Biologically Inspired Cognitive Architectures (2015) 14, 86–96

Available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/bica

RESEARCH ARTICLE

# A neurobiologically inspired model of social cognition: Memes spreading in the Internet

**Armando Freitas da Rocha** [a], **Eduardo Massad** [a], **Paulo Cesar C. dos Santos** [a], **Alfredo Pereira Jr.** [b,*]

[a] *Department of Medical Informatics, University of São Paulo, Brazil*
[b] *Department of Education, Institute of Biosciences, State University of São Paulo (UNESP), Brazil*

Received 26 April 2015; received in revised form 8 September 2015; accepted 8 September 2015

**KEYWORDS**
Memetics;
Fuzzy logics;
Biologically inspired architectures;
Internet;
Facebook

**Abstract**
The field of memetics has attracted interdisciplinary attention as a biologically inspired approach to animal communication and sharing of human cultural patterns. Here a formalization of the theory of memes is proposed, making use of a formal language that is adequate to represent neural information processing. This formalization is the basis for our development of a model of social cognition including mathematical tools derived from the field of epidemiology. The model describes processes of communication between individuals of the same biological species, which share the same computational mechanisms of neural information processing. An example of the 'modus operandi' of the model is shown, consisting of a brief study of meme spreading in the Internet. Among the results of this study, we highlight: (1) The operationalization of memetics in a cognitive architecture that is based on biological constraints and possible to be implemented in digital computers; (2) the proposed model of meme spreading in an online social network may be of interest for public organisations, private corporations and people in general; and (3) the limitation of modeling should be considered when interpreting data about any dynamical phenomenon.
© 2015 Elsevier B.V. All rights reserved.

## Introduction

The evolution of the human individual began with macroevolutionary events that culminated with the first *Homo* species, about two and a half million years ago. By about 160,000 years ago *Homo sapiens* (White et al., 1997) appeared. They controlled fire, developed agriculture and probably some form of language.

The evolution of the brain is achieved both by increasing the number of neurons and allowing new functional specializations. Brain size increase, however, has a price

* Corresponding author.
*E-mail address:* apj@ibb.unesp.br (A. Pereira).

http://dx.doi.org/10.1016/j.bica.2015.09.001
2212-683X/© 2015 Elsevier B.V. All rights reserved.

(Blackmore, 1999): oversized brains are expensive to run. Our brains consume 20% of the body energy for a size corresponding to only 2% in weight. The amount of protein and fat necessary for the development of human individuals forced the first members of the Homo genus to increase their meat consumption by means of better hunting strategies, which in turn fed back into increased brain size.

Big brains are dangerous to produce. Human babies have to pass through a narrow birth canal. This implies — in addition to higher maternal and foetal mortality — that the human baby is born prematurely, as compared with other primates. This circumstance has the beneficial consequence that our brain has greater neuronal plasticity, which increases its learning capacity. But this requires continued guidance from parents and forced familial relationships to be strengthened.

The amount of protein and fat necessary for the development of human individuals forced the first members of the Homo genus to increase their meat consumption requiring better hunting strategies taking profit of group activities. According to Power and Schulkin (2009), ''gathering food and bringing it to a communal place where it is shared among the other members of the social network probably is a key evolutionary event''. These and other large-scale collective behaviours stimulated an impressive development of the social brain as a collection of neural circuits to handle other persons' intentions, cooperative actions, fair play and collective decisions (Adolphs, 2009; Rocha, Burattini, Rocha, & Massad, 2009; Tomasello, 1999).

According to Adolphs (2009), evolution shaped us as an essentially social species that share cognitive resources more intensively than other species. We are organisms who understand conspecifics as beings *like ourselves*; we ascribe to them intentional and mental lives like our own. Although a definition of social cohesion is very complex and disputable (see, e.g., OECD, 2011), it certainly involves a sense of belonging to various groups in modern society and being able to communicate in effective ways to sustain collective projects. This sense of belonging is sensitive to how much individual social brains share beliefs, ideas, concepts, myths and icons. These cognitive processes are assumed to depend on the existence of common biological mechanisms of information processing in the individuals belonging to the human species.

## Meme

Humans are capable of imitation. We can copy ideas, habits, skills, behaviours, inventions, song and stories. These are all *memes*, a term which first appears in Richard Dawkins' book *The Selfish Gene* (Dawkins, 1976). Dawkins first thought of '*mimeme*', which had a suitable Greek root, but he wanted a monosyllabic word, which would sound like 'gene' and hence the abbreviation of mimeme into *meme*. The *Oxford English Dictionary* contains the following definition:

**Meme** *An element of a culture that may be considered to be passed on by non-genetic means, esp. imitation.*

In this context, memes are cultural expressions of societies of individuals who share the same biological structures and functions. The content of memes is information (Blackmore, 1999; Ropp, 2015), which is assumed to have a neural basis. Memes are traditionally propagated by direct interaction of individuals, but recently mass media, and specially the Internet, arised as important vehicles for meme spread (JafariAsbagh, Ferrara, Varol, Menczer, & Flammini, 2014; Gal, Shifman, & Kampf, 2015; Kligler-Vilenchik & Thorson, 2015).

Memes — as originally introduced by Dawkins (1976) — are simple pieces of information like genetic viruses. They are held in memory and capable of being copied from memory to another's memory. Because of the cultural diversity of individuals, different people are distinctively affected by memes. Different groups of people share different sets of memes. In this context, memes are important contributors to social cohesion (e.g., Gal et al., 2015; Kligler-Vilenchik & Thorson, 2015).

## Formal grammars

Noam Chomsky (1965) proposed Generative Grammar as a linguistic theory that considers grammar to be a system of rules that is intended to generate exactly those combinations of words that form grammatical sentences in a given language. Chomsky and colleagues have argued that many of the properties of a generative grammar arise from a universal grammar, which is innate to the human brain.

A formal grammar (**G**) is a set of rules for rewriting strings, along with a ''start symbol'' from which rewriting starts (e.g. Hopcroft & Ulmann, 1979).

$\mathbf{G} = (V, \omega, P)$

where

- **V** (the *alphabet*) is a set of symbols containing elements (variables) $v_i$ that can be replaced.
- **ω** (*start*, *axiom* or *initiator*) is a string of symbols from **V** defining the initial state of the system.
- **P** is a set of *production rules* or *productions* defining the way variables can be replaced with combinations of constants and other variables:

$$\mathrm{p}: \ \delta v_i \gamma \rightarrow \delta v_j \gamma$$

- δ, γ specify the context for rule application.

Formal grammars are frequently classified as (Hopcroft & Ulmann, 1979):

- *Context-free grammars* is a grammar in which the left-hand side of each production rule consists of only a single nonterminal symbol.
- *Regular grammars* is a grammar in which left hand side is again only a single nonterminal symbol, but now the right-hand side is also restricted to be the empty string,

متن کامل مقاله ← دریافت فوری

ISIArticles
مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات