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A Complex Systems
Perspective of
Communication
from Cells to Societies

Edited by Anamaria Berea



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Edited by Anamaria Berea

Contributors

Cheryl Marie Cordeiro, Liat Klain Gabbay, Snunith Shoham, Jose Julio Fernandez, Jacqueline Arguello, Paul A Brown, Anamaria Berea

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Meet the editor



Anamaria Berea holds a PhD in economics (2010) and computational social science (2012) and her current research is focused on the emergence of communication in biological and social networks, by applying theories and methods from economics, complex systems, and information theory to understand fundamental patterns of communication in both living and non-living (in silico) systems. She is an interdisciplinary scientist and uses a wide range of computational and data science methods (agent-based modeling, network analysis, natural language processing techniques, Bayesian networks, and other machine learning), as well as complex systems and economic modeling to study heterogeneous, noisy, complex phenomena, such as information diffusion in human networks or to find what is universally possible for life in astrobiology problems.

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Preface

When I was invited to edit and put together this book, as part of the Women in Science Competition in 2018 proposed by IntechOpen, I was very excited to get the opportunity to put together a collection of works in the field of communication that would resonate with the idea of pursuing a fundamental thread of how communication has evolved on life on Earth, from the very building blocks of life such as DNA or cells, to supra-human organisms such as institutions and computer systems.

The idea of finding universal, fundamental patterns of communication arose while I was working on a computational model of information exchange that could find its applications in molecular biology as well as in artificial intelligence. While researching this idea, I came across a wide variety of research from most fields of study, such as biology, anthropology, history, marketing, economics, information sciences, psychology, social sciences, to name only a few. Particularly in biology, psychology, and marketing or business, topics such as animal communication or communication with children or effective communication in business seemed very large, broad, and predominant, but without much reference between each other or across disciplines. This gap in the current literature and the siloed research within fields spurred the idea of trying to find what is common and fundamental in communication between these seemingly different subfields.

A first step towards opening the dialogue and research on common threads of communication in various and different systems was done by the publication of the book “Emergence of Communication in Socio-Biological Networks” at Springer in 2018. But this has only scratched the surface and, given the wide diversity of the fields and researchers involved, the next logical step was to gather into a collection the works of worldwide researchers that are intimately familiar with specific aspects of communication.

This book is highly curated, as the chapters published here are not the typical research on communication specific to each field, but research on communication as a complex system that can be read and understood across disciplines and that can address a wider audience than within one’s specialty. This effort shows again how big the gap is in the cross-disciplinary approach of communication, how open and wide the field is and how important it is to keep on pursuing in this search for knowledge.

As this is another important step in the discovery of fundamental communication patterns, I am confident that it is also only another open door to an even wider and broader body of research and therefore I see this book as an invitation for the current and future scientists and scholars to look at this phenomenon through the lenses of complex systems, multidisciplinary and universality.

I would like to express my deepest gratitude to the authors that put in a great deal of effort into their papers and for submitting their work to this edition, to the

publishers at InTech Open for working with me and supporting me in this effort, as well as to the Ronin scholars that gave me invaluable advice at their seminars on how to conceptualize and approach this idea in depth.

Anamaria Berea, PhD
Complex Adaptive Systems Laboratory,
University of Central Florida,
Orlando, Florida, USA,
Ronin Institute, USA

Section 1

Introduction

Introductory Chapter: The Role of Communication as a Fundamental Process for Life and Society

Anamaria Berea

1. Communication as a fundamental process for life

The area of research of communication is one of the largest and vastest one can find oneself immersed in. Without communication, none of the living systems on Earth could exist, as life itself is an emergent process of interactions between different organisms, whether these interactions ultimately lead to the creation of new organisms or to the death of one or both of the organisms engaged in the process of communication [1]. This is true both in the natural and the social worlds, where organisms are either single celled or human institutions. In the largest sense, communication can be viewed as peer to peer interactions. In the narrowest sense, communication can be viewed as specialized language. Either way, communication implies a process of information exchange and the latest developments in information and computer science can tell us a little bit more about the process of communication in living systems as well [2].

Unlike interactions, which are common in physical nonliving systems as well, communications are about intent and outcomes that are not necessarily deterministic in nature, such as chemical reactions are, for instance. In living systems, communication is intimately linked to the action, either to initiate or to receive information, or to take some action post-communication, based on the information exchanged [2].

While each field of study has researched communication within its own framework, I was not able to find a broader view of communication that would encompass this larger view of the phenomenon. Surely, biologists have an in-depth view of animal communication with the specifics of each species, marketing specialists have an in-depth view of communication between institutions and customers, psychologists have an in-depth view of communication between humans in various contexts, and social scientists have an in-depth view of communication between groups or cultures, while linguists have an in-depth view of communication we call language. Yet, there is little attempt to cross borders between disciplines and to try to understand this phenomenon at large, in its universality, and not inside different contexts and scenarios.

Perhaps because such a view is too large to be approached in one research endeavor, or perhaps because the phenomenon itself is too broad, or perhaps because attempts have been made but failed; nonetheless, as scientists, when faced with fundamental and ubiquitous phenomena, we have the duty to try to understand them in these terms and aim toward grasping their universality [3].

Nonetheless, given some ubiquitous and fundamental understandings of what communication is about, we must at least attempt to discover common and universal features that run across disciplines, or characteristics that are similar in all living systems.

As we understand from science today, we know that nonliving systems (such as atoms, chemical compounds, even human made artifacts, do not communicate with each other), unless we take a look at computers or computer-enabled physical systems which, due to human technological innovations and repeated communication throughout history, have become tools to help facilitate communication. But even in the midst of the current explosion of information society, we can undoubtedly state that communication is a feature of life and living systems.

A caveat is worth mentioning with respect to artificial intelligence (AI) and AI-based systems that have the potential to initiate communication, in the absence of predetermined goals. These features are yet to be developed and achieved, and currently, we can only speculate on how this autonomous, unpredictable AI is going to look like.

2. Communication as a complex system

The problem of determinism or nondeterminism for communication, as mentioned above, lies in its intentionality. Communication, with its intent, can have deterministic or causal features, but unlike simple physical interactions, the outcome of communication is unknown or nondeterministic [4].

Communication is also an emergent phenomenon. We cannot really decompose it into parts, as we could a car or a computer; it represents the outcome of one or several relationships between two or several organisms, with various expectations and interpretations of the information being exchanged [5]. While we may know what makes a cell communicate with another and sometimes even manipulate this in the lab, we do not know what the overall outcome of multiple cells communicating repeatedly with each other would become. Even more so, in human societies, communication is very hard to pinpoint into indivisible components and to fully be able to predict what the outcome of the communication of many people or institutions would be. Therefore, communication is also an open system, with potential for both creativity, further action, but at the same time, misinterpretation, partial retention, and inaction.

As it represents a relationship and an interaction, communication is also a fundamental aspect of any living network [6]. And as networks are essentially graphs, communication can mathematically be viewed as a nonlinear process. It is a feature of both the individuals in the network and of the network at large, whether this network is a group of cells, animals, humans, or institutions, or any combination in between. While the simplest representation of communication is a direct relationship between two peers, the effects of this relationship can have unpredictable and nondeterministic effects.

In living systems, communication is also related to memory—most organisms communicate in order to store the information received or they communicate based on their accumulated memory, for future actions. And it is also prone to partial retention and forgetting as well, depending on the processes of selection and adaptation that govern those organisms.

And none of the least, communication has adaptability—it depends highly on the organisms that exchange the information, on the means of communication and on the environment within which it takes place. Just to give a very simple example, a conversation about animal communication would be completely irrelevant in a heliophysics conference context, while, at the same time, it can be of great relevance to the heliophysicist that is trying to understand the behavior of his or her dogs at home.

These features mentioned above are only a few of the many features of communication, but they all support the idea that communication is a complex system, and that it should be studied as such [7, 8].

3. Communication as a multidisciplinary paradigm

Throughout this brief introduction, another idea has become more and more obvious—the fact that communication cannot be studied in isolation or in niches or subfields of science. For this broader view as a fundamental and complex process, we need to cross scientific barriers and study the phenomenon in the context of the multidisciplinary paradigm.

This book is only a first step and attempt at bringing several fields together to achieve this grandiose goal. Truly, for an integrated discipline of communication, the support of many scientists, within their specialties, need to cross into other disciplines and follow the difficult, but very rewarding thread of understanding universal phenomena.

Author details


Anamaria Berea^{1,2}

1 Complex Adaptive Systems Laboratory, University of Central Florida,
Orlando, Florida, USA

2 Ronin Institute, USA

*Address all correspondence to: anamaria.berea@ucf.edu

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Section 2

Biological Foundations of Communication

Extracellular Vesicles: Living Prototypal Communication System

Paul A. Brown

Abstract

Communication is an ever-present part of our world. Such transfer of information occurs on many levels from the spoken natural languages, to artificial languages, to the cellular exchanges that govern the molecular world. Cells interact using various coded and non-coded molecules, which although not natural languages, could be considered types of biological language. These molecules are packaged into extracellular vesicles by cells from all three domains of life. Vesicles may then participate in intracellular trafficking of their cargo molecules. Or cells may secrete vesicles into the extracellular world, from where they are transported to, and taken up by, target recipient cells. Once delivered, extracellular vesicles exert a plethora of physiological and pathological effects, as well as an influence on recipient cell evolution. In executing their functions, both vesicles and their molecular cargo face evolutionary pressures over time and across habitats, forcing them to adapt to meet changing needs. This chapter will present extracellular vesicles as a highly conserved prototypal communication system.

Keywords: extracellular vesicles, exosomes, microvesicles, apoptotic bodies, outer membrane vesicles, membrane vesicles, biological network, cellular communication

1. Introduction

Communication is ubiquitous in our world and spans the range of human experience from social, to physical, to biological. In all these spheres, systems have been developed, or have evolved, to facilitate the transfer of information. All communication requires the delivery of a shared system of codes and signals between a source and a recipient. The information must be packaged, relayed and received for effective communication to occur.

We package our spoken languages by our choice of words and phrases (diction) from among our vast repertoire, as well as by how we arrange those words (syntax). But other types of information can also be packaged in different ways, like our choice of facial expressions, gestures and body postures. The information is then relayed either verbally or in non-verbal ways, to be received by a recipient who understands and can respond to the information received. If any of these stages is not properly executed, effective communication may not occur.

This chapter will describe an evolutionarily conserved biological method of communication that also packages, transports, and delivers intelligible information,

but between a donor and recipient cell. Recipient cells must also be capable of responding to the information received for effective communication to occur. At the heart of this communication system are microscopic lipid-bilayer-encapsulated structures called extracellular vesicles (ECVs) that are released from, and taken up by, cells from all three domains of life.

2. Communication systems

At its most basic level, communication can be thought of as a process of sending and receiving, involving source, conduit and destination [1]. Many different models of communication and communication systems have been proposed. In healthcare, communication may involve various people, their messages, communication channels, as well as regulatory protocols and policies, all of which facilitates several types of communication services using different communication devices [2]. Others describe the concepts of flow and interactivity. Information flows interactively as it is created, released, transferred, received and processed repeatedly, as applicable for example to computer systems [1]. Biological communication involves the reciprocally adaptive relationship between a signal and response; a signaler and a receiver who have each evolved to interact with each other [3].

Implicit in these descriptions is the transfer of meaningful information. To be effective, communication requires that the received message is processed and elicits an appropriate response on the part of the recipient [3]. Such activities are easily identified among higher animals, including humans. However, even among the latter, it is understood that much of this communication is non-verbal [4, 5].

Biological communication obviously falls into this latter category. There is a vast amount of interaction that occurs at the cellular and sub-cellular levels. This chapter will discuss one such communication system; extracellular vesicles. But before these are explored, it is important to come to some understanding of what is being communicated. What do ECVs transport?

2.1 The 'alphabets' of life

Our genes are comprised of only four different nucleotides, namely guanine, cytosine, adenine, and thymine (**Figure 1**). As reported by Watson and Crick [6], these are arranged sequentially along two antiparallel strands. Traditionally they have been represented by the letters G, C, A, and T, respectively, giving the impression they are part of some kind of alphabet. Each of the four interacts with a corresponding nucleotide in the adjacent strand, G with C and A with T, forming what is referred to as the double helix that characterizes a deoxyribonucleic acid (DNA) molecule [6].

The base adenine was first isolated from pancreatic tissue in 1885 by Albrecht Kossel. This was followed by his isolation of the other three bases over the next few years [7]. The base pairings were deduced from experiments beginning in the 1940s, involving the separation of individual bases by paper chromatography and their subsequent identification and quantification using ultraviolet spectroscopy [8]. The results demonstrated that the A:T and G:C molar ratios were fairly constant and close to unity [9, 10]. Together, these early experiments laid the foundation for our understanding of genetic material as a coded system; a biological alphabet.

At first glance, these four molecules that comprise the genetic code may not appear particularly impressive. English for example has 26 letters in its alphabet, Spanish has 27 and Greek has 24. However, when one considers the average size of a

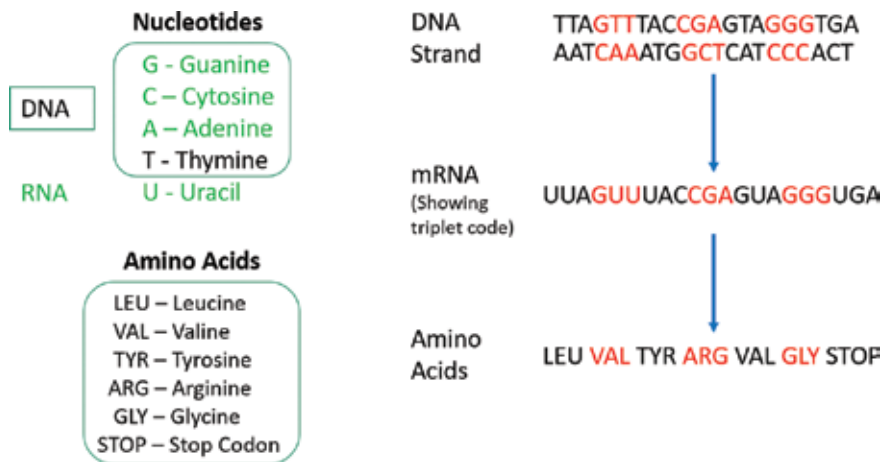


Figure 1.
 The molecular codes.

gene in both prokaryotes and eukaryotes [11], then the potential semantic diversity of the code becomes evident.

To complicate matters further, there are other ‘codes’ that must be deciphered by cells. The nucleotides present in a portion of coding DNA, are converted by a process of transcription into messenger ribonucleic acid (mRNA). These molecules also comprise just four different nucleotides, namely guanine, cytosine, adenine, and uracil (**Figure 1**). Here, thymine is replaced by uracil (U) [12], with the maintenance of an impressive semantic range. Both DNA and RNA molecules are therefore composed of nucleotides and are referred to as nucleic acids.

Cells have evolved one additional group of codified molecules. The mRNA molecules are further translated into a string of amino acids based on the arrangement of triplet nucleotide sequences [13] in the mRNA molecule, referred to as the RNA codon. Cells therefore possess at least three distinct molecular codes, each with its own ‘alphabet’, that allows the transformation and transfer of information from DNA to RNA to protein (**Figure 1**).

2.2 A molecular language?

What exactly do these molecular codes represent? Do cells use a molecular language? An often-used test is Zipf’s Law, which when applied to languages, states that a word’s rank in terms of frequency is inversely proportional to its frequency. Therefore, the product of a word’s rank and frequency equals a constant, as shown in Eq. (1) below [14].

$$R \times F = C \quad (1)$$

In addition, if the rank and frequency of all words in a language were determined and plotted on a logarithmic scale, the rank-frequency distribution would approximate a linear plot that obeys a power law (**Figure 2**), known as a Zipfian distribution [14].

But authors disagree on whether the molecular codes obey Zipf’s Law, with some reporting favorable evidence [15, 16], while others refute such claims [17, 18]. In this regard, there appears to be important differences between coding and non-coding regions of the genome. It is the coding regions that appear to lack higher structure

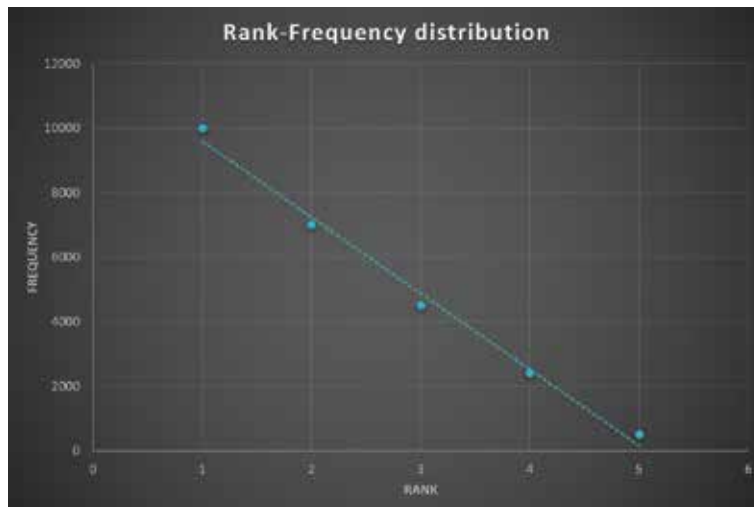


Figure 2.
Zipfian rank-frequency distribution.

and therefore fail Zipf's Law [16]. The codes simply stand on their own. In contrast, non-coding or 'junk' DNA does appear to possess some linguistic features, including compliance with Zipf's Law and demonstrating redundancy, features not expected in random texts or sequences [16, 19]. Still others argue that DNA does not demonstrate linguistic properties [20].

However, Zipf's Law applies to a diverse range of phenomena. For example, the rank-size plot for cities greater than 10 kilometers throughout the world, is remarkably Zipfian [21]. A similar distribution has been reported for global income distribution [22]. In fact, many phenomena obey the power law including number of citations, telephone calls received, relative income, earthquake magnitude, and the number of species in a genus, implying that a Zipfian distribution is not a definitive criterion of languages [17, 23, 24].

It is also worth noting that we still do not fully understand molecular codes. For example, of the approximately 3 billion base pairs that comprise the human genome, it is estimated that only 3% is coding DNA, that is nucleotides that code for proteins [25]. The remaining 97% is described as non-coding DNA and was often referred to as 'junk' [16, 26]. This is an unfortunate term as increasing evidence has accumulated that demonstrate that this 'junk' DNA may actually have important functions [27] implying it carries some sort of message [16]. Unlike the non-repetitive coding regions that transmit the conserved blueprints for protein architecture, the repetitive syntax of the non-coding regions governs organization, and coordination; a dualism reflected in natural languages [26].

