István Czachesz
University of Groningen

The Emergence of Early Christian Religion
Toward a Naturalistic Approach

Pre-publication draft

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This article will assess some algorithmic models of social behavior for understanding religiosity and look for ways of applying such models to the emergence of early Christian religion. I will be operating especially within the theoretical framework of distributed, self-organizing, and dynamical systems.

Why do we need such an approach in the study of (early Christian) religion? For a long time, historians have been looking in vain for causal laws that explain the course of history (cf. Buchanan 2000; Casti 2003). We do not know rules that would enable us to predict the behavior of individuals or groups—not to mention whole societies or cultures. It seems that the development of history, culture, and society involve such complex interactions of underlying factors that predictive models of them cannot be constructed. Consequently, we cannot reconstruct the emergence of early Christianity as a chain of causal links. It does not mean, however, that there is nothing to say about the history or the emergence of religious movements. There are scientific methods to study complex and nondeterministic behavior: dynamical systems theory offers such an approach. In dynamical systems, the behavior of the whole is more than a sum of the behavior of the parts. In other words, the system displays emergent qualities. In this article I propose ways to look at religion—and specifically early Christianity—from this perspective. In particular, I will put forward the hypothesis that religious ideas emerge as a necessary consequence of the sophisticated "flocking" rules of human societies.

First, I will outline the concept of distributed systems. Second, I will identify four major components of religion and explain why a distributed systems approach is needed. Third, I will give examples of applying such an approach to religion, including observations about early Christianity. I will conclude with some methodological observations.

1. What are distributed, dynamical systems? What is distributed knowledge?

In distributed systems, the behavior of the system is not centrally regulated; it rather emerges from the behavior of its individual parts. In other words, such systems are "self-organized" (cf. Resnick 1994; Clark 2001: 103-119). Originally the theory of "dynamical systems," or simply "systems theory," made use of differential equations to describe changes in complex, non-linear systems, the behavior of which cannot be explained as the sum of the behavior of their parts (e.g., Mainzer 1997; van Leeuwen 2005). Although the distributed systems discussed in this article can also be examined from the point of view of classical systems theory, we call our systems "dynamical" primarily in the sense that their state is determined in every single moment through the interaction of their parts. Instead of looking for equations that describe the overall behavior of the system, we will focus on the elementary interactions among its parts. Knowledge in such a system is distributed: the parts obtain and store information about their environment and react accordingly. There is no central agent receiving information from the individual parts and deciding about their behavior. Finally, such systems can also be characterized as "stochastic:" whereas the interactions among their elements can in principle be described by deterministic rules, their behavior on the whole is random.

Let us consider a few examples of simple distributed systems. Craig Reynolds (1987) simulated flocks of bird-like objects he baptized "boids" (from "bird-oids") using computer modeling. Each individual in the flock follows three simple rules of behavior. The rules are, in a decreasing order of priority (Reynolds 1987: 28):

(1) Collision Avoidance: avoid collisions with nearby flockmates
(2) Velocity Matching: attempt to match velocity with nearby flockmates
(3) Flock Centering: attempt to stay close to nearby flockmates

If we launch the system after assigning each boid a randomly chosen initial position and speed, after a short while a collective behavior emerges on the screen (Reynolds 2001). Reynolds (1987: 30) calls this an "eagerness" to participate in a flock-like motion. The same algorithm can be used to simulate the motion of schools of fish and herds.

In the boid model, the flock will reach a steady state ("relaxation") after a while, which is the result of a trade-off among the different constraints governing its behavior. The more variegated behavior of real flocks, Reynolds argues (1987: 31), is due to their interaction with the environment. In other words, realistic flock behavior involves "agent-agent" as well as "agent-environment" interactions. By adding obstacles to the simulation and a “steer-to-avoid” mechanism to the boids, the flock shows a particularly graceful obstacle-avoiding behavior. A nice example can be seen in the Disney movie “The Lion King” (1994), where a wildebeest stampede was animated using a similar flocking algorithm (Tiemann 1994; Reynolds 2001). Obstacles are not necessarily fixed in space. For example, in the “Cool School” model (Hooper 1999) a school of fish realistically attempts to avoid a whale as well as a number of smaller predator fish.

The behavior of a group of people can also be modeled using a flocking algorithm. Reynolds suggests (1987: 32) that the boids model could be used to simulate traffic patterns. Jessica Hodgins and her collaborators at the Georgia Institute of Technology have created various simulations of human motion, including groups of bikers avoiding an obstacle or riding through a bend (Brogan and Hodgins 1997; Hodgins 1998). The school of Tamás Vicsek at Eötvös University (Budapest) and Collegium Budapest modeled various types of group behavior (Helbing, Farkas, and Vicsek 2000; Farkas, Helbing, and Vicsek 2002). One of their models exemplifies the significance of distributed approaches for the study of critical real-life problems. Understanding the motion of crowds in corridors and fire escapes is crucial for the design of public buildings. For some two decades, various mathematical tools have been tested to model the motion of large crowds, none of which, however, yielded a satisfying solution (Helbing et al. 2001). Models based on the collective behavior of fluid and gas particles have already signaled a move toward a systems-theoretical approach. Yet a real breakthrough was achieved when scholars turned to the distributed paradigm, concentrating on the rules governing *individual* pedestrian motion. Dirk Helbing and his collaborators (Helbing, Farkas, and Vicsek 2000) used “flocking” rules to model the flow of crowds in panic situations. They have successfully simulated the deadly effects of impatience and herding when passing through fire-exits, the build-up of clogs at doors as well as in widenings (!), and the usefulness of pillars that prevent the formation of bottle-necks. Again, the overall behavior of these models emerged from the simple rules governing the individuals rather than from equations describing the whole, as was usual with earlier approaches.

Whereas research on flocking has yielded perhaps the most spectacular distributed simulations, there are also many other kinds of distributed models that have been developed in the past few decades. A particularly fruitful field of study has been the modeling of ant and termite societies. Following simple rules of behavior, ants collect food and termites build nests (Resninck 1994: 59–68, 75–81; cf. Nicolis and Prigogine 1989: 232–38; Mainzer 1997: 107–12). Mitchel Resninck (1987) has developed the very approachable StarLogo programming environment, in which various types of group behavior involving agent-agent and agent-environment interactions can be modeled. In connection with collective ant and termite behavior, we have to mention the field of ant robotics: instead of running computer simulations, these distributed models employ several robots that cooperate following simple behavioral rules (e.g. Wagner and Bruckstein 2001). For example, robot ants cluster around food, follow a leader, and play tag (www.ai.mit.edu/projects/ants). In such models, complex interactions occur between agents as well as between agents and the environment. There is no single centralized mechanism behind the phenomena: algorithms govern the individuals from whose behavior ant society as a whole emerges.

The examples have given us a taste of the potential of distributed models to produce spectacular group behaviors. But how is this all related to religion? In the next section of the article I will give an overview of the directions of the cognitive, empirically oriented study of religion and highlight issues that particularly invite the use of distributed models.

2. The need for a distributed, dynamical systems approach in the Cognitive Science of Religion

Recent cognitive studies of religion have focused on four elements: religious experience, beliefs, texts and rituals. I will describe a model uniting the four elements (Fig. 1) and suggest that a distributed, dynamical systems perspective can substantially enhance our understanding of religion in all four areas.

Figure 1
Religion as a system of four components

1. Religious experience
- elicited
- interpreted
- anticipated
- also hard-wired?

2. Belief system
- interpret experience
- intuitive/reflexive
- counter-intuitive
- “spontaneous pop-up”?

4. Rituals
- use texts
- elicit experience
- reinforce beliefs
- involve different memory systems? (modes theory)
- involve different roles of the divine? (ritual form theory)

3. Texts
- include literature, arts etc.
- interact with beliefs
- transmission supported by rituals
- how does innovation occur in transmission?

2.1. Religious experience

Religious experience has been studied in the lab for decades (Wulff 1997: 169–204; Hood 2001; Livingston 2005). At the early stages (from the 1930s), physiological parameters have been recorded of subjects performing yoga, Zen meditation and Transcendental Meditation. More recently Electro Encephalograph (EEG) and neuroimaging technology has been used (e.g. Azari et al. 2001; Livingston 2005). Religious experience has been actively elicited by isolation, drugs, hypnosis, sound and light effects, and a special swing called “the cradle of creativity.” Among the many theories that the results of these experiments have generated, probably the best known is Michael Persinger’s model of Medial Temporal Lobe religiosity (Persinger 1987; cf. Pyysiäinen 2003: 147–72). The temporal lobes are located at the lower part of both sides of the brain and contain brain areas involved in sound, speech, vision, remembering, and emotions. Persinger argues that this particular ensemble of brain areas—especially due to the involvement of the amygdala, responsible for emotions—made humans capable of feeling euphoria and depression, connecting these feelings with the experience of the self, which ultimately resulted in the experience of the terror of personal extinction. The biological capacity of the God Experience, Persinger suggests, was critical for the survival of the species inasmuch as without such a balance the phenomenon of the self could not be maintained. The God Experience is correlated with transient electric perturbations of the temporal lobe: when such *temporal lobe transients* (TLTs) occur, the innate feelings of the God Experience are displayed. TLTs and the God Experience can be elicited by various conditions, such as hypoxia (lack of oxygen) occurring at high altitudes or during yoga breathing; lack of blood sugar (achieved by starvation or fasting); release of stress hormones (e.g. changes of life style); as well as drugs, music, dance, and smells. Persinger (1983) first “experienced God” when stimulating his own temporal lobe area with a rapidly fluctuating magnetic field. The experience itself often involves a sense of profoundness without clear details. Visions, voices, and a sensation of flying are also frequent. Secondary properties of the God Experience include circumstantiality (excessive persistence with a topic), obsession-compulsion (repeated patterns of motor, word, or thought sequences), sobriety, euphoria, and the widening of affect (that is, the interpretation of everyday trivial circumstances as signs of the God Experience).

