Maffei R, Convertini LS, Quatraro S, Ressa S, Velasco A. 2015. Contributions to a neurophysiology of meaning: the interpretation of written messages could be an automatic stimulus-reaction mechanism before becoming conscious processing of information. PeerJ 3:e1361 https://doi.org/10.7717/peerj.1361

Contributions to a neurophysiology of meaning: The interpretation of written messages could be an automatic stimulus-reaction mechanism before becoming conscious processing of information.

Roberto Maffei[1*], Livia Selene Convertini[1], Sabrina Quatraro[1], Stefania Ressa[1], Annalisa Velasco[1]

[1] A.L.B.E.R.T. (ARPA-Firenze Landmarks on human Behaviour Experimental Research Team), Florence – Italy.

* E-mail: roberto@robertomaffei.it ; albert@arpafirenze.it

Abstract

Background. Interpretation is the process through which humans attribute meanings to every input they grasp from their natural or social environment. Formulation and exchange of meanings through natural language are basic aspects of human behaviour and important neuroscience subjects; from long ago, they are the object of dedicated scientific research. Two main theoretical positions (cognitivism and embodied cognition) are at present confronting each other; however, available data is not conclusive and scientific knowledge of the interpretation process is still unsatisfactory. Our work proposes some contributions aimed to improve it.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Methodology. Our field research involved a random sample of 102 adults. We presented them a real world-like case of written communication using unabridged message texts. We collected data (written accounts by participants about their interpretations) in controlled conditions through a specially designed questionnaire (closed and opened answers). Finally, we carried out qualitative and quantitative analyses through some fundamental statistics.

Principal Findings. While readers are expected to concentrate on the text's content, they rather report focusing on the most varied and unpredictable components: certain physical features of the message (e.g. the message's period lengths) as well as meta-information like the position of a statement or even the lack of some content. Just about 12% of the participants' indications point directly at the text's content. Our data converge on the hypothesis that the components of a message work at first like physical stimuli, causing readers' automatic (body level) reactions independent of the conscious attribution of meaning. So, interpretation would be a (learned) stimulus-reaction mechanism, before switching to information processing, and the basis of meaning could be perceptual/analogical, before propositional/digital. We carried out a first check of our hypothesis: the employed case contained the emerging of a conflict and two versions ("H" and "S", same content, different forms) of a reply to be sent at a crucial point. We collected the participants' (independent) interpretations of the two versions; then, we asked them to choose which one could solve the conflict; finally, we assessed the coherence between interpretations and choice on a 4-level scale. The analysis of the coherence levels' distribution returned that, with regards to our expectations, incoherence

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

45 levels are over-represented; such imbalance is totally ascribable to “H” choosers. “H”
46 and “S” choosers show significant differences ($p << 0.01$) in the distributions of
47 coherence levels, what is inconsistent with the traditional hypothesis of a linear
48 information processing resulting in the final choice. In the end, with respect to the
49 currently opposing theories, we found out that our hypothesis has either important
50 convergences or at least one critical divergence, joined with the capacity to encompass
51 they both.

52

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Introduction

Human-environment interactions have something special, with regards to the other animals' interactions: human behaviour is not restricted to appropriate reactions; it encompasses also conscious knowledge, which entails the attribution of meanings (semantic aspect) to the incoming signals and stimuli. The other animals can perform sophisticated reactions to the environmental inputs; however, it seems they do not "understand" them (Gruber et al., 2015), even though they certainly can socially exchange some learnings through imitation (about this, a classic study in Mainardi, 1988 and some recent examples of research in Baciadonna, McElligott & Briefer, 2013; Carter et al., 2014; Suchak et al., 2014).

Interpretation, namely the operation through which the meaning is attributed, is a still widely unknown process. A specific difficulty is represented by natural language, i.e. the main instrument through which human species (the only one endowed with such capability in Nature) formulates and exchanges meanings and consciously understands things. Natural language and its use have been studied almost since the dawn of humankind, with researches ranging from the ancient rhetoric (for example, Geymonat, 1970; Barthes, 1970; Perelman, 1977) to the most recent approaches integrating linguistics with biology and neurosciences (for example Zuberbühler, 2005; Locke, 2009; Stekelenburg & Vroomen, 2012). Nevertheless, none of the hypotheses proposed up until the present times can be considered capable to exhaustively solve the problem of interpretation (some general reflections on this subject's complexity in Deacon, 2012). Even though natural language has been traditionally approached under its profile of

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

symbol-based system, the way it works cannot be reduced to a simple coding-decoding procedure. By one hand, a one-to-one correspondence among written signs (or spoken sounds) and words does exist; by the other hand, no such correspondence can be found between any word/expression and the meaning attributed to it. This led a famous Italian linguist to label natural language as structurally "equivocal" (De Mauro, 2003)[1].

Messages are (or, at least, they appear) made up just of words; however, understanding a message always goes far beyond the message's words[2]. The available data does not give definite answers to the researchers' questions; in fact, interpreting the interpretation process is a challenge that modern science has not yet won. Our field research brings some contributions to such endeavour.

Research lines and ideas: a synthetic overview. The available scientific literature is so wide to make it impossible, inside the boundaries of our work, an exhaustive analysis. However, a rapid survey is sufficient to reveal some trends, the first of which is the accelerating extension of these studies from the pure humanistic disciplines to science field; recently, even a "hard" natural science like physics has generated a "psychophysics" branch, specifically oriented to deepen the knowledge problem through the instruments of that discipline. Another trend, thanks to the extraordinary development of technology and informatics, is the enhancement of the studies that explore

[1] De Mauro, 2003 states that natural language is "equivocal" in etymological sense: from Latin *aeque vocare* (to name [different things] in the same way). That means: a same word can be used to refer to different meanings and different words can be used to indicate the same meaning.

[2] Material regarding the attempts to explain human communication and the questions of meaning and interpretation is really countless. Specific works will be indicated within the manuscript. Taking linguistics apart, we make reference to Pettigiani & Sica, 2003 for a review (in Italian) of psychological main approaches; Krauss & Fussell, 1996 for a wide survey from the perspective of social psychology.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

93 interpretation inside the neural processes of the brain cortex; the neuron-level research
94 and the wide use of advanced imaging techniques witness for this. All this considered,
95 we can roughly outline a picture with two main scientific research lines:

96 ▪ **Mind-centred approaches** – Understanding/interpretation is totally based on
97 abstract (conceptual) knowledge. Information feeds are provided through the
98 body (perception) but the "mind"[3] processes stimuli and incoming signals at
99 symbolic level, transforming them in propositional representations in the brain
100 cortex and understanding them in terms of concepts. The answer to the inputs
101 (reaction) is based on such comprehension and is shaped as a command to
102 some effectors (typically the motor system). Knowledge is the result of a sort
103 of computation; the mind is separated from the body and rules it. The role of
104 the motor system is totally passive.

105 ▪ **Body-centred approaches** – Understanding/interpretation is attained through
106 a motor reaction of the body that can, at maximum, co-exist with conceptual
107 knowledge. When an external stimulus/signal is perceived, it is firstly "under-
108 stood" through a motor reaction which is automatic, involuntary and based on
109 "mental maps" that are motorial, not (or not only) propositional. Understand-
110 ing is a sort of motor experience that goes along with conscious (rational) in-

20 [3] We will not enter the disputed question of mind, its existence, its nature and its relationships with
21 the body in general and the brain in particular. For a first level of delving further into the subject: by
22 one hand, the early survey of Sperry, 1952; by the other hand, the more recent works of Marcus,
23 2004; Rose, 2005; Zeki, 2010. In the context of this introduction, the "mind" is simply intended as a
24 factor which, by following some theoretical positions, totally controls body through different
25 functions with respect to biological processes.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

formation processing; the body is not detachable from the mind and can drive it. The role of the motor system is active and decisive for understanding.

The first group theories' main features are synthesized in some recent works like, for example, Zipoli Caiani, 2013 (Chapters 1 and 2); Ferrari & Rizzolatti, 2014 (specially Pag. 2); Gallese, 2014 (specially Pag. 2, with the concept of ontological reductionism); Pulvermüller et al., 2014 (specially Introduction and Fig. 1). In addition to this, a browsing of the literature unveils a wide series of theories that, even if they differ in many details, consider the mind (see Footnote 3) through the metaphor of the computer, or even of simpler mechanisms. The range goes from the merely mechanical (and naïve) theories of psychoneural isomorphism (Sperry, 1952, pp. 293-294) and those inspired by the first electronic computers (Newell, Shaw & Simon, 1958), to the various I.P. (information processing) models (Massaro & Cowan, 1993) and current cognitive science positions (Negri et al., 2007; Mahon & Caramazza, 2008; Mahon & Caramazza, 2009). The shared concept is that information is essentially processed in a linear and unidirectional sequence, based upon a functional (besides the anatomical) separation among sensory, associative and motor areas of the brain cortex (for a general presentation and discussion see also Rizzolatti & Sinigaglia, 2006, Chapter 1, specially pages 20-22; for a synthesis of the cognitivism paradigm see Gallese, 2000, page 27). The motor system is conceived as a merely operative instrument, totally dependent on the output from associative areas. For precision's sake, we must add that our description is a simplification: there are theories and ongoing research lines that can be included in this first group while they, nonetheless, take motor processes into a special account. For

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

example, the current formulations of Common Coding principle (Prinz, 1997; Hommel et al., 2001) and Ideomotor principle (Pezzulo et al., 2006; Sauser & Billard, 2006; Melcher et al., 2008).