In addition, parallels can be made between the genetic code and other codes including human speech. Ji outlined eight linguistic analogues between human language and 'cell language', including alphabet, lexicon, sentences, grammar, phonetics, semantics, first articulation and second articulation [25]. To this, Witzany adds pragmatics, recognizing context-dependent meaning found in both natural languages and codes [26]. Others suggest that nucleotide bases that represent the fundamental structure of DNA are grouped into triple codons that parallels the fundamental units of sound (phonetic features), which are grouped into phones [28].

When the molecular codes are finally fully deciphered, it is plausible that we will marvel at the extent of their vocabulary (e.g. non-coding DNA sequences), syntax, grammar (e.g. regulatory units), semantics and pragmatics (e.g. epigenetics). Perhaps only then will the elegance and sophistication of the molecular codes be fully appreciated.

However, despite the analogies, this chapter does not argue for equivalence. Molecular codes are obviously not natural languages, notwithstanding the challenge of defining the latter [29].

Acknowledging the difficulty, Wardhaugh suggests the possibility of different types of language, a situation that makes them hard to be subsumed under a single definition [29]. A pragmatic approach offered by Bell entailed using various criteria to distinguish between these different kinds of languages. These include standardization (process of codification), vitality (existence of community of speakers), historicity (provides a sense of identity), autonomy (distinct from other languages), reduction (existence of subordinate varieties), mixture (lack of purity of the variety), and de facto norms (of proper usage) [29, 30].

Direct comparison is obviously futile as it is unreasonable to expect molecular codes to exhibit the linguistic features of natural languages. Yet nucleic acid codes and codons, and amino acid sequences could be described based on some of Bell's criteria. They entail obvious codification and autonomy. As described above, there are also in-built de facto norms of use. Molecular codes could therefore be considered to represent an ancient mode of communication, a group of biological languages, conveying units of information that are sent and received by cells across the kingdoms of life [31, 32].

Further, our written and spoken codes, remarkably unique among the kingdoms of life, probably represent a relatively recent adaptation to the bio-social conditions that presented a fitness-advantage to reciprocal altruism in humans [33]. It seems intriguing that natural languages, whose development across species was restricted by evolutionary costs [33], still echo some of the blueprints embedded in the molecular codes. The question then is not only whether molecular codes are languages, but also what traces of these ancient codes, prototypes of communication, have bridged the apparent bio-social divide.

2.3 The multilingual cell

The codes and codons transmitted as nucleic acids, and amino acid sequences, must be understood not only by the source or donor cell, but also by other cells with which it communicates. The relationship between these molecular codes is popularly represented by what is known as the central dogma of molecular biology (**Figure 3**) described by Watson [34] (cf. the original concept published by Francis Crick [35], in 1958).

Functional sequences embedded in the DNA code are first transcribed into messenger RNA molecules (mRNA). The resulting nucleic acid sequences represent a complimentary but limited replica of the DNA molecules from which it originated; like a local dialect or subordinate variety [29]. The cell's machinery recognizes these mRNA molecules, which direct various cellular functions. For example, the mRNA code is reinterpreted as triple codons, another dialect, which directs the cell to add the corresponding amino acid to a growing peptide chain that will ultimately form a mature protein molecule. The latter is represented by yet another code, the amino acid sequence; a different molecular language.

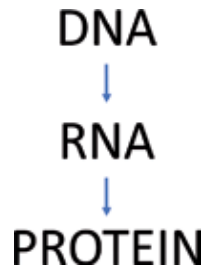


Figure 3.
The central dogma of molecular biology, as described by Watson [34].

Subsequent discoveries have modified and expanded Watson's portrayal of the central dogma. For example, the unidirectionality of information flow would be challenged [36, 37]. In addition, epigenetic markings are now known to determine context-relevant expression [26, 38]. Further, other types of RNA can direct cellular processes. These include micro-RNA (mi-RNA) molecules, which are involved in the regulation of gene expression [39, 40]. These regulators often determine which, among the vast number of genes, is transcribed. In other words, in a given cell, the local epigenetic and mi-RNA dialects could determine the semantic range of the genetic code.

In addition, there are other types of information that are relayed between cells. These take the form of lipids, carbohydrates and a diverse array of signaling molecules, each with its own set of molecular structures [41].

Cells must therefore understand various molecular codes in order to function effectively. Throughout the vast diversity of life forms, one mechanism has emerged as a highly conserved communication system, capable of protecting and relaying the multiple codes and other signals utilized by cells. This system is deployed by what are known as extracellular vesicles [41].

3. Vesicular comunicasomes

Extracellular vesicles (ECVs) are produced by cells from all three domains of life: archaea, bacteria, and eukaryotes [42, 43]. Eukaryotic ECVs are classified in many ways, including their mode of biogenesis and size. Based on biogenesis, consensus appears to have emerged around the classification of these vesicles as exosomes, microvesicles or apoptotic bodies [41, 44–46]. However, some controversy remains regarding their size, with estimates ranging from as low as 10 nm, to over 5000 nm; with exosomes being the smallest, microvesicles intermediate and apoptotic bodies the largest [42–44, 46]. Gram-negative bacterial vesicles have been referred to as outer membrane vesicles (OMVs) [47] and those of gram positive bacteria and archaea, which both lack an outer membrane, as simply membrane vesicles (MVs) [47, 48]. Vesicles derived from the prokaryotes (bacteria and archaea) tend to be smaller, ranging from well below 100 nm to a few hundred nanometers [42, 47–51]. This nomenclature will be used throughout the remaining sections.

3.1 Early history of extracellular vesicles

Bacterial OMVs were described several decades ago, at least as early as 1966, when Knox et al. described the presence of blebs protruding from the outer membrane of *Escherichia coli* cells grown in lysine-limited culture, with subsequent

extracellular formation of “globules” [52]. A subsequent report, a decade later, included the description of outer membrane fragments and vesicles in *E. coli* culture during normal growth [53]. By 1990, Dorward and Garon confirmed vesiculation and vesicle DNA content in several bacteria, including two species of the gram-positive bacteria *Bacillus* [54]. Several years later this phenomenon, then understood to be common among gram negative bacteria was reviewed by Beveridge, who referred to them as outer membrane vesicles [55]. By then, it was also understood that OMVs were involved in bacterial virulence, and had potential medical applications including as drug delivery and vaccine agents [55]. Towards the turn of the century, vesiculation was observed by electron tomography of the ice-embedded archaea, *Sulfolobus* [56], a phenomenon soon shown to be widespread among the thermoacidophilic members of the *Sulfolobus* genus [48].

Eukaryotic vesicles may have been alluded to from as early as 1941, when MacFarlane et al. described the loss of coagulation attributable partly to either the deposit derived from high-speed centrifugation of human plasma or filtration through 0.46 µm membranes [57]. This procoagulant component appears to be the particulate fraction sedimentable at 31,000 g that was referred to as “the thromboplastic protein of blood” a few years later [58], and subsequently a vesicle-containing fraction called “platelet dust” [44, 59]. Another earlier function attributed to these vesicles was the selective removal of no-longer required surface membrane components during reticulocyte maturation. These vesicles were termed “exosomes” [60]. Eventually several other terms would enter the literature, including ectosomes, microvesicles, shedding vesicles, microparticles, apoptotic vesicles and apoptotic bodies [44].

Subsequent studies would reveal the ubiquitous secretion of ECVs across the domains of life as well as the plethora of functions related to both normal and pathological processes, as will be discussed later. But before delving into these aspects of vesicular biology, it is important to understand how vesicles are produced, and delivered between donor and recipient.

3.2 ECV biogenesis, release

It has been known for some time that exosomes are formed as part of the endosomal system or endocytic pathway (**Figure 4**). Early endosomes result from the inward budding of the plasma membrane. When they fuse with endocytic vesicles, they together with their membrane-derived nucleic acids, proteins and lipids are destined for recycling, degradation or secretion [41, 61–63]. Early endosomes not targeted for recycling, develop into late endosomes that accumulate increasing numbers of inner vesicles by subsequent inward budding of its limiting (outer) membrane, forming what are known as multivesicular bodies MVBs [61, 63, 64]. This process of vesiculation allows for the sorting of cytosolic nucleic acids, proteins and lipids into the inner vesicles [41].

The process of exosome biogenesis can be mediated by different groups of drivers. These include the endosomal sorting complexes required for transport (ESCRTs) I, II and III, which together induces cargo clustering, membrane bud formation and subsequent cleavage to form inner vesicles in yeast cells [65]. There is also an alternative ESCRT pathway in which syndecan, syntenin and ALIX play key roles in the MCF-7 human cell line [66]. In addition, an ESCRT-independent but ceramide (lipid)-dependent pathway has been reported in Oli-neu cells, a mouse oligodendroglial cell line [67]. Importantly, the mechanism of biogenesis appears to vary with cell type and with exosome content [41], implying that cells may recruit from a slate of internal machinery to produce various exosome phenotypes.

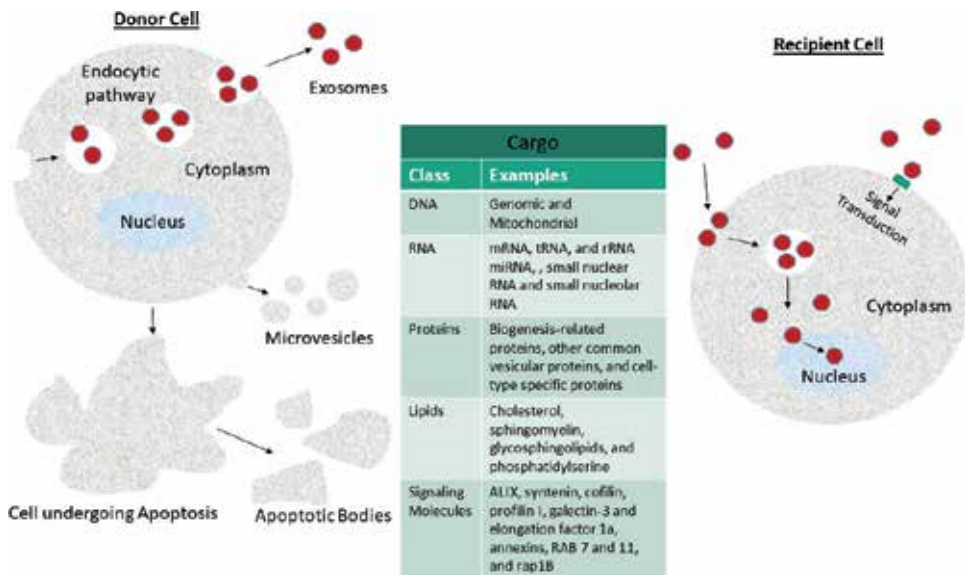


Figure 4.
ECV biogenesis, uptake and cargo.

MVBs not destined for recycling or degradation complete a membrane-to-membrane cycle by fusing with the plasma membrane to externalize the limiting membrane and release the enclosed vesicles, called exosomes [61]. Exosome release is also influenced by a range of mechanisms: stimulation by RAB GTPases in mouse Oli-neu cells [68]; SNARE proteins in the human chronic myeloid leukemia cell line, K562 [69], as well as diacylglycerol kinase α (DGK α) inhibition in human T-cells [70]. Here again various cell types utilize different mechanisms to trigger the release of exosomes, with distinct cargo [66, 69, 71]. The endocytic pathway therefore facilitates not just the recycling of materials but the selective packaging and release of specific molecular codes and signals.

Microvesicle biogenesis and release are somewhat merged processes as vesiculation involves outward budding of the plasma membrane (**Figure 4**). This involves initial redistribution of phosphatidylserine to the outer membrane leaflet and completed by ERK-induced phosphorylation and activation of the myosin light chain resulting in cytoskeletal contraction and membrane fission [63, 72]. Phosphatidylserine translocation is induced by increased intracellular Ca^{2+} and Ca^{2+} -induced activation of the protease calpain [73], as seen for example with platelet microvesiculation [74]. However, as with exosomes, other effectors and mechanisms may be involved, including hypoxia, which induces microvesicle production in human breast cancer cells through hypoxia-inducible factors (HIF)-dependent RAB22A GTPase expression [75].

Apoptotic bodies, or apoptosomes, are formed during the process of apoptosis (**Figure 4**) that involves chromatin condensation, membrane blebbing and disintegration of cell contents into the defined membrane-enclosed vesicles [63]. In Jurkat cells (a hematopoietic cell line) vesiculation involves Caspase 3-induced cleavage of the serine/threonine kinase ROCK1, which is associated with myosin light chain phosphorylation [76], suggesting apoptosome formation also involves cytoskeletal rearrangement [63].

Like microvesicles, OMV production in gram negative bacteria may be initiated by rearrangement of membrane components, leading to curvature of the lipid bilayer [47]. Such rearrangement could involve deposition of peptidoglycan fragments into the periplasm producing an elevated turgor pressure; down-regulation

of outer membrane proteins that favor peptidoglycan interaction; or charge repulsion in regions with accumulation of negatively charged lipopolysaccharide (LPS) O-antigen [51]. Yet another proposed mechanism, potentially highly conserved among gram-negative bacteria, involves membrane curvature induced by accumulation of phospholipids in the outer leaflet of the outer membrane, which is further enhanced by subsequent accumulation in both leaflets, until the vesicle is finally pinched off [77].

Similarly, vesiculation in gram positive bacteria may involve protrusion of plasma membrane microdomains as well as peptidoglycan degradation [51]. Although less is known of archaeal vesicle formation, protein homologs of ESCRT-III subunits have been isolated from these membrane vesicles [48].

3.3 Vesicular uptake

Uptake of eukaryotic ECVs by recipient cells also occurs by several mechanisms. These include the interaction of the vesicle with the plasma membrane with release of content, or the internalization of the ECV through endocytosis (**Figure 4**). There are several different types of endocytosis recently reviewed by Abels and Breakefield, including clathrin-, caveolin-, and lipid raft-mediated endocytosis, macropinocytosis, and phagocytosis [41]. Internalized ECV exosomes must be released into the cytoplasm and this process is promoted by the low pH-environment within endosomes resulting in fusion of exosomal and endosomal membranes [78]. Interestingly, prokaryotic vesicle uptake is also mediated by similar processes, including macropinocytosis, various endocytosis-dependent processes and membrane fusion [79].

Apoptotic body uptake is mediated by specific interactions between altered apoptotic cell membrane components and receptors on phagocytes, which engulf and remove these vesicles [63]. These components include phosphatidylserine translocated to the outer membrane leaflet bound by Annexin V in Scott B lymphoblastoid cells [80], complement C3b deposition on Jurkat cells [81], surface molecules bound by thrombospondin, and exposed side chain sugars [82], all of which are recognized by phagocyte receptors [63, 82].

These mechanisms imply that ECV biogenesis, release and uptake are evolutionarily conserved processes that although demonstrate divergence across the domains of life, still exhibit remarkable similarities. This underscores their fundamental functional importance. Considering their cargo, their importance becomes even more evident.

3.4 Extracellular vesicle cargo

The content of specific ECVs vary based on several factors, including their mode of biogenesis, cell type of origin and the prevailing physiological state [41]. However, both eukaryotic (**Figure 4**) and prokaryotic vesicles have been shown to carry a wide range of biologically active molecular codes and signals.

Eukaryotic ECVs contain many types of nucleic acids. These include vesicle enclosed genomic DNA as derived from mouse cardiomyocytes [83], and mitochondrial DNA from rat astrocytes and human glioblastoma cells [84], cargo that could facilitate recipient evolution and enhanced functions, as will be discussed. Also found are various RNA species, including mRNA, tRNA, and rRNA, as well as various non-coding RNAs including miRNA, small nuclear RNA and small nucleolar RNA [39, 83, 85–88]. Among these, rRNA may dominate in apoptotic bodies [87], and small RNAs including miRNA seem to be the dominant RNA species in exosomes [87, 88]. DNA has also been shown associated with the external surface of bacterial OMVs as well as within intact vesicles [89].

It is difficult to draw conclusions on the protein content of different ECV types as the cell types and research methodology used varies among studies [41]. However, despite this variability, review of different reports gives an overview of the types of proteins normally found in vesicles. Proteins found in eukaryotic ECVs can be classified as biogenesis-related proteins, other common vesicular proteins, and cell-type specific proteins [41, 43]. Among the early proteomic analyses was that performed by Théry et al. on dendritic cell exosomes. They identified proteins involved in exosome biogenesis, release and function as well as intracellular membrane transport and signaling (ALIX, syntenin, cofilin, profilin I, galectin-3 and elongation factor 1a, annexins, RAB 7 and 11, and rap1B), many of which were cytosolic [90]. Parotid gland exosomes also contain several proteins involved in exosome biogenesis and release (ALIX, RAB proteins), as well as several cytosolic proteins involved in signaling and immune functions [91]. Bacterial vesicle proteomes have also been studied. OMVs from the gastric pathogen *H. pylori* were reported enriched in membrane proteins, porins, adhesins, immune-modulators, and virulence factors including vacuolating cytotoxin (VacA), cytotoxin-associated gene A (CagA), and neutrophil-activating protein (NapA) [49]. Membrane vesicles from the crenarchaea *Sulfolobus acidocaldarius*, *S. solfataricus* and *S. tokodaii*, were shown to contain proteins involved in vesicle biogenesis, including proteins homologs of ESCRT subunits as well as proteins associated with transcription and translation [48].

Being derived from membrane structures, the lipid composition of ECVs share many similarities with their cells of origin and reflects their biogenesis [41]. However, differences are clear. Exosomes derived from the prostate cancer cell line PC-3, contained several fold greater lipid:protein content and were highly enriched in cholesterol, sphingomyelin, glycosphingolipids, and phosphatidylserine [92]. In contrast, the OMVs of *Pseudomonas aeruginosa* contain large proportions of phosphatidylglycerol [93], while membrane vesicles from *Sulfolobus* species have been reported enriched in archaeal tetraether lipids [48].

3.5 Active sorting of cargo

The diverse cargo of ECVs suggests the involvement of some kind of sorting process in their biogenesis. This is in keeping with an effective communication system that requires targeted delivery of information; a deliberate separation of the signal, from the noise that would otherwise drown it. The immense array of molecular codes and signals that could be packaged into ECVs must be filtered so that meaningful information is ultimately delivered.