Without discussing Persinger’s theory in detail, it is not difficult to realize that a puzzling variety of feelings and behaviors is associated with TLTs. Can all of these experiences be directly related with (only) religion? Are there perhaps other (non-religious) patterns of behavior that result from TLTs? Reacting to Persinger’s theory, Vilayanur Ramachandran and Sandra Blakeslee pointed out (1998) that seizures of the Medial Temporal

Lobe are well-known as a source of obsessive behavior. However, many of their patients with such epilepsy were obsessed not with religion, but with writing, philosophy, or sex. I can see theoretically two solutions to this dilemma: either (1) different (religious vs. non-religious) sorts of experience result from different activations (e.g. activations involving different circuitries) of the same brain area; or (2) other conditions, such as one's mindset and belief systems, determine whether experience caused by TLTs (or more serious epilepsies) is understood as religious.

Religious experience seldom occurs spontaneously. A look at real-life religious systems shows that they induce as well as explain subjective experience. They elicit experience using techniques such as fasting, deprivation, music, dance, prayer, meditation, mass events, pilgrimage, architecture, art, and drugs. They also provide means to interpret (as well as anticipate) such experience, for example, as spiritual possession, journey of the soul, conversion, or works of the Holy Spirit. One component of the success of Early Christianity was probably the efficiency with which it engaged religious experience and interpreted it, for example, as gifts of the Spirit, conversion, or dying and rising with Christ.

2.2. Belief system

We can thus safely assume that religious beliefs are needed for experience to be conceived of as religious. Simple beliefs can be studied on animal models. The simplest ways to learn about environmental clues are habituation and sensitization (Squire and Kandel 2003 [1999]: 24–28, 48–50; Eichenbaum 2002: 41–46). In habituation, the animal learns about the properties of a benign or unimportant stimulus that can be ignored; in sensitization, the animal learns about the properties of a harmful or threatening stimulus, and responds more vigorously to a variety of other stimuli as well (e.g., for some minutes after hearing a gunshot we will jump at hearing any noise). Sensitization and habituation are forms of non-associative learning. To associate two stimuli requires a more complex form of learning called classical conditioning (Squire and Kandel 2003 [1999]: 57–59; Eichenbaum 2002: 46–48). In operant conditioning, the subject learns about the relationship of a stimulus to the subject's behavior. For example, an animal learns to associate pressing a bar or a key with the delivery of food. Animals are also capable of learning from each other, which results in simple forms of cultural transmission (Hauser 2000: 115–40).

Humans also have beliefs acquired by observation. Following Dan Sperber (1996: 77–97), we can call them "intuitive beliefs." Most religious beliefs, in turn, belong to another sort: "reflective beliefs," which we learn from other people. Whereas both animals and humans are capable of cultural transmission, human cultures and the "reflective beliefs" sustained by them are evidently much more complex than those transmitted by animal societies. Some recent cognitive studies have questioned the importance of cultural transmission for religion. According to Pascal Boyer (1994: 227), "even if there was a completely random variation in religious representations, with every generation starting from scratch, certain types of representations would be favored. Jesse Bering (2002: 228; cf. Boyer 2003) goes a step further when he suggests that "implicit afterlife beliefs (. . .) would be characterized more or less as innate—piggybacking standard mental representational abilities specialized to human beings". His conclusion is rather straightforward: "Ghosts come from within, not without." Notwithstanding these opinions, we have good reasons to assign cultural transmission an important role in the survival and stability of religious concepts and rituals (see below). Whereas the mental representation of religious ideas is to some degree explained by the theory of counter-intuitiveness (Boyer 1994 and 2001), a major challenge is to understand how ideas such as "omniscient god" or "eternal life" are mentally represented. While the latter concepts, indeed, violate ontological expectations, both of them involve a cognitive element ("omniscient" and "eternal," respectively) that is not explained (in fact, not even addressed) by the theory of counter-intuitiveness. The solution might be recursion (Czachesz forthcoming b), which Marc Hauser, Noam Chomsky, and W. Techumseh Fitch (2002) suggest is the only uniquely human feature of the language capacity. By recursion, we may be able to think about "knowledge" and "life" as being infinite. For example, some people know more than others, but some know even more: recursion enables us to infinitely re-apply this relation upon itself, until we arrive at the concept of "omniscience."

