parts of office buildings, whereas after
238 sporting contests the winner is invited to take the top spot on the podium. Empirical research shows
239 that individuals who take on postural positions that augment their perceived size feel more powerful
240 than their "constricted" counterparts (Huang, Galinsky, Guenfeld & Guillory, 2011) and are
241 commonly considered as more socially dominant by viewers (Marsh, Henry, Schechter & Blair,
242 2009; see also Tiedens & Fragale, 2003). Higher social power/ranking is also attributed to human
243 figures which are placed on an elevation as opposed to figures in a non-elevation position (Schwartz,
244 Tesser & Powell, 1982). When faces are presented in a raised position they are evaluated as being
245 more dominant than their "lowered" equivalents (Mignault & Chaudhuri, 2003). Recent research
246 suggests that, in humans, this sensitivity for bigness is already present from a very early age.
247 Specifically, Thomsen and colleagues (2011) report that, as of ten months old, infants use relative
248 size as a cue for predicting dominance in a conflict of goals.

249 Of relevance for our argument about RMA is that this sensitivity for bigness does not only
250 become activated by a social agent's body size or by its specific bodily posture (e.g., grandstanding).
251 Recent research demonstrates that already very simple height, verticality and size cues create

252 impressions of power. While the effects of such cues are mainly studied from the perspective of
253 embodied cognition research, they are consistent with the evolutionary perspective taken in this
254 paper. For example, Schubert (2005) showed (among others) that respondents are faster at identifying
255 powerful groups when these groups were represented on top of a computer screen than at the bottom,
256 supporting the view that the concept of power is visually represented as a vertical difference (see
257 also: Fiske, 1992; Haidt & Algoe, 2004). When in an organization chart the vertical line which
258 connects the leader to the employees is made longer, then the leader is judged as being more
259 powerful (Giessner & Schubert, 2007). Schubert, Waldzus and Giessner (2009) found that subjects
260 were faster and more accurate in indicating whether a concept described a powerful group (e.g.,
261 “professor”) when this concept was written in large as opposed to small fonts, which is consistent
262 with the view that size cues correlate positively with perceptions of power. Similar results speak from
263 the fact dominant individuals have a visual preference for the vertical dimension in space (Moeller,
264 Robinson & Zabelina, 2008) and that activating concepts referring to powerful groups/individuals
265 (e.g., “president”) drives attention to higher spatial positions (Zanolie et al., 2012).

266 We hypothesize that in as much as size, and especially height are characteristic to RMA, such
267 edifices can be interpreted as cultural signals that exploit in spectators the sensitivity for bigness, i.e.,
268 the tendency to see and feel power/dominance in objects/features that are big, or at least suggest
269 bigness. This particular claim receives further support from the finding that power and dominance are
270 also associated with ecologically relevant stimuli (i.e., mountainous topographies) (Gagnon et al.,
271 2011), and not only with the aforementioned simple height, verticality or size cues. Thus, in addition
272 to the fact that in RMA power is evident from the fact that massive amounts of energy and labor were
273 necessary to erect these structures (cfr., Trigger, 1990; Neiman, 1998), the SE perspective extends

274 that view by suggesting that also particular formal attributes of these buildings (especially height)
275 lead to subjective impressions of power².

276

277 **1.2.3. RMA galvanizes cultural evolution**

278 According to the framework outlined so far, instances of RMA not only signal wastefulness (cfr.,
279 Neiman, 1998), but they also tap into an adaptive sensitivity for bigness. It is worth noting that the
280 two components central to our dual account of RMA (i.e., costliness, bigness) are not exclusive to
281 human built accomplishments, but are sometimes even characteristic to animal constructions.
282 Consider for example, the *Vogelkop* bowerbird species which builds bowers that are many times
283 higher than their makers. Such structures too seem to be characterized by both costliness (in
284 precision and construction cost) and monumentality (in size). This conspicuous similarity between
285 (aspects of) certain human and animal constructions illustrates how cross-species comparisons can
286 shed light on the possible ultimate functions of human building behavior, suggesting that also the
287 aesthetics of human architecture is constrained by evolutionary factors (see for example Hersey,
288 1999).

289 In the bowerbird example, female bowerbirds use the male bower as quality-indicators of its
290 builder. Analogously, in Neiman's account (Neiman, 1998), building monumentally is assumed to
291 convey a fitness advantage to their Mayan builders because the fact that they were able to expend
292 valuable amounts of energy and resources on such inherently useless structures reliably illustrated
293 their genetic fitness. In our dual account, however, the function of RMA should not necessarily be
294 restricted to a sexual selection framework (cfr., Miller, 2000). Rather than solely serving genetic

² Along similar lines, clothing and garments that artificially increase an individual's height (cfr., thick boots, high heels, tall hats, miters) can be understood as culturally evolved objects that exploit the sensitivity to bigness. Like RMA ,they are one of the possible ways in which people use designed elements or artifacts to appear powerful and dominant.

295 transmission, RMA can also be a vehicle for cultural transmission. For example, according to dual
296 inheritance theory (DIT; Richerson & Boyd, 2005) culture – being understood as “knowledge stored
297 in brains” – is adaptive, and the evolution and transmission of cultural variants is driven and guided
298 by social learning, imitation and teaching. Of particular interest is that cultural learners employ a
299 number of fast and frugal heuristics to identify good learning models that allow them maximize the
300 success of social learning. Learners are, for example, biased to learn from and imitate models (e.g.,
301 individuals or groups) that send out signals that are indicative of cultural success, such as prestige
302 (Henrich & Gil-White, 2001). Inasmuch as massive religious edifices signal prestige, such structures
303 can galvanize the transmission of the particular cultural variants adhered to by the cultural models.
304 One of the central tenets of DIT is that cultural and genetic evolution do not always operate in
305 unison. Dual inheritance allows to view the prestige which RMA enjoys not only as an indicator of
306 good genes, but also as an indicator of good “cultural variants,” thus being one of religions’ devices
307 to promote and facilitate their own cultural dissemination.

308

309 **1.2.4. Religious monumental architecture exploits awe**

310 Having sketched the main lines of our dual account of RMA, in the next sections we will turn to
311 another aspect which has received little attention in accounts of monumental architecture, namely, the
312 emotions that are experienced when encountering such massive structures. In Neiman’s costly
313 signaling account (Neiman, 1998), the emotional impact of RMA remains largely implicit. Our aim is
314 to open this black box and to bring the “hot”, i.e., the emotional impact of RMA to the foreground.
315 Specifically, our account attributes a central role to the emotion of *awe*, and attempts to explain how
316 its experience interlocks with RMA, and the associated religious doctrine’s possible functions. In the

317 ensuing sections we first give a brief overview of the central characteristics of awe, after which we
318 discuss which characteristics of RMA might possibly trigger this particular emotion.