The evidence demonstrates that this is exactly what cells do. For example, there is relative enrichment of membrane and cytoplasmic compared with nuclear and mitochondrial proteins in eukaryotic ECVs [43], and preferential selection of specific proteins for inclusion in both prokaryotic and eukaryotic vesicles [43, 94]. During exosome biogenesis, both membrane proteins and lipids are selectively incorporated into the MVB limiting membrane and subsequently into the exosome bound inner vesicles [61]. Similarly, *H. pylori* OMVs are enriched in outer membrane and periplasmic proteins [49]. Although eukaryotic ECVs contain several membrane lipids, there is enrichment of a select group of lipids, including sphingomyelin, cholesterol, ganglioside GM3 and phosphatidylserine. In addition, the preferentially sorted mix of lipids varies between cell types [95]. Lipid content also varies between the outer membrane and outer membrane vesicles of gram-negative bacteria [93]. Selective packaging of ECV nucleic acid content has also been shown. Eukaryotic exosome analysis has identified enriched and depleted mRNAs and miRNAs compared with the donor cell, as well as mRNAs not detected in the donor cell [85, 86]. Similar differential sorting has been reported in prokaryotes,

as with *Pseudomonas aeruginosa* OMVs enriched in specific chromosomal regions involved in virulence, stress response, antibiotic resistance and metabolism [89].

Several methods may be involved in cargo sorting into eukaryotic ECVs. It has long been known that various proteins can be sorted into, or excluded from, cholesterol/sphingolipid-enriched lipid rafts [96]. Similarly, galectin-3 may be involved in the sorting of proteins into exosomes by stabilizing their cross linking to form high molecular weight clusters in the apical membrane that are sorted into the vesicles [97]. Various mechanisms have been proposed for miRNA sorting. These include an interaction between a four-nucleotide motif (GGAG) and the ribonucleoprotein, hnRNPA2B1; post-transcriptional 3'-uridylation; protein mediated pathways via neutral sphingomyelinase 2 (nSMase2) or Protein Argonaute-2 (AGO2); and elevated cellular levels of miRNA [41, 98]. Loading of mRNAs has been associated in human HEK-293 T cells with a particular 3' untranslated region (UTR) containing a CUGCC core on a stem-loop structure as well as an miRNA-binding site, whose interaction enhances loading [99].

In bacterial and archaeal vesicles, various mechanisms may also be utilized to accomplish this [51]. Among these mechanisms specific proteins could be localized to certain microdomains based on their affinity to particular moieties, the overall charge or length of local lipopolysaccharide (LPS) molecules, or through recruitment by a sorting factor that simultaneously binds recruiting signals in the protein and specific sites on the LPS molecules [94].

Cells are therefore not simple automatons. Instead their messages are delivered by multiple molecular codes and signals; diverse, nuanced and presumably meaningful. If they were automatons, ECVs would be produced by repetitive packaging of identical cargo as observed on a factory assembly line. If they were, ECVs would be monosemic, devoid of physiological and pathological pleiotropism. Evidence for this final link in the communicative process, logical response to the transmitted information, will now be presented.

4. ECV-mediated communication

Now that the message has been packaged, transported and received, is it intelligible? As with any other form of effective communication, the transferred information delivered by ECVs must have meaning to the recipient. Otherwise, the signal will be understood as non-sense and no communication would have occurred. However, we know that this is not the case. ECVs do affect recipient cells and in specific ways. As shown in **Figures 4** and **5**, some may initiate signaling through interaction with recipient cell receptors. Others must enter the cell and be released into the cytoplasm or delivered to the nucleus [41].

4.1 Communicating with living codes

For ECVs to function as a communication system, they must be able to package and transport relevant information to recipient cell(s). This is exactly what they do. There is mounting evidence that the delivered cargo is functional.

ECVs transport molecules which are themselves living codes of information, in the form of nucleic acids and proteins. For example, DNA associated with mouse cardiomyocyte-derived vesicles has been shown to be distributed within fibroblast cytosol and nuclei, in conjunction with differential gene expression of more than 300 genes [83]. Similarly, new mouse proteins were recovered from recipient cells after the transfer of mouse exosomal RNA to human mast cells, suggesting that the delivered RNA was successfully translated in the presence of functional

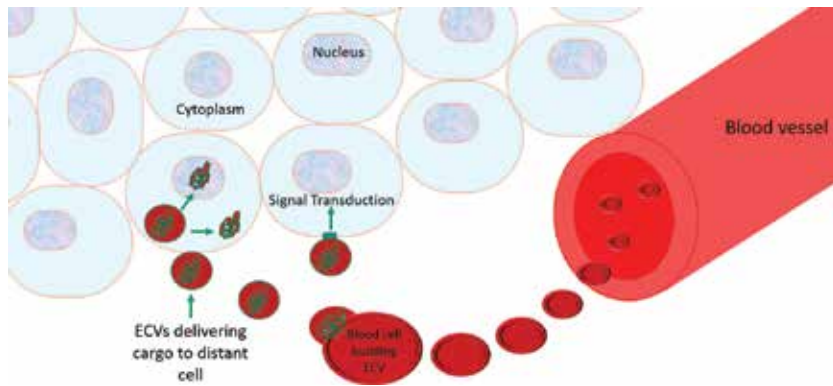


Figure 5.
Intercellular communication mediated by extracellular vesicles.

protein synthesis machinery, made available within the recipient cells [85]. Such translation of functional proteins has also been reported in healthy human brain microvascular endothelial (blood vessel wall) cells in response to delivery of cancer cell (glioblastoma)-derived microvesicles [86], implying that ECVs derived from abnormal cells can be utilized to direct the genetic machinery of normal cells.

Furthermore, recipient cells respond predictably to the delivery of ECV-delivered regulatory cargo. Dendritic cell-derived exosomes containing miRNAs, were shown to target and repress mRNAs in recipient dendritic cells [39]. Such responses may also be part of a pathological process. For example, glioblastoma-derived microvesicles can stimulate the proliferation of other glioma cells, as well as promoted angiogenic processes in normal endothelial cells [86]. Viral mi-RNA molecules derived from Epstein–Barr viruses (EBV) that have infected nasopharyngeal carcinoma (NPC) cells are packaged into NPC-derived exosomes [100]. EBV-infected B-cells secrete EBV mi-RNAs via exosomes, which are internalized by dendritic cells in co-culture and lead to suppression of known target genes, including immunoregulatory genes [40]. Similar suppression has been documented in murine endothelial cells treated with exosomes isolated from bone marrow-derived macrophages [98]. Horizontal transfer has also been demonstrated between rat fibroblasts and murine recipient cells, resulting in in-vitro loss of contact inhibition and a tumorigenic phenotype in vivo [101].

As with eukaryotic ECVs, bacterial vesicles have also been shown to package and transport biological codes to others cells. One of the most well studied bacteria, *Escherichia coli*, has been demonstrated to release OMVs carrying DNA, which are transferred to recipient bacteria [50]. Nuclear localization has been reported with *P aeruginosa* OMVs, delivering bacterial genetic codes to the cytoplasm and then nuclei of eukaryotic epithelial cells [89]. These vesicles can relay functional biological codes. *E. coli* delivers DNA to other *E. coli* cells as well as to other bacterial cells where it is expressed and results in appropriate biological response [50].

4.2 Communicating with signaling molecules

Multicellular organisms also utilize ECVs to deliver other signaling molecules for physiological processes as well as to facilitate pathogenetic mechanisms.

Vesicular transport is essential for sperm motility, a critical component of one of the most fundamental biological processes; reproduction. Normal fertility requires, among other factors, motile spermatozoa. Motility is dependent on Ca^{2+} signaling [102] and involves Ca^{2+} mobilization and entry [103]. These processes in turn require a slew of molecules, including various receptors and enzymes, which

are transferred to the neck of the sperm, delivered by fusion of prostate gland-derived extracellular vesicles called prostasomes [103, 104].

Among the most lethal ECV-mediated dysfunctions, cancers represent a significant cause of mortality worldwide [105]. Evidence suggests that one of the methods involved in the subversion of normal biology, to promote cancer growth and survival, is the delivery of molecules by ECVs. For example, it has been shown that cancer cells release the protein Survivin into the extracellular space, in the form of exosomes [106]. In addition, the extracellular form of Survivin is secreted by several types of cancer cells (including breast, cervical, prostate, pancreatic, bone and blood cancer cells), is transferrable to other cancer cells and induced increased proliferation and reduced apoptosis (cell death) of the recipient cell [107], features that enhance cancer progression.

OMVs also mediate host-pathogen interactions that could result in pathology. Vesicles isolated from *H. pylori*, contain the known virulence factors CagA, VacA, and NapA, which not only induced morphological changes in gastric cells, but promoted a pro-inflammatory environment including enhanced interleukin-8 (IL-8) secretion from gastric cells, colonic cells and duodenal explants, as well as neutrophil migration [49].

4.3 Interspecies transfer and evolution

Perhaps the most powerful impact one cell could have on another is through horizontal gene transfer. Not only does intercellular genetic transfer allow for an immediate response, there is the possibility that the donor could influence the recipient's progeny for generations, if not millennia, to come.

Despite several claims, genetic transfer from prokaryotes to eukaryotes is replete with challenges [108]. However, there is clear evidence of DNA transported into eukaryotic recipients from endosymbiotic (mitochondria and plastids) and other eukaryotic sources, which could introduce new genes into the genome or replace existing genes [32, 109]. It is now becoming clear that ECVs may also introduce new genetic material into recipient cells. Within a multicellular eukaryotic model, this is what appeared to happen when fibroblasts were transfected with cardiomyocyte-derived vesicles, resulting in altered gene expression within recipient cells [83].

On the contrary, horizontal gene transfer into prokaryotic cells is thought to be common, conferring evolutionary benefits, including acquisition of antibiotic resistance and enhanced virulence. Such transformations can be mediated by mobile genetic elements such as bacteriophages and plasmids [31, 110]. It is therefore not surprising that Yaron et al. had previously reported vesicle-mediated DNA transfer from the food-borne pathogen *Escherichia coli* O157:H7, to *Salmonella enterica* serovar *Enteritidis* and *E. coli* JM109, leading to several fold increased cytotoxicity of recipient cells, as well as ampicillin resistance in transformed *E. coli* JM109 cells [50].

ECVs are therefore agents of interspecies genetic transfer. As such, they have the potential to serve as drivers of evolution.

5. Conclusion

Cells interact using various coded and non-coded molecules, which although not natural languages, could be considered types of biological language. It seems logical that these highly-conserved molecules pre-date the emergence of natural languages, whose evolutionary advantage arose relatively recently and only in limited circumstances. Ubiquitous molecular languages were, and will remain, fundamental to life because they direct the most basic of cellular functions throughout all life-forms. Natural

languages on the contrary probably developed under the limited circumstance when reciprocal altruism conferred a selective advantage [33]. Molecular languages are therefore an adaptable prototype, representing a highly conserved model of information.

Their significance is further underscored by the fact that cells from all three domains of life have evolved limited modes of transporting such crucial cargo. Despite the clearly diverse mechanisms involved in ECV biogenesis, packaging, release and uptake, the basic modes of ECV-mediated intra-cellular, inter-cellular and inter-species communication have been widely replicated. Extracellular vesicles are therefore also another adaptable prototype, representing a highly conserved model of communication.

This scenario probably reflects the enormous evolutionary pressures brought to bear over evolutionary time, as well as across various habitats, for cells to effectively communicate with each other. It also underscores a fundamental biological principle: structure determines function. Development of universal codes allowed for wide-spread interpretation of shared information [111]. Similarly, development of universal cellular transporters allowed for wide-spread accessibility to this information. However, selective packaging and targeting of these codes, which have evolved over time, facilitates an extensive context-relevant semantic range, and therefore selective and specific communication. In this regard, ECVs have proven fit for purpose.

As with any communication system, this prototype is versatile, diverse, nuanced and meaningful. This is exactly what one would expect from an effective communication pipeline that delivers targeted information; one that intuitively separates the signal, from the noise. In so doing, ECVs ensure that actionable biological information is ultimately delivered. It is this prototypal communication system that not only directs normal physiology and induces pathology when disrupted, but has the potential to influence the evolution of recipient cells.

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Conflict of interest


The author has declared no conflict of interest.

Author details

Paul A. Brown
Department of Basic Medical Sciences, University of the West Indies, Kingston,
Jamaica

*Address all correspondence to: paul.brown02@uwimona.edu.jm

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Section 3

Cultural Foundations of
Communication

Toward a Systems Perspective of Culture and Communication in the Field of International Business Studies

Cheryl Marie Cordeiro

Abstract

Biology and culture co-evolve, affecting collective social behaviors in the way we interact with others and with our environment. The working assumption in this study is that biology and culture provide the environment in which individuals interact/communicate. Human communication is thus both created and circumscribed by culture. Cultural values differ between different groups of individuals. This relativity in culture is illustrated by various social artifacts and resulting differences in socio-communicative behaviors that often leads to miscommunication between individuals of different cultures. This inherent relativity of culture has also posed a methodological challenge for researchers who study culture and thus communication management, particularly within the field of international business (IB) studies, where transactional behavior makes up for much of human behavior. Global challenges and a changing business environment due to converging technological platforms place increasing pressure on the need to revisit the cultural dimensions construct. The aim of this chapter is to give readers an overview of current frameworks of how culture is studied within the field of IB and how this perspective can be broadened with ideas drawn from other disciplines including social-biology, quantum theoretical physics and psychology. It revisits current culture research strategies and suggests a model in which relativity in culture can be addressed through a systems perspective of research.

Keywords: global challenges, culture collective behavior, communication management, international business, research methodology, system theory

1. Introduction: culture in international business

Biology and culture coevolve. The gene–environment coevolution has been established as foundational knowledge in different disciplines from language and cognitive studies [1, 2], social biology [3], sociology [4], philosophy [5] and systems theory/perspective of life that views all biological, cognitive, social aspects of human and animal behavior in an ecological dimension [6]. When it comes to human communication and social organization, the concept of organization ‘climate’ was discussed and studied mainly in the field of psychology in the early 1900s [7] where the authors spoke of ‘group norms’.

International business (IB) and trade is part of a socio-biological human activity where communicating across cultures is increasingly inevitable. In that sense, IB is both an agent and recipient of cultural change [8] due to that IB and trade processes are inherently uncertain and evolving [9, 10], requiring a nuanced understanding of communication processes across cultures. With a large part of human activities being involved in daily transactions and exchange as a means of living, today's economic theories, developed in an era of energy and material wealth from the 1800s onwards, is today largely out of sync with advancements in digitalization, climate change, biodiversity loss and rising social inequality [11, 12]. What is needed in address to global challenges is for a change in collective thinking and belief, i.e. a change in our culture, the way we communicate between ourselves and our environment, and how we conceive to manage our global resources as part of our daily transactions.

Because of our evolving business environments, there has been an interest in scholastic literature since the late 1990s, for new perspectives in the study of culture in the field that includes communicating across cultures in trade negotiations [13], cultural dynamics in goods and services consumption such as what constitutes as luxury foods [14–16], culture in organization behavior and applications of the cultural dimensions construct to the study of culture [17–23].

This chapter contributes to the current debate on how to frame future studies of a relative concept such as culture. It begins with giving a synopsis of the current paradigm of research methodology of the study of culture within IB, going on to address the two research questions of:

- How and what can the field of IB studies gain with a broader definition and perspective of culture through a systems perspective? And,
- Is there a means to operationalize a systems perspective framework to the study of culture (and thus the processes of communicating across cultures) within IB?

1.1 Current research paradigm of culture within international business studies

The discourse of organization culture in the field of international business (IB) began around the late 1970s with the work of Geert Hofstede [24–26]. In the 1950s, 'cultural ecology' was a focal concept in anthropology, evolving in response to the natural environment [27] anchored in the context of social life [28]. Culture was studied as an adaptive system with ecological and ideational dimensions [29].

As culture and communication processes are intricate features of groups of individuals and manifests itself on various dimensions and levels of society, it is not an easy concept to decipher or measure [30, 31]. This challenge is further compounded today by advancing developments in information communication technologies (ICTs) that are digitally enabled. Digital infrastructures, wireless technology and social media platforms on the Internet for example, allow for the forming of virtual groups with instant contact that further blur concrete geographic boundaries of groups of individuals. It is these developments in technology coupled with the continued divergent views on the concept and definition of 'culture' that has proved to be one of IB's biggest challenges. Already in 1952, Kroeber and Kluckhohn [32] had uncovered 164 definitions of 'culture', with their own being classified by Allaire and Firsirotu's ([33]; p. 196) as "historical diffusionist" under culture as a "sociocultural system" though personally, their definition of culture that considers patterns of behavior and ideas reflects too, an acknowledgement of culture as a product of the mind through shared meanings and symbols:

“Culture consists of patterns, explicit and implicit, of and for behavior acquired and transmitted by symbols, constituting the distinctive achievements of human groups, including their embodiments in artifacts; the essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values; culture systems may, on the one hand, be considered as products of action, and on the other as conditioning elements of further action.” ([32]; p. 357).

Today there would be more definitions to contend with [34], as expressed by anthropologist Hall ([35]; p. 210), “I have come to the conclusion that the analysis of culture could be likened to the task of identifying mushrooms. Because of the nature of the mushrooms, no two experts describe them in precisely the same way, which creates a problem for the rest of us when we are trying to decide whether the specimen in our hands is edible.”

Perhaps in address to the myriad definitions of culture, IB literature from the 1980s onwards suggests that culture has been investigated in a form that could be explicitly measured. The methodology is based on Hofstede’s cultural dimensions/distance (CD) construct that measures how distant cultures are when compared against certain constructs such as power distance, individualism vs. collectivism, uncertainty avoidance, masculinity vs. femininity and long-term vs. short-term orientation for relations [36–43]. The effect of the CD construct was to provide the field with knowledge of culture that is mostly delineated by geographic region with a tendency toward average cultural values with an ‘either/or’ perspective that dichotomized similarities and differences between nationalities. Current global challenges today however, puts pressing need on a redefinition of culture study frameworks where culture needs to be understood from a systems network perspective.

2. Culture in the context of systems theory

In the Hofstedian CD construct, the notion of values is intricately tied to the radius of national culture that is operationalized in the cultural dimensions construct of culture applied to organization and management, to which culture is defined as “the collective programming of the mind which distinguishes the members of one category of people from those of another” ([25]; p. 389). There are however, complementary alternative views of how culture can be studied:

“National identities are not predetermined. They emerge at particular points in time, under specific circumstances, ... according to ‘a standard plot’ (Ting, 2008; p. 463), and these regularities form a basis for comparison of otherwise disparate cases (Laponce, 2008)” ([43]; p. 146).

There has also been a suggestion that culture can be studied at different levels, using several frames of references, from geographical territorial boundaries and regions [44] to global cultural flows [45], whilst others advocate a multiple culture perspective that beyond the national and regional, also included organizational and professional cultures [22].

“Obviously, we can study culture at different levels, just as we can adjust the focus of a camera to account for a large landscape or a small detail. Cultural analysis may result in a more or less fine-grained picture, every succeeding focus bringing additional information. The challenge is to define at each level a consistent approach to culture, which may account for what is shared and what is not.”
([46]; p. 170).