It has been proposed that supernatural beings are especially important in most religions. These beliefs seem to make use of various archaic mental structures (Boyer 2001: 171–77, 376). (a) The *agent detection system*, specialized for the identification of purposefully moving things, originally served to detect the presence of dangerous beasts and potential prey in our environment. (b) Our *theory of mind* (see below) enables us to read other people's thoughts and feelings. (c) *Moral intuitions* serve social interaction and successful cooperation. Consequently, when hearing of spirits and gods, we intuitively compare them to the unseen presence of predators and make conjectures about their perception, knowledge, and plans. Most importantly, we attribute them full knowledge of strategic information, that is, knowledge of "morally relevant aspects of what we do and what others do to us."

It is remarkable that all three mental tools identified by Boyer as underlying religious beliefs are in fact indispensable mechanisms serving interactions among human individuals. Such interactions, however, are the building blocks of dynamical social systems as well (cf.

Semin and Smith 2002). We may hypothesize that if we can describe society in terms of dynamical systems, also sets of religious beliefs can be described by such a model.

2.3. Texts

"Texts" refer in a general sense to oral and written texts as well as other cultural artifacts. In Dan Sperber's terminology they are "public representations" (1996: 98–118; see below). Since we have not yet found a human civilization that does not produce texts (in the above sense), we can only make guesses about what religion would look like without cultural transmission. Would Mowgli have a human mind and be religious (i.e. display human religious behavior)? What we know about historical Mowglis (e.g., Ward 2002–2006), however controversial the evidence is, suggests that they do not think (and generally: do not behave) like humans. Human thought extends into the environment by means of texts and there seems to be no reason to bracket out this component from the investigation of religion.

Sacred texts, hymns, liturgy, religious vocabulary, and many other elements of religion are handed down from generation to generation. Such "public representations" regenerate a similar set of beliefs in the minds of the next generation. A major issue is how innovation occurs and whether one can speak of an evolution here (Rubin 1995; Pyysiäinen 2004: 147–59; Czachesz 2003; forthcoming a). Beliefs are basically transmitted in two different ways. In some cases, the behavior of one individual (such as speech, mimics, or gestures) is read by another individual in whose mind internal representations are generated. At other times, some kind of medium (such as writing, art, or architecture) records the memories of one individual and these signs are read by another person. Expressed in the terminology of distributed systems, beliefs are transmitted either by agent-agent or by agent-environment interactions.

2.4. Rituals

Rituals utilize the material culture of religion (such as texts, art, and music) and elicit religious experience. Rituals also play an important role in the generation and fixation of religious beliefs by repetition. There are two major cognitive theories of ritual. Harvey Whitehouse (1995; 2000; 2004) has proposed the "modes of religiosity" theory which makes a distinction between "imagistic" and "doctrinal" forms of religion and establishes a connection between the sensory stimulation in a ritual and the ritual's performance frequency, connecting to them a number of other psychological and social variables. Robert McCauley and Thomas Lawson (2002), drawing on their ground-breaking study from 1990 (Lawson and McCauley 1990), put forward the "ritual form hypothesis," according to which both performance frequency and sensory stimulation are functions of how the role of supernatural agents is conceptualized in the ritual.

In terms of my religious systems model, the fixation of beliefs occurs by simultaneously generating religious experience and exposing believers to external representations such as art, music, hymns, and texts. Rituals, as I will argue below, may arise from simple behaviors, such as operant conditioning and flocking. Rituals, in conclusion, can be also described as dynamical systems driven by interactions between agents and the environment (ritual space and artifacts) as well as interactions among agents.

2.5. Two types of distributed systems in religion

In sum, we need a distributed systems approach in the study of religion for several reasons. Religion emerges from the interaction of a great number of participants with each other and their environment. Rituals are repetitive actions that emerge from these interactions. Texts (public representations) are environmental components that have been formed by the agents. Beliefs and experiences are generated by texts and rituals and describe the internal states of the agents. On a different level, however, also beliefs and experiences can be studied as distributed phenomena, inasmuch as they are emerging from the interaction of different parts within the human mind.