319

320 ***Central characteristics of awe – “vastness” and “need for accommodation”***

321 Religious monumental architecture can trigger a wide range of emotions in human individuals,
322 among others admiration, beauty, delight, goose bumps, aesthetic chills, fear, dizziness, romance or
323 hope. One of the core assumptions of the argument put forward in this paper is that a common and
324 frequent emotional response on perceiving instances of RMA is – and always has been – awe. While
325 grand natural scenes are perhaps amongst the most widely known elicitors of this emotion (cfr., the
326 *Grand Canyon*), it is very likely that cases of religious monumental architecture that have a
327 comparable splendor and grandeur are also able to spark feelings of awe (Shiota, Keltner &
328 Mossman, 2007). Awe is for example experienced by heritage tourists upon visiting cathedrals
329 (Francis, Williams, Annis & Robbins, 2008), and height, which often is characteristic to RMA, has
330 also been found to provoke feelings of awe and respect in human individuals (Schubert, 2005). As
331 will be argued further on, triggering this particular emotional response supports the community
332 function of religions.

333 The emotion of awe has received a fair bit of attention in the religious, philosophical and
334 sociological literature, but it is only since the last decade that it has become studied from a
335 psychological perspective – albeit still to a limited extent (e.g., Keltner & Haidt, 2003; Shiota, et al.,
336 2007; Armstrong & Detweiler-Bedell, 2008). One of the most in-depth psychological discussions of
337 this emotion has perhaps been provided by Dacher Keltner and Jonathan Haidt (Keltner & Haidt,
338 2003). In their “prototypical” approach to awe, Keltner and Haidt consider awe to primordially be a
339 social emotion, which can be traced back to the submissive feelings which (low-ranked) individuals

340 experience in the face of powerful individuals or leaders. The adaptive function of this emotion, they
341 maintain, is to affirm and consolidate prevailing social hierarchies. A crucial point, according to
342 Keltner and Haidt (2003), is that awe is not only experienced in response to powerful or dominant
343 social *agents*, but “... generalizes to other stimuli ... to the extent that these new stimuli have
344 attributes associated with power” (Keltner & Haidt, 2003, 306-307).

345 Based on a reading of the relevant literature on awe, Keltner and Haidt (2003) contend that
346 two primary appraisals are at the heart of prototypical awe experiences. First, awe can arise when
347 (social or non-social) stimuli are encountered that are powerful or “vast” with regard to a particular
348 frame of reference (Keltner & Haidt, 2003; see also Shiota et al., 2007). According to Keltner and
349 Haidt (2003) “vastness” should not necessarily be restricted to physical size, as applies for example
350 to the majestic *Pyramid of the Sun* at Teotihuacan (Mexico). Awe-inspiring stimuli might – among
351 others – also be vast in time, space, degree of elaboration, or ability. On this account, recognizing
352 that gargantuan efforts have gone into constructing a religious monumental structure might also color
353 one’s experience of the edifice with awe.

354 If only appraisals of vastness were to occur in response to a particular stimulus, people would
355 probably be more likely to feel – say – reverence or submission, rather than awe. According to
356 Keltner and Haidt (2003) full-blown awe only occurs when this vastness is of an overwhelmingly
357 high intensity. Put differently, by its “vastness”, the awe-evoking stimulus does not only co-opt the
358 human sensitivity for dominance signals, but it also becomes a super-stimulus by exceptionally
359 exaggerating that vastness (Tinbergen, 1951). While such exceptional vastness can create a sense of
360 physical insignificance in spectators, Keltner and Haidt (2003) contend that the second important
361 dimension of awe relates to how individuals cognitively appraise those feelings of insignificance.
362 Specifically, the experience of exceptional vastness deeply challenges or “shakes” an individual’s

363 cognitive conceptions, involving an inability to assimilate the awe-provoking experience into current
364 mental structures. This is supposed to trigger a compensatory need to “accommodate” the awe-filled
365 experience, involving an adjustment of existing mental schemes (Keltner & Haidt, 2003). Notice that
366 such awe-provoking, (cognitively) overwhelming vastness often seems to be an intrinsic
367 characteristic of instances of RMA. For example, the *Notre Dame Cathedral* in Paris very probably
368 triggered awe in the medieval peasant population because its splendor and massive scale was unlike
369 any built structure they had ever seen. It largely surpassed these individuals’ mental conceptions of
370 possible human creative accomplishments.

371 Note that underlying the argument that RMA is/was a common trigger of awe is the
372 assumption that RMA has had similar emotional effects across different cultures and epochs. But is
373 there any evidence for this? Already two decades ago, Ekman (1992) speculated that awe should be
374 considered a basic emotion, but he also noted that empirical support for this speculation was lacking.
375 Likewise, Haidt and Keltner (2002) anticipate that awe is experienced among most cultures, although
376 there might be between-cultural variation in the importance attached to the emotion. Although
377 systematic research is lacking, there are some indications for the cross-cultural prevalence of awe.
378 For example, in the *Natyashastra*, an ancient Indian treatise on the performing arts, awe/wonder
379 (“*Vismaya*”) is an essential part of the repertoire of nine basic emotional responses. Research by
380 Haidt and Keltner (1999) furthermore shows that both American and Indian respondents employ awe
381 to label particular emotional facial expressions (Haidt & Keltner, 1999), whereas these two cultural
382 groups are also able to correctly identify wonder/awe in the dynamic (facial and bodily) expressions
383 in classic Hindu dance performances (Hejmadi, Davidson & Rozin, 2000). From a cross-species
384 perspective, so-called “waterfall-displays” by chimpanzees are sometimes associated with awe.
385 While such displays involve the primates to dance near the waterfalls that emerge after heavy

386 rainfalls, they have also been found to contemplate this natural event for many minutes, as if standing
387 in wonder and awe about it (Goodall, 1986). Thus, while more empirical research is required to settle
388 the issue as to whether awe occurs cross-culturally and cross-temporally, these studies and
389 observations at least tentatively suggest that it is likely to be the case.

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396 *Figure 1: Some examples of religious monumental architecture. Top: Buddhist temples at Bagan,*
397 *Burma; Middle: Pyramid of the Moon (Teotihuacan, Mexico). Bottom: Cologne Cathedral (Cologne,*
398 *Germany).*

399

400 ***Triggers of awe in RMA***

401 But what exactly is it about RMA that can trigger awe? In accordance with Keltner and Haidt's
402 (2003) prototypical approach to awe, the vastness inherent to RMA can be considered as the primary
403 cause of awe. But what does this "vastness" exactly amount to? First of all, vastness can – of course –
404 refer to the sheer physical size of the monumental structure. However, the "raw" or absolute scale of
405 RMA is probably not the only physical source of awe. Consider the fact that in human mate choice,
406 large breasts and buttocks can provoke awe or awe-related states in males, whereas large upper body
407 muscles can trigger awe in females. These observations suggest that awe is based on implicit
408 contrasts to what is normal, rather than on absolute scale. Monumental (religious) structures, such as
409 cathedrals or pyramids, are massive and awe-evoking even by today's standards (pyramids,

410 cathedrals). However, despite the fact that many monumental built structures of small-scale societies
411 are considerably smaller absolutely, they were still much larger than any surrounding structures, and
412 could therefore well have been a source of awe during their epoch. Our argument thus not only
413 applies to the “traditional” examples of RMA, like pyramids or cathedrals, but extends to
414 monumental structures such as ashmounds, barrows, longhouses, or stone circles (e.g., *Stonehenge*)
415 (see figure 1 for examples of RMA).