The second group of theories (the body-centred ones) can be traced back, at least, to XIXth Century, up to the works of Lotze, 1852 (cited in Rizzolatti & Sinigaglia, 2006) and James, 1890, which present reflections on the relationships between perception and action. Other philosophers followed[4], up until a new series of neurophysiological studies appeared, in the second part of XXth Century[5]. Such researches gathered evidence that the sequential processing theory and the supposed totally passive role of motor system are untenable. In addition, a leap ahead has probably been accomplished with the discovery of mirror neurons (di Pellegrino et al., 1992) and the following studies on them (for example Gallese, 2000; Rizzolatti & Craighero, 2004; Iacoboni et al., 2005; Rizzolatti & Sinigaglia, 2006). According to this theory, understanding (at least, understanding of motor acts) would be firstly attained through a motor reaction of the body, "immediately and automatically"[6]. Cognition would be "embodied".

[4] Some special mentions about the philosophers: Mach, 1897, in particular pages 1-8 (on the relationship between scientific knowledge and perceptual experience of physic world), pages 15-17 (a famous example on subjectivity of perspective) and pages 93-95 (sense organs as active elements of perception, fine-tuned through experience, rather than as passive receptors); Poincaré, 1902 [2003], especially Chapter 4 (on the relations between geometrical space and "representative", i.e. perceptual, space); Poincaré, 1908 [1997], Part I, specially pages 52-63 (phenomenology of a mathematical discovery and the role of sensitivity and aesthetic feeling); Merleau-Ponty, 1965, particularly Part II (with special regards to introduction chapter, on the impossibility to have a knowledge of the environment that is independent of the body experience).

[5] Some special mentions about the neurophysiological studies: Sperry, 1952, especially pages 299-300 about the relationships between perceptions and ideas; Jeannerod et al., 1995; Liberman & Wahlen, 2000; Fowler, Galantucci & Saltzman, 2003.

[6] We are intentionally employing the words "immediately and automatically": they are typically used in describing the mirror-systems' working.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Embodiment of cognition, and its consequences on knowledge and interpretation process, are the object of a heated scientific dispute. Some parts of our work will touch such question; then, it is worth referring to an example, in order to clarify out the different positions. In a review that critically examines the mirror neuron-based approach to cognition (Hickok, 2009) the author proposes an example, aimed to dispute the embodied cognition hypothesis (direct reference to Rizzolatti, 2001). He invites to imagine someone pouring a liquid from a bottle into a glass. Then, he continues arguing that, by following that hypothesis, an observer can "embodily" understand such action since, thanks to his mirror neurons, he undergoes a motor reaction "as if" himself was actually pouring (by the way, such reaction does not turn into any actual movement, it remains virtual). This said, the author replies that pouring "could be understood as *pouring*, *filling*, *emptying*, *tipping*, *rotating*, *inverting*, *spilling* (if the liquid missed its mark) or *defying/ignoring/rebelling* (if the pourer was instructed not to pour)…" (see Hickok, 2009, page 1240, italic by the author).

The contrast between these two positions has not yet been solved even though, with respect to its beginning, the debate has grown up far further. In particular, the hypotheses based on the mirror neurons discovery have been refined, for example through the concepts of Mirroring mechanisms (MM) and Embodied simulation (ES) (Gallese, 2005, 2006, 2007, 2008, 2009a; Gallese et al., 2009; Gallese & Sinigaglia, 2011a; Ferri, Gallese & Costantini, 2011; Marino et al., 2011; Gallese & Sinigaglia, 2012; Ferrari & Rizzolatti, 2014; Gallese, 2014). About this ongoing dispute, a summary and a state-of-the-art outline can be found in Zipoli Caiani, 2013; apart from this, one of

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

the most interesting documents is a forum (Gallese et al., 2011) inside which the most delicate and controversial questions are widely debated. The main ones, with regards to the subject of our work, are the following four: goal-dependency of mirror reactions, with references provided by upholders (Umiltà et al., 2008; Cattaneo et al., 2009; Rochat et al., 2010) and detractors (Range, Viranyi & Huber, 2007; Hickok, 2009; Hickok & Hauser, 2010; Muller & Cant, 2010); the nature of motor representations in the brain cortex and the hypothesis that action understanding obtained through mirror neurons would be a form of knowledge qualitatively different from the propositional and abstract ones (widely discussed in Gallese et al., 2011); the interpretation of the human ability to understand actions that cannot be performed, like the barking of a dog (Rizzolatti & Sinigaglia, 2006; Hickok, 2009; Rizzolatti & Sinigaglia, 2010); the interpretation of neuropsychological evidence about the relationship among motor impairments and action recognition underperformances (with works that uphold one position, for example Moro et al., 2008; Pazzaglia et al., 2008, or the other, for example Negri et al., 2007; Hickok, 2009).

In the end, it is worth dedicating a special mention to the sector of psychophysics, in which researchers investigate cognition and semiosis through probabilistic models (Chater, Tenenbaum & Yuille, 2006; Ingram et al., 2008; Tenenbaum et al., 2011), in particular applying the Bayesian inference to reproduce mental processes and describe it through algorithms (Griffiths, Kemp & Tenenbaum, 2008; Bobrowsky, Meir & Eldar, 2009; Perfors et al., 2011; Fox & Stafford, 2012). Such concepts are currently in use also

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

191 in the Artificial Intelligence (AI) studies[7]. Inside psychophysics, a specific sector
192 concentrates on what follows interpretation, that is confrontation among different
193 "apprehensions" (conscious perceptions); the result of such confrontation is a
194 "judgement", that is decision and conceptualization (Arecchi, 2010a; 2010b; 2010c;
195 2011a). New concepts are introduced to investigate semiosis: semantic and non-semantic
196 complexity (Arecchi, 2008), deterministic chaos (Guastello, 2002; Arecchi, 2011b),
197 inverse Bayesian inference (Arecchi, 2010d), creativity as NON-bayesian process
198 (Arecchi, 2010e), quantum dynamics (Arecchi & Kurths, 2009; Nathan et al., 2012) and
199 the reference to Gödel's incompleteness theorem as a limit to the possibility of
200 understanding cognition "from inside" (since that, while studying cognition, we become
201 a system that investigates itself)[8].
202
203 **Method**
204 All this matter has not yet been adequately cleared; one reason is that there are
205 still structural obstacles of technical and ethical nature[9]. Another difficulty is the

50 [7] The origins of Artificial Intelligence (AI) studies can be traced back to the Thirties and the works of
51 Turing on a possible "intelligent machine". About the origins see Leavitt, 2007, chapters 6 and 7,
52 and Turing, 1950 (the original work of Alan Turing). About the "Turing test" (testing the ability of
53 distinguishing humans from computers through written messages exchanges) see a journalist's
54 account in Christian, 2012. Some materials about recent research threads, closer to our article's
55 topics (like machine learning and natural language or image interpretation), can be found in
56 Mitchell, 1997; Menchetti et al., 2005; Mitchell, 2009; Khosravi & Bina, 2010; Verbeke et al., 2012.

57 [8] See Goldstein, 2006 for a popular-scientific coverage about Gödel and his theorem; Leavitt, 2007,
58 chapters 2 and 3, for a particularly clear synthesis of the theorem and its genesis (in connection with
59 the *Entscheidungsproblem*, i.e. the "decision problem").

60 [9] About the technical difficulties of data collecting: experimental techniques used on macaque
61 monkeys (electrodes direct insertion inside single neurons) return very accurate measuring, but on
62 small brain cortex surfaces. About the ethic difficulties: these techniques are almost impossible to be
63 used on humans, and only indirect techniques as fMRI (functional Magnetic Resonance Imaging),
64 MEG (Magnetoencephalography), PET (Positron Emission Tomography) or TMS (Transcranial

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

206 complexity of natural language (its "equivocal" nature, see De Mauro, 2003 and Footnote
207 1), usually overcome through a laboratory approach, i.e. studying interpretation isolated
208 from the interpreting organism and employing simple stimuli (single words, simple and
209 very short phrases; for instance Bedny & Caramazza, 2011). Such approach entails
210 limitations (underlined, for example, in Pulvermüller et al., 2014, specifically Pag. 80,
211 Chapter 7) that might undermine the research conclusions. In short: a message is not just
212 a bunch of words, and the the question of interpreting a message cannot be considered as
213 satisfactorily cleared through adding up the interpretations of isolated words. On the
214 contrary, studying interpretation in the actual conditions it is usually performed
215 (interpretation of messages) could bring something new to our knowledge.

216 The methodological aspect is crucial, and we delved a little further into it. Some
217 of the mirror neurons discoverers and theorists have expressly tackled such aspect and
218 highlighted that one strong point of the neurophysiological research that led to such
219 discovery is the researchers' preference for a naturalistic-like approach: they let observed
220 macaque monkeys freely interact with available objects, rather than stimulate them with
221 selected artificial stimuli only (Rizzolatti & Sinigaglia, 2006, p. 3). About the
222 reductionism question, and the distinction between methodological and ontological
223 reductionism, see Gallese, 2000, p. 26, and Gallese, 2009b; Gallese, 2010. Opposite to

67 Magnetic Stimulation) are systematically employed. They cover wider brain cortex surfaces but with
68 inferior accuracy; moreover, they present difficulties with regards to instrument positioning and
69 image interpreting. For a survey of these difficulties see Rizzolatti & Sinigaglia, 2006, chapters 2, 6,
70 7, and Rizzolatti & Vozza, 2008, *passim*. A recent thread of research is investigating the connections
71 among single neurons activity and the total effects detectable through indirect techniques (see
72 Iacoboni, 2008, chapter 7). In addition to all this, data interpretation and comparing are intrinsically
73 difficult, given the differences in macaque and human brain cortex and the associated problem to
74 check reliable correspondences.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

these stances, Pascolo & Budai, 2013, which disputes the monkeys' actual freedom in the experiments and the same existence of mirror neurons in humans.