Although we have been mainly using the “flocking” paradigm in this article (due to its intuitive and approachable character), we have to notice that there are also other kinds of distributed systems. Whereas flocks consist of a great number of similar agents, other distributed systems contain fewer parts and the parts behave differently. For example, Andy Clark (2001: 112–17) distinguishes “emergence as collective self-organization” (such as flocking behavior) from “emergence of unprogrammed functionality.” In the latter category, the participating elements are neither numerous nor similar, yet their interaction yields behaviors that are “not subserved by an internal state encoding the goals or how to achieve them.” Both types of emergent behavior are finally characterized as “interactive complexity.”

We can use this broader sense of distributed behavior to think about beliefs and experience. The human brain contains approximately 100 billion (10^{11}) nerve cells (neurons), and even a “piece of the brain the size of a grain of sand would contain one hundred thousand neurons” (Ramachandran and Blakeslee 1998: 8). Although neurons fall under many morphological types, they constitute large enough communities to model them by some kind of “flocking” approach (Clark’s collective self-organization). A good example is the self-organizing synchronization of neurons to provide functions such as the circadian cycle, face-recognition, or even consciousness (Strogatz 2003: esp. 260–84). Large-scale synchronization of the brain is an underlying factor of epileptic seizures (Bethany et al. 2005). Given that TLTs are microseizures of the brain, it would not be surprising if neural synchrony played an important role in religious experience (cf. Aftanas and Golocheikine 2001).

The human mind also produces the second kind of complexity, that is, Clark's "unprogrammed functionality." Most systems-theoretical approaches to cognition have in fact been proceeding in the latter direction (Port and Van Gelder 1995; recently Van Leeuwen 2005). Interactions among brain areas (anatomical units) or mental modules (functional units) result in emergent behaviors that are not programmed in any of the participating components. Rituals involving a small number of objects and participants may be also approached from this perspective. Belief systems may be excellent candidates to be studied from a distributed perspective in either sense (cf. Pinker 2005).

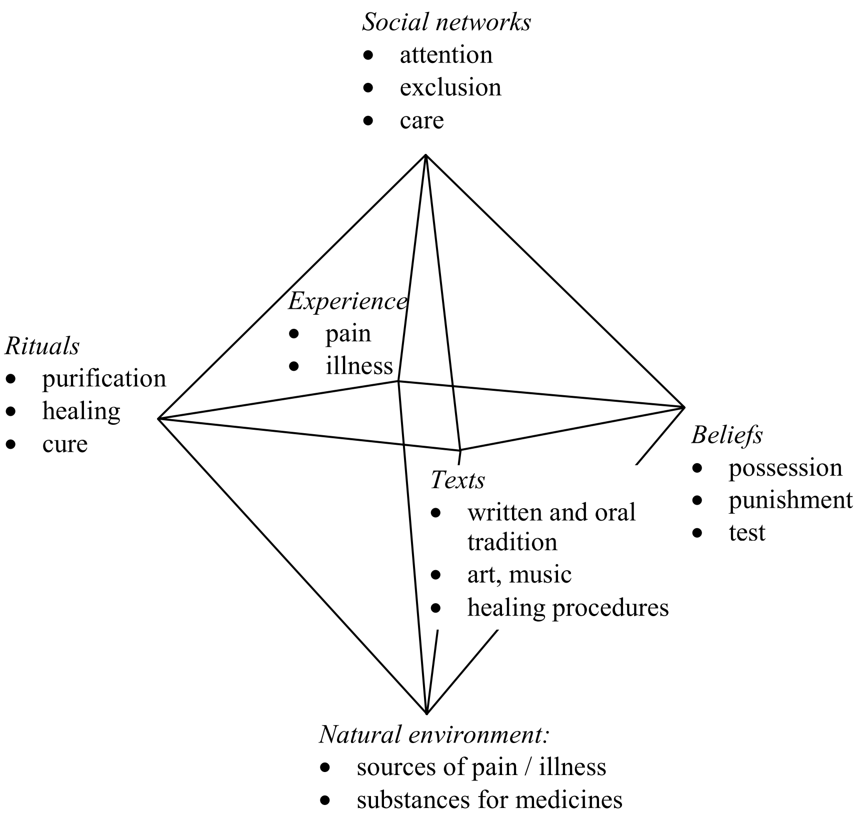
Finally, the model of religion that I have been outlining in this section can also be approached as a distributed system, particularly in the sense of "unprogrammed functionality." Different components of religious systems engage in delicate interactions so that minor changes in the system can result in complex, unpredictable outcomes. The problem is remarkably similar to the issue of biological and cultural complexity (e.g. Oltvai and Barabási 2002; Denton 2004) and its detailed discussion must be postponed to another occasion.