416 As outlined in our characterization of awe (section 1.2.4), certain immaterial characteristics
417 can also be considered as “vast”, such as the “big” personality of charismatic leaders (cfr, Martin
418 Luther King), or extraordinary physical accomplishments (e.g., finishing an ultra-marathon). In an
419 analogous way, the (effortful) *processes* involved in, or necessary for constructing monumental
420 religious buildings (e.g., the vast amount of work) can also be a source of “vastness” (besides direct
421 physical appearance). Building monumentally almost per definition requires huge amounts of labor,
422 energy and time, and recognizing this might amplify, or further support the awesomeness triggered
423 by the vast physical form. Vastness might also refer to extraordinary craftsmanship, such as speaks
424 from the accuracy of the decorative stonework in the *Alhambra* (Spain), or from the
425 technical/structural virtuosity necessary to construct a vaulting spanning a huge stretch of space in a
426 medieval cathedral. It might refer to the use of materials that are notoriously difficult to collect or
427 that are very labor-intensive to work or process. Of course, all these processes need to be managed,
428 and this managerial ability can itself be a source of awe when it takes on extraordinary proportions. A
429 recent example is the *Beijing Airport* which has been built at the occasion of the 2008 Olympic
430 Games and took less than four years from plan to completion. The airport’s physical scale is not only
431 impressive, it also represents an awesome display of bureaucratic efficiency.

432 It thus appears that there are two principal sources of vastness in RMA – and hence of awe –
433 and these run along the same lines as the two perspectives brought together in our dual account of
434 RMA. That is, (a) the direct perception of “bigness” can be a source of awe as much as (b) the
435 costliness (i.e., wastefulness) underlying the construction of that bigness. Note however, that a certain
436 amount of knowledge might be required to be awed by costly building activities (i.e., condition (b)).
437 Consider the case of a tiny temple built atop a huge mountain. Although this temple might fulfill the
438 physical vastness condition (i.e., (a)) because it is built on a high place, the building could be seen as
439 a form of cheating because it derives its high position solely from the height of the mountain.
440 However, learning/knowing that the mountaintop was absurdly inaccessible at the time of the
441 construction of the temple might still fill one’s experience of the building with awe. Probably, when
442 both the physical size of the building (condition (a)) and the costly investments made to construct it
443 (condition (b)) are impressive, and embodied in one and the same building, then it becomes very
444 likely that an intense awe response to the building will occur.

445 Notice that in the case of RMA, bigness often *necessarily* goes hand in hand with costliness.
446 In the age of dazzling skyscrapers, it is easy to forget how difficult it was in the past to achieve great
447 height. Without great width, depth and mass, massive structures often ran the risk of collapsing, as is
448 illustrated – for example – by the case of the *Notre Dame d’Amiens* (France). In this cathedral the
449 flying buttresses were initially placed too high, and were barely able to counteract the lateral forces
450 that came from the ceiling arch. First, this was resolved by placing lower buttresses, but when after
451 some time cracks in the lower walls of the building began to appear, builders finally installed an iron
452 bar chain running inside the walls, holding the cathedral together (Nova, 2012). This example clearly
453 shows that it is difficult to exploit the sensitivity to bigness on the cheap. In the past building high
454 almost necessarily was a costly enterprise, requiring – among others – technical ingenuity, large

455 human labor investment and an abundance of material resources. One of the few “easy” ways in
456 which height – or rather subjective impressions of height – could be increased was through illusion.
457 In gothic cathedrals, for example, impressions of height are sometimes amplified by the (vertical)
458 shafts running from the floor up to the ceiling. Other methods for creating the optical illusion of
459 added height is to taper the walls of the monumental structure, or to paint the higher versus the lower
460 parts in different shades (the higher the lighter the shade), like is the case in the *Eifel Tower*³.

461

462

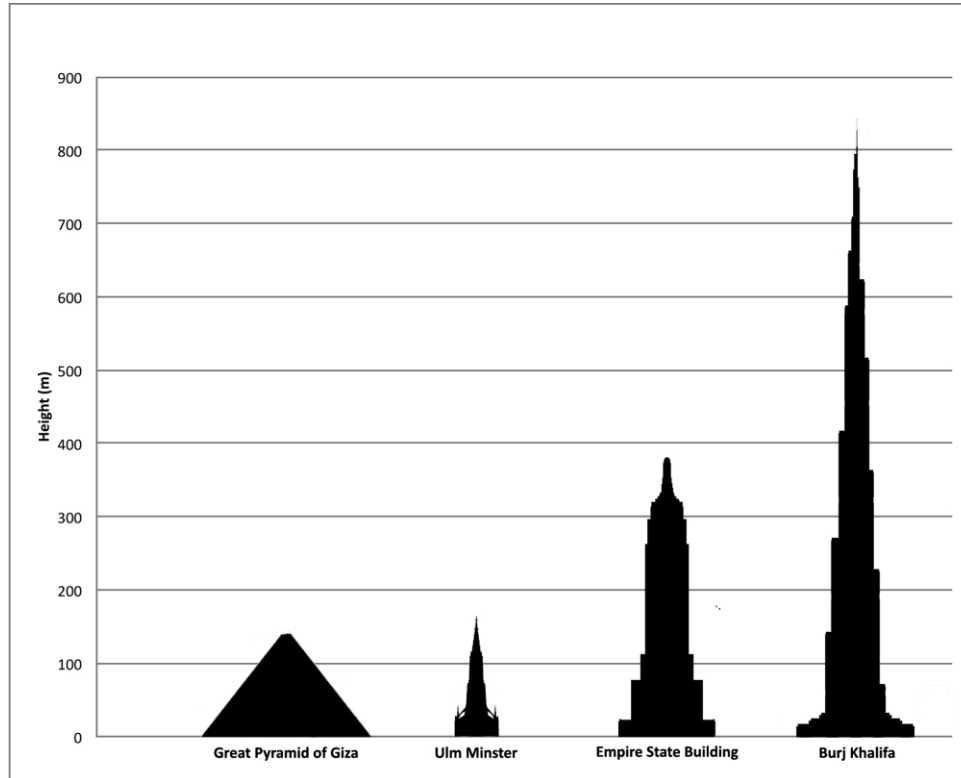
463

464 ***Ever higher***

465 If triggering dominance perceptions and awe experiences is indeed an important function of religious
466 monumental buildings, it can be expected that their religious (or ideological) builders will have
467 attempted to build as high as they were capable of. In agreement with this prediction, it appears that
468 throughout history the achieved height of the world tallest buildings increased synchronously with
469 the development of new engineering and technological skills (Figure 2). However, apart from their
470 pure height, also the height to width ratio of monumental buildings seems to have increased over
471 time, probably stemming from an increased ability to overcome the technical limitations hampering
472 building high structures. For example, the highest church in the world, the *Ulm Minster* (Ulm,
473 Germany, 1890 AC, 161,5m) only slightly exceeds the *Great Pyramid of Giza* (± 2560 BC, 146,5m)
474 in height, but it is far more slender than the pyramid, even though buttresses had to be added to keep
475 the church buildings upright. Skyscrapers of the first decennia of the 20th century, such as the New
476 York *Empire State Building* (1931 AC, 381m), achieved approximately two times the height of the

³ Note that male bowerbirds also use forced perspective in their bowers, possibly to appear bigger to females (cfr., Endler, J.A., Endler, L.A. & Doerr, 2010).