From our point of view, we had in our background two works about interactions inside online collaborative groups (Maffei, 2006; Maffei, Cavari & Ranieri, 2007) which let us appreciate the potential of scientific observation on real-world communication cases. Thus, for our research, we tried a naturalistic approach, designing observations in conditions the closest as possible to the natural ones. On these bases, we designed field research on a random 102 adult sample, challenging them with a real world-like written communication case, using complete and unabridged message texts and collecting the participants' interpretations through a specially designed questionnaire. Further details about method in the Supporting Information, Section 0; a full documentation of the survey process, containing research guide-lines, case description and research protocol, as well as the questionnaire, in the Supporting Information (SI) Sections 1, 2, 3, 4 and Section 5 with Tables S1, S2. In addition: a description of the sample and of the sub-samples drawn from it for control purposes in SI Section 6 with Tables S3-S5; some quantitative aspects of collected data in SI Section 7; quality check of the collected data, their compliance with the research necessities and their suitability in SI Sections 8 and 9 with Tables S6, S7 and Fig. S1-S3.

It is worth specifying that the study of meaning and interpretation at behavioural as well as neuronal level implies the use of indirect techniques: the meaning is not something that can be directly measured and interpretation is a process that occurs inside the brain and/or the body in ways that cannot be directly observed; for this, just indirect

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

246 approaches are available. Our research represents no exception; our indirect approach has
247 been based on the participants' accounts for their own interpretations immediately after
248 they had read the submitted messages. Naturally, such conscious accounts cannot be
249 considered an exact report of the actual interpretation process, given the possibility that
250 they are unconsciously biased. Indeed, by one hand, we have employed these data to
251 investigate correlated but different aspects; by the other hand, we have checked them
252 with other data and analyses in order to verify their real contribute to the research's goals.
253 Our work is not a clinical trial and no experimentations on the participants took
254 place. Our sample was not recruited in hospitals or any other institution; we gathered it
255 through the conductors' personal relationship network (details on sampling and survey
256 modalities in SI Section 3, particularly points 10.-13.). In addition, no personal data was
257 collected or anyhow involved in the survey. Through our questionnaire, we just
258 collected, in a strictly anonymous way (details here below and in SI Section 3), the
259 participants' opinions about an exchange of written messages, in order to investigate the
260 process of message interpretation. The submitted case was a fiction closely resembling
261 some real cases the authors had dealt with in their professional activities; its contents
262 were totally neutral with regards to the participants' lives and environments and did not
263 touch any sensitive subject. For these reasons, our research did not involve any critical
264 issue related to ethics; we anyway requested, and obtained, the approval of the Ethics
265 Committee for Scientific Research of the Association ARPA-Firenze. The Committee
266 held a dedicated session to our research (in 2012, april 2d) and its approval was given

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

through a formal decision documented by the session's official report, signed by all the Committee's members and filed in the Association's archives.

About the **informed consent** of participants, it was necessary not only for ethical, but also for technical reasons: since the answers to the questionnaire's questions were handwritten by participants (directly on the submitted forms), the research should have been impossible without a conscious, voluntary participation to the survey. Participants (all of them were adult) received written information about the research through the title-page of the questionnaire (SI Section 4), being invited by the conductors to carefully read it. After such reading, their consent was requested and obtained verbally. The reasons why we did not collect written consent lie on the sampling and data collection procedure, designed to fully guarantee the participants' anonymity (see also the research protocol in SI, Section 3). By one hand, the technical features of data collection and the personal relations among participants and conductors prevented any possibility of unwilling contribution. By the other hand, a written consent would have implied a general database, whose creation and management would have increased the risks of an accidental information diffusion. Instead, our procedures made it impossible for everyone, all along the research work (and the same is at present and will be in the future), either to trace back participants by starting from the filled questionnaires or to recreate the participants' database. Along with its approval of the research guide-lines, the Ethics Committee for Scientific Research of the Association ARPA-Firenze approved also this informed consent procedure.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

We set two objectives for our research: (1) To understand the process of interpretation (i.e. how messages in natural language are turned into meanings by receivers) as it works in real conditions and design a structural model in order to adequately represent it; (2) To produce a first check of the formulated hypothesis. Consequently, we have divided our research into two parts: the first one is referred to Messages #1, #2 and #3 of the case and to Questions #1 and #2 of the questionnaire; it is mainly (even though not only) qualitative, investigates the process of taking into account a message and turns into a hypothesis (a model of the interpretation process). The second part is referred to Messages #4/H, #4/S and #5 of the case and to Questions #3, #4 and Final of the questionnaire; it is quantitative, focused on a decision to be taken about a reply to send, and represents a first check about our hypothesis. See SI Section 4 for the messages' and the questions' texts.

The first part of the research: observing and hypothesizing

The first level of our analysis regarded our research's first part and yielded something expected and something unexpected. We remind that each questionnaire's question sent two inputs to the respondents: at first, they were requested to freely interpret some aspects of the submitted messages; then, they were requested to account for their own interpretations through indicating the “concrete elements” on which these were founded. Data related to the first input provided, through a qualitative analysis, the main expected outcome: the scatter of the participants' interpretations. Data from the second input provided, through a quali-quantitative analysis, the main unexpected

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

outcome: the possibility of an intermediate, unpredicted step following text decoding and preceding text content processing.

Answers to the questions' first input: qualitative analysis. These answers have fully confirmed the expected wide scatter of the respondents' interpretations. About interpretation scatter, we have quoted an example (taken from Hickok, 2009) in our Introduction. In addition, some descriptions, referred to special cases and entailing divergence of interpretations, can be found in Bara & Tirassa, 1999; Sclavi, 2003; Campos, 2007[10]. Inside our research, the answers to Question #2 provide us a specific example. Firstly, we asked participants if, through comparing Message #3 to Message #1, they found the attitude of XX (the sender) toward YY (the receiver) being changed (SI Section 4 for the messages' and questions' texts). Then, to the 61 who answered "YES" (60% of the sample), we asked to specify how they would define the new XX's attitude. They provided 83 specifications: 64 stated XX's position as strengthened, 12 as weakened and 7 unchanged (although these seven, too, had answered "YES" to the first part of Question #2). In addition, we can find completely opposing statements in these specifications and we can see that scattering covers very different aspects of the XX-YY interaction (behaviours, emotions and so on, Table 1).

Such a phenomenon can be observed for all the messages and for any part of them, even if accurately selected: it is impossible to find parts of a message that are interpreted in the same way by all the participants. The observed interpretation scatter

[10] Specifically: Bara & Tirassa, 1999, pp. 4-6 (communicative meanings as joined constructions); Sclavi, 2003, pp. 93-98 (the "cumulex" play); Campos, 2007, pp. 390-394 (analysis of a real communication event).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

can be represented through a "megaphone-shape" picture (Fig. 1): receivers take into account the same information but their final interpretations diverge[11]. We named this phenomenon "classic interpretation scatter" and tried to delve further into it. We made a first attempt using a semantic approach: we considered the respondents' answer texts like semantic sets to be investigated through pre-defined categories of meaning. After several tries, we abandoned such approach realizing that, whatever category set we used, too many exceptions, not-decidable cases and ambivalences we found (what confirms the "equivocal nature" of human language, see Footnote 1).

Answers to the questions' second input: quali-quantitative analysis. These answers contain the "concrete elements" respondents have indicated as the basis of their interpretations. We found the following categories of concrete elements:

- Summaries of the message texts and syntheses of their information content, presented through respondent's own words.
- Quotations between double quotes, referred to selected words, full phrases (or parts of them) or periods. Such kind of indications have been provided also through pointing the beginning and the ending word of the quoted strings ("from… to…"). The string length could cover up to a whole paragraph of the message (from a keyboard "Enter" to the following).

[11] In the exact same way of the example drawn from Hickok, 2009 and presented in Introduction: in that case a physical action is described as interpretable in very different ways (by different observers as well as by only one who is observing from different points of view). However, there is no question about the action *per se*. In our case, the reading of the same message by different people evokes very different interpretations; however, the message information content cannot be under question (being the message typed and having a unique editing).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

- Incidental strings, meaningless *per se*. Such strings were extracted from original full phrases and quoted isolated from the rest.
- Complement/accessory parts of the text: punctuation marks[12], personal or professional titles used in the opening, the salutes used in the closing etc.
- Items unrelated to the text semantics or to the message content; a tight selection is presented in Table 2. The list is indefinite, given that each item generally appears at low frequency while the range of possible items is extremely widespread. Items of this kind are actually unpredictable; even the **lack of some content** can be focused and reported as a source of meaning (Table 2, final row).
- References to some overall effects produced by the message on the respondent (see SI Section 8.a, final part, for details). In fact, in this kind of answers respondents state they cannot indicate any "concrete element"; the meaning they have attributed derives from a "general impression" received from the message, from the message's "general tone".