3. Some applications of the distributed model to religion and early Christianity

In the third part of the article I will apply the distributed systems approach to various aspects of religion. I will primarily talk about religion in terms of the four components that I have discussed in the previous section. Nevertheless, it must be realized that defining religion is not an easy task. The four elements in my model can be used to describe other domains of human behavior, as well. Health care may be an example, as shown in the following diagram (Fig. 2). To the four components that have been identified already in religious systems I added here references to social networks (top of the diagram) and the natural environment (bottom of the diagram). In this article I do not make an effort to solve this issue (see recently Day 2005), but the solution might be that "religion" is a heuristic concept in the study of human behavior, which we will able to dismiss in the future.

Figure 2

Health care as an example of cultural systems



3.1. Religious beliefs and distributed systems

Distributed systems, as we have seen, offer a framework in which we can model social behavior with the help of a few simple rules of interaction between individuals (and the environment). In the examples which we have discussed hitherto each agent interacted with a few agents in its physical neighborhood and all agents interacted with approximately the same number of neighbors.

In human societies, and often in animal societies, social networks are far more complex. The structures of the simplest human societies are largely shaped by the physical space they live in. The formation of villages and networks of villages follows geographical divisions. Even in the simplest human civilizations, however, people who never physically meet each other may know of each other and may influence each other's behavior. The village on the other side of the river or mountain, or even other people living at a longer distance, may be part of social reality without much, if any, physical exchange. Humans, and arguably some other species as well, can simulate the minds of other individuals even without a sensory input. Many children have imaginary playmates (Taylor 1999; recently Hoff 2005). Furthermore, we can handle people as real, of whom we read in novels or hear in epic narratives, even if we think they were made up by the writers.

The mental tool we are using to achieve this is the so-called "theory of mind" (Frith and Frith 2005). The concept of the "theory of mind" has come under criticism recently (Leudar, Costall, and Francis 2004) and therefore it seems best to use it as a shorthand term for the above-mentioned abilities, rather than as a well-understood mental structure. At the base of this ability we probably find the mechanism of imitation (Brass and Hayes 2005; Byrne 2005), which occurs often without our knowledge or even against our will. One may think about the stickiness of yawning, well-known in other species as well. "Mirror neurons" are thought to be responsible for this and similar phenomena, although the exact mechanisms are largely unknown as yet (Rizzolatti et al. 2002).

Whatever the neurological explanation may be, humans make simulations of the thoughts of other humans whom they do not see or hear, or even of other people they never knew. The organization of states relies on such mental abilities: leaders make assumptions of the behavior and reactions of their subjects and vice versa; large social groups are formed by individuals who never meet each other, or even never hear from each other. Wrong assumptions are often made, which in fact frequently results in social tension and unrest.

My suggestion is that religious ideas emerge as a necessary side-effect of the sophisticated "flocking rules" of human societies. The large-scale dynamics of human societies emerge as we make decisions based on interactions with our neighbors as well as on simulations of unknown, distant, and foreign human individuals. Some of the latter simulations are maintained in stabilized, stereotyped, and socially transmitted forms, such as national stereotypes. Ideas of religious agents are long-standing, stabilized, stereotyped, and socially transmitted simulations of distant or abstract persons. Religious agents, in fact, are often important family members, rulers, or distant, exotic people.

In terms of this hypothesis, there is little, if any, difference between abstract, distant social agents and religious ones. The major difference lies in the way secularized Western societies handle those ideas. However, in spite of this intended differentiation in Western societies, an appeal to ideas such as nation, social class, or monarch can evoke the same behavioral response as references to religious agents. In this framework it also makes perfect sense that in Melanesian religious imagination foreign investors are identified with the tribal ancestors (Whitehouse 1995). In the framework of our flocking models, such ideas may be thought of as agents who follow the average behavior of a very large group of individuals.

They may be imagined as “boids” with a very large mass and impetus. Individuals, in turn, adjust their behavior to those agents.

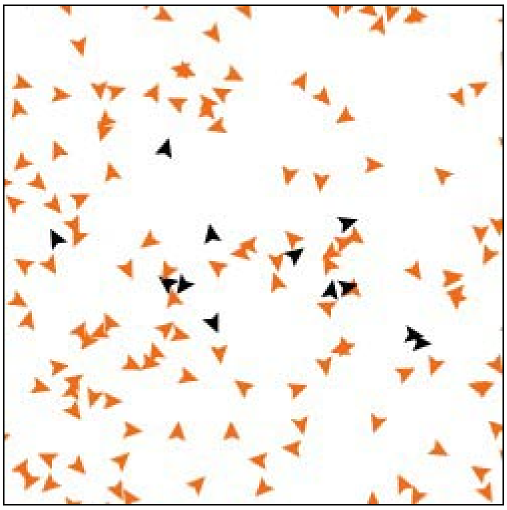
Elsewhere I have argued that the figure of Jesus in early Christian religion was extremely successful because it was shaped after the idea of ancestors, a widespread and attractive religious concept (Czachesz forthcoming a). Jesus is very similar to us humans, except that he is free of body and is morally flawless. The frequent application of family metaphors to Jesus supports this reading. Relying on our arguments about the nature of religious ideas, we can add that Jesus’ figure incorporates other widespread notions of abstract social agents inasmuch as he is thought about as Israel’s Messiah and a monarch. I suggest that one of the major factors which enabled the formation of such a rich and flexible religious agent was the rapid as well as widespread circulation of the idea.