477 world's tallest churches, but with a similar height to width ratio. Finally, the height of the *Burj*
478 *Khalifa* (2010 AC, 828m), a skyscraper in Dubai, doubles that of the *Empire State Building*, whereas
479 its basis has approximately the same width.



480

481 *Figure 2: Heights of four of the world's tallest buildings throughout history.*

482

483 2. Building communities by exploiting awe

484 In a nutshell, in the previous sections we argued that RMA exploits feelings of awe in spectators by
485 being at the same time a costly signal and a structure that taps into our shared sensitivity to bigness.

486 Having made this framework explicit, in the following sections we will elucidate how awe
487 experiences interlock with and promote religions' social function. In the first section, the role of awe
488 in vertical social stratification is discussed, while the second section touches upon the possible
489 community building effects of experiencing this emotion. In the third section, we explain how RMA

490 might have coordinated and monitored social life. Note that in these sections we aim to shed light on
491 the function(s) of RMA from the perspective of the (large-scale) religious community in which the
492 instance of RMA was embedded. We do not exclude, however, that RMA might have had analogous
493 functions for certain smaller groups or even for the particular individuals *within* those communities.
494 While RMA might be interpreted as a means of religious communities to yield prestige, it is of
495 course entirely possible that RMA might also have increased individuals' own prestige because, for
496 example, they actively contributed to building the structure. We refer to the discussion section for a
497 further consideration of the possible consonances and conflicts between the functions of RMA on the
498 group versus the individual level.

499

500 **2.1. The role of religious monumental architecture in vertical social stratification**

501 There is ample evidence that in the presence of dominant individuals, or visual cues correlating with
502 actual dominance, people are inclined to behave obediently or submissively. In the infamous
503 obedience experiment by Milgram, for example, volunteers went so far as to give (seemingly) lethal
504 electroshocks to a stranger because an authority figure (i.e., the experimenter) pressed them to do so
505 (Milgram, 1963). Recent research demonstrates that watching individuals power posing (e.g., taken
506 an open posture) leads to hormonal changes that correlate with submissive behavior (i.e., decrease in
507 testosterone, increase in cortisol) (Carney, Cuddy & Yap, 2010). When individuals are faced with a
508 dominant confederate, their submissive behavior is evident from the fact that they tend to adopt
509 constricted postures (Tiedens & Fragale, 2003). A study by Fennis (2008) shows that individuals
510 behave more submissively towards confederates when the latter surround or associate themselves
511 with high status brands/products.

512 Inasmuch as RMA can, by its size and height, be considered as an architectural embodiment
513 of a dominant/powerful religious group or entity, the foregoing research suggests that commoners are
514 prone to behave more obediently and submissively when faced with such grand edifices. Thus, as a
515 signal tapping into the aforementioned sensitivity for bigness and its (emotional) effects (especially
516 awe), RMA's physical appearance might have actively contributed to the process of vertical
517 stratification and social ranking. This complements the costly signaling view on monumental
518 architecture outlined earlier (section 1.1). According to that view, social organization and
519 stratification result from the building process, i.e., from the recognition that the builders were capable
520 of mobilizing and controlling large amounts of energy and labor (cfr., Neiman, 1998).

521 It is important to note that the mechanism through which RMA has its socially stratifying
522 effects probably deviates from that underlying dominance displays. During such displays, size cues
523 (e.g., grandstanding) are also often employed, but the dominant individual – or the one trying to
524 dominate – uses these to *enforce* a hierarchical relationship upon another individual. If RMA would
525 play a closely analogous role, then it mainly would have functioned as a device for oppressing and
526 intimidating people. If that were RMA's sole function, then it needs to be explained why instances of
527 RMA are often also highly aestheticized, and are often attractive rather than merely oppressive. This
528 suggests that such edifices also functioned to attract or “seduce” commoners, rather than to merely
529 intimidate them (Huysen, 1996).

530 It seems that by exploiting awe RMA can have it both ways. On the one hand, due to the fact
531 that awe is primordially rooted in submissive feelings toward dominant individuals (Keltner & Haidt,
532 2003), RMA might tap into emotions related to submission. On the other hand, contrary to “pure”
533 dominance displays, those feelings seem to be *willingly* conferred to the stimulus that provokes awe
534 (cfr., Henrich & Gil-White, 2001). Or as Frijda and Parrott (2011) put it: “Awe recognizes the power

535 and quality of someone, some object, or some performance. One willingly and openly recognizes
536 the target's superiority, refrains from competing, and from challenging the target's power" (411). The
537 sense of smallness and cognitive inadequacy that derive from perceiving the grandeur of RMA might
538 thus define and consolidate hierarchical ranking, but that relationship seems primarily to result from
539 freely "surrendering" to the awe-producing authority, rather than that it is caused by an attempt at
540 (enforced) submission by that authority.

541 RMA is thus not solely intimidating and oppressive, but it can also deeply impress the
542 (religious) spectator, being attractive rather than repellant. However, in addition to the vastness
543 inherent to RMA, further particularities of the construction process and of the building's shape, can
544 give RMA either a more oppressive or impressive/attractive "flavor". Appraisals of "oppressiveness"
545 or "impressiveness" can derive from the building process itself. For example, throughout history
546 constructing monumental architecture has frequently been a way of leaders to mercilessly oppress
547 and dehumanize certain (ethnic) groups or minorities, like it happened in Hitler and Speer's
548 monumental architecture program. The specific shape or layout of the building, or particular
549 architectural features can however also bring about feelings of oppression or impression.
550 Oppressiveness can, for example, be due to including anxiety inducing elements in RMA, such as
551 sharp spires/towers or piercing forms (Larson, Aronoff, Sarinopoulos & Zhu, 2009), dark enclosed
552 spaces (Stamps, 2005) or representing threatening animals in ornament (Barrett, 2005). On the other
553 hand, incorporating shiny and glistening surfaces (Coss, 2003), brightly colored architectural features
554 (cfr., gothic rose windows) or ornaments of nonthreatening elements might make a monumental
555 structure attractive rather than intimidating.

556

557 **2.2. The role of religious monumental architecture in communal bonding**

558 Besides introducing and enacting social ranking and facilitating “vertical” attachment to religious
559 leaders and deities, we conjecture that RMA is also capable of generating “horizontal” attachment,
560 that is, increased bonding and attachment *among* religious followers. The actual physical appearance
561 and geographical location of such buildings might already play a role in this process. Due to their
562 massive scale, inside and around instances of RMA there often is a lot of space for large groups of
563 people to gather, providing ample opportunities for social interaction and social sharing. Medieval
564 cathedrals, for example, are known to have served as civic gathering places or even marketplaces
565 (Estabrook, 2002).