In such analysis we have tackled the answers like something *physical*, rather than semantic, and have treated their texts independently of their content and meaning. Doing so, we have seen that the meaning can spring from parts of the message bereft of any intrinsic content, from aspects external to the text and even from the lack of content itself. In short: whichever the message, the source of its meaning can lie anywhere; this

[12] In one of the two pilot-sessions of the survey, one message contained an exclamation mark; it was specifically identified, and noted as a meaningful component *per se*, by one of the participants. For this reason, it was removed in order to limit influencing respondents. In fact, other respondents successively picked up, from questionnaires now bereft of that exclamation mark, quotation marks (used in certain passages of the submitted messages) as a meaningful component *per se*.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

368 was unexpected. In truth, the idea that the interpretation of a message is a question far
369 overtaking its pure words is widely investigated with regards to spoken communications;
370 this is reasonable if we consider the possible added signals, like non-verbal language and
371 context stimuli, in such situation (see, for example, Horchak et al., 2014, specially the
372 concept of "situated cognition", and Gibson, Bergen & Piantadosi, 2013). It has been
373 quite surprising to discover it in written communications, that are totally bereft of such
374 added signals; there was something else, in this matter, and it did not seem a simple
375 question of added information. Indeed, our impression that the meaning attributed to a
376 message can lie "anywhere" should be taken into a literal account: it seems impossible to
377 previously write up a "complete" list of the features that could become sources of
378 meaning, given that any new reader can introduce new subjective criteria and detect new
379 sources, totally unpredictable for the other readers. The question now is: how does all
380 this work? How can we describe, and model, the process of interpretation, subjected to
381 such uncertainty?

382 In order to answer these questions, we named "components" the items indicated
383 in the answers to the questions' second input and went back to the questionnaires in order
384 to tally the components present in our survey. We have tallied a total of 1,319
385 components clearly indicated by participants and we have displayed in Table 3 their
386 absolute and relative amounts. Indications that clearly focus on the information content
387 constitute only a small minority (around 12%, see Table 3, "%" row, "Cont." column)
388 while references to different text components reach, on the whole, about 65% (Table 3,
389 "%" row, sum of the first five column totals). The indications referred to some overall

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

effects of the message represent about 15% of the total. About the meaningless components (void of content *per se*, mere "form" components), their relative amount can be estimated in at least 35% (holding together symbols, incidental passages, other components and grammatical notations).

In order to verify our statement, we firstly carried out some distribution analyses about the components. Such analyses return a picture without any significant imbalance: by one hand, the distribution of the provided indications results uniform with respect to the different questionnaire's questions (Fig. 2) and almost regularly shaped with respect to the types of the components (Fig. 3). By the other hand, the sample distributions with respect to the amount of the component types employed (Fig. 4) and with respect to the total indications provided by each respondent (Fig. 5) result in "bell curve" shapes. Secondly, we have further checked our quantitative analysis; we considered that references to full sentences or periods (20.9% in the total) could be another way used by participants for indicating contained information. However, even in such case the sum of the two components would occupy just one third (exactly, 33.1%) of the total indicated components. Still unsatisfied, we carefully re-examined the filled questionnaires about the information content component. We found (Table 4) that one half of the sample (51 people) expresses, among the others, at least 1 reference to such component (no recordable similar hint by the other half). However, only 7 respondents provide a balanced or prevalent amount of indications (50%, or more, of the personal total) about information content. Among them, only one reaches 100%. In fact, references to the information content are a definite minority in participants' indications.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

412 In synthesis: our observations do not match the concept of interpretation like a
413 sequential taking into account of the message's content along with its conscious
414 processing. Rather, the emerging picture is the following:

415 ▪ The interpretation process looks to be starting like a selective and subjective
416 picking up of (or focusing on) the most different components, rather than be-
417 ing a systematic, conscious scanning of the text's content. Such behaviour is
418 widely scattered: in the whole research, with regards to each specific message,
419 it is impossible to find two identical combinations of focused on components.
420 ▪ Readers seem to interpret a message indifferently picking up meaningful and
421 meaningless components and subjectively combining them. While reading and
422 text decoding go ahead sequentially, readers go on freely (randomly, from an
423 external observer's point of view) isolating "chunks" of the text (as well as
424 other components and even external context aspects) and selecting them as the
425 foundation of the message's meaning.
426 ▪ While the final meaning attributed to the message is justified through the se-
427 lected components, no reason (at all, in any cases) is provided for that selec-
428 tion: in the respondents' accounts, the focused components suddenly appear;
429 they are presented just as "given", and without any doubt[13].

430 At this point, we named "disassembling" the observed selective focusing and took
431 two measures. At first, we hypothesized a new image for the interpretation process,

109 [13] The unique doubt expressed in the whole research is the following: 1 participant (out of 102)
110 declares uncertainties in his final choice writing that the final effect could be obtained with both the
111 messages under choice. It must be noted that, with regards to the other questions, also this special
112 participant's answers are totally doubt-free, like the rest of the participants' ones.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

inverted with respect to the "megaphone-shape" (Fig. 1) one. Our argument was that, if scatter manifests itself in the beginning (scattering of focus), a "funnel-shape" picture (Fig. 6) could be more suitable: people that select one same component are expected to interpret it in very similar ways. Secondly, we picked up from our data an example of disassembling and decided to carry out an in-depth analysis of it.

A disassembling example in detail and a perceptual hypothesis. Question #1 requests evaluations with regards to sender-receiver positions and to the relationship between them, on the basis of Messages #1 and #2 (SI Section 4 for the messages' texts). We found that 53 people (52% of the sample) had quoted an expression the sender (XX, see SI Sections 2, 4) used in Message #1[14]: she premised her request of a technician inspection with the words "we would be pleased if at least once…". This simple expression, apparently trivial (also short, 8 words in a 67 word message, and in no way highlighted in comparison to the rest of the text), has collected 68 quotations (15 people expressed two, see Footnote 14). Then, respondents have given such specific passage at least 22 divergent interpretations, summarized in Table 5.

This means that focusing on the same component does not imply convergent interpretations. As much as to say that the interpretation scatter manifests at both levels: the disassembling (scattering of focusing on components) and the following attribution of meaning (each sub-group, focused on a same component, provides scattered conscious interpretations). This means also that the "funnel-shape" picture, too, must be revised: what we observed could be better expressed through an "hourglass-shape" picture (Fig.

[14] The 53 people have expressed their interpretations answering Question #1-a (23), #1-b (15) or both the questions (15). See SI Section 4 for the questions' full texts.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

7). In fact, disassembling and classic interpretation scatter would co-exist and manifest themselves **in sequence**. We notice that the expression we are considering appears to be a minor element in Message #1 text, something incidentally expressed; it is composed using common words and bears no inherent information content (once the passage gets isolated from the rest of the message, it is impossible to attribute it a definite meaning). In short: it is a mere form component. So, how could respondents select such incidental passage? And what did they, exactly, grasp in it? What is more, given that the following interpretations are scattered, what did respondents, exactly, interpret, having started from an identical, spontaneous selection?

Now, the message we have used in our research was always the same, invariable with regards to written form as well as to information content. Thus, if the interpretations of the readers are so scattered, this cannot depend on the message itself, it must depend on the readers: they evidently give an active contribution in attributing meanings, they are not passive symbol decoders. Nothing new, so far: our observations confirm old ideas, for example the ones that the constructivist hypothesis proposed many years ago (Watzlawick, 1984). The question is: how can this happen? By one hand, respondents explain through the outcomes of "disassembling" the conscious attribution of meaning that follows; by the other hand, no accounts report about the source of disassembling. The selective focusing manifests "immediately and automatically", apparently preceding and feeding the conscious processing that follows, and that is all.

At this point we felt we had elements enough to draw a conclusion and propose a hypothesis. The first part of the observed process ("disassembling") does not resemble

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

any information processing, symbol treatment or sign decoding; it rather looks like a **perceptual scheme**. We mean that, if we hypothesize that the components are focused because they firstly act like "physical" **stimuli**, triggering automatic reactions off ("body" level) in the receivers, then the observed phenomena will become comprehensible. The main points of our hypothesis are the following:

- Considering interpretation as a process, decoding of written signs must be its first step, for turning them into words. Decoding is the "technical" aspect of reading, not directly linked to meanings and just feeding the following steps.
- Along with the sequential decoding, words and the other message components would immediately act like stimuli, triggering a receiver's automatic reaction off ("body" level). This would be the second step, i.e. disassembling. Its results would be different from a person to another given that the capacity of a component to act like a stimulus depends on the subjective reactivity of each receiver.
- Then, the conscious processing of the collected inputs would start. Being the steps set in a cascade, the "input" on which this third step would be carried out should (mainly, at least) consist of the automatic reaction's outcomes, not of the source message's content.

Our hypothesis is that the interpretation process structure can be represented with a three-step (three sub-processes) model like the one in Fig. 8. It gives account of how respondents focused on the incidental passage and what they grasped from it: they automatically reacted to a stimulus (presumably through some unconscious connections

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

497 with previous experiences that had involved something similar) and such stimulus
498 oriented the following conscious process. One more question remains: exactly, how can
499 we precisely identify what a reader picks up when he/she selectively focuses on
500 meaningless/contentless components? We think we can label it as **the fact that** one of
501 these components is present in the message; it can be considered some meta-information
502 to which readers can automatically react even though it is not embedded inside the
503 message words (Table 6). This clarifies which aspect of the incidental passage ("we
504 would be pleased if at least once…") has triggered the participants' reaction off: the fact
505 that XX had (redundantly) placed it in a certain point of the message[15].

506 In synthesis: interpretation process would firstly consist in a re-experiencing of
507 past situations through an analogical resounding at body-level, thanks to a stimulus-
508 reaction mechanism triggered off through perception. Such reaction would feed forward
509 (presumably through proprioception) the following attribution of conscious meaning to
510 the subjective experience (rather than to the source message).

511

512 **The second part of the research: checking the hypothesis**

513 Our research's second part represents a first check about our hypothesis. We
514 started submitting to participants two alternative versions (Messages #4/H and #4/S) of a
515 possible reply to Message #3. Then we asked them to, firstly, interpret (independently)
516 the two versions (Questions #3 and #4) in terms of their effects on XX; secondly, to

123 [15] It is particularly interesting to note that the expression "the fact that…" is spontaneously used by
124 several respondents in their answers. For example, in the collected questionnaires we can find
125 expression like the following: "the fact that the arguments are presented through a dotted list"; "the
126 fact that XX is referring to public money".

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

choose between them (Final question) the one suitable, in their opinion, to origin the final XX's answer (Message #5, that seals the positive ending of the case; see SI Section 4 for messages' and questions' full texts; Section 5 and Tables S1, S2 for details about the reasons of the alternative). Our rationale was the following: the participant's choice could come as a result of the text information's conscious processing (cognitivism stance) or as an automatic reaction independent of every conscious processing (embodied cognition stance). In the first case (our "Hypothesis 0"), the final choices should be outcomes of the interpretations given to the messages; thus, they should result somehow correlated with them. In the second case, no correlation, or a different kind of correlation, should be found (our "Hypothesis 1"). The problem emerged of measuring such correlation.

The coherence between interpretation and choice. Firstly, we displayed (Table 7) the choices indicated by the sample members (SI Section 6 and Tables S3-S5 for the sub-samples description) and found out a strong imbalance between "S" and "H" indications. Secondly, we compared the interpretations of Message #4/H with those of Message #4/S (SI Section 4 for messages' full texts). Source data (opened answers) was purely qualitative. However, answers were easily classifiable into two main categories: predictions for the message inducing a solution of the case (easing or solving the emerging conflict between the interlocutors); predictions for the message inducing a surge, or escalation, in the conflict. We created the dummy variable "Expected effects" and assigned it two values: "+" in the first condition; "-" in the second one. Then, we labelled each questionnaire with two new symbols: one referred to Message #4/H (H+ or H-) and one to Message #4/S (S+ or S-). The combination of the two symbols indicates

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

539 the combined predictions each participant expressed about the effects: H+/S+ (both the
540 messages solving the conflict), H+/S- (Message #4/H easing the conflict while Message
541 #4/S escalating it), H-/S+ (the opposite), H-/S- (both escalating). Finally, we arranged the
542 symbols into a dichotomous table (Table 8). There is a clear convergence on combined
543 prediction "H-/S+"; the Chi-squared test highlights, at this first stage, that some
544 correlations between "H" and "S" interpretations could exist (p = 0.001988, total sample;
545 p = 0.015600, sub-sample "AGE"; p = 0.003861, sub-sample "EMPLOYMENT"). Given
546 that the messages' presentation sequence was counterbalanced (see SI, Section 3, Point
547 9), it is unlikely that the respondent's first interpretation can drive the second; probably,
548 some other factor drives both of them.

549 Then, we cross-checked the combined predictions with the final choices (Table
550 9). The most frequent combined prediction (H-/S+) appears to be strongly associated to
551 "S" choice; indeed, the significance tests (Chi-squared) show that some further relations
552 do exist between combined predictions and choice (p = 0.000017, total sample;
553 p = 0.001174, sub-sample "AGE"; p = 0.000383, sub-sample "EMPLOYMENT"). Such
554 results led us facing the core-question related to our hypothesis: given the existence of
555 some correlations between choice and combined predictions, which is its direction? We
556 mean: do the interpretations (the predictions) drive the choice (cognitivism stance) or,
557 oppositely, does the choice precede and somehow drive, or overcome, the interpretations
558 (embodied cognition stance)? To delve further into such subject, we created a "coherence
559 indicator" starting from the following premises (SI Section 4 for messages' full texts):

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

- The final Message #5 clearly indicates XX's satisfaction; therefore, the conflict has come to its end.
- Now, let us figure a respondent whose answers to Questions #3 and #4, for example, return a combined prediction H+/S- (Message #4/H solving the conflict, Message #4/S escalating it). Then we expect that this respondent indicates Message #4/H in his final choice (answer to Final question). Such combination (H+/S- & "H" choice) would represent the maximum coherence level.
- If another respondent provides the same combined prediction but indicates Message #4/S in his final choice (combination H+/S- & "S" choice), this would represent the minimum coherence level.
- Given the natural variability always recorded in human samples, we expected to find also intermediate coherence levels, based on the other possible combinations (H+/S+ and H-/S-). These could be also due to the predictable scattering of interpretations about the final Message #5: someone could interpret it as something different from the sign of the conflict's ending (what happened in a fistful of cases).

We defined four coherence levels, increasing from L (low) to LM (low-medium), MG (medium-great) and G (great); the scale is fully presented in Table 10. In this way, it has been possible to study the final choice with respect to the coherence levels (Table 11). The percent distribution histogram of the whole sample (Figure 9, data from Table 11) shows that the distribution is the expected one except for the frequency of the low

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

582 coherence bin, over-represented. Actually, we expected L frequency to be null or very
583 close to null; anyway, it should show the lowest frequency of all. On the contrary, we
584 found L values higher than the LM ones and representing 11% of the sample.

585 At this point, we refined our analysis through separately analysing distributions
586 of "H" and "S" choosers; for the reliability of comparison, we excluded data referred to
587 the respondents having just primary education levels (only 4 out of 102 in our sample).
588 Data is displayed in Table 12, 13, 14, which show a surprising asymmetry whose
589 significance is confirmed by Chi-squared tests (always $p<0.01$). Graphic representations
590 render even better such asymmetry: the total sample histograms (Fig. 10, percent
591 distributions from Table 12) show that the percent frequency of "S" choosers (white
592 bins) increases regularly from L category to G, reminding (as expected) of certain power,
593 or exponential, curves. At the opposite, the percent frequency of "H" choosers (grey
594 bins) is arranged in an irregular, almost bimodal shape. We checked these distribution
595 shapes by using many different sub-samples (selection displayed in Fig. 11-16), included
596 the already mentioned "Age" (Fig. 15, data from Table 13) and "Employment" (Fig. 16,
597 data from Table 14) sub-samples. We always obtained the same significant imbalance.

598 Now, Chi-squared tests and graphic representations clearly indicate the existence
599 of a correlation between the participants' choice and the coherence level; but what about
600 its strength and its direction? In order to investigate the strength, we calculated the odds
601 ratio. Our success item was the L level, our failure items all the other levels of coherence.
602 Using data from Table 12, we can find ODDS1 = 0.346 ("H" choosers, 1 success every
603 about 2 failures) and ODDS2 = 0.028 ("S" choosers, 1 success every about 36 failures).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

604 The final result is ODDS RATIO = 18,9 which highlights a strong correlation between
605 the “H” choice and the L coherence level. As much as to say that, if you choose message
606 #4/H, it is much more likely (with respect to message #4/S choosers) that your choice is
607 inconsistent with your interpretations of the two messages. About the direction of such
608 correlation (the interpretations precede and drive the choice or the choice is independent
609 of interpretations), we think the first position is not tenable; indeed, it could be confirmed
610 just in case of general consistence between interpretations and choice.

611 All this contrasts our “hypothesis 0”: the participants' choice does not seem to
612 come as a result of the text information's conscious processing. Then, the choice should
613 be independent of the previous interpretations, what upholds our “hypothesis 1”. After
614 this first conclusion, we set up a second indicator (“block preference” indicator) to
615 further check our hypothesis. For text length reasons, we present details about the
616 indicator, its employment and relative analysis in SI, Section 10 with Tables S8-S11. No
617 contradiction has been found with the previous results.

618

619 **Discussion**

620 We will start our discussion summarizing our main findings. Then, we will
621 situate our work in the current scenario of scientific research; finally, we will discuss
622 some possible consequences of our results and indicate the possible directions in which
623 this study could be developed.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

624 *Summary of the research's main findings*. The following points synthesize our
625 interpretation of the interpretation process, upheld by our work's experimental outcomes
626 (specified in italic).

627 ➢ In all circumstances, the interpretation of natural language is a complex,
628 global experience not reducible to the interpretation of isolated spoken or
629 written words. *Reference to our qualitative analysis of the participants'*
630 *answers to the first input of the questionnaire's first part questions*
631 *(specifically: description of the message non-word and meta-information*
632 *components, that prevail over verbal components and firstly orient the*
633 *reader's interpretation)*.

634 ➢ After decoding, a random, selective focusing on the most various and
635 unpredictable components of the message ("disassembling") starts, preceding
636 the conscious processing of the information content. *Reference to our*
637 *qualitative analysis of the participants' answers to the first input of the*
638 *questionnaire's first part questions (specifically: observations about the*
639 *sudden appearance, extreme subjectivity and unexplained origin of the widely*
640 *divergent and unpredictable selected components).*

641 ➢ "Disassembling" looks like a stimulus-reaction mechanism, rather than an
642 information treating process. *Reference to our quali-quantitative statistical*
643 *analysis of a disassembling example (the case "we would pleased if at least*
644 *once...") drawn from the participants' answers to the second input of the*
645 *questionnaire's first part questions*.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

- Each message component would at first work like a physical stimulus, rather than an information carrier; in other words, it would trigger an automatic reaction off (body level) before the conscious processing of information content starts. *Our hypothesis, consistent with the data we collected, suitable to give account for our observations and compatible with the current research scenario.*

- Since "disassembling" feeds forward the following step (conscious processing), it orients the attribution of meaning: conscious interpretation would be carried out on the body's reaction, rather than on the source information. *Reference to our quantitative statistical analysis of the participants' answers to the questionnaire's second part questions (coherence indicator, coherence level distributions and related significance checks; block preference indicator and related analysis)*.