Chevrier’s idea that it is varying sizes of groups of individuals who make up these levels, seem to run parallel to the life’s work of American psychologist Graves on his

theory of human psychological development and stages of maturity he entitled the Emerging Cyclical Level of Existence Theory (ECLLET). ECLLET defines a value system that depends upon the interaction of two entities, (i) the socio-environmental context that Graves labels A, B, C, D, E, F, to A' and N' etc. and (ii) the neuropsychological capacities of the organism (individual, group or organization) to cope with (i) that Graves labels N, O, P, Q, R, S, to N' and O'.

The aspects of (i) when interacting in combination with (ii) produce the 8 systems of values and levels of existence that Graves labels AN, BO, CP, to A'N' and N'O'. These systems of values and levels of existence provides a varying radius of framework as a way for man to conceptualize reality, consolidate their set of beliefs and corresponding behavior. These value systems can be found both at individual and group/national/regional levels. The Gravesian model is emergent, developing in an oscillating fashion in a double-helical structure (**Figure 1**). It illustrates socio-cognitive behavior in a systems-level approach to understanding culture and values. The level of existence model by Graves postulates that a level of living circumstance once stabilized over a period will tend to create its own existential problems to be solved, so that a next level of existence is necessarily sought for:

“Overall, psychosocial development can indeed be seen as a complex wave-like phenomenon. But development does not occur in the smooth and flowing manner [but rather in] more a spurt-like, plateau-like, more a progressive, steady state, regressive movement in which certain demarcation points can be identified in the flowing process.”—Graves ([47]; p. 178)

Figure 1 shows a double helical representation by Graves of the oscillating, spiraling development of the human psychosocial existential states. The value systems develop in a fixed order, though there can be progression or regression within this order. The space in between the areas within the two lines created by the alternating

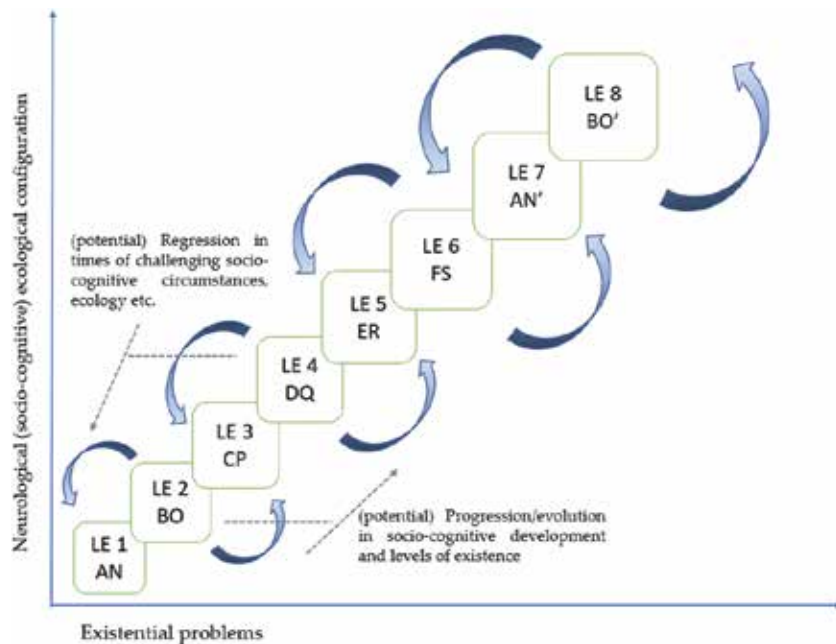


Figure 1. A double helix representation adapted from Graves [47; p. 187, 48] of the emergent development of the human psychosocial, existential states with potential development/evolution into more mature levels of existence and regression in times of socio-ecological challenges.

spurt and plateau of development phases, indicate increasing degrees of conceptual space. Each developing space on the spiral is larger than the one prior, developing in entropic fashion, in an emergent, open-ended system.

Table 1 shows the value systems in brief with its corresponding labels and resulting problems of existence. The information in **Table 1** and its levels of existence do not represent pure characteristics in which individuals can be

Level of existence (LE)	Existential state	Nature of existence	Description of existential state	Problems of existence
LE 8 Second being	B'O'	Experientialistic	A new order of 'we' and 'us' is understood; the Self sees all elements as interconnected; a recognition of interdependence in the System	Accepting existential dichotomies, and entropic relativities
LE 7 First being	A'N'	Cognitivistic	Return in new and higher order form to new survival problems in an age of scarcity; focus on reorganizing for interdependent existence	Restoring viability to a disordered world
LE 6	FS	Personalistic	Equal trade sacrifice with a focus on the Inner Self that cooperates with Others; an understanding of cooperation	Living with the human element
LE 5	ER	Materialistic	Focuses on the Outer Self of expressing things in the interest of one's Self; pretense that what is of interest to Self is also in the interest of Others	Conquering the physical universe to overcome want
LE 4	DQ	Differentialistic	Faith in authority; sacrifice Self for others; postponement of reward; focus on Inner Self	Achieving everlasting peace of mind
LE 3	CP	Egocentric	Self is all important at cost of Others; need to control the external world	Living with self-awareness
LE 2	BO	Tribalistic	Self-subsumed in Others; sacrifice to clan and survival of clan is important; focus is on the control of the Inner world	Achievement of clan safety
LE 1	AN	Automatic	Survival on automatic basis; no awareness of Self or Others; no differentiation of Outer and Inner world	Maintaining physiological stability

Table 1.
An adaptation of Graves' levels of existence and their corresponding existential states from Cowan and Todorovic ([47]; p. 169).

pigeonholed neatly even if evolution occurs in an ordered hierarchy. Newer, higher level systems necessarily subsume lower level ones. Within this model, an element of regression is accounted for. Individuals/groups when confronted with a problem to be solved, may wish to withdraw into their 'comfort zones'. Once realizing that this comfort zone no longer exists and when faced with increasing problems, they are then coerced into finding new solutions that thus push themselves into greater heights of the evolutionary double-helical structure of maturation and growth. As such, each value system is necessarily associated with a specific perspective of reality or 'world-view', thus generating multiple truths/cultures. The Gravesian model is useful because it points toward a generic model of human biological socio-cognitive development, where similar values can be mapped across national geographical boundaries. This lends a broader, more encompassing manner in which to understand how humans manage resources and live together. The individual being a unique and complex biological organism can be described to have layers upon layers of level building as they mature from the Automatic (AN) core, upwards and outwards in entropic fashion. The successive layers are not uniform, but rather they are flexible, dynamic and flow under various biological and contextual stresses as the individual reacts and relegates behavior in their own spacetime accordingly. Graves likened the individual's evolution and maturing psychology as a "wrinkled plastic onion", with layers of various flexible thicknesses that undergo continuous adjustment depending on perspective, frame-of-mind and surrounding context.

Connecting knowledge across disciplines, the Gravesian system of levels of existence in the field of socio-cognitive science has related concepts from the field of quantum theoretical physics, that of (i) Niels Bohr's "phenomenon" and (ii) Werner Heisenberg's uncertainty principle illustrated in "wave-particle" duality. Bohr's 'phenomenon' refers to that no elementary phenomenon is a phenomenon until it is a registered (observed) phenomenon. This, Bohr had raised in his years of friendship with Albert Einstein when Einstein was at Princeton between the 1930s and 1950s. At the beginning, Einstein was none too comfortable with the concept of quantum physics and tried to show that quantum physics was incompatible with any form of reasonable understanding of reality, to which Bohr's reply in brief was that Einstein's concept of reality was too limited ([49]; p. 182). Bohr maintained that "what answer we get depends on the question we put, the experiment we arrange, the registering device we choose. We are inescapably involved in bringing about that which appears to be happening." ([49]; p. 184).

Heisenberg's uncertainty principle has historically been confused with the "observer effect" which notes that measurements of any system cannot be made without affecting the systems. While Heisenberg offered that account at a quantum level as an explanation to quantum uncertainty, what should be highlighted is that the uncertainty principle is inherent in the properties of all wave-like systems where in quantum mechanics, all objects possess at the same time, a matter wave or wave-particle nature. Thus, the uncertainty principle in effect states a fundamental property of quantum systems and it is not about the observational interferences from the observer toward the system. All particles have at the same time, wave qualities, regardless of observation. In that sense, it is nonsensical to discuss the precise location of a wave on a string because particles do not have perfectly precise positions; just as likewise nonsensical to discuss the wavelength of a "pulse" wave traveling down a string since particles do not have perfectly precise momenta. When a position is relatively well defined, the wave is pulse-like and has a very ill-defined wavelength and thus momentum. Conversely, when momentum and thus wavelength is relatively well defined, the wave looks long and sinusoidal and therefore it has a very ill-defined position.

The study of culture and communication strategies within the field of IB has thus far been delineated in relation to a collected set of values that belong to a group of individuals which tends to discount that individuals can behave and communicate differently in different groups and contextual settings. If we combined the perspectives of Bohr’s “phenomenon” and Heisenberg’s uncertainty principle with Graves’ levels of existence and human development, culture and how humans communicate with each other and their surrounding environment can be studied in relativity. Culture and communication processes can be viewed as dialogic processes between Individual and Group, each would define and perpetuate the other without which, neither would exist.

Since values, motivation and beliefs define the individual and thus a group of individuals who share the same values and manners of communication, then these same levels of existence or system values necessarily go across borders, where the borders remain ill-defined (similar to Heisenberg’s uncertainty principle and in address to Hofstede’s micro-level analysis of cultures reflected in **Table 2**), defined only in relation to the observation point in relation to a specific purpose (similar to Bohr’s “phenomenon”). As such, the concept of culture and communication processes reflect both Individual and Group at the same time, the measurement of similarities or differences between the people of different groups of cultures defined only in relation to point and purpose of observation.

The conceptualization of culture and manners of communication within such a framework of systems theory drawn from the fields of quantum physics, socio-cognitive science/psychology and IB, depending point of observation of the phenomena, seemingly draws together the two dominant metaphors of culture in IB, as that of the layers of an ‘onion’ [50] and as that of the ‘ocean’ [51–54]. Within this system perspective framework, culture and communication processes can be studied as inherently emergent.

Unit/ level of analysis	Purpose of analysis	Goals of analysis	Research strategy/design outcomes
Group	To investigate/understand micro-level variables across societies	1. Prove universality of micro-level laws	Culture is viewed as a black box with need to define micro-variables. Could be too complex to be fully explained. Vulnerable to ethnocentricity
Group	To investigate/understand micro-level variables within societies	2. Illustrate uniqueness of each group/society	Culture is viewed as a black box with too many variables lacking specificity. Polycentric perspective
Society	Concerned with ecological variables between societies. Focus on similarities/differences between societies	3. Determine types of subsets of societies	Culture specified in cultural dimensions construct. Polycentric perspective
Society	Concerned with ecological variables between societies. Focus on similarities/differences between societies	4. Determine dimensions of societies and macro-level laws	Culture specified in cultural dimensions construct. Geocentric perspective

Four available research strategies with their goals numbered 1–4 for comparative multisociety studies, and the advantages/disadvantages of the research design outcomes.

Table 2.
Adapted from Hofstede’s Culture’s Consequences ([24]; p. 35).

2.1 Conceptualizing culture beyond the cultural dimensions construct

In critique of the CD construct, the metaphor of culture as an ‘ocean’ was proposed by Fang [51, 54]. Fang proposed a switch from Hofstede’s metaphor of culture as “onion” to “ocean” to “propose an alternative approach to the study of national cultures and international cross-cultural management in the era of globalization” ([51]; p. 72). The “onion” metaphor used by Hofstede [50, 55] illustrates how culture can be viewed as layers. These different layers of characteristics can be learned through teaching and practice, and can be displayed by rituals, in admiration of heroes (both real and fictive) and through (status/material) symbols. These outer manifestations, of layers of culture radiate from and surround a somewhat stable and defined core of the ‘onion’ that are the basic socio-cultural values that is what people tend to believe things ‘ought to be’, where in accordance of culture as a programming of the mind, Hofstede argued that by age 10, most children would have had their basic values in place, set with their foundation orientation toward society’s dominant ideology. Fang saw the “onion” metaphor as “a product of the cold war era during which national cultures were like “black boxes” (self-contained, tangible and rigid “onions”). Few cultures knew what other cultures were thinking and doing.” ([51]; p. 84) But in the era of globalization, he felt that a better metaphor would be to view culture, with all its inherent paradoxes and internal variations, as an “ocean”, where the ocean “has no boundaries, and its various waters are both separate and shared, both different and similar, and both independent and dependent” ([51]; p. 88).

Uncomfortable with the “functionalist” [56, 57] and “deterministic” [20] paradigm that seeks objectivity, measurement and prediction, Fang felt that research frameworks in IB had philosophical foundations heavily influenced by Karl Popper’s “analytical logic” that continued to encourage the tradition in literature of a bipolarized perspective of culture with “either/or” dimensions. He preferred instead, “a dialectical approach that sees each national culture as having a life of its own full of dynamics and paradoxes” ([51]; pp. 71–72) where an eastern ‘dualities’ approach to culture theory with a “both/and” perspective would be more useful considering today’s global challenges and changing business environments.

3. Revisiting research strategies and frameworks of analysis

The previous sections addressed the first research question posed in this chapter. By incorporating perspectives from other disciplines (social biology, physics and psychology) on how culture is studied, the field of IB can move toward a systems theory understanding of culture and communication processes in address to global challenges and changing business environments.

Comparative studies of organizations inherently favor a binary approach to what is being studied [24, 58]. In address to the second research question, one way of beginning to operationalize a systems perspective to culture and communication processes is to revisit the foundations of the CD construct reflected in Hofstede’s Figure 1.6 ([24]; p. 43) shown in **Table 2**, where Hofstede illustrates four types of research strategies and their goals (numbered 1–4 in **Table 2**) for studying universal and specific characteristics of culture at different levels of analysis.

Cells 1 and 2 are studies that focus on either similarities or differences among and between groups in societies. These studies are concerned with micro-level variables and their relationship, meant to be measured both within and across different societies. Cell 1 studies try to prove the universality of micro-level laws with a nomothetic-etic orientation [59], whilst Cell 2 studies are more idiographic-emic

where showing the differences among societies also means showing the uniqueness of each [60]. Hofstede argues that studies in Cells 1 and 2 can go across cultures [61, 62] but do not necessarily specify what “culture” stands for, thereby likening it to a “black box”, else stating that it is set against a “culture-free context”. Micro-level group studies can also go across cultures by comparison of the average scores of each group. This he acknowledged is problematic since in the broader sense of research strategy, the variables considered may be too many to be known and too complex to be fully understood. These uncertainties thus contribute to inaccurate measurements and difficulties in operationalizing a research framework that can be applied to practical use.

Cells 3 and 4 are studies that focus on either similarities or differences among societies based on “ecological variables and their relationships” measured at the level of societies. In Cell 3, subsets of cultures are studied in relation to others similar among themselves but differ from other types or subsets [63–65]. Hofstede recognizes Cell 4 studies, as “geocentric” in nature, whereas Cells 2 and 3 are “polycentric” and Cell 1 studies as “ethnocentric”. Cell 4 research strategies would be comprehensive enough to cover various geographical regions, with the assumption that focusing on differences will also highlight similarities between societies/nations and regions.

Still, in this debate is the recognition that studies situated in their own respective Cells are seldom, if ever, provide an adequate overview of the study of cultures per se, where Hofstede deemed it positive to have studies situated across all Cells with the results thereafter compared, where the approach to the study of culture and organization should not just be multidisciplinary but multi-leveled. In his pioneering efforts, Hofstede [24] lends examples to studies situated in all four cells, clearly defining that his own efforts with IBM and the formulation of cultural dimensions as belonging to studies “concerned with determining dimensions of societies and laws at the level of societal variables” ([24]; p. 43).

4. Operationalizing research strategies for the study of culture from a systems perspective

Viewed from an integrated systems perspective, **Table 3** illustrates how studies can be done in each quadrant whilst scholars even when using different approaches to the study of culture and communication processes, would continue to cross-reference the works of colleagues both within and across disciplines to gain broader insights into culture, communication and eco-organization management. The main difference between the research strategies perspective in **Tables 2** and **3** is that studies in Cell 2 in **Table 3** allows for a re-formulating of the current cultural studies framework that take into consideration how culture and communication processes are studied in other disciplines. The resulting framework to the analysis of culture for studies in Cell 2 of **Table 3** can be approached by using both quantitative and qualitative methods.

	<i>Within groups/constellations</i>	<i>Across groups/constellations</i>
Concerned with micro-level variables	1. Determine types of subsets of societies	2. Determine global values, including in virtual spaces
Concerned with macro-level variables	3. Illustrate uniqueness of each group/constellation	4. Determine cultural dimensions of group/constellation

Table 3. *Reworking the framework to research strategies for comparative studies on culture, communication processes and organization at micro and macro levels, within and across national boundaries, in the era of globalization.*

Using the research strategies outlined in **Table 3**, the previous works of other outstanding scholars in the field of cultural studies that began in the 1930s with studies in cultural anthropology in relation to organization [66–70].

To this end, both Hofstede's CD construct and Fang's Yin Yang approach provide a platform toward a larger integral system of studying culture. The CD construct provides neatened frameworks for cultural averages to be studied and the eastern dualism approach provides for an overarching theoretical framework to explain the anomalies within the CD paradigm. Considering current global challenges and an increasing inequality, humans from various regions and parts of the globe will need to increasingly learn to co-exist and co-evolve with the ecological dimension.

5. Reflections, limitations and conclusion

Current research strategies of studying culture and communication processes that bolster dominant economic theories within the field of IB seems inadequate in addressing challenges faced by evolving business environment and global challenges, from the management of the global resources to the management of our ecology. The purpose of this chapter is to contribute to the debate on finding means toward an integrated systems approach in culture theories toward an assimilated co-existence with remaining global resources and ecology where IB and trade makes up a large part of human living and management.

In address to the first research question posed in this chapter, this study works with the assumption that international business and trade are inherent human activities that constitute a large part of living, managing and co-evolving with other global systems. The field of IB can work toward a system-network understanding of culture and communicating across cultures for IB studies by incorporating perspectives of culture and communication processes as studied in the fields of social-biology, quantum theoretical physics and psychology.

In address to the second research question, operationalizing a systems perspective to culture and communicating across cultures, would require a revisit of current research strategies of culture in studies as applied to the field of IB and organization management. It is the Gravesian perspective of the evolution of human psychological maturity (that extends to groups, companies and societies) and levels of existence set within the context of the fundamental theoretical points of quantum physics—Heisenberg's uncertainty principle and Bohr's "phenomenon"—that can help define a concept of culture and manners of communication that go across geographical boundaries. The triangulation of theoretical perspectives from these different fields enables an explanation where perspective and point of observation is important in defining the radius of culture and communication strategies. Both Individual and Group are dialectically related in defining group culture and their communication processes, where one would not exist without the other.