566 In addition to providing physical opportunities for gathering, we deem that by triggering
567 awe, RMA can also *psychologically* facilitate social gathering/bonding. Examinations of the *direct*
568 effects of awe suggest that this particular emotion indeed has community building potential by
569 making people feel connected and act prosocially toward each other. Shiota and colleagues (2007),
570 for example, discovered that experiencing awe causes people to feel as belonging to a large group,
571 whereas this effect did not occur for other positive emotions, such as pride. Similarly, Saroglou,
572 Buxant and Tilquin (2008) found that watching awe-eliciting events/scenes, such as natural scenery,
573 made respondents feel more connected and committed to others, when compared to respondents who
574 had seen an amusing video-clip. Van Cappellen and Saroglou (2012) recently replicated this effect by
575 showing that in spiritual/religious respondents, experiencing awe leads to sentiments of oneness with
576 close others and with humanity as a whole, as opposed to experiencing humor. Awe makes people
577 also more willing to spend their time on helping others (Rudd, Vohs & Aaker, 2012). Our own
578 research findings are consistent with this and point out that exposure to natural, awe-evoking scenes
579 makes people more inclined to act prosocially towards others compared to mundane natural
580 scenes/elements (Joye & Bolderdijk, unpublished data).

581 Based on these empirical findings we propose that RMA can exploit the social unification
582 effects of awe, and as such, can also “horizontally” contribute to religious community building.
583 Further research is however needed to uncover the exact mechanism responsible for this effect. Our
584 own hypothesis is that the community-building effect of awe is driven by two interlocking
585 psychological mechanisms, which directly tap into the two central features of awe experiences,
586 proposed by Keltner and Haidt (2003), i.e., vastness and need for accommodation.

587 A first mechanism is linked to the vast physical scale of these religious edifices. Research
588 shows that priming individuals with large versus small spatial distances makes them frame and
589 consider things in terms of more abstract mental representations or “construals” (e.g., “fruit” versus
590 “apple”) (Henderson & Wakslak, 2010). Of particular interest for our argument is that Meyers-Levy
591 and Zhu (2007) found that high versus low ceiling heights makes individuals classify objects into
592 broader and more inclusive categories. In an analogous way, we conjecture that exposure to the
593 massive scale and height of RMA will have made it more likely that religious followers represented
594 fellow-followers in terms of a “collective” entity or group, rather than as a collection of separate
595 individuals. This focus on the communal might be further reinforced by the fact that the highly
596 attention-grabbing character of awe-triggering stimuli brings about a diminished sense of self in the
597 viewer and a strong focus on external events and elements (Shiota et al., 2007).

598 However, neither focusing on others (instead of on oneself), nor viewing them in terms of a
599 collectivity will necessarily motivate an individual to turn to or to *attach* to a group of individuals. A
600 second mechanism which we identify (for community building) relates to the feeling of
601 mental/cognitive inadequacy that might arise from perceiving the vastness inherent in RMA.
602 Specifically, people are likely to turn to, or to rely on others to compensate for the sense of
603 insignificance and (cognitive) uncertainty that can be caused by experiencing awesome events or

604 elements (Derbaix & Vanhamme, 2003; Marigold, McGregor & Zanna, 2009). In as much as RMA
605 created – through awe – feelings of uncertainty and insignificance (cfr., Griskevicius, Shiota &
606 Neufeld, 2010) and shook an individual’s mental structures, a tendency for religious followers to
607 “flock together” would have constituted a compensatory strategy to curb those feelings (for a review,
608 see: Kay, Gaucher, McGregor & Nash, 2010; Rucker & Galinsky, 2008).

609 The crux about the previous argument is that RMA exploits psychological dispositions
610 closely interwoven with awe, which – indirectly – facilitate communal bonding. On the one hand, we
611 assume that the subjective sense of (cognitive and physical) insignificance caused by RMA leads to a
612 compensatory need for attachment to others. On the other hand, monumental architecture’s massive
613 spatial scale makes that people’s representations of those others tend to transcend the level of
614 “particular selves”. Notice that this last conclusion dovetails with the proposition that in religions
615 experiences of self-transcendence contribute to generating group cohesion (Durkheim, 1915). Self-
616 transcendent states are commonly reached during ritual performances or acts, in which individuals
617 participate in, for example, singing or synchronous rhythmic behavior. Research confirms that jointly
618 making music (Kirschner & Tomasello, 2010) and moving synchronously (i.e., walking in step)
619 (Wiltermuth & Heath, 2009) leads to increased cooperation and helping behavior, which can foster
620 communal living. As will be further discussed in section 4, RMA should be viewed as being an
621 integral part of, and supporting this ritual component of religious doctrines.

622

623 **2.3. Religious monumental architecture as a social monitoring device**

624 Inevitably, religious communities are faced with the challenge of regulating communal/religious
625 living. Without appropriate social monitoring, freeloaders might reap the benefits of the prosocial and
626 cooperative efforts of fellow community members without themselves complying to the social rules

627 and norms. It has been hypothesized that religions have a number of built-in adaptive strategies to
628 deal with problems of defection and freeloading. One proposal, made (among others) by Rossano
629 (2007) is that ever-present supernatural beings are a means for social scrutiny, encouraging social
630 cooperation among community members and, in so doing, consolidating social community living
631 (see also: Alcorta & Sosis, 2005).

632 In religions it is commonplace to use artifacts to remind people of the customary religious
633 *ethos* (e.g., the cross in Christianity). Quite probably, instances of RMA will have played a similar
634 social regulatory role (cfr., Atran & Henrich, 2010). In so doing, such edifices complement the
635 regulatory function of physically present social monitors (e.g., priests) and supernatural monitors
636 (e.g., deities). Due to their massive scale, monumental constructions are often extraordinarily salient,
637 grab and engage attention, and are therefore suited for regulating social/religious life across
638 considerable spatial distances. Of further importance is that the interpretation of such “monumental
639 monitors” does not depend on language, age, gender or culture and that they can be simultaneously
640 accessed by large groups of individuals, and this during different epochs (De Marrais et al., 1996;
641 Alcorta & Sosis, 2005). We anticipate that exposure to awe-evoking RMA will have made it more
642 probable that followers live up to the prosocial norms that are embodied in, or evoked by such
643 buildings, as opposed to non-awe-provoking religious buildings. This is because awe involves an
644 (implicit) recognition of the presence of a superior and highly powerful authority (Keltner & Haidt,
645 2003), almost literally “looking down” on religious followers and (implicitly) commanding them to
646 live up to the prevailing social rules and norms⁴.

⁴ It might be noted that there is a seeming contradiction between the “monumental monitors” idea and the claim that RMA should be understood in terms of a costly signal. Could it not be the case that the height of cases of RMA is merely a prerequisite for optimally performing the monitoring function? In other words, is RMA, considered from the perspective of monitoring, not just efficient design instead of strategically wasteful design? Against this, it can be pointed out that monitoring only seems to require that the structure stands out so much among surrounding (built) structures that it (significantly) enters the visual field. One often sees, however, that RMA is vastly higher than the surrounding buildings and fills a substantial portion of the visual field. Moreover, the use of elements which increase subjective

647 What is the mechanism through which such architectural monitoring could have taken place?
648 Two pathways can be distinguished. A first one is directly related to the finding that priming
649 individuals with religious concepts (e.g., “divine”) makes them more inclined to conform to prosocial
650 norms, and to behave and act more prosocially towards other members of their social group (that
651 could also imply behaving non-socially toward out-group members) (see: Preston, Ritter &
652 Hernandez, 2010; cfr., Shariff & Norenzayan, 2007; Saroglou, Corneille & Van Cappellen, 2009;
653 Pichon, Boccato & Saroglou, 2007). Recent research confirms that similar prosocial effects can occur
654 when religious *buildings* are employed as primes, rather than religious concepts (cfr., Atran &
655 Henrich, 2010). Specifically, Pichon and Saroglou (2009) found that when religiousness is primed by
656 a church, people express to be more willing to help the homeless than when they are primed with a
657 non-religious building (i.e., a gymnasium). Meier and colleagues (2007) also found that vertical
658 space and upward position – both of which are typical to RMA – activate divinity-related cognitions,
659 which, in turn, might make particular (pro)social norms salient.