3.2 Networks

Although the work of Richard Dawkins and Dan Sperber have inspired much theorizing about the propagation of ideas, relatively little attention has been paid to a major factor in that process. I am referring here to social networks along which ideas (cultural bits) are transmitted. In the framework of distributed systems we can study also this phenomenon. We can use, for example, Uri Wilensky’s NetLogo environment (Wilensky 2004), which is based on Resninck’s above-mentioned StarLogo, to experiment with the spread of messages in different social networks. In Wilensky’s simple model, a message spreads in a society of randomly moving individuals (Fig. 3; I have modified the colors for better visibility). When the simulation starts, only one agent is colored black, the one having the message. As other agents meet the “messenger,” they turn black and become messengers themselves. The transmission of messages in real social networks is much more complicated than this. (1) First, not everyone is equally interested in a given message. (2) Second, not everyone meets the same number of people. (3) Third, we learn, forget, and modify information. (4) Finally, different messages spread along different networks (for example, we talk with different people about soccer, scholarship, and family life).

Figure 3

Spread of a message in NetLogo



Recently network theory has made tremendous advance in understanding the underlying common mechanisms of various natural and artificial networks (Barabási 2002; cf. Buchanan 2002). Society can be easily modeled as a network, consisting of people and connections among them. A network can be described with a handful of parameters, such as its *diameter* (describing how quickly we get from someone to someone else on the network); its *degree distribution* (telling us whether there are very isolated or very popular individuals); and the strength of connections. This last feature was especially relevant for the spread of early Christianity (Czachesz forthcoming b). Strong connections provide the backbone of networks and removing a few of them destroys the network structure: one may think of the royal family and its social connections in feudal societies. So-called weak links, in turn, can be removed in large numbers without immediate consequences; yet various observations about natural and social networks suggest that these connections have an important stabilizing effect (Csermely 2006). Early Christians have created weak links in many different ways. They invested into charity; they regularly entertained visitors, such as teachers, prophets, and other wandering Christians; finally, a great number of women joined the movement, which added to it an extra networking potential, as compared with, for example, the male society of the Mithras cult. The diverse weak links helped to preserve the unity of the manifold movement in spite of the various debates and tensions that existed from the very beginning (Luttikhuizen 2002).

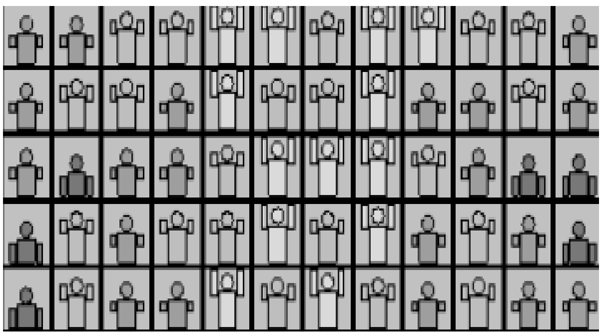
3.3. Rituals

Rituals are important locations for the generation of memories and for the reinforcement of existing ideas. Although this function of rituals has been appreciated (Lawson and McCauley 1990; Whitehouse 1995, 2000, 2004; McCauley & Lawson 2002), less attention has been paid to the mechanisms shaping the rituals themselves (e.g., Hinde 1999; Boyer 2001). I suggest that ritual may be approached as social behavior emerging in a distributed system.

An interesting example is the so-called “Mexican wave” seen in football stadia (Farkas, Helbing, and Vicsek 2002). A “Mexican wave” is a typical distributed behavior that emerges when a large number of spectators follow a few simple rules: when you see your second or third neighbor standing up, stand up yourself, raise your hands, and then sit down and lower your hands. Whether a wave emerges and spreads successfully, depends on how many spectators initiate it and where they sit in the stadium. Illés Farkas and his collaborators have successfully simulated the Mexican wave on the analogy of excitable media (Fig. 4), a model originally created to describe processes such as forest fires or wave propagation in heart tissue. People are regarded as excitable units that can be activated by an external stimulus: a distance- and direction-weighted concentration of nearby active people. Once activated, each unit follows the same set of internal rules to pass through the active (standing and waving) and refractory (passive) phases before returning to its original resting (excitable) state.