Addressing global challenges from rapid climate change, biodiversity loss and rising social inequality in a context of uncertainty and changing business environments lend increasing pressure to understand and study culture and human-ecology communication processes from a systems perspective. Understanding cultural values across geographical boundaries and what we today would call a miscommunication between cultures due to cultural friction could be re-perspectivized as differences in levels of socio-cognitive and ecological maturity development, rather than as differences in national cultures and identities. There is after all, only one globe in which we are all a part.

Author details

Cheryl Marie Cordeiro
The Norwegian Institute of Food, Fisheries and Aquaculture Research (NOFIMA),
Tromsø, Norway

*Address all correspondence to: cheryl.cordeiro@nofima.no

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Section 4

Communication and Society

Scholarly Communication and the Academic Library: Perceptions and Recent Developments

Liat Klain-Gabbay and Snunith Shoham

Abstract

This chapter focuses on the role that academic libraries play in the process of scholarly communication and presents a mixed-methods study to investigate (a) how faculty members perceive the involvement of academic librarians in scholarly communication and (b) how academic librarians perceive their own abilities to be involved in this process. The research population included faculty members from the faculties of humanities and social sciences in three Israeli academic institutions and academic librarians working in the libraries affiliated with these faculties. Interviews regarding the role of academic librarians in scholarly communication indicated wide gaps between faculty members and academic librarians and between individual members of each group, while questionnaires showed that a similar percentage of librarians and faculty members believe that academic librarians are potentially capable of being involved in this process. However, when asked whether the academic librarians should be involved in scholarly communication, only 36% of the librarians answered positively, as compared with 55% of the faculty members. These gaps highlight the need for change in academic libraries, as librarians should possess adequate technological skills, broad general knowledge, and an understanding of how to reorganize the library work so as to accommodate collaborations with faculty members.

Keywords: scholarly communication, science communication, academic library, academic librarians, faculty members

1. Introduction

1.1 Human communication

Communication enables interpersonal transfer of messages and ideas and is a basic component of human interactions. Of all manifestations of human communication—e.g., facial expressions, body gestures, signs, or drawings—language appears to be the most complex, as it enables people to express complex ideas using a very wide range of words, subjects, and expressions, constructed into elaborate sentences. While researchers believe that language, or at least the ability to express thoughts by using words as means of communication, expression, and survival, is around 150–200 thousand of years old [1], it has evolved considerably with time, human biological and technological development, and changes in the human way of living, such that new words and expressions have been shaped to express ideas vis-à-vis life in the modern world.

Humans interact with each other whether they intend to or not; they interact with others at will, but they are also obliged to communicate non-voluntarily as part of society and of the world in which they live. As the communication, relationships, and activity of humans are affected by their thoughts, perceptions, motivations, life experiences, and biology, their actions are sometimes voluntary and are affected by thoughts and decisions. At other times, however, human actions are automatic—affected by biological elements that make one behave in a particular way in response to a certain event or constraint [2, 3]. Sherry and Bowman [4] defined communication as an interaction between two brains, thus highlighting the physical, mental, and interactive components of communication between people. They emphasized three types of traditional communication: interpersonal communication, human-media communication (i.e., communication between people made by using media), and mass communication (i.e., from media to people).

Human communication has evolved from the spoken language to the written language, which, since ancient times, has enabled not only breaking the limits of memory but also the storage of information, the preservation of knowledge, and the transfer of documents from one place to another. Writing is considered a technology, as it employs materials and means outside the human body. The invention of the printing press in the fifteenth century, which was defined as the first mass revolution, enabled the distribution of knowledge to the masses in unprecedented speed and scope, gave easier access to information, and improved the ability to preserve knowledge and use accumulated knowledge. The printing press had various impacts on society, including the emergence of intellectual foci, the spread of literacy, the democratization of certain societies, the proliferation of literature, art, and science, and the freedom of speech. In addition to printing books, the printing revolution also enabled the development of new formats, including announcements, letters, state orders, and others, and, by the seventeenth century, the publication of newspapers and scientific journals. Mass media, which enabled, for the first time in history, the transfer of information to the masses in real time and the exposure of information and interpretations, served as a democratic tool that allowed diverse voices, opinions, and contents to be heard by the public.

The means enabling human communication has developed greatly with the development of new technologies. The telegraph and the telephone (in the nineteenth century), and, later, the fax machine, enabled a rapid transfer of information and established connections between individual people, including scholars. During the twentieth century, other means of mass communication emerged, including cinema, radio, and television, which all facilitated the distribution of knowledge, news, art, and ideas to millions of people worldwide. Today, the development of the computer—in particular, of personal computers—together with the development of the Internet, allows us not only to talk with each other but also to rapidly transfer data, files, and articles, thus facilitating research collaborations between employees of international companies and between scholars who are geographically distant from one another. The latest revolution is the emergence of social networks; this is the newest and most advanced step in the development of communication means, which, for the first time, enables each person to produce knowledge and distribute it throughout the world; this is a distribution from the masses to the masses, which facilitates the formation of new communities—sometimes of enormous scale—without the traditional barriers of physical location. Network-mediated communication (chats) enables personal, business, and scientific communication between people, thus promoting ideas and shared activities, such as political actions or even the formation of social/political demonstrations. Lang [2] lists the types of communication as follow: human-computer interaction, human-media interaction, social media, message processing, digital gaming, virtual realities, and all the types of human communication not listed here or not yet invented.

1.2 Scholarly communication

The study hereby presented regards scholarly communication as a unique type of communication, mostly between academics, that is used to establish connections between individual scholars and international research groups with shared fields of interest and research. Such communication yields research publications in journals and conference proceedings, and it enables the exchange of opinions, positions, and information regarding conferences. Scholarly communication can be seen as the connection among scholars, which increases the awareness of one scholar to the work and ideas of another; indeed, scholarly communication has always been considered a fundamental aspect of scholarly and scientific research [5]. The scholarly communication system is the primary driver of the culture that shapes research practice within the academic sphere; after all, claims Hill [6], “the insights from research are of little, if any, value until they are shared” (p. 366).

Scholarly communication can be verbal, concrete, virtual, formal, or informal and includes the traditional elements of interpersonal communication and communication through media. Today, scholarly communication is more complex and sophisticated than in the past and employs diverse online means. Scholarly communication can be understood as the system through which research and other scholarly writings are created, evaluated for quality, disseminated to the scholarly community, and preserved for future use, and it promotes a shared system of research and scholarship [7]. Scientific publications play a central role in systematically documenting research findings and facilitating the exchange of information between researchers. In academia, articles that receive more attention from other scholars, in terms of citations, are generally considered more important and prestigious [8]. Publishing research outcomes is a central aspect of scholarly communication, and technological advancements have considerably changed how these outcomes are published; the formal scientific scholarly communication system, which originated in the seventeenth century, has evolved through the centuries, creating an authority structure in the form of journal publications, which still remains the preferred venues for sharing scientific research findings [9].

Today’s scientific communication workflows are based on the availability of Internet connection and devices, which make drafting, publishing, and accessing scientific publications in digital form the norm for the average scientists [10]. Thus, publishing in the digital era includes, in principle, any product (publications, datasets, experiments, software, websites, blogs, etc.), which is the result of a research activity that is relevant to the interpretation, evaluation, and reuse of the activity or part of it [10]. Almost all journal titles are available today in a digital format—over 96% in science, technology, and engineering subjects and over 86% in arts, humanities, and social science subjects [11].

In addition, and in its broader sense, scholarly communication refers to both the formal and informal connections among scholars and disciplines [12]. According to Menzel [13], scholarly communication has seven different roles in research: (1) providing answers to specific questions, (2) keeping scientists up to date regarding the recent developments in their fields, (3) helping scientists understand new fields, (4) verifying the reliability of information sources by additional testimony, (5) helping scientists understand the major trends in their fields, (6) providing scientists with feedback on their own work and its relative importance within the research field, and (7) redirecting or broadening the span of interest and attention of scientists. Importantly, in the digital era, research articles can be considered not only as representations or manifestations of knowledge but also as social objects that scholars share, cite, and discuss and which enable them to cross the boundaries of time, place, and discipline, interact and establish social connections with other scholars (e.g., through social and research

networks), share information, and evaluate their own reputations [14]. Moreover, new initiatives continually arise to construct the means by which to store the documentation of research, including the experiments and methodologies while the research is still ongoing. The objective is to offer researchers all the elements to repeat (“same experiment, same lab”), replicate (“same experiment, different lab”), reproduce (“same experiment, different configuration”), or reuse (“include part of the experiment into another experiment”) the experiment. Finally, information and communication technology (ICT) services offer scientists tools by which to create and share alternative forms of research products, which are not generally intended as valuable for publishing (p. 2) [10].

Assante and colleagues [10] present a holistic view of the act of publishing, claiming that the emergence of ICT facilities has enabled the establishment of modern scientific communication workflows in which scholars can easily publish their research outcomes (literature, datasets, experiments, etc.); breaking the reign of the paper paradigm is necessary for better representation and understanding of how scholarly results come into existence [15]. In addition, in recent decades, a new route of publication has emerged: the preprint. The first preprint server, arXiv, was initiated in 1991 and has become an established part of the publishing landscape in physics, computer science, and mathematics, hosting 1 million articles by the end of 2014 [16]. Preprint servers allow researchers to publish manuscripts that have been submitted for publication prior to peer review, thus providing a route for the rapid dissemination of findings. Equivalent facilities have been created for biology (bioRxiv) and the social sciences (the Social Science Research Archive, SSRN, and following the acquisition of SSRN by Elsevier, SocAr-Xiv). Further innovation has developed around the idea of preprint servers, with journals, such as F1000 Research, in which all articles are published in a preprint form prior to peer review [6]. The digital format has also reached the field of monographies, and, today, more books are being published electronically; in many instances, such digital publishing occurs in parallel to print publishing, but this situation is also bound to change in the future.

The field of publishing has also been drastically changed with the development of open access (OA) and institutional archives. OA literature is “digital, online, free of charge, and free of most copyright and licensing restrictions. What makes it possible is the Internet and the consent of the author or copyright-holder. OA is entirely compatible with peer review, and all the major OA initiatives for scientific and scholarly literature insist on its importance” (Suber, 2004c in [17]; p. 112). In other words, publishing in OA enables other researchers and academics direct access to academic and scientific journals, books, theses and dissertations, and multimedia materials. The researcher must sign an agreement for his/her article to be published in OA, which will be available to the public according to the criteria set by the publisher. OA is a platform of research journals that employs a pricing framework that is different from that of traditional journals (which require the academic libraries to purchase a subscription). The goal of OA publication is to change, at least partially, the current situation, wherein researchers must publish in journals governed by the most prominent publishers controlling the market and academic libraries and are required to pay increasingly higher fees to purchase subscriptions to databases and scientific journals that these publishers provide [18]. Another development in the field of OA is the emergence of mega-journals [19], which are OA journals that, by reason of being digital, contain a vast number of articles. Other characteristics of mega-journals are their broad disciplinary scope and their peer-review criteria, which are based specifically on the soundness of the research, as well as the basic criterion of OA that is typically based on a business model of prepublication article-processing charges (APCs) [20]. Lăzăroiu [21] claims (p. 1047) that mega-journals have swiftly advanced into the mainstream of academic communication and may

essentially alter the manner in which novel research is disseminated. Therefore, the emergence of mega-journals, in practice, changes the extreme field-specificity of journals, which has been evident over the past few decades.

In contrast to scientific journals, institutional archives are not concerned with the publication of research but, rather, with safekeeping existing publications and enabling users to access these publications. The institutional archive is an electronic reservoir of research publications written by the faculty of an academic institute, which is accessible to researchers and academic scholars and is maintained by the institute. As such, the institutional archive reflects the scholarly activity in the institute, enabling access to theses and dissertations, research reports, books, multimedia material, articles in electronic journals, technical reports, lectures in conferences, and even studies conducted within the institute and which have either not yet been published or will not be published (e.g., works of bachelor degree students) [22]. To enable such an endeavor, the institutional archive concentrates on publications by researchers of the institute, such that they are made easily accessible to the users.

Recently, in addition to the OA publishing movement, a new requirement has been raised, that for “Open Data,” which will revolutionize the way science is documented [9]. Data sharing maximizes the value and use of data by promoting follow-up research and facilitates the combination of data from multiple sources and locations. Traditionally, to support their research claims, scientists have shared research data as tables, graphs, and summaries in their publications; with advances in computer and communication technologies, data can be collected, stored, archived, disseminated, retrieved, and analyzed in ways that are much easier and faster than before. As data are considered the foundation of science, data sharing is gaining momentum.

The continuous advancement in information technologies has considerably expanded scholarly communication, not only by facilitating the preservation, organization, and distribution of information [12] but also by supplementing the traditional means of formal and informal scholarly communications with newer means of communication. Indeed, modern information technologies enable scholars to readily use e-mails and electronic databases, distribute information regarding new conferences, journals, and publications through the Internet, and participate, either as individuals or as scholarly groups, in professional virtual communities that employ Internet-based chats, forum discussions, blogs, and other online communication tools that expand their professional networks [8]. Moreover, some scholars use not only academic social network platforms (such as ResearchGate, Academia.edu, or Mendeley) but also a variety of social media, such as Twitter, Facebook, Flickr, YouTube, Dropbox, blogs, and podcasts for scholarly communication [23]. These social media tools have expanded the possibilities of informal communication. Social networks and tools, such as Facebook or Twitter, have increased the number of connections and the diffusion of scholarly information. For instance, discussing academic conferences and articles through interactive, wide-ranging, and cross-disciplinary conversations in Twitter was found to reflect the academic impact of these conferences and articles, and being cited or mentioned on Twitter could be a new sign of one’s academic impact [8]. Lee and colleagues [24] explain that, in the context of scholarly conferences, Twitter is the most convenient social medium to spread information and communicate between conference participants. Indeed, social media tools, such as Twitter, have become prominent tools for scholarly activities and communications, and many scholars have shed new light on Twitter as a useful means of informal scholarly communication [25, 26]. Noorden (2014, cited in [24]) suggests that although Twitter is used regularly by only 13% of researchers (according to a survey by Nature), it is much more active and social than other media; researchers often use Twitter to follow discussions on research-related issues, and 40% of them testified that Twitter had become both a public and a private

medium for “commenting on research that is relevant to my field” (as compared with 15% on ResearchGate.net) (p. 127). Facebook, by contrast, is not widely used as a professional network, and Academia.edu and ResearchGate.net are typically used as a means to contact other researchers. Lupton (2014, cited in [27]) identified Twitter, LinkedIn, Academia.edu, Facebook, ResearchGate, blogs, and YouTube as the most popular services used in the context of academic work. These media have facilitated scholarly communication that is easy, rapid, and global [12], and they have transformed the process from private communication between individuals into a branched, developed, cooperative, and group-oriented form of communication [28]. Abrizah et al. [29] claim that the move to digital scholarship, amplified by the use of social media and OA, may have served to break down the social and cultural barriers that prevent academics from peripheral countries to take their rightful place in the international research community.

1.3 Scholarly communication and the academic library

The main outcomes of formal scholarly communication are printed or electronic publications. The number of such publications has been continuously increasing and, in the past three decades, commercial publishers—rather than universities—have taken control over the process of scholarly communication. Today, following several mergers between journal publishers, major sectors in the market of academic journals (particularly in the fields of sciences and medicine) are dominated by only a few large corporations. Together with a sharp increase in the price of journals, these mergers yielded new pricing mechanisms that negatively affect the buying power of libraries [30]. Moreover, to meet the demands of the changing technologies and user expectations, contemporary academic libraries must develop new resources and service areas; however, the high cost of digital information items currently prevents them from achieving this goal, and they cannot adequately provide access to the wide range of knowledge available in the digital space [31]. Changes in library activities aimed at creating an atmosphere of mutuality and shared action to facilitate scholarly communication pose a significant challenge for academic libraries.

It is important to note that the content and rights of the scholarly research that faculty members conduct belong to the publishers, who then sell access to this content, at exaggerated rates, back to the academic libraries [32]. Thus, constructing and maintaining additional open education resources (beyond subscription content) are a crucial need for contemporary academic libraries [33], as it could enable librarians to mediate between the researchers, who conducted the research, and the users of the resulting information (e.g., other researchers) [34]. Some academic libraries today have already begun collecting online campus-created content and making it freely available in institutional repositories—a trend that is promoted mainly by campus librarians in an attempt to reduce costs and better serve their community of users. The ongoing developments in information technology also facilitate this process, as they allow the academic community to publish research independently of commercial publishers, thereby increasing the demand for free and open access to scientific publications [30]. By overcoming physical, linguistic, geographical, and other obstacles, current Internet-based information technologies allow researchers to communicate with colleagues across the globe, publish their scholarly work online, and locate other researchers working in the same field—actions that facilitate the establishment of international scholarly communities that cross the boundaries of academic institutions and nations [35]. Concomitantly with these developments, and in striking contrast with traditional publishing norms, some scholars and librarians today have undertaken to develop models that allow OA to research materials; such models turn the library into a mediator between

researchers and publications and thus increase the power of the library and its involvement in scholarly communication [36]. As a result, one of the new assignments of librarians is adding OA resources to the library catalog [37].

As more universities incorporate new technologies into the teaching and learning processes, the demand is increasing for technological and instructional support for faculty and students to extend beyond being facilitators, brokers, and guardians and to promote changes that would benefit the whole research community [38]. This demand creates new and attractive opportunities for academic librarians. For instance, in 2014, more than half of the employment positions advertised by the Association of Research Libraries (ARL) in the United States and Canada were for either newly created or significantly redefined roles [39]. In addition to the creation of new roles in traditional library areas, a trend is emerging in which functional specialists with a strong digital or technological background are hired. Indeed, as modern academic libraries must fulfill new and more specialized capacities, institutions should be sufficiently flexible to adapt to these new roles [39].

How can librarians contribute to scholarly communication? Several fields of contribution have been identified [40, 41]: (1) informing researchers of the various models of OA and helping them make their research more accessible to others; (2) assisting researchers with issues regarding copyrights (e.g., teaching them about fair use and copyrighting materials) and publisher agreements; (3) assisting researchers with their actual research, e.g., in evaluating the materials that they use and locating research grants, budgets, and support; (4) educating and informing faculty, graduate students, and campus administrators about scholarly communication issues; (5) advocating for sustainable models of scholarly communication; (6) working closely with faculty members to understand their changing workflows and patterns of scholarly communication; and (7) assisting in the development of tools and services to facilitate scholarly communication. Significantly, although academic libraries are already involved in some aspects of scholarly communication (e.g., when they purchase scientific publications and databases), librarians often lack an adequate understanding of how research is conducted in a digital setting, are unaware of the importance of developing skills for working with advanced technologies and digital materials [28], and do not fully understand the information needs of faculty members; on the other hand, faculty members appear to be unaware of the entire physical and electronic capabilities of the library [42–46]. To more effectively utilize the skills of liaison librarians, faculty members need to better understand their roles, e.g., through in-person meetings with the academic librarians in their institutes, which may facilitate a more receptive and close communication [47].