660 A second possible pathway underlying monumental monitoring is that spectators actually
661 associate, or attribute supernatural social agency to the monumental structure. This may make
662 commoners feel as if being watched or monitored, thereby stimulating them to act and behave
663 prosocially. This claim is in line with evidence showing that the presence of (minimal) social cues
664 (e.g., eye-spots) makes individuals behave more generously in economic games (Haley & Fessler,
665 2005) and more willing to donate to a good cause (Bateson, Nettle & Roberts, 2006). Note that,
666 consistent with this view, in different religions religious monumental buildings are assumed to be the
667 dwelling places of supernatural beings. For example, the Egyptian word for temple – *hwt-ntr* –
668 literally means “god’s House” (Trigger, 1993).

impressions of height and the use of adornments and decorations, suggest that such edifices were not only intended to monitor commoners, but also to appear attractive to them.

669 Belief in the presence of divine agency in RMA could, of course, merely be an article of faith
670 shared by many religions, which followers acquire after having become acquainted with the religious
671 doctrine. However, it is also possible that attributing (supernatural) agency to monumental edifices is
672 partially independent from the particular teachings of a doctrine. Being an intentionally made
673 structure, RMA might already activate cortical networks that lead to mental state attributions, even if
674 the monumental structure does not contain any direct cues of social agency (Steinbeis & Koelsch,
675 2009). Those ascriptions of agency might get flavored with supernaturalness as a way to make the
676 structure's mind-boggling grandeur and complexity more intelligible (cfr., Bloom, 2007).

677 Note that monumental buildings can also contain, or be accompanied by visual
678 features/elements that make spectators inclined to (implicitly) ascribe agency to RMA. Some cases of
679 religious (monumental) architecture are, for example, adorned with human-like figures or are
680 "guarded" by monumental statues (e.g., the *Sphinx* at Giza), while others contain eye-like schemas,
681 such as, Imre Makovecz's church in Siófok or the stupa of the Swayambhunath buddhist temple in
682 Kathmandu. Some (monumental) buildings from the Classic Mayan period are even adorned with
683 breathing imagery, suggesting that these constructions were in a sense "alive" (Saturno, Taube, Stuart
684 & Hurst, 2005). Given the finding that vertical upward motion is associated with animacy (Szego &
685 Rutherford, 2008), the upward movement embodied in many instances of RMA can also be a trigger
686 of perceptions of agency.

687 The view that RMA has regularly been imbued with (supernatural) agency can perhaps
688 expand one's understanding of why such type of building has also been a perennial target for
689 destructive acts and why that destruction was often followed by extremely violent retaliations. Within
690 religious doctrines, the installment of new religious leaders often went hand in hand with cycles of
691 demolishing and rebuilding RMA (sometimes even taking on ritual forms), which has been

692 interpreted as a way of these (religious) elites to legitimize their newly obtained leadership, to cut
693 commoners' ties with previous rulers and to create and strengthen new attachments. However, it is
694 also very common for RMA to be attacked by external groups, belonging to rival ideologies and
695 religions⁵. Consider for example the Taliban's dynamiting of the *Buddha's of Bamyam* (2001,
696 Afghanistan) or the demolition of the *Babri Mosque* (1992, India) by Hindus. Of course, as being
697 conspicuous religious symbols, cases of RMA might just be the "easiest" and most visible targets to
698 eliminate. However, inasmuch as RMA is truly a materialization of supernatural agency, then
699 destroying such buildings might be considered as an attempt to almost literally "kill" a religion's
700 (supernatural) agents, and one of the most powerful (psychological) ways to try to wipe out the rival
701 religious/ideological doctrine. Annihilating these monumental monitors may make followers to feel
702 as being deserted by their deities, leading to widespread despair and vulnerability.

703 The fact that especially *high* monumental buildings are perceived as signaling devices of
704 religious or ideological dominance is illustrated by the 9/11 attacks on the *World Trade Center*
705 (WTC) towers in New York. First, there is the remarkable fact that destroying the extraordinarily
706 high towers of the WTC imposed such psychological distress on Americans, whereas they did not
707 seem nearly as upset by the big hole blown in the horizontally-expansive Pentagon – and perhaps
708 they would not have, even if the Pentagon had been utterly destroyed. Second, the *Twin Towers* were
709 perceived as quasi-religious monuments, both by attackers and the attacked. For example, Osama bin
710 Laden declared that the attacks on the WTC were acts in a Muslim "holy war", i.e., a religious war
711 against the United States of America. Some American Christians, from their part, still tried to see
712 traces of their god's presence in the remains of the buildings after the attacks. Specifically, the steel
713 beams shaped like a cross which were discovered in the aftermath of the 9/11 attacks by a worker

⁵ The destruction of competitors' conspicuous signaling devices is not limited to the human species. The analogy we previously drew with bower construction applies here as well: in some bowerbird species males destroy bowers of competitors (Borgia 1985; Borgia & Müller 1992).

714 from the rubble at Ground Zero (New York) were seen as "a sign that God never abandoned us at
715 Ground Zero" (Reuters, 2011).

716

717 **3. RMA builds religious beliefs by exploiting awe**

718 Up to now, we have said little to nothing about the beliefs which permeate religious communities. In
719 the cognitive science of religion, religious beliefs are often considered to be beliefs in supernatural
720 agents. One influential view is that belief in such agents is similar to attributing intentional agency to
721 simple geometric shapes moving on a screen (Heider & Simmel, 1944), both of which are little more
722 than misapplications of mental modules for detecting agency (Barrett, 2000; Atran & Norenzayan,
723 2004). In the ensuing sections we explore how feelings of awe, triggered by RMA, might have
724 influenced and interacted with the process of adopting supernatural beliefs. In the first section we
725 argue that RMA can create ideological/religious openness in followers, whereas the second section
726 discusses how, as being a signal of religious commitment, such architecture can further support the
727 process of religious belief adoption. Notice that the community perspective still constitutes the
728 backdrop of this exploration. That is, belief commitment is deemed to actually support or reinforce
729 the social function of religions (for a discussion, see, e.g., Atran & Henrich, 2010).

730

731 **3.1. Religious monumental architecture creates ideological openness**

732 Keltner and Haidt (2003) conjecture that feeling awe can foster (religious) belief adoption and/or
733 ideological transformation. Research by Shiota and colleagues (2007) supports this claim by showing
734 that individuals with a high disposition to experience awe are indeed more willing to revise their
735 mental structures, or to admit their inadequacy, compared to individuals who have a high disposition
736 for other positive emotions (i.e., dispositional pride and joy). The impact of experiencing awe on

737 spirituality and religious openness has been directly investigated in a few experiments. A qualitative
738 ethnographic study among wildlife tourists by Curtin (2009), for example, reveals that experiencing
739 awe and wonderment, caused by watching wildlife, sparks spiritual feelings in participants. Research
740 by Saroglou and colleagues (2008) points out that respondents score higher on spirituality measures
741 after having watched an awe-eliciting video (e.g., involving nature scenery, among others) rather than
742 a comedy, or an emotionally neutral video. When recalling an event filled with awe,
743 religious/spiritual people are also more inclined to undertake a journey to a spiritual destination (i.e.,
744 Tibet) than to a hedonic destination (i.e., Haiti) as opposed to respondents recalling an event
745 triggering pride (Van Cappellen & Saroglou, 2012).