- After disassembling, the receiver's contact with the original message would be lost[16]. C*onsequence of the "in a cascade" setting of our model's three steps (further details, with direct references to recent scientific paper consistent*

[16] Our data led us to conclude that such contact can be recovered (like a sort of "fourth step" after the basic three of our model) only later and just in peculiar conditions; however, this is another story and, in this article, we will not delve further into it. In our research, one example of this can be the intervention of XX's colleague in the case. Even though the used case is a fiction, it is very close to observed real cases, in which the process can be described as follows: an expert, after **text decoding** (first step), detects an issue through **becoming alarmed** (automatic reaction, second step). Then, his/her feelings come to conscience and lead him/her to **consciously attribute** that text a negative assessment (third step). At this point, he/she starts the **in-depth analysis** of the case (our presumed "fourth step") through recovering the source message and studying it from a different point of view and through a different approach. The final result is the expert's solution of the case.

with such conclusion, in next paragraph, which situates our work in the current scientific research scenario).

- The final outcome of the whole 3-step process is the meaning consciously attributed to the incoming message and expressed by the receiver through natural language.

Situating our work in the current research scenario. Scientific research of present times is, naturally, swayed by the confrontation between cognitive and embodied hypotheses. The "cognitive field" frequently engages the noun-verbs dissociation problem, studying it through researches on cortically damaged, selectively impaired patients; such studies are mainly aimed to define the nature of the concepts' representations in the brain cortex (lexical or semantic, lexico-semantic dissociation issue), and to cortically map it (for example Crepaldi et al., 2006; Arévalo et al., 2007; Moseley & Pulvermüller, 2014; Gallese, 2014). Conversely, the "embodied cognition field" mainly go searching for the connections between language and its motor correlates, one well-known of which is the ACE (Action-sentence Compatibility Effect), often checked through measuring and comparing the reaction times collected during language-and-action combined match-advantage experiments (see for example Vitevitch et al. 2013; Horchak et al., 2014). Such studies are frequently carried out through neuroimaging works (for example Tettamanti et al., 2005; Aziz-Zadeh et al., 2006; Speer et al., 2008; Aziz-Zadeh & Damasio, 2008).

We have already reminded, in the Method section, the methodological aspect we consider common to the two research lines: they both use, during the experiments, words

684 and short phrases isolated from every context (see, for example, Bedny et al., 2008;
685 Bedny et al., 2012, especially the Method sections; and, for some critical reflections
686 about the question, the already cited Pulvermüller et al, 2014, specifically Pag. 80,
687 Chapter 7). Such methodological aspect elicits a further consideration: there is a cross-
688 concept widely and implicitly shared by cognitivism and embodied theories, namely the
689 idea that the meaning is something embedded inside words. These would work somehow
690 like "carriers" of meaning and interpretation would consist in the "extraction" of
691 meaning from words (actually, the verb "to extract" is overtly used in scientific
692 publications, for instance Mahon & Caramazza, 2011).

693 The divergence between the two approaches can be synthesized as follows (for
694 further reference see, for example, Bedny et al., 2008; Rizzolatti & Fabbri-Destro, 2008;
695 Goldman & de Vignemont, 2009; Gallese, 2011; Gallese & Sinigaglia, 2011b; Bedny et
696 al., 2012): cognitivism upholds the sequential processing idea, i.e. cognition being
697 conceptual and resulting from a sequence of perception / symbolic processing of the
698 incoming information / (motor) reaction. Oppositely, the embodiment theories uphold the
699 concept of direct connections among cortical sensorial and motor areas ("sensorimotor
700 grounding" of cognition, Guan et al., 2013). In this sense, cognition would be
701 embodied[17]. Now, how could our work be positioned in such picture? In a third position,
702 we would say. In fact, both theories are based on the implicit idea that human
703 communication is a continuous, homogeneous process. On the contrary, we hypothesize

155 [17] Such embodiment, inside the same embodied cognition field, can be conceived in different ways: it can
156 stand alone, *per se* resolving the problem of knowledge ("sensorimotor processing underlies and
157 constitutes cognition", Guan et al., 2013), or can be a "motor representation" that accompanies conscious
158 knowledge processes (the two kinds of knowledge proposed by Gallese, for example in Gallese et al.,
159 2011; see also Gallese, 2014).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

704 discontinuity, with the interpretation process made-up of three discrete, in-a-cascade
705 steps which can result compatible with both ideas.

706 Actually, in our opinion, the embodied concept's features are clearly akin to our
707 second step ("disassembling", see Fig. 8): an immediate and automatic reaction that
708 precedes conscious processing of information. This last (our third step, Fig. 8) is clearly
709 akin to the cognitivist hypothesis, that refers to a conscious processing of the inputs with
710 subsequent conceptual output. We must add that such overlapping is just one aspect of
711 the question; our proposal entails at least one important difference with respect to the two
712 theories: the discrete, in-a-cascade structure of our process implies a feeding chain, with
713 the first step (decoding) that feeds the second (disassembling) which, in turn, feeds the
714 final one. This results, after "disassembling", in the loss of the contact with the source
715 message and in the conscious processing performed on the body-reaction signals
716 (presumably received through proprioception). The real object of our (first level, see
717 Footnote 16) knowledge would not directly be the outer world; rather, it would be our
718 instinctive reactions to it (the outer inputs combined with our inner world). This is a
719 relevant point, and we have selectively examined some of the available literature for a
720 first check of it.

721 Conscious thinking following (rather than preceding) "body" reaction can be
722 traced back up to the hypotheses of Nineteenth Century philosopher and psychologist
723 William James. In one of his examples (the "James's bear", see James, 1890, Chapter
724 XXV), James explains his theory of emotions suggesting that, for example (our
725 synthesis), we do not run away from a bear because we see it, we know it is very

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

726 dangerous, so we are scared of it and, consequently, we consciously decide to run away
727 (as common sense would sustain). Conversely, we feel like we are afraid because
728 (consciously and successively) we discover our body having started a desperate run. In
729 other words: what we call "emotion" is usually intended as a body reaction consequent to
730 the rational processing of consciously perceived environmental stimuli; James suggests
731 that the body reaction follows perception immediately and what we call "emotion" is the
732 consciousness of the new body state (a form of self-consciousness). We are aware that
733 James's theory (exactly: James-Lange theory) has been criticized and opposed through
734 several alternative theories (for example Cannon, 1927; Schachter & Singer, 1962);
735 nevertheless, we do refer to it because recent scientific research and reviews seem to
736 suggest some re-consideration of the matter (for example, Friedman, 2010). We will not
737 deepen the question here; however, we feel that James-Lange's intuitions could deserve
738 another chance.

739 In Twentieth Century, we can find the Gregory Bateson's approach to human
740 communication as a system and to the question of the receiver's active role; he uses a
741 strictly formal presentation (see Bateson, 1972, in particular Chapter 4.8 on the logical
742 categories of communication, founded on Russel and Whitehead's theory of logical
743 types). In addition, we remind of a group of theories and models (which repeatedly refer
744 to Bateson's studies) that tackle the question mainly from a pragmatic slant: the so called
745 "pragmatic models" (Berne, 1961; Watzlawick, Beavin Bavelas & Jackson, 1967;
746 Bandler & Grinder, 1975). Conceived inside a psychoanalytic context, they all put
747 perception and stimuli at the centre of their attention and reverse the relationship between

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

748 action and thought using action (rather than thought) to induce training and therapeutic
749 effects[18]. We find no important contradictions among our hypotheses and such models;
750 rather, we find complementarity: they show how physical stimuli can act like messages;
751 our results tell that words (even if only written) can act like physical stimuli. In addition,
752 we can propose an explication of an unsolved point related to them: the biological
753 foundations of the "aspect of relation" in human communication (Watzlawick, Beavin
754 Bavelas & Jackson, 1967). On the basis of our results, this aspect could be exactly the
755 body-level automatic reaction which precedes the conscious information processing.
756 About the relevance of unconscious processes in human behaviour, some
757 fundamental clarification is provided by Custers & Aarts, 2010 through a review of
758 experimental works that re-examines the disputed question of the passage from
759 perception to action. The authors compare the traditional positions of Sensory-motor
760 Principle (SMP, for example Massaro & Cowan, 1993; and, for a presentation and
761 discussion about the sequential processing of stimuli conceived as the foundation of
762 human/environment interactions see also Rizzolatti & Sinigaglia, 2006, chapters 1, 2)
763 and Ideomotor Principle (IMP, Stöcker & Hoffmann, 2004; Pezzulo et al., 2006; Melcher
764 et al., 2008; and, for a synthesis, Iacoboni, 2008, Chapter 2, pp. 56-57 of Italian edition).
765 In so doing, they show how certain stimuli (images, solid objects or even written words),

166 [18] By one hand, it is worth mentioning a special work coming from NLP founders (Grinder & Bandler,
167 1979): it appears different from the work that founded this theory (Bandler & Grinder, 1975) and
168 that has successively been developed by NLP specialists (for example Dilts, 1998). As a matter of
169 fact, that work gives a central role to perception and to physical stimuli (not mediated by language)
170 as a possible communication and therapeutic instrument (see, in particular, the concept of "sensorial
171 anchors" in Grinder & Bandler, 1979). By the other hand, we should remind a Watzlawick's work
172 on the modern evolution of psychotherapy (Watzlawick, 1987) that represents a severe critic to the
173 classic approach and reverses the relation between action and thought (an Italian translation is
174 retrievable in Nardone & Watzlawick, 1990, Chapter 1). In the same Nardone & Watzlawick, 1990,
175 see also chapter 2 on perception as one main source of psychopathology.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

766 intentionally added to an experimental setting, can alter the sample behaviours, even if
767 such stimuli are not consciously detected: "under certain conditions, actions are initiated
768 even though we are unconscious of the goals to attain… [and] goal pursuit can… operate
769 unconsciously" (Custers & Aarts, 2010). They also sustain that arguments frequently
770 presented as rational motivations for action are, actually, *ex-post* justifications of
771 unconsciously performed behaviours.