Figure 4

The Mexican wave model



As I have noticed above, people display synchronized behavior in many different settings. Synchronization can be modeled in a distributed framework, by assigning simple rules to a number agents (e.g., Strogatz 2003:55–59 and passim). Synchronized behavior is a source of joy and confidence, just think of marching, synchronized swimming, or dance. As Steven Strogatz has noticed, people often spontaneously fall into synchronicity. For example, sisters, roommates, close friends, or coworkers synchronize their menstrual periods. Eastern-European audiences synchronize their clap. Pedestrians synchronized their steps at the opening of the Millenium Bridge in London, putting the new bridge in danger. The Mexican wave is only one example of a wide range of synchronized behaviors.

It has to be noticed that joint action often involves complementary rather than identical behavior (Sebanz, Bekkering, and Knoblich 2006). However, synchronization spontaneously occurs even in such cases. Recent studies have shown that individuals working on mental tasks together non-consciously mimic each other's actions and synchronize rhythmical movements. Shall we replace the "theory of mind" with a "theory of body"? Do we synchronize our bodies so that we can read each other's minds? Communication experts have always warned us that our bodies tell more than our words. It seems that the long-standing interest in reading minds must be complemented (if not replaced) by a study of synchronizing bodies (cf. Gallese et al. 2004). Distributed models and rituals will occupy an important place in such a paradigm.

3.4. Innovations

The final issue to be mentioned is innovation. This is a very broad subject that is not exclusively related to religious behavior. In general, the success of the human species is largely dependent on its ability of inventing new forms of behavior and transmitting them without relying on genetic changes, which occur too slowly to follow fast changes in the environment (cf. Richerson and Boyd 2005). Still the subject is highly relevant for the study of early Christianity, which emerged as a set of successful innovations in the belief system, rituals, and institutions of first century (Jewish) religion.

The social dynamics of innovation include experimentation and imitation (cf. Kameda and Daisuke 2003). Individuals who experiment take a risk when they abandon the established ways of dealing with a situation. They may, however, sometimes find more efficient behaviors, and succeed where others fail. Still the majority is formed by so-called free-riders, who simply imitate the innovators. It is important that imitators do not only follow successful behavioral patterns, but also maladaptive ones. Any real-life society displays a balance of the two strategies, that is, innovation and free-riding. This can be excellently studied on a distributed model (Helbing, Farkas, and Vicsek 2000). Dirk Helbing with his collaborators has designed a model to discover how a group consisting of innovators and free-riders can escape from a smoke-filled room. Innovators tried to find fire-exits randomly, whereas free-riders just followed the innovators. The simulations have shown that the group succeeds in leaving the room within the shortest time if it includes both innovators and free-riders.

The application of such a model to religious innovation is complicated by the fact that we do not know what the fire-exits stand for in a religious system, that is, we do not yet exactly know what makes religion successful. If religion is functional in human society, the doors may stand for some optimal social effects. Even if religion is not functional we may be able to identify certain attractors, that is, optimal and therefore long-standing forms, which are approached by religious experimentation. Optionally, religion may turn out to be a set of social behaviors which appear to the rationalist mind as strange and irrational, without being substantially different from other similar but more favorably received behaviors, as I have suggested above. In this case, the attractors may be looked for by studying interactions with distant and abstract social agents (such as dead persons, monarchs, or nation) in a distributed system. If we succeed in finding algorithmic or mathematical models of religious innovation, we may be also able to minimize the emergence of socially destructive religious systems as well as the destructive use of existing forms of religiosity.

4. Concluding remarks

A distributed systems approach bridges the gap between individual behavior and social phenomena. It helps to solve some fundamental difficulties of studying the social. Society has no behavior—individuals do; society has no knowledge—individuals do. Yet behavior and knowledge always present themselves as social realities. The same holds true for religion.

Finally, historians have the important task of supplying historical nuances to social theories and testing such theories against historical data. Religious systems and other social systems related to distant and invisible social agents may fulfill very different roles in different historical situations. Evolutionary approaches tend to bracket out historical differences as ones of secondary significance. For the student of the first century Mediterranean, the need for a historical perspective is obvious. Structurally similar social agents, such as ancestors, monarchs, nations, gods, and spirits, operate very differently at distant times and places. Therefore, the successful research strategy should integrate a systems-theoretical approach with well-informed historical differentiation.

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