746 If, as the foregoing findings seem to suggest, awe can indeed foster ideological/religious
747 openness, then RMA can be interpreted as an artful device to make the minds of potential followers
748 more open to the religious beliefs that are preached in, or associated with such religious contexts.
749 This ideological/religious openness might subsequently make (potential) followers to actually take up
750 particular supernatural, and hence, inherently counterintuitive concepts, beliefs or narratives. Note
751 that this effect was clearly exploited in reformation Europe (among others). As Brown (2004)
752 documents, during that epoch the papal patrons appointed artistic geniuses like Bernini and
753 Michelangelo to create awesome architectural spaces, such as the *Saint Peters Cathedral* in Rome, in
754 an attempt to further propagate the faith.

755 What is the possible mechanism through which cases of awe-provoking RMA might promote
756 ideological/religious openness? Probably, this relates to the fact that when experiencing awe one's
757 available mental frameworks prove to be inadequate for fully grasping the object or event that
758 triggers awe (Keltner & Haidt, 2003). Due to a compensatory need to update or revise those
759 frameworks, individuals might become more willing to embrace new or alternative

760 beliefs/frameworks that enable them to surmount this mental inadequacy (Shiota et al., 2007; Kay et
761 al., 2010). At the same time, this cognitive inadequacy is caused by structures that transcend the scale
762 and complexity of common built accomplishments to the highest degree. This probably makes people
763 more open to invoke *supernatural* beliefs into the process of cognitive accommodation, or tips them
764 into believing that the building cannot be other than the work of the god(s) (Bloom, 2007), as
765 compared to smaller, hence, non-awe provoking religious buildings.

766

767 **3.2. Religious monumental architecture illustrates belief commitment**

768 The picture emerging from the previous section is that cases of awe-inducing RMA can instill
769 ideological openness in religious followers. Of course, the transition from being open to a set of
770 religious beliefs to actually adopting those particular beliefs depends on many factors. For example,
771 when individuals have experienced awe, they appear to process messages more deeply rather than
772 heuristically, with the result that weak propositions are considered as substantially weaker than when
773 they have experienced other positive emotions (e.g., amusement) (Griskevicius, Shiota & Neufeld,
774 2010). The implication is that while awesome RMA might foster openness to religious beliefs, only
775 those beliefs that are backed up by sufficiently “strong arguments” will be favored and retained.
776 There are probably a number of “context biases” that mediate the relationship between ideological
777 openness and actual belief adoption. For example, given the influence of prestige signals on social
778 learning (Richerson & Boyd, 2005), beliefs that are endorsed by prestigious individuals have more
779 chance of being retained by learners than those that do not have such endorsement.

780 While we do not have the intention to provide an exhaustive review of possible mediating
781 factors, we would like to touch upon one potential characteristic – often intrinsic to RMA – that can
782 facilitate the transition from ideological openness to actual religious belief adoption. Following

783 Henrich (2009), religious monumental buildings can be interpreted as illustrating the principle of
784 “actions speak louder than words” (Gervais & Henrich, 2010; Atran & Henrich, 2010). Specifically,
785 Henrich (2009) argues that learners should be more willing to overtake beliefs from religious models
786 (e.g., priests) who support their (supernatural) beliefs with acts or behavior that demonstrate that they
787 are actually committed to those beliefs, than from models who just verbally or symbolically express
788 those beliefs. Individuals will, for example, be more inclined to take over a prestigious individual’s
789 belief in altruism when (s)he backs this belief up by donating money to a good cause, rather than
790 when (s)he merely preaches that belief.

791 While specific religious practices (e.g., ritual bloodletting) are often considered as key examples
792 of such “credibility enhancing displays” (CREDS) (Henrich, 2009), constructing monumental
793 architecture might be another way to demonstrate religious belief commitment (cfr., Atran &
794 Henrich, 2010). Religious leaders/institutions, but also members of the general population who
795 physically or financially contributed to constructing such edifices (e.g., through taxation) illustrated
796 by this toward potential followers or fellow-followers that they were actually committed to particular
797 supernatural beliefs. Therefore, belief structures which are backed up by monumental building
798 achievements had more chance of being overtaken from models than beliefs which are not, or to a
799 lesser degree supported by such accomplishments. When RMA not only produced ideological
800 openness through awe (see section 3.1), but at the same time also represented a reliable signal of
801 commitment to those ideas, then this might have been the kind of “strong argument” (cfr.,
802 Griskevicius et al., 2010) that could further stabilize or “fix” religious beliefs in the minds of
803 followers, which ultimately contributed to religious steadfastness. In other words, when an awe-
804 evoking instance of RMA also was a CRED, then this might have bolstered actual adoption of, and
805 commitment to the associated supernatural beliefs. Thus, in addition to the fact that creating height in

806 RMA was costly due to constructional/technical limitations (see section 1.2.4), the foregoing
807 argument suggests that costliness might also be required for strengthening belief commitment.

808

809 **4. Religious monumental architecture as context for religious activities and rituals**

810 Up until now we have mainly considered RMA as an isolated phenomenon. It needs to be noted,
811 however, that the emotional impact of these religious structures also depends on, and interacts with
812 the specific activities that are/were performed in or near them. Specifically, rather than standing on
813 its own, this type of architecture should be viewed as being part and parcel of, and supporting the
814 ritual component of religious doctrines (De Marrais et al., 1996). But how should this cross-
815 fertilization between rituals and RMA be conceived? On the one hand, the emotional impact of a
816 monumental religious building might have been further intensified or colored by the fact that such
817 edifices regularly were the stage of rituals or ritualistic activities, and were an intrinsic part of a
818 network of religious beliefs (Alcorta & Sosis, 2005). Such “supplementary” emotional charging
819 might have been particularly important when, after repeated exposure, habituation to RMA would
820 kick in, diminishing the intensity of the original awe response.

821 On the other hand, by causing awe, RMA might also have emotionally charged particular
822 religious (ritual) activities, beliefs or narratives. For example, due to conditioned association, beliefs
823 voiced in or near monumental religious contexts could have become further emotionally loaded and
824 sanctified, reinforcing their regulative and coordinative function (Alcorta & Sosis, 2005). Research
825 furthermore indicates that beliefs or messages that are arousing (Berger, 2011), or that trigger strong
826 emotions, such as disgust (Nichols, 2006; Heath, Bell & Sternberg, 2001), awe (Berger & Milkman,
827 2011) or surprise (Derbaix & Vanhamme, 2003), have a mnemonic advantage over beliefs/norms that
828 have less emotional salience. Together, these findings suggest that, in as much as beliefs or religious

829 messages can be embodied in, or communicated by the overall building, beliefs exemplified in awe-
830 evoking RMA will have had a mnemonic, and hence, transmission advantage over beliefs
831 exemplified in more mundane religious structures.