772 The role of physical stimuli in swaying communication through natural language
773 is confirmed by a series of recent works (for example Zhong, Bohns & Gino, 2010; Tsay,
774 2013; and, for a popular-scientific coverage, Lobel, 2014). Further, quite unpredictable
775 factors that can sway message interpretation can be the specific national languages used
776 (for example Marian & Kaushanskaya, 2005; Costa et al., 2014) or the metaphors used to
777 express concepts (Thibodeau & Boroditsky, 2011; Thibodeau & Boroditsky, 2013). Our
778 data is consistent with all this in that it confirms precedence of perception-reaction with
779 regards to conscious processing.

780 In the end of this rapid survey, we think it is worth re-examining the example
781 (Hickok, 2009, for the opposing point of view see Gallese et al., 2011) presented in our
782 Introduction in order to check our proposal in a concrete case. About the capacity of an
783 observer to understand the action of pouring performed by someone, the author
784 highlights that the "embodied cognition" hypothesis cannot explain the fact that the
785 observer can interpret such action "as *pouring*, *filling*, *emptying*, *tipping*, *rotating*,
786 *inverting*, *spilling* (if the liquid missed its mark) or *defying/ignoring/rebelling* (if the
787 pourer was instructed not to pour)…" (see Hickcok, 2009, page 1240, italic by the

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

788 author). The author also anticipates the counter-argument of a supposed mirror neuron
789 theorist, i.e. that mirror neurons codify the goals, or intentions, of the actor: "But a goal,
790 say to fill a glass with water, can be accomplished with any number of individual actions
791 or sequence of actions: pouring from a pitcher, turning a spigot, dipping a glass in a lake,
792 setting the glass in the rain…" (*ibidem*).

793 In our opinion, embodied cognition hypothesis looks at the act of pouring in its
794 **purely motor** nature; conversely, understanding it, for example, as "pouring" or
795 "filling", requires the interpretation of a **situation** which is not limited to the act for
796 itself. In order to attribute the "pouring" meaning, one must focus on the liquid flow
797 direction (inside to outside, from the bottle); for the "filling" meaning, one must focus on
798 the glass receiving the liquid; for the "emptying" meaning, one must focus on the bottle
799 content's amount. An operation must be preceding the attribution of a conscious
800 meaning: the previous, unconscious selection of a specific point of view, which is
801 something closely resembling our "disassembling" step.

802 *Some possible consequences*. One main consequence of our results, once they
803 will be confirmed, would concern the nature of words. We are used to consider words
804 almost exclusively in their symbolic nature; however, our research shows that they could
805 have a double nature: they could work like symbols as well as physical stimuli. In a
806 specific circumstance, which of the two natures will be active depends on the subjective
807 "disassembling" performed by the receiver, rather than on the sender's intentions. This
808 implies that which nature is in action will become observable only at the moment of the
809 receiver's interaction with the message. This is very similar to what happens in certain

physics phenomena, for example the double nature of light (waves/particles) or the uncertainty about some features of many atomic particles: the ambivalence is solved just in the process of measuring the phenomena (Zeilinger, 2010, for a discussion about the case of photons, and von Baeyer, 2013 for a recent point of view about such ambivalence). All this entails what follows:

- There is a structural uncertainty in the human communication process: when a sender prepares a message (message production sub-process), he/she has the intention to produce some effects on the receiver (his/her communication has a goal, this is the pragmatic aspect); however, the actual effects the message will produce will depend on another sub-process (interpretation) that is under control by the receiver, not by the sender. Uncertainty is linked to the irreducible subjectivity of the receiver's "disassembling"[19].
- Such subjectivity is not just a question of statistical scatter, with regards to presumed pre-definable message components; the question is that it is impossible to foresee what components, exactly, will trigger the receiver's automatic reaction off (receiver's reactivity is an absolutely individual feature).
- What is more, the selective focusing, by the receiver, on specific message components, seems to be a creative act, rather than a simple recognition of something contained inside the message. So, it would be impossible to

[19] Another way to express such concept is considering the sender-receiver couple as a complex system, and the meaning like an emergent phenomenon which characterizes it (about this specific matter see, for example, Guastello, 2002).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

previously detect and list, in a laboratory condition, "all" the components of a message. In fact, whatever the message, the concept of an inherent message's measurable information content fades. Human communication seems to be a process having a different nature from computer communication.

In the end, communication and knowledge processes would be firstly analogical, rather than digital. Meaning would be established starting from the body automatic reaction in the "disassembling step", analogically triggered through individual reaction schemes probably based on similar, previous personal experiences. The final meaning, expressed through natural language, would be the result of the following step, i.e. conscious taking into account of the outcomes of such analogical process. This final meaning would not be directly based on the source message; rather, it will be based on the body reaction. Indeed, all this could lead us to approach natural language like a system of acquired reflexes and such feature could heavily affect the possibility to reproduce human interpretation process on digital computers, regardless of their processing power and data storage capacity. The two systems could result not only different, rather incompatible. We are not the first to propose such observation (for example Arecchi, 2008; Arecchi, 2010b; Arecchi, 2010c on the non-algorithmic nature of knowledge and intelligence). In the end, all this could lead to an operative definition of "meaning" (expressing the meaning of "meaning"), beyond the possible abstract ones: *The meaning attributed to a message is the receiver's synthetic conscious report on the final state of his/her organism after experiencing the interaction with the message*.

Other possible consequences of our results are the following:

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

- The distinction between content and form of a message would lose its sense, given that the apparently most insignificant (from the sender's point of view) variation of the form can completely change the message's meaning (from the receiver's point of view). Given a message, we simply could not distinguish what is "content" and what is "form", before the receiver interacts with it.
- Human beings do not interpret data or single signals/stimuli; rather they interpret *situations*. Again, the human approach to a message, as well as to the surrounding environment (natural or social), would work analogically, through the organism's resounding to a recognizable situation, rather than digitally, through a rational scanning of the available incoming information.

Opened questions. We have provided some data upholding our hypothesis and our discussion; at the same time, we are conscious that our results and our conclusions need to be confirmed. Among the undoubtedly several points to be checked, we highlight two main questions. The first one is linked to the matter of analogical vs. digital nature of the processes that contribute to meaning and knowledge building. Following our hypothesis, both the natures would be playing a role, each in a specific step of the interpretation process: "disassembling" has an analogical nature while the conscious processing has a digital one. The main question is the timing of these two steps: if conscious processing precedes, then some current models would be confirmed; if disassembling precedes, then our hypothesis would be confirmed. The problem is just to find a way in order to definitely answer such question, what does not seem easy.

The second point to be checked regards the reasons of the observed radical difference between the "H" choosers and "S" choosers group behaviours in terms of interpretation/choice coherence; about this, we think there are two possible hypotheses: (1) The two subsamples follow different paths in interpreting natural language messages ("S" choosers would base their choices on rational information processing, which would precede action, while "H" choosers would react instinctively and choose before analysing the available information); (2) The two subsamples actually follow the same path (automatic reaction preceding conscious information processing, in our opinion) and the difference they show is linked to the differences in their automatic reaction schemes ("S" choosers' reaction would privilege the attention to the relational aspects while "H" choosers' reaction would privilege the content aspects). We consider relevant such matter and we will not engage ourselves in extemporaneous considerations about it; rather, we have already begun to think to a dedicated specific research.

Conclusion

Human behaviour (communication through natural language and "understanding" included) must be rooted into biology. We consider established and thoroughly share this idea; for this, our results have to pass the crucial test: valid compliance with the evolution theory. Specifically, we must ask ourselves if a conscious organism that reacts before

892 rationally thinking (what our work seems to confirm) could be a valid outcome of the
893 evolution process.

894 At present times, human beings live inside sophisticated societies; however, their
895 biology is the result of natural selection and represents the best fitting in a **natural**
896 **hostile environment**. Biologically, we are "still the ones of the stone and of the sling"[20]
897 even though, from a cultural slant, we can account for ourselves in different ways.
898 Rational thinking is, undoubtedly, much slower in comparison to intuitive reactions; at
899 the same time, in a natural environment, fast reaction capacities are a critical surviving
900 factor. Thus, reaction preceding reflection appears to be consistent with the evolution
901 theory. Human communication and culture could have begun by employing the new
902 feature of language through such general rule: at first, perception would not start
903 complex (and slow) information treatment; rather, the entire organism automatically
904 would change its state and, "resounding" similar situations, would be primed for
905 immediate action. Then, rational thinking would follow. Another possible example of the
906 "exaptation" process (Gould & Vrba, 1982).