To fulfill their role and effectively support researchers, academic librarians need to be aware of the information needs and search behavior of researchers in various fields [48], requiring them to be flexible and collaborate with different workgroups. Already today, reference librarians (also designated as subject specialists [49] or subject librarians [50]) in some academic libraries collaborate directly with faculty members, both in scholarly communication processes and in research processes. It has been suggested that modern academic libraries should become hybrid libraries, which both house collections and supply information technology [50]. Faculty members who incorporate media-based assignments into their courses rely more on librarians to help students learn media-production skills, and universities increasingly expect librarians to undertake more responsibilities in programmatic and teaching contexts; however, some evidence indicate that librarians may lack the pedagogical background to design and facilitate a sustainable course [39]. Such changes in roles and perceptions have affected the discourse among librarians, leading, for instance, to discussions about the possible need to introduce changes

into the curricula of Library and Information Science (LIS) master's programs and to educate active librarians about collaboration with faculty members [51].

In its Scholarly Communication Toolkit, the Association for College and Research Libraries (ACRL) recommends several actions for librarians to integrate scholarly communication into the library [7]. Among others, the Toolkit suggests partnering with academic departments to host public events to proactively inform faculty, students, and university administrators of the latest development of key scholarly communication topics; identifying allies among faculty and students and collaborating with them to create and adopt an OA policy at the institution; promoting the benefits of using and creating open educational resources; collaborating with the graduate school and similar programs concerned with scholarly authorship, publication, and research data management; hosting workshops; and collaborating with library schools to train future information professionals [7]. Important agents in obtaining these aims and reaching out to faculty are subject librarians, who are typically more aware of research and publications coming from their faculty and who can thus alert the repository librarian to any relevant research output [37].

In the pre-digital era, the traditional roles and tasks of librarians—acquiring resources, cataloging, organizing, serving library users, etc.—were performed without the involvement of the users, who passively received what the librarians offered. The emergence of new technologies, such as e-books, e-journals, and other electronic information resources, has dramatically enriched the library collections and services and has both extended and complicated the roles of the librarians and the library users; the relationship between the two has, therefore, changed, such that the users have become more independent in choosing and using the library services. Today, users can access online library-supplied databases at the convenience of their own time and place, register to receive relevant e-mail notifications, and provide feedback on the usability of library websites. Thus, library services have become more flexible [52].

In a content analysis of 63 publicly available strategic plans of the institutions involved in ACRL's Value of Academic Libraries National Summits, Saunders [31] examined the stated goals of academic libraries to discover how they cope with the emerging changes relative to their traditional strategic plans. She concluded that librarians should take additional actions, beyond their traditional roles, to better accommodate the needs and requirements of modern library users and that changes in scholarly communication are forcing librarians to shift their mental models and alter their services.

How should resources be prioritized and allocated? Such decisions should be made in collaboration with each library's parent institution, as colleges and universities face their own pressures, driven by increasing demands from stakeholders to hold themselves accountable and demonstrate how programs and services support and extend the mission and goals of the institution. In this environment, academic libraries monitor trends in LIS (and in higher education, in general) to determine where to focus their resources and efforts. A Horizon Project report [39] suggests that academic libraries will continue to be impacted by changing technologies, including mobile devices, OA, the Internet of Things, the Semantic Web, and linked data.

The recent changes in the academic publications industry—including the multiplicity of journals, the sharp increase in their prices, the changes induced by the opening of collections, and the ever-expanding research needs—affect scholarly communication and, accordingly, alter the demands made of librarians, their job descriptions, and their involvement in academic issues [53]. Today, faculty members appear to prefer direct methods of information searching over using the library: scholarly communication is typically conducted among the researchers themselves, while the academic libraries are still not considered to be central participants in this process (although they purchase materials and access technologies for the

researchers). It is important to note that the attitudes of faculty members toward the academic librarians vary and depend upon various factors, including the field of research, relationship with librarians, awareness of the capabilities and the services provided by librarians, and assessment of the ability of librarians to assist them. Because faculty members are the relatively permanent population of an academic institution, they are stakeholders in the library, and their perception of the librarians can influence the library in many ways. Therefore, it is important for librarians to be continually aware of and to appropriately adjust and attend to the changing needs of faculty members [54].

Some of the changes in the role of academic librarians, as discussed above, already manifest in breakthrough libraries. For instance, some libraries have begun appointing librarians specializing in assisting in the process of scholarly communication with the faculty in their institutes, e.g., in the Oregon State University library, a librarian for research and scholarly communication was nominated in 2016 [55] and some voices have already been heard that indicate the need for the library community to increase investment in common open infrastructure and open publications. For example, in a much-echoed publication, Lewis [56] calls for the “2.5% commitment initiative”, i.e., to allocate 2.5% of the budget of American academic libraries toward an open common infrastructure, that is, projects that provide software or services that support open scholarship.

2. Perceptions of scholarly communication in the academic library

2.1 Problem statement

Like other forms of communication, scholarly communication—in both its formal and informal form—has changed dramatically in recent years and is expected to continue changing with the development of novel technologies. While academic librarians may potentially contribute to scholarly communication in the digital era, it is still unclear to what extent the faculty members and the academic librarians themselves understand and materialize this potential. It was shown that faculty members are receptive to collaborations with librarians and that liaison visits to the faculty increase the extent to which faculty members use the library’s resources and services, making them more aware of the convergence between what they need as teachers and researchers and what the library can offer [57]. Currently lacking, however, are qualitative and quantitative data that describe how faculty members and librarians in today’s academic institutions perceive the function of academic librarians and their integration into the process of scholarly communication. Understanding this reciprocal relationship may highlight gaps in the perceptions of faculty and librarians regarding scholarly communication; as “basic perception–action links are crucial building blocks for social understanding and social interaction” (p. 103 in [58]), understanding these perception gaps is an important step toward strengthening the collaboration between faculty members and academic librarians.

2.1.1 Research questions

1. How do faculty members perceive the involvement of academic librarians in scholarly communication?
2. How do academic librarians perceive their own abilities to be involved in scholarly communication?

2.2 Methodology

2.2.1 Research methods

This integrated, mixed-methods study integrated both qualitative and quantitative approaches to provide a better understanding of the situation by using a wide range of data collection tools [59]. In the first stage of this study, interviews were conducted to enable an in-depth analysis of librarians' and faculty members' perceptions. Based on the collected data, a questionnaire was subsequently formed to analyze the prevalence of various perceptions.

The research population comprised two groups: (a) faculty members (lecturers, senior lecturers, and professors) who teach and conduct research in the faculties of humanities and social sciences in three Israeli academic institutions and (b) academic librarians working in the libraries affiliated with these faculties and institutions. The interviews were based on a convenience sample of 20 faculty members and 15 academic librarians (selected by the snowball sampling technique), while the questionnaires were distributed to all participants.

2.2.2 The study sample

Faculty members. From an initial population of 619 faculty members, 191 (30.85%) agreed to participate in the study, of which 56.5% ($n = 108$) were men and 43.5% ($n = 83$) were women. The duration of employment of participants at their current academic institution ranged from 1 to 43 years ($M = 13.44$ years, $SD = 10.36$ years).

Academic librarians. From an initial population of 80 librarians, 50 (62.5%) agreed to participate in this study, of which 6% ($n = 3$) were men and 94% ($n = 47$) were women. The librarians in the sample worked in libraries of various types, including departmental, faculty, and central libraries, and their seniority at the institution ranged from 3 to 40 years ($M = 18.64$ years, $SD = 11.23$ years).

2.2.3 Data collection techniques

2.2.3.1 In-depth, semi-structured interviews

All interviews reported here were conducted during the 2012–2013 academic year. The interviews were flexible and allowed the interviewer to ask the prepared questions and to develop the conversation based on the answers of the participant [60]. Developed according to the model of Patton [61], the interview questionnaire related to six issues: experience and behavior, opinions and values, feelings, knowledge, sensory perception, and demography. More specifically, the interviews with faculty members included seven demographic questions and seven content questions (each comprising several sub-questions) and assessed the attitude of the participant toward the involvement of academic librarians in the process of scholarly communication, OA, and institutional archives. The interviews with academic librarians included five demographic questions and six content questions (with some sub-questions) and assessed the perceptions of the academic librarian toward scholarly communication, OA, and the degree to which the librarian is involved in these functions.

2.2.3.2 Questionnaires

Structured questionnaires with closed, multiple-choice questions were used to obtain relevant quantitative data, focusing on all participants as a single group [62].

The same questions, in the same order, were presented to all participants, and the purpose of the research was not concealed [63]. Pretest questionnaires were initially sent to five faculty members and five academic librarians, but they did not recommend any significant modifications.

The questionnaire for academic librarians included demographic questions, questions relating to their awareness of the scholarly communication process, and questions regarding their view toward the involvement of the library in scholarly communication and toward OA to research materials.

Similarly, the questionnaire for faculty members included demographic questions, questions relating to the perception of the faculty member of the degree to which academic librarians are aware of the process of scholarly communication, and questions regarding their view toward the involvement of the library in scholarly communication and toward OA to research materials.

2.3 Findings

2.3.1 Perceptions of faculty members

2.3.1.1 Positive perceptions of cooperation

The interviews revealed marked variability in the perceptions of faculty members regarding the involvement of academic librarians in scholarly communication: some interviewees indicated that such an involvement should be part of the duties of the academic librarian, some did not find a connection between the librarian and the process of scholarly communication, and some felt that librarians can have a limited role in this process.

One senior researcher defined scholarly communication as follows:

Scholarly communication is the possibility of transmitting information and knowledge between people in the context of problems and their solutions in fields of human thought. This is a broad definition but these communications are supposed to be conducted on an intellectual level between academic researchers ... digital systems, Internet forums, virtual communities, topical communities. The wealth of possibilities for transmitting information changes and influences the traditional library, but it should not be forgotten that the library remains important as an archive of information, and that the people working in the library have an equally central role ... The librarians have some level of awareness, they need a lot more training. (Interviewee 4)

This participant also made an interesting proposal regarding the involvement of librarians in scholarly communication that could potentially promote the position of the librarian as a partner in communication on campus:

I mean that one possible future development in the global world may be a library that offers international services ... This would be a new profession, a significant change in function. This is the future of librarianship as I see it. (Interviewee 4)

A senior lecturer in one university explained how librarians could better collaborate with faculty members and be more involved in scholarly communication:

They should be more involved in the use and utilization of technologies that would enable them to communicate with their clients, students and faculty members. Work in the library needs to be divided such that each person is responsible for a certain field. That person can then participate in social networks of scholars in the

field. In addition, he or she can update faculty members in the field, which I would call "pushing information." (Interviewee 13)

2.3.1.2 Negative perceptions of cooperation

In contrast to the opinions presented above, other faculty members explained that, although they appreciate the library staff, they cannot see a role for librarians in scholarly communication:

I do not think it is the job of the library to be involved in scholarly communication. We receive publications from professional groups. I do not see the library as a tool for transmitting information about things like this. (Interviewee 2)

In the field where I work, there are international communities ... The community communicates and has systems for distributing information. It is virtual, but there are also several conferences each year. I receive information from annual conferences, not from the library. The library is already involved in purchasing journals and other materials ... The scientific world is full of research fields and sub-fields and it is impossible to expect a librarian to specialize in them. (Interviewee 5)

The job of librarians is to make information accessible; they are mediators in this field ... I do not think that librarians think in terms of scholarly communication, they think in the direction of developing the collection ... Beyond this, I do not think that they need to be involved in other aspects. (Interviewee 20)

2.3.1.3 Thoughts about involvement

Some faculty members indicated that they had not previously thought about the issue of involving librarians in scholarly communication, but they offered various suggestions and assumptions during the interviews.

For instance, one senior researcher proposed a different idea for the involvement of librarians in scholarly communication:

Perhaps it would be possible to develop library activities that would move the academic library closer to the schools, for example, developing forums to which the library would invite both well-known and other lecturers. It would be possible to hold a monthly meeting on innovations, publications by major authors ... Various activities to bring them closer. Despite the fact that, practically speaking, this would be difficult... (Interviewee 5)

Another suggestion was raised by a university lecturer who initially presented negative opinions regarding the involvement of librarians in scholarly communication:

The librarian could be involved for example, in providing information about conferences, new databases, calls for lectures at conferences, etc. Definitely yes! You have no idea how many conferences I have missed because of a call for papers ... There should be an ongoing communication between researchers and librarians, and then the librarian would better know the researchers, their fields of research, and will be more aware of developments... (Interviewee 8)

2.3.2 Perceptions of librarians

Some librarians explained that they had heard of the term scholarly communication before, but they were unable to explain its meaning. In the questionnaire, the librarians were asked to define scholarly communication by agreeing or disagreeing with six possible statements, as shown in **Figure 1**.

The most prevalent definitions of scholarly communication were the generally accepted definitions, namely, “cooperation between researchers,” “information transmitted at conferences,” and “membership in research networks” (46%). However, only 22% regarded the connection between the faculty and the academic library to be part of the scholarly communication process, whereas approximately 80% did not include a clear role for the librarian in this process.

In the interviews, after the interviewer adequately defined scholarly communication, opinions varied regarding the possible role of librarians in the process, although most librarians agreed that they can perhaps be more involved in it.

2.3.2.1 Positive attitudes toward involvement

Some librarians indicated that various library activities could be considered as scholarly communication—and were generally positive about being involved in the process—but they emphasized that such an involvement is mainly in teaching and not in research. The degree to which librarians were aware of and willing to participate in scholarly communication processes varied even between librarians from the same institution.

One university faculty librarian said:

The librarians work on a high level and are aware of the needs, but this relates mostly to needs of teaching and not to needs of research ... Regarding research, the one-on-one service of individual reference librarians could be better integrated into the world of research. (Interviewee 6)

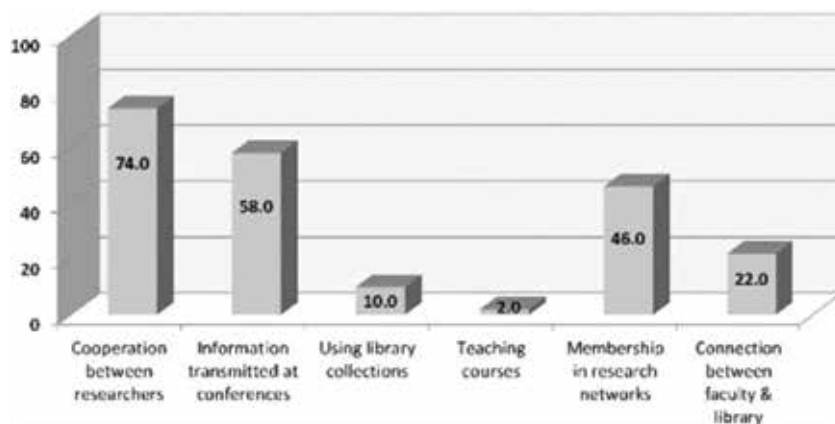


Figure 1. Percentage of academic librarians agreeing with different definitions of scholarly communication.

Some librarians detailed the constraints that make their involvement in scholarly communication difficult. For instance, the director of a faculty library at one university explained:

If I examine the situation truly, few librarians in the library are really partners in research. The ones who have more exposure to research either work in the reference department or are research students themselves. Some of the reference librarians working in specific fields have an interest in that field, but others do not. (Interviewee 9)

The director of a departmental university library explained that librarians cannot initiate such a process on their own without cooperation and recognition from the academic side. She felt that, at present, such recognition and support are lacking.

I think this must come from the department. I mean, if they were to send us to various conferences and seminars, and fund these for us, then I think we would be able to be more involved in this process Faculty members understand how I can help them on a technical level but do not sufficiently value my ability to assist them in collaboration and research. (Interviewee 11)

The director of another departmental university library explained that departmental libraries cannot accommodate scholarly communication activities because they are physically smaller, employ fewer librarians, and receive less funding than larger libraries:

I do think that it is desirable for librarians to be involved, but it is appropriate for large libraries that have larger personnel, here it would be really problematic. Small libraries, on one hand, employ professional people who understand the narrow field and it could be easier for them to be involved in this ... On the other hand, small libraries have a serious problem of personnel, which does not make it possible. (Interviewee 15)

2.3.2.2 Negative attitudes toward involvement

One librarian in a departmental library at a university said:

Regarding librarians' involvement, if the faculty members ask, we will help them, but from our perspective, it does not seem to me that we would approach them and offer any kind of further involvement. (Interviewee 7)

This view, shared by many librarians, hinders the development of a fruitful collaboration between the librarians and faculty. Indeed, it seems that increasing the awareness of librarians regarding their ability to be involved in scholarly communication, the importance of such an involvement, and the (formal and informal) connections between faculty members could further develop this collaboration.

Some librarians remained negative about being involved in scholarly communication even when the interviewer explained which scholarly communication-related activities librarians could be involved in:

None of this activity happens here. I think that today's librarians do have the technological abilities and education, but I really do not know if anyone here does anything like this. Regarding the future — might it be necessary to develop teams to work with faculty members? I have never thought about that... (Interviewee 7)

To summarize, the interviews with faculty members and academic librarians highlighted considerable gaps—both between and within the two groups—regarding the involvement of librarians in the process of scholarly communication. Regardless of the institution with which the interviewees were affiliated, high interindividual

variability was observed, and perceptions varied from the view that librarians should be much more involved in the process of scholarly communication to the view that they have no place in it. Notwithstanding, the interviews also revealed how librarians could improve collaboration with faculty members and promote the image of the library in the eyes of the faculty, e.g., by developing subject skills, increasing their involvement in academic conferences, and establishing better connections with faculty members while acknowledging the importance of such connections.

In the questionnaire distributed to the librarians and faculty members, the participants were asked to either agree or disagree with the two following statements: “librarians are capable of being involved in scholarly communication processes (with capability being defined as having the suitable education and technological abilities)” and “the library should be involved in these communication processes” (Figure 2). The fraction of participants who agreed with the first sentence was similarly low (~28%) in both groups. However, the fraction of participants who agreed with the second sentence was considerably higher among the faculty members than among the librarians (56 versus 36%, respectively).