832 In addition, by providing a physical context for performing or attending rituals, such
833 emotionally arresting environments might have made that the rituals or religious happenings, and the
834 specific messages/beliefs implied in those, became more firmly anchored in the minds of participants.
835 For example, as certain rituals functioned to initiate or reinforce belief commitment, awe-evoking
836 contexts will have further emotionally colored such happenings, and in so doing, contributed to
837 making such episodes more memorable. This is nicely illustrated in one of the key-scenes of the film
838 *Apocalypto* (2006, Mel Gibson), where the powerful emotional impact of Mayan ritual human
839 killings is amplified by the fact that these take place on top of monumental pyramids. Such dramatic
840 monumental backgrounds probably made it more likely that followers “kept the faith” and increased
841 the chances that such beliefs became transmitted in the religious community. Monumental
842 architecture thus seems to be part and parcel of what Whitehouse coins the “imagistic” component of
843 religious systems (Whitehouse, 2004). In this mode, remembering religious beliefs and vows does
844 not so much depend on repeated learning of central aspects of the doctrine (i.e., the “doctrinal”
845 component), but it rather follows from partaking in highly arousing events.

846 Finally, notice that in our view, RMA is – initially – not emotionally neutral, as opposed to,
847 for example, water which has been turned into *holy* water during ritual practices (Alcorta & Sosis,
848 2005). Such edifices rather seem to play on pre-existing, and possibly pre-wired emotional/aesthetic
849 sensitivities (e.g., sensitivity to bigness). A concern might be that our argument was mainly built
850 around two “structural” features of awe (i.e., vastness, cognitive inadequacy) (cfr., Keltner & Haidt,
851 2003), but remained largely silent about the specific emotional valence of awe-evoking instances of

852 RMA. In recent discussions awe is commonly considered as a positive emotion (cfr., Griskevicius et
853 al., 2010). However, in as much as this emotion, and the elements which are able to trigger it,
854 encompass mental inadequacy or insignificance, awe can also have some negative loading. In
855 addition, and as already mentioned in section 2.1, RMA can exhibit characteristics, unrelated to the
856 two central features of awe, which further emotionally “flavor” the experience of the awe-provoking
857 structure, in positive as well in negative ways. This might, in turn, amplify some of the proposed
858 effects of RMA. For example, the dark and shadowy interior of a particular instance of RMA can
859 flavor the experience of awe with fear (Keltner & Haidt, 2003), through which potential freeloaders
860 might become more strongly motivated to behave prosocially compared to RMA that has no such
861 flavoring (Alcorta & Sosis, 2005).

862

863 **5. Discussion**

864 In this paper we attempted to demonstrate that a Darwinian approach can shed light on (some of) the
865 evolved functions of architecture, and of religious monumental architecture in particular. We started
866 our argument with a discussion of Trigger (1990) and Neiman’s (1998) account of monumental
867 architecture, according to which the costliness of such building accomplishments signals the
868 competitive ability of their elite builders. Our dual account of RMA extends Neiman’s costly
869 signaling account in three respects. First, in addition to costly signaling theory, we invoked sensory
870 exploitation theory to more fully explain particular formal characteristics of RMA. Specifically, in
871 RMA there is a perennial tendency to express costliness/wastefulness through height, and we
872 interpreted this as a way of RMA to exploit the adaptive tendency to associate height and size with
873 power and dominance (i.e. “sensitivity to bigness”). Second, we challenged the view that RMA’s
874 evolved function can solely be grasped from the perspective of sexual selection (cfr., Neiman, 1998).

875 Rather than signaling the “good genes” of their builders, such buildings can also be interpreted as
876 prestige signals that, once picked up by social learners, galvanize cultural evolution. Third, our
877 framework extends common accounts of RMA in that it gives center stage to the emotional impact of
878 RMA. In particular, the emotion of “awe” was considered as one of the most typical emotional
879 responses to the two different types of vastness inherent in RMA i.e., vastness in size and vastness in
880 effort.

881 Once the theoretical structure of our model was spelled out, we argued that RMA – being
882 understood as a (culturally) evolved device for inducing awe – served four interrelated functions in
883 religious communities: to contribute to vertical stratification; to facilitate bonding between religious
884 community members; to monitor religious/social life across time and space; and to create
885 ideological/religious openness in the religious population. Notice that it is very probable that (some
886 of) these hypothesized functions of RMA are also being exploited in secular contexts by monumental
887 non-religious built structures, such as corporate skyscrapers, government buildings, courthouses,
888 banks, sports stadia, airports, railway stations, statues or even virtual constructions in video games.

889 In this paper, religion was considered as a culturally evolved device that help(ed) creating,
890 regulating and enacting (large-scale) community living. Our purpose was to look at how far we could
891 understand the physical appearance, as well as the wasteful processes underlying instances of RMA,
892 from that social perspective. We want to stress, however, that besides this social function, RMA
893 might have had, or obtained functions which are largely unrelated to that community perspective.
894 Building a massive religious edifice provided an occasion for many parties to gain a little more
895 money, prestige, and glory for themselves, regardless of the monumental building’s religious content
896 and symbolism. For example, in the context of medieval cathedral building the apprentice stone-
897 mason promoted to master mason might have attracted a mate, impressed by his wonderful gargoyles

898 or flying buttress details. The head priest of the religious monumental building might consider the
899 structure not only as a way to strengthen community solidarity, but also as a means to increase his
900 own prestige, and his influence and authority over commoners.

901 Our exploration of the social function of RMA was situated at intersection of religious
902 doctrines and the religious communities associated with them. It must be clear however that instances
903 of RMA are at the nexus of very complex, shifting, multi-generational networks of people, families,
904 groups, (rival) ideologies, each trying to nudge the benefits of RMA in their own favor. With its
905 focus on the group level our paper has mapped only a fraction of that complexity. We hope that
906 future research will further unravel the possible (evolved) functions of RMA obtained for these other
907 stakeholders.

908 It is furthermore very much possible that the community function of RMA sometimes
909 conflicted with other (individual and group) levels and interests. For example, religious/ideological
910 leaders might have tried to increase their own prestige and that of their communities by pushing for
911 ever bigger monumental buildings, which were however beyond what the population could bear in
912 terms of taxation and labor. Not only might this have made followers turn against their leaders, when
913 there were insufficient monetary or physical resources to complete the monumental building it might
914 become a source of (ingroup and outgroup) ridicule and embarrassment, rather than a source of
915 communal pride and bonding. The still unfinished, and 330 meter high *Ryugyong Hotel* in North
916 Korea, whose building started during the Cold War, is perhaps one striking example of monumental
917 architecture gone awry.

918 The research that was presented in this paper can be viewed as being part and parcel of a
919 broader research agenda that tries to map out why human minds generate religious beliefs. How do
920 we construct such beliefs, why do we accept them, how do we spread them, and how can they cause

921 otherwise rational human beings to be murderous in the name of supernatural agents? Against this
922 particular research background, we hope that our exploration of the (culturally) evolved functions of
923 RMA provides an addition to the field of religious studies. We are furthermore confident that our
924 argument also illustrates that an evolutionary approach to architecture can offer valuable insights into
925 the emergence, persistence and occurrence of particular types of architecture.

926

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