907 Summing up all the data, literature and considerations we have presented, two
908 things remain to be said. The first is that, now, we have at least a hypothesis to describe
909 how human beings understand or do not understand one another and their environment: it
910 depends on the way they firstly react (biological level) to the inputs and then can manage
911 (cultural level) their own reactions. The second is that, if there is any possibility to

193 [20] From the poem *Uomo del mio tempo* (Man of my age), of Italian poet (1959 Nobel Prize) Salvatore
194 Quasimodo, 1947: *Sei ancora quello della pietra e della fionda, / uomo del mio tempo…* [You are
195 still the one of the stone and of the sling, / Man of my Age…]. A complete text of the poem (original
196 language) is *available at http://www.incontroallapoesia.it/poesie%20salvatore_quasimodo.htm*
197 (accessed 1 Sept 2014).

912 represent human semantic approach to the surrounding environment through a
913 computational device, then its model should be the whole human being, not the sole brain
914 cortex. As a consequence, what really can prevent present times computers from
915 imitating human thought is not insufficient data processing power or data storage
916 capacity; rather, it is the lack of a special peripheral unit: a human body.

917 _____
918
919
920
921 **Acknowledgements**

922 We thank Laura Baglietto, Andrea Baldini, Marco Calabrò, Leonardo Cavari, Hasna El-
923 Hachimi, Alessandro Farini, Alessandra Gasperini, Maddalena Morandi, Claudia
924 Santovito, Arabella Tanyel-Kung for their comments.
925 A special thanks to Fortunato Tito Arecchi for his suggestions; to Andrea Fiaschi and
926 Christina Tsirmpa for their text revision; to Letizia Scrobogna for her contribution to data
927 revision; to Irene Maffei for her final text survey and impact assessment.

928 **References**

929 Arecchi FT, Kurths J. 2009. Nonlinear dynamics in cognitive and neural systems:
930 Introduction to focus issue. *Chaos* 19, 015101 (2009).

931 Arecchi FT. 2008. *Coerenza, Complessità, Creatività*. Roma: Di Renzo.

932 Arecchi FT. 2010a. Coherence, cognitive acts and creativity (The physics of mental acts).
933 In: Agazzi E, Di Bernardo G, ed. *Relations between Natural Sciences and Human*
934 *Sciences*. Actes de l'Academie Internationale de Philosophie des Sciences, Rovereto-
935 Italie, 15-20 Sept. 2008. Genova: Tilgher, 307-329.

936 Arecchi FT. 2010b. Coherence, complexity and creativity: from lasers to cognitive
937 processes. *Giornale di Fisica - Quaderni di Storia della Fisica* 16 (2010):157-183.

938 Arecchi FT. 2010c. Coherence,complexity and creativity: the dynamics of decision
939 making. In: Faggini M, Vinci CP, ed. *Decision theory and choices: a complexity*
940 *approach*. Milan: Springer-Verlag Italia, 3-21.

941 Arecchi FT. 2010d. Dynamics of consciousness: complexity and creativity. *The Journal*
942 *of Psychophysiology* (2010) 24 (2): 141-148.

943 Arecchi FT. 2010e. The physics of mental acts: coherence and creativity. *Journal of*
944 *Physics:* Conference Series 174, 012010 (2009).

945 Arecchi FT. 2011a. Phenomenology of Consciousness: from Apprehension to Judgment.
946 *Nonlinear Dynamics, Psychology and Life Sciences* 15: 359-375.

947 Arecchi FT. 2011b. Chaos and Complexity. In: Jencks C ed. *The Post-Modern Reader*.
948 Chichester: John Wiley & Sons, 279-283.

949 Arévalo A, Perani D, Cappa SF, Butler A, Bates E, Dronkers N. 2007. Action and object
950 processing in aphasia: From nouns and verbs to the effect of manipulability. *Brain and*
951 *Language* 100 (2007) 79–94. DOI : 10.1016/j.bandl.2006.06.012.

952 Aziz-Zadeh L, Damasio A. 2008. Embodied semantics for actions: Findings from
953 functional brain imaging. *Journal of Physiology – Paris*. DOI:
954 10.1016/j.jphysparis.2008.03.012.

955 Aziz-Zadeh L, Wilson SM, Rizzolatti G, Iacoboni M. 2006. Congruent embodied
956 representations for visually presented actions and linguistic phrases describing actions.
957 *Current Biology 16* (September): 1818-1823. DOI: 10.1016/j.cub.2006.07.060.

958 Baciadonna L, McElligott AG, Briefer EF. 2013. Goats favour personal over social
959 information in an experimental foraging task. *PeerJ* 1:e172. DOI: 10.7717/peerj.172.

960 Bandler R, Grinder J. 1981. *La struttura della magia*. Roma: Astrolabio-Ubaldini. [Or.
961 ed.: Bandler R, Grinder J. 1975. *The structure of magic*. Palo Alto: Science & Behaviour
962 Books.]

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

963 Bara BG, Tirassa M. 1999. A mentalist framework for linguistic and extralinguistic
964 communication. In: Bagnara S, ed. *Proceedings of the 3rd European Conference on*
965 *Cognitive Science (ECCS '99)*. Roma: Istituto di Psicologia del CNR.

966 Barthes R. 2000. *La retorica antica*. Milano: Bompiani. [Or. ed.: Barthes R. 1970.
967 L'ancienne rhétorique. *Communications* 16: 172-223. DOI: 10.3406/comm.1970.1236.]

968 Bateson G. 1976. *Verso un'ecologia della mente*. Milano: Adelphi. [Orig. ed.: Bateson G.
969 1987 (1972). *Steps to an Ecology of Mind: Collected Essays in Anthropology,*
970 *Psychiatry, Evolution, and Epistemology*. Northvale: Aronson.]

971 Bedny M, Caramazza A, Grossman E, Pascual-Leone A, Saxe R. 2008. Concepts are
972 more than percepts: The case of action verbs. *The Journal of Neuroscience*, October 29,
973 2008, 28(44):11347-11353. DOI: 10.1523/JNEUROSCI.3039-08.2008.

974 Bedny M, Caramazza A, Pascual-Leone A, Saxe R. 2012. Typical Neural
975 Representations of Action Verbs Develop without Vision. *Cerebral Cortex* February
976 2012, 22: 286-293. DOI: 10.1093/cercor/bhr081.

977 Bedny M, Caramazza A. 2011. Perception, action, and word meanings in the human
978 brain: the case from action verbs. *Annals of the New York Academy of Sciences* 1224: 81-
979 95. DOI: 10.1111/j.1749-6632.2011.06013.x.

980 Berne E. 1971. *Analisi transazionale e psicoterapia*. Roma: Astrolabio-Ubaldini. [Or.
981 ed.: Berne E. 1961. *Transactional analysis*. New York: Grove.]

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

982 Bobrowski O, Meir R, Eldar YC. 2009. Bayesian filtering in spiking neural networks:
983 noise, adaptation, and multisensory integration. *Neural Computation* 2009 May, 21(5):
984 1277-320.

985 Campos MN. 2007. Ecology of meanings: A critical constructivist communication
986 model. *Communication Theory* 17: 386-410. DOI: 10.1111/j.1468-2885.2007.00304.x.

987 Cannon WB. 1927. The James-Lange theory of emotions: a critical examination and an
988 alternative theory. *The American Journal of Psychology* Vol 39, 1927, 106-124. DOI:
989 10.2307/1415404.

990 Carter AJ, Marshall HH, Heinsohn R, Cowlishaw G. 2014. Personality predicts the
991 propensity for social learning in a wild primate. *PeerJ* 2:e283. DOI: 10.7717/peerj.283.

992 Cattaneo L, Caruana F, Jezzini A, Rizzolatti G. 2009. Representation of goal and
993 movements without overt motor behavior in the human motor cortex: A transcranial
994 magnetic stimulation study. *Journal of Neuroscience* 29: 11134–11138.

995 Chater N, Tenenbaum JB, Yuille A. 2006. Probabilistic models of cognition: Conceptual
996 foundations. *TRENDS in Cognitive Sciences* Vol.10, No.7, July 2006.

997 Christian B. 2012. *Essere umani: che cosa ci dice di noi il test di Turing*. [Or. ed.:
998 Christian B. 2011. *The most human human: What talking with computers teaches us*
999 *about what it means to be alive*. New York-London: Doubleday – Random House.]

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1000 Costa A, Foucart A, Hayakawa S, Aparici M, Apesteguia J, Heafner J, Keysar B. 2014.
1001 Your Morals Depend on Language. *PLoS ONE* 9(4): e94842. DOI:
1002 10.1371/journal.pone.0094842.

1003 Crepaldi D, Aggujaro S, Arduino LS, Zonca G, Ghirardi G, Inzaghi MG, Colombo M,
1004 Chierchia G, Luzzatti C. 2006. Noun-verb dissociation in aphasia: the role of
1005 imageability and functional locus of the lesion. *Neuropsychologia* 2006; 44 (1): 73-89.
1006 PMID: 15922372.

1007 Custers R, Aarts H. 2010. The unconscious will. *Science* 329: 47-50. DOI:
1008 10.1126/science.1188595.

1009 De Mauro T. 2003 (1980). *Guida all'uso delle parole*. Roma: Editori Riuniti.

1010 Deacon T W. 2012. *Natura incompleta: Come la mente è emersa dalla materia.* Torino:
1011 Codice Edizioni. [Or. ed.: Deacon T W. 2012. *Incomplete nature: How mind emerged*
1012 *from matter.* New York: W. W. Norton & Company.]

1013 di Pellegrino G, Fadiga L, Fogassi L, Gallese V, Rizzolatti G.1992. Understanding motor
1014 events: A neurophysiological study. *Experimental brain research* 91: 176-180. DOI :
1015 10.1007/BF00230027.

1016 Dilts R. 2003. *Creare modelli con la PNL.* Roma: Astrolabio – Ubaldini. [Or. ed.