2.4 Discussion

The perceptions of faculty members regarding the involvement of academic librarians in scholarly communication-related processes varied considerably. While some faculty members were positive about such an involvement, others perceived scholarly communication to be beyond the scope of the librarian’s job and stressed the variability between the numerous research fields, which would hinder librarians from providing substantial research assistance. Several issues can explain the individual differences between faculty members, including their perceptions of the complexity of their research fields, their feelings about sharing their research with others, their relationships with the librarians in their institutions, and their expectations and perceptions of the ability of these librarians to provide assistance. On the other side, librarians claimed that they do not even know how to define scholarly communication and do not understand what their role could be in this process. Others claimed that the library is already involved to a sufficient extent. Still others stated that the library should be more involved in scholarly communication and claimed that the library in which they work acts to increase such an involvement. The librarians seem to be more passive in their perceptions and activities, although they raise two important issues: the lack of cooperation with faculty members and the lack of knowledge required to be involved more actively in scholarly communication-related processes.

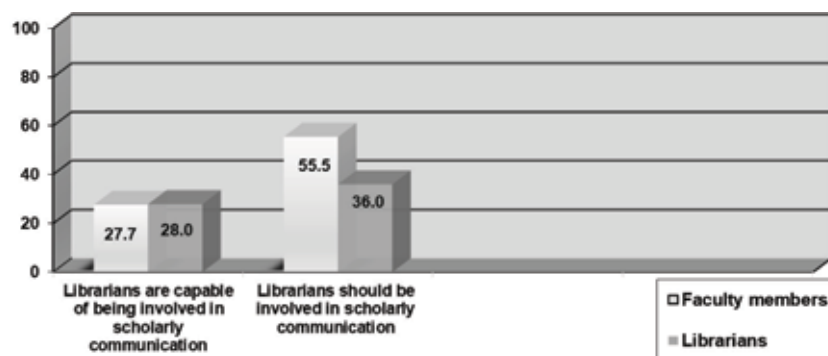


Figure 2. Percentage of faculty members and academic librarians agreeing with two different statements describing the involvement of the academic library in scholarly communication.

The quantitative data obtained by the questionnaires revealed that the percentage of librarians and faculty members who think that librarians are capable of being involved in the process of scholarly communication is similar—but relatively small. In contrast, more faculty members than librarians appear to think that the library should be involved in scholarly communication, highlighting the perceptual gap between the two groups. Some faculty members stated that they do not need librarians to help them in scholarly communication, and it can be expected that these participants would not see a place for librarians in the process of scholarly communication. A more passive approach was conveyed by the librarians, who appeared to be uninterested in assisting researchers with scholarly communication processes or did not perceive such assistance to be part of their job definition. It is possible that these librarians hold a traditional approach toward the role of the academic library or that they believe that they cannot assist in this process because they lack the required professional capabilities.

The current study focused on collaboration between faculty members and librarians in the field of scholarly communication; however, the gaps in perceptions are similarly manifested. It appears, therefore, that awareness must be raised in both communities, possibly by better defining activities in which the librarians and faculty members can and should collaborate. Perceptual gaps between librarians and faculty members were previously reported by Shen [45] regarding the possible role of librarians in assisting research-related activities (notably, as compared with the awareness and willingness of librarians to assist with scholarly communication, as reported in the current study, the librarians examined in Shen's study were more aware and willing to assist faculty members with their research activities). Shen [45] reported that the main gaps between librarians and faculty members regarded the content of activities in which librarians may assist faculty members. Thus, faculty members considered the possible involvement of librarians to be most important in three research-related activities: (1) developing collections together with the faculty members, (2) raising the awareness of faculty members regarding relevant new publications, and (3) providing information regarding copyrights. In contrast, the librarians considered two activities to be most important in assisting faculty members with their research-related activities: (1) teaching and training information literacy skills to both the faculty members and their students and (2) adding to the regular curriculum various “library orientation” courses. Similarly, Yousef [46] showed that, although librarians are generally willing to collaborate with faculty members and vice versa, the activities that faculty members expect librarians to perform are different from those that the librarians believe they can and should provide. Such gaps, therefore, appear to be prevalent and hinder fruitful collaboration between the two groups.

Another important finding in this study is that some librarians believe that the library should assist the teaching requirements of the faculty more than their scholarly communication and other research-related requirements, which they perceive to be beyond the scope of the academic librarian's job. From the point of view of the librarians, the lack of appropriate training seems to be a significant obstacle in their ability to assist faculty with scholarly communication or research-related activities; this perception raises important questions and concerns that librarians should discuss thoroughly. Issues to discuss include the source of the gap between the expectations of faculty members and the practical work of librarians in the field (is it an issue of budgets, personnel, and working hours, or do academic librarians direct their activities mostly toward other fields of librarianship?) and the possible need to change and update the training of librarians in LIS programs (specifically, although these departments teach various courses on information technologies, still lacking are courses on how to support faculty members in various aspects of their work). When asked about activities related to scholarly communication, several librarians noted that their work in this field is hindered by the lack of cooperation

from faculty members, by financial difficulties, and by an inadequate organizational structure of the library.

It is important to mention that some academic librarians are considered faculty members in their institutions and are, therefore, required to conduct their own research and publish in research journals throughout their careers. Although they usually do so in LIS (rather than other subject areas), they become more acquainted with the ongoing research in a specific scholarly field and, more importantly in the context of the current study, develop research-oriented skills. Such skills, in turn, strengthen their self-confidence, increase their feelings of capability, enable them to better understand the needs of faculty members, and increase the effectiveness of faculty-library collaborations. These processes will likely positively affect the perceptions of faculty members regarding the academic librarians in such institutes, thus increasing collaboration and support.

The interviews presented above also revealed that librarians employed in smaller libraries had a deeper knowledge of the research fields in their department but they were more limited in their ability to generate active collaborations with faculty members (due to budget problems, small staff size, and limited opening hours). Reorganizing libraries to maintain the advantages of the departmental libraries within larger faculty libraries may help in this regard.

2.5 Conclusions

The perceptual gaps between faculty members and academic librarians call for changes in academic libraries, which could increase collaboration between librarians and faculty in issues concerning scholarly communication. Such changes may include increasing the size of the library staff and teaching the librarians the technological know-how that is required for collaborating with the faculty members. In addition, to be able to effectively contribute to scholarly communication, the librarians should possess broad general knowledge, understand the scholarly communication process, and recognize the importance of their involvement in this process. Establishing a team of designated research librarians could contribute to these efforts and help improve the image of the library in the eyes of the faculty, thus positioning the library as an important factor contributing to campus life and activities. Initiating a dialog between disciplinary faculty and librarians, based on common interests in scholarship, would enhance the role of the academic librarians to the benefit of both the library and the academic community. To fulfill the vision of Wiegand [57] of the library as a learning space centered on the educational mission and integrated into learning and scholarship activities, academic librarians should learn more about how scholars and students work and improve their collaborative relationships with the faculty.

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Conflict of interest

The authors of this chapter declare no conflict of interest.

Author details

Liat Klain-Gabbay^{1*} and Snunith Shoham²

1 The College of Management-Academic Studies, Main Library, Rishon-Lezion, Israel

2 Department of Information Science, Bar-Ilan University, Ramat Gan, Israel

*Address all correspondence to: liatk3011976@gmail.com

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Digital Media and the Challenges for Fundamental Rights

José Julio Fernández Rodríguez and Jackeline Argüello Lemus

Abstract

The digital world has created new media within the framework of the information society. This new media affects a wide range of fundamental rights. In this paper, we first analyze the changes in freedom of speech and information provoked by advertising companies. Then, we outline some insights regarding the privacy of users' data. Finally, we connect these topics to the debate over the Internet control and its impact on the democratic system (participation, pluralism, and public opinion formation). The current situation is an ongoing process and shows contradictions, which demand scholars to continue developing the intellectual frontiers.

Keywords: information society, freedom of speech, freedom of information, communications privacy, democracy

1. Introduction

Communication conveys meanings linked to culture and generates a context where human interaction takes place. This process determines socialization to a large extent [1]. Communication accompanies human beings from the very beginning of their existence and determines their knowledge, culture, and communities. It has evolved from oral to written, and with this evolution the formats have changed as well. Handwriting gave way to printing (the Gutenberg Galaxy according to the well-known formula described by McLuhan [2] which involved a huge qualitative shift with deep effects on the advancement of knowledge and culture). In the nineteenth century, visual communications meant a great breakthrough with the discovery of photography. In the next century, the radio, film, and television industries were further developed. This brings us to the communication that uses digital formats as a medium. The Internet is an example of such mutations.

The evolution of communication, briefly described in the former paragraph, is one of the most significant transformations in the history of humanity. Human natural capabilities increase thanks to these technical achievements. Nowadays we find ourselves immersed in a new scenario which raises questions we have not addressed satisfactorily yet.

In the middle of this process, fundamental rights impose a series of demands that must be met in a democratic society [3, 4]. This is essential if we want to maintain the rule of law and democracy. Fundamental rights are connected to human dignity and are translated in different capacities [5, 6]. Their safeguarding ensures a fair, ordered coexistence. We use the term “fundamental rights” which is common to constitutionalism instead of “human rights” (more used in international law) [7]. However, both concepts are understood as synonyms in this paper.

In this paper we will approach some of the most relevant elements that explain the convergence between new forms of communication and fundamental rights. We have no intention to exhaust the subject but to offer some possible answers, the most important answers.

2. The stage of the digital world

As we know, we live in a new world, the digital world, in a new society, society of information, even in a new stadium of humanity, the *infolitic* stage. The Internet, the network that connects all computers in the whole world, is the emblem of this transformation. Since the point of view of communication, the Internet is one more step in this evolutionary process that we have introduced in the previous lines. In the cyberspace, we do not work with atoms anymore but with intangible realities that are in the virtual space.

The principal feature of digital communication lies in the possibility to convert data into a series of zeros and ones (bits, binary digit); it reduces the storage volume and renders the possibilities to deliver and process information less difficult (and less expensive). In any case, the Internet is a new world of communication, which leads Castells to talk about the “Internet Galaxy” [8].

This digital technology is like the Jano God; on the one hand, it has a nice and positive face, and on the other, there is a negative face, which shows us contradictions and ambiguity in the current stage. This certainly makes it difficult to analyze. In this way, among the positive elements, we have the opening of new channels and ways of communication, the leisure alternatives, the direction of citizen education and training, or the possibility of renewing democracy. Among the negative elements, we can find the technical determinism, the quantitative preponderance, and the criminal spaces of deep web, even dysfunctional chaos. Be that as it may, we must consider the digital gap phenomenon, that is to say, the territorial, generational, and cultural differences in technological issues that prevent a truly generalization of the beneficial elements that the Internet has to offer. We have condemned previously this inequality in other papers because of the dialectics between poverty and wealth in matters of information [1].

The advent of disruptive technologies has opened a second phase of information society. Particularly, we refer to the Internet of Things (IoT), cloud computing, big data, artificial intelligence (AI), blockchain, drones, and robots. In fact, these phenomena coexist, so we cannot consider them separate issues. Next evolution of these technologies will bring relevant social changes, making real what we know as the fourth industrial revolution.

The information society has also propitiated interdependent processes that we know as globalization (perhaps hyperglobalization) [9–11]. This shapes the scenario where current communications are articulated. Despite the preponderance of economic issues in this globalization path, it is necessary to consider that communication phenomena entail relevant cultural and ideological implications. This point really has more structural and semantic consequences. In this way, the globalizing process transcends the economic field and jumps to other theoretical frameworks where scholars are still looking for explanations. Traditional strands of thought are no longer valid in these virtual spaces (e.g., historical materialism lacks the necessary analytical tools).

In the previous century, the film industry anticipated a cultural globalization, since Hollywood Studios achieved an overwhelming success which announced a single cultural perspective to the whole world. Also, news flows were dominated by a small group of agencies during the nineteenth century, first by the British Reuters

and the French agency Havas, replaced by the Agence France-Presse. After the First World War, the American Associated Press (AP) and United Press International (UPI) grew powerfully.

However, it is with the information society when this process has become truly global, through the Internet and social networks, which in contrast provide ideological and cultural plurality. From a critical point of view, users all over the world denounce the imposition of cultural products by the great powers which threaten to destroy national cultures. Such critics (sometimes exaggerated) are expressed by opponents to occidentalization. This has led public powers to take over promoting their own cultural functions to avoid big scale risks.

Last ideas show us the impact on the issue of communication: the globalization phenomenon has brought parallelly a local effort. The “glocalization” concept emerges because of the global and local dynamic [12]. The aphorism “think global, do local” lies next to such process. As Mattelart points out, new approaches on the links that are established between the global and the local have arisen, which break with the previous idea of the fatality of monoculture [13].

In this sense, it is important to review how mass media sets out an agenda that responds to this idea. It is a proven fact that global information flows gain more visibility if at the same time local issues are served. This implies to decentralize information that allows a more active citizen participation. This scenario unleashes a coexistence between powerful medium and unequal micromedia that are favored by the possibilities of technology (this would be an example of the subversive factor of technology). Again, there are two contradictory faces that act in unison: on the one hand, unification and at the same time, the reinforcement of particularisms.

It is convenient to remember the existence of different convergence processes, promoted by globalization. Economical concerns encourage the confluence of interests in broader frames. In that way, a convergence of mass media, informatics, and telecommunications has been propitiated. At the same time, it is possible to find another technical conjunction among the Internet, telephone, and television which is still pending of settlement.

Analysis must go beyond pure technical issues and should focus on cultural and content aspects, as we have said. They determine the axiological basis of these processes and explain the legal regulations regulating them. In this order of ideas, Wolton alludes to an epistemological duty which should not confuse technique, culture, and society [14]. That is, we must reject technical determinism, by recognizing that while the technique affects the social structure and cultural construction, the cultural scheme in individual and collective terms is projected in the technique, which is born, precisely, of this cultural scheme [1].

In the same way, it is important to consider the differences between public and private spheres, because of the blur of lines that give rise to the neopublic space, as we have called it. This kind of space connects many people in a non-face way, with plenty of people interconnected but without masses [1]. Neopublic space–time has cultural and social implications for the citizenship of the digital world.

3. The public communication

To expose clearly the central ideas of this paper, it is necessary to distinguish the communication processes that are public and pretend to reach many citizens, among those which are meant to remain private. The law should be able to offer different legal stipulations for each one.

3.1 Freedom of speech and information

In the field of fundamental rights, the public communication that is meant to be public develops under the umbrella of freedom of speech and information, which is at the same time agglutinated in the broader freedom of communication. Rosenfeld mentions three bases for these freedoms [15]: the need of democratic self-government, the public responsibility to seek for the truth (the marketplace of ideas pointed out by Stuart Mill), and the individual right to express the personality. The first one of these assertions is directly connected to freedom of information and the last one to the freedom expression.¹

The current legal recognition of these freedoms is produced in a parallel way within different constitutional and international regulations. As examples we have the Article 20 of Spanish Constitution, the Article 21 of the Italian Constitution, the Article 5 of the German Constitution, or the First Amendment to the United States Constitution and at the international level, Article 20 of the Universal Declaration of Human rights, Article 10 of the European Convention on Human Rights, or the Article 20 of the International Covenant on Civil and Political rights.

Indeed, freedom of speech and information of freedom are two different rights. The former allows people to express their own ideas and opinions and value judgments by different channels. The latter is the guarantee of communication and reception of facts or events that will become news. To inform about transcendent public facts is necessary to ensure the participation of citizenship in the collective life [17].

Both liberties have a double dimension: individual and institutional. They are subjective faculties of the people, and they are basic elements of public opinion. Internet does not suppose changes in this double dimension since constitutional guarantees must not decrease depending on the vehicle used.

As a simple approach, it is possible to assert that the digital world has opened new possibilities for both kinds of freedom from a quantitative and a qualitative point of view. We will discuss this issue in the next section.

3.2 Quantitative changes

Nowadays the reality of digital world is more than evident. The Internet has a lot of influence in the ways we communicate.

As a matter of fact, we have noticed a substantial increase in the *ways of communication*. The e-mail², social networks, or web pages have been added. This triumvirate offers lots of opportunities to come in the communication horizon.

¹ Historically, the precedent of current legal stipulations can be seen in the freedom of the press. Enlightened thinking inserts at the origin of liberal constitutionalism that it is necessary to form a free public opinion that serves to control power. To do so, publicity is necessary, especially the freedom of press. Art. 11 of the Déclaration des droits de l'homme et du Citoyen (1789) stated that "la libre communication des pensées et des opinons est. un des droits les plus précieux de l'homme" so that every citizen can "parler, écrire, imprimer librement, sauf à répondre de l'abus de cette liberté dans les cas déterminés para la loi."

In the Virginia Declaration of Rights (1776) it is stated that "the freedom of the press is one of the great bulwarks of liberty and can never be restrained but by despotic governments" (Section 12). In Spain the issue was relevant in Cadiz Courts as the Spanish Constitution of 1812 recognized the freedom of all Spaniards to "write, print and publish their political ideas without licensing" (Art. 371). The difficulties of the practical application of this freedom gave rise to allegations in the defense of the free exchange of ideas. As an example, we can cite the utilitarian vision of John Stuart Mill [16] and the realist vision of Oliver Wendell Holmes.

² Although the e-mail does not have as a main goal the public communication, we refer it to highlight the importance of the changes in communication technologies. Also, social networks can be used with privacy standards (profile access can be restrictive or public). However, we mention them now because of their systematic use in the media.

At the same time, the now-existing formats have gone digital such as the television, the telephone, and the radio.

All these forms of communication are spread all over the planet. It is notwithstanding the fast colonization of social networks. Besides their communicative spectrum, they have become a cultural and social phenomenon that we would have never foreseen in the past. Social networks have a fragmented use according to the user's needs (friendship, business, academics, leisure) which is a characteristic of the information society.

Traditional channels of communication can be either private or massive. The private ones have a bidirectional character as the mail post, the telephone, or the fax. The massive ones as the press, radio, or television have a unidirectional character depending of the main emission center, and there is a multitude of passive recipients. However, digital technology offers ways of communication that combine individual systems with the logic of massive communication. The key is the idea of interactivity, a technical characteristic that makes a change transferring the control to the user. This feature turns her into recipient-user-publisher-sender as we will see in the next section. The logic of international regulation that restricts mass media and assigns limited space (as radioelectric space) does not fit well with this idea we have described.

When it comes to *communication formats and supports*, there is an expansion as well. Satellites, Hertzian waves (radioelectric support), and terrestrial communication systems are used simultaneously. Among terrestrial systems, there are other types such as optical fiber that replaces copper wires. Its attribute is to transmit the signals with high quality, reducing interference frequencies.

It can be considered that optical fiber changes the world of communications. Its wires are compound of pure and narrow glass filaments, which are guided by luminous impulses (unlike other wires, which transmit electromagnetic waves). That is, optical fiber carries optical signals instead of electrical ones.

Thus, the quantitative options of expression and information spread up, while new formats appear. Such possibilities to obtain, communicate, and disseminate information give rise to think about the Internet as an important instrument for promoting and protecting human rights [18]. From this quantitative point of view, the valuation is thus positive.

3.3 Qualitative changes

Beside quantitative changes, we have witnessed qualitative changes linked to new ways of communication that also have consequences for fundamental rights. This is relevant in matters of philosophical issues which makes the analysis even more complex. In the following lines, we will deepen the line of argument previously established by elaborating on some aspects [17].

First, digital technology increases the quality of communication, while it offers information systems that combine texts, images, and sounds. As a result, the partial additions of these characteristics create a synergy which improves the human being's options in the communicative dimension. Mass media of the digital world takes advantage of quality changes given their space universality, immediacy, temporality, and specialization or segmentation.

Second, multidirectionality turns into a matter at hand for understanding this current stage. This point lets the network users assume an active and intelligent position instead of a passive one regarding the traditional mass media. The Internet shows itself as a multidirectional media because it lets users perform as creators and recipients at the same time. The communication sender, publisher, producer or author, and the recipient converge in a figure that expresses itself in the form of a profile in the cyberspace. As Smith affirms, in the Internet, anyone is a publisher [19].

This gives rise to a new concept: the *prosumer*, which is the consumer who produces its own content, opinions, and elements that increase the value of the product [20, 21].

Third, public and private are contested realms, and so are their legal attributes. As we know the clash between freedom of information and the right to privacy has a specific procedural treatment depending on the public or private character of an individual. On the Internet, it is difficult to distinguish between public and private because of the ambivalent position of the subjects in the network. Llana identifies the fourth basic characteristics of the Internet communication based on the Supreme Court of the United States and remarks this ambivalent position: the existence of minimum access barriers for communicating is the same for senders and recipients; every content is potentially accessible for any user, and the access is significative for those who want to express themselves [22].

In fourth place, the *construction of reality* is complex. Reality never has been unique but multiple. However, with the digital world, this feature is enhanced. We used to have the “real” reality, the published reality, and the well-known reality. Now, the Internet provides completely unknown segmentations, plenty of solutions are made fit, and everything is personalized which subjectifies the content. In that sense, the political-social reality of the constitutional state starts up a new stage with uncertain consequences (as we will see in the Part 6 of this paper).

Fifth, the classic difference between expressing and informing gets blurred. Based on this distinction, as we saw above, the objectives of freedom of speech and freedom of information are different. The first falls on intellectual conceptions, such as opinions, the second on what is considered as the news. The diligence of the informant (especially of the journalist) to collect such facts gives them truthfulness, thus entering in the scene the protection typical of the freedom of information. In the Internet information gets mixed up with opinions, values, and data, which renders it difficult to differentiate one liberty from another. In the same line, it must be pointed out that the requirement of the veracity of the information is shown particularly blurred and difficult to specify in the cluster of the contents of the network, which anyone can enter, alter, or manipulate. The new realities of the *post-truth* and the *fake news* intensify this confusion.

Finally, the new technological realities impact directly on the construction of public opinion as the basis for a democratic system. This construction is both rich and complex, full of contradictions, and varied sources. Castells points out that there is a double sense process of interaction among media and audience related to the real impact of messages. These are distorted, readapted, and occasionally subverted by the audience [23].

Along this way, something we have called the imbalance between supply–demand arises: the products of content creators that are supplied through the Internet respond to their own logic away from the hypothetical wishes of consumers, whose demands go through other ways. Also, there is a confusion between the supply and demand because of multidirection and active positions on the citizenship of the society of information. The ones who supply at the same time are demanding. Again, we have this prosumer (producer and consumer) adding value.

As a result, it is precise to revisit the expression and information rights to adapt their object and content in this stage we have explained previously. The jurist must be capable to make these new interpretations of the international and constitutional regulations that come from the analogic world. The objective is to maintain the efficiency and operability of fundamental rights.

4. The private communication

The right to *secrecy in communications* is the legal response to protect private information from third parties. Even though this is an autonomous right, historically it is linked to privacy rights, and for that reason they present some common assertions³.

This type of right protects all the communications that occur through a close channel, which leads participants to keep certain expectations regarding privacy. If the channel is open, then the right loses its possible application (as we find ourselves in the realm of public communication). This secrecy in communications has its origins in the postal service but maintains its formal dimension (the message is protected apart from its content). Now, the secrecy protects both the interception and the content of the message.

It is necessary that the right to secrecy covers all the Internet communications through closed channels as mails, chats, video conferences, phone calls, or SMS. In this way, Article 5.1 Directive 2002/58/EC⁴ stipulates: "Member States shall ensure the confidentiality of communications and the related traffic data by means of a public communications network and publicly available electronic communications services, through national legislation. Particularly, they shall prohibit listening, tapping, storage or other kinds of interception or surveillance of communications and the related traffic data by persons other than users, without the consent of the users concerned, except when legally authorized."

As we said, the issue of the secrecy of communications is linked to a privacy dilemma. Both rights are in a fragile scenario: one of the obvious problems of the Internet's security. The issue is relevant because in recent years we have witnessed the emergence of new aggressions to privacy or the reformulation of aggressions that already existed in the analogue world. As examples we can state the following scenarios: entering a hard disk of a computer without the holder's consent; the creation of fake profiles; intercepting e-mail messages; identity theft (phishing); electronic harassment (spam); misuse of directories and users' lists on the network; the accumulation, registration, and/or transfer of data without consent; alteration or destruction of information; and blocking access to information or to an administrator's account. These aggressions overlap each other and are produced with specific mechanisms and newborn techniques, for example, sniffers, Trojan horses, worms, virus, or logic bombs. They are several expressions of malware.

Besides these mechanisms, technology offers solutions as firewalls, antivirus, passwords, and cryptography. We can observe Jano God again, showing us positive and negative elements at the same time. This aggression and protection mechanisms respond to the geopolitical conditions; they are strategically used by the governments. Every day, we witness international attacks under the political demands.

To face these dangers, the European Union has promoted a new regulation of data protection (an autonomous right but connected to the previous ones) through regulation 2016/679, of the European Parliament and the Council. The objective of this rule is to strengthen the control and legal certainty facing data use on an unprecedented scale and at a global level. In this way, a system of data processing

³ The historical antecedent of this fundamental right is found in the French revolutionary period. Thus, the decree of the National Assembly of August 10, 1790, affirmed that "Le secret des lettres est. inviolable." Today it is established in Art. 18.3 of the Spanish Constitution, 15 of the Italian Constitution, 34.1 of the Portuguese Constitution, 10 of the German Constitution, or indirectly through the IV USA Amendment [24] and also in Art. 8 of the European Convention on Human Rights, 12 of the Universal Declaration of Human Rights, or 17 of the International Covenant on Civil and Political rights.

⁴ Directive 2002/58/EC of the European Parliament and of the Council of July 12, 2002, concerning the processing of personal data and the protection of privacy in the electronic communications sector.

is imposed based on the accountability, lawfulness, fairness and transparency, data minimization, accuracy, or the needs of security. These requirements of security's treatment must allow, in relation to the personal data, to guarantee confidentiality, integrity, and availability. A regulation of the European Union is a standard of direct application in all the member states (unlike a directive which in principle applies only if there is national law of transposition). Since May 25, 2018, the European Data Protection Regulation applies. The processing controllers of personal data have new obligations: information, implementation of appropriate technical and organizational measures, records of processing activities, cooperation with the supervisory authority, notification of a personal data breach to the supervisory authority, data protection impact assessment, and designation of the data protection officer.

In conclusion, we can affirm that the digital communications that want to remain out of the knowledge of third parties find themselves in a difficult situation due to the differences in interpretation. Civil law tries to react with different legal dispositions, which are partially effective. What is clear is that legal interpretation of rights should be updated or it should include legal dispositions such as deeming the home address and the electronic address comparable, to extend the guarantee scheme.

5. The problem of content control and regulation

A specific issue is the problem of content control in the Internet. This issue affects different clauses relative to the fundamental rights such as limits to freedom of speech, censure, hypothetical legal procedures, or to remove publications.

The Internet should not be a space without control [25–27], although it is more difficult to exercise it due to the peculiarities of the network. Therefore, the traditional legal idea of responsibility must also be present. An activity sanctioned by the legal system must be prosecuted regardless of whether we are in the analogue or digital world. This is especially important in the current context, with a deep web full of criminals and radicals that use the Internet as a strategic tool (e.g., DAESH or organized crime)⁵. This requires international coordination actions and continuous intelligence supervision.

However, it is also necessary to bear in mind that the sanctioning regime must be the same in the analogical and digital world; the technical differences do not justify a change of legal regime in this sense. And at the same time, alongside these control efforts, we must try to promote freedom while guaranteeing fundamental rights. In this way, measures that play in favor of equal access and the use of digital technology must be considered, measures that face the digital divide.

In the information that flows through the Internet, different subjects intervene, ranging from the providers of access to content providers to the users in a multidirectional position. It does not seem possible to apply the usual regime of cascade responsibility of the analog world. The decentralization of services and the possibility that an actor may exercise various or cumulatively various functions make it difficult, as Féral-Schuhl points out, to determine the respective responsibility of the different people involved in the process [28]. It would be necessary to look for a more nuanced formula, concentered in the real participation of each actor in the action or harmful content. Therefore, legislation on fundamental rights should always be applied. In the case of civil and trade law, there is the need to formulate specific regulations in order to address different contexts.

⁵ It is only in a framework of reasonable security context that fundamental rights can be exercised. Despite of DAESH ending of territorial control in Syria and Irak, terrorist advertisements cross borders in the cyberspace, and now they have been adapted to the new interconnected world.

Likewise, the difference between illicit content and harmful content must be considered. Illicit acts are contrary to the legal system of reference, among which, logically, those of a criminal nature stand out. In contrast, harmful content is legal but harmful (from a social, ethical, or moral point of view) for a certain sector of the population, such as teenagers or children.

The illicit contents must activate the reaction of the security forces to proceed with their persecution, which will find in many cases the stumbling block of the supraterritoriality, which must be overcome with bilateral or multilateral international collaboration. In addition, it can also happen that what is criminal in one country may not be in another, which may be a more important obstacle.

To deal with harmful content, the options must be different from mere criminal prosecution and declarations of illegality. Cultural differences introduce many nuances in this matter. This makes it difficult to speak of a commonly accepted universal culture of reference (we cannot speak of a global democratic culture). In this sense, it is not appropriate to introduce new restrictions and limitations for freedom on the Internet. The underlying idea is not to prohibit on the Internet what is allowed in other media (such as pornography). This is the line that has already been followed, for example, by the US Supreme Court when the organ confirmed on June 26, 1997, the unconstitutionality of the decency act in the Communications Decency Act of 1996. This act declared the transmission of indecent or obscene material to be illegal. Lower instances had already rendered this measure unconstitutional since it was considered contrary to the First Amendment of the Constitution⁶. The solution will not come with the criminalization of the network. Other more reasonable options to solve the problem of harmful content are filters and self-regulation. With content filters the user can control Internet access, which can be used by parents to supervise the navigation of their children. There are several options in the filters, such as whitelists (only allow access to those addresses), blacklists (do not allow access to the pages of the list), tagging of websites, and detection of suspicious words or copies of the accessed pages. In turn, self-regulation will overcome a large part of the inadequacies of the typical unilateral coercive regulation of the state. Self-regulation aims for suppliers to establish codes of conduct that serve both themselves and their customers.

The importance of self-regulation reveals the difficulties of applying technical and traditional regulations to the Internet. Therefore, it is imperative to look for new international arrangements that include *soft law* elements and the already mentioned self-regulations. Also, the network control, because of international security risks we have mentioned before, must respond to the proportionality principle (the general sweep of communications made by the United States through systems such as the Echelon network is not acceptable). It is possible to fight successfully against terrorism from the rule of law.

6. Communication and democracy

Democracy is a continuous process of power control that is articulated through different forms, which in any case are related to citizen participation.

Traditionally, the nucleus of democracy revolved around the representative electoral system, built upon the fundamental right of suffrage (active or passive). However, for a long time, there has been a sense of a crisis of representative democracy, with the consequent need for its renewal. The ideas of deliberative democracy or participatory democracy respond to this situation [29, 30]. In this sense, the

⁶ *Reno v. American Civil Liberties Union*, 521 U. S. 844.

digital world, in theory, enables pluralism and participation, through the new forms of communication and qualitative changes that arise, as we have mentioned before. Democracy now is also electronic and digital. Options increase. However, nowadays we are facing new challenges to our democracies such as new types of risks.

One of the most common concerns about the liaison between digital life and the protection of fundamental rights revolves around the topic of democracy. The millennium was born along with new spaces for the political arena—digital activism, the spread of news through social media, and a space for civil society to interact encourage participation beyond voting. At the same time, there are some challenges that governments and societies need to address such as the Cambridge Analytica scandal that involved the collection of personally identifiable information of over 87 million Facebook users [31]. The borders between freedom and protection thus become unclear. In addition, there is considerable concern among scholars on how political agendas are shaped through the digital spectrum.

One of the issues that immediately arise has to do with censorship and free speech. As a global society, we are facing the traditional threats to democracy but now with a renewed skin under the scope of cyberspace. The militarization of the digital world is one of these menaces.

As Robert J. Deiner points out:

“The Internet has long been seen as providing a technological fortification for free speech. Citizens can publish their views to a worldwide audience, communicate in an unrestricted fashion with other citizens, and create new communities of interest. Social forces have emerged, however, that have begun to chip away at that technological fortification. The most direct assault comes from increasingly sophisticated forms of state content filtering [...] A more unlikely source comes from intensifying pressures to regulate intellectual property and copyright” [32].

The lines between security and filtering get blurred, and this affects democracy. On one hand, states have to guarantee a secure environment for the economy. According to an estimate calculated during the Obama administration, “60% of small firms that are hacked go broke, and billions of dollars worth of intellectual property have been stolen from industry, including military blueprints from leading defence contractors” [33].

However, the situation goes beyond the protection of intellectual property. Ever since the 9/11 attack, governments have understood the importance of the Internet as a suitable vehicle that terrorist employ in order to achieve their goals. Nevertheless, this is only one side of the debate. Some scholars question the expansion and adoption of offensive information warfare capabilities by states. “The military use of cyberspace operates on a new terrain, presenting many thorny legal and moral questions concerning the targeting of civilian infrastructures, and the boundaries between an armed assault, a probe, collection of information, and the dissemination of propaganda.” [32]. As a result, we find ourselves in dilemma: we want a strong Leviathan capable of protecting users’ data from hackers, but at the same time, we remain suspicious. What if states use their faculties not only against hackers but also against civil society? The allegedly Russian meddling in American elections in 2016 is one example of how thin the lines between protection and intervention are.

The militarization of cyberspace is not the only concern regarding democracy and the digital world. A strong democracy needs reliable information, so citizens can make their choices. An informed population should be able to decide what the most important matters are. However, Castells contended that “what does not exist in the media does not exist in the public mind” [34]. Therefore, a legitimate question arises: who determines what exists in the media?

Jessica Feezel recently tested whether being exposed to political information through Facebook yields an agenda-setting effect by raising participants' perceived importance of certain policy issues. She found that "participants exposed to political information on Facebook exhibit increased levels of issue salience consistent with the issues shared compared with participants who were not shown political information" [35]. To claim that mainstream media influence and shape agenda setting is a common place. Nevertheless, this apparently self-evident assertion becomes more complex when we think about *fake news* and how easily they can be spread in the digital media posing a challenge for democracy. States are not the only actors that can benefit from users' data. The Facebook and Cambridge Analytica scandal showed that social media is more than just a vehicle for communication.

According to a parliamentary committee, the United Kingdom faces a "democratic crisis" with voters being targeted with "pernicious views" and data being manipulated [36]. Governments are now acknowledging that democracy will have to face serious threats unless social media companies face tougher regulation or a new tax. Despite these issues, it is undeniable that social media allow an activism never seen before and that society benefits from it. According to the Pew Research Center "Certain groups of social media users—most notably, those who are black or Hispanic—view these platforms as an especially important tool for their own political engagement. For example, roughly half of black social media users say these platforms are at least somewhat personally important to them as a venue for expressing their political views or for getting involved with issues that are important to them. Those shares fall to around a third among white social media users" [37].

According to the expressed above, the digital arena opens both the opportunity to robust democracy via the fundamental right to participation, but at the same time, it challenges democratic practices as well.

7. Conclusions

The new communicative environment of the information society poses several challenges for fundamental rights, which must be addressed in order to maintain the quality of our democracy. As we have seen, freedom of information, freedom of expression, secrecy of communications, privacy, or rights linked to political participation are affected. In a final verdict, it seems clear that the digital world has been beneficial for freedom of expression and information, which finds options and possibilities previously unknown, allowing citizens to reposition themselves at the center of their own history. However, regarding the secrecy of communications and matters relating to privacy, the verdict must be negative, because on the Internet it is very difficult to achieve true security to protect these rights. In another related right, such as data protection, the European Union is committed to a very relevant regulation that tries to mitigate threats. Time will tell if they manage to deactivate such dangers.

About political participation in particular and democracy in general, it is much more complex to make a conclusive final assessment. In theory, participatory options have increased with new forms of communication, but in practice the imbalances and problems are continuous, and manipulation and populism are real threats that diminish the stability of coexistence. The current situation is still under construction and shows contradictions, which exemplify again that ambivalent character of technology, with positive and negative elements.

Be that as it may, the key is to keep the guarantees of rights operative, regardless of the support that is used for their exercise. This requires legal operators and the legislator to update their work and the diverse regulations so that technical progress does not render legal regulations obsolete. We hope that we are up to these demands and offer

the public renewed public systems. New forms of digital communication, correctly used, can help us. Let's take advantage of their strengths and mitigate their weaknesses.

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Conflict of interest

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Author details


José Julio Fernández Rodríguez¹ and Jackeline Argüello Lemus^{2*}

1 University of Santiago de Compostela, Spain

2 National Autonomous University of Mexico, Mexico

*Address all correspondence to: jarle09@hotmail.com

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This book is an interdisciplinary effort to understand the evolution of communication from cells to societies, both in living organisms and in non-living ones, such as designed or emergent systems from socio-technological innovations (i.e., digital communication, institutional communication). It aims to provide better understanding of the universal versus contextual patterns of communication that we can potentially classify and identify if we look deeper into the history and evolution of this phenomenon at large. Novel research from a variety of disciplines, such as information theory, biology, linguistics, culture and social science that take a complex perspective is being explored, for an integrated understanding of what communication is at a fundamental level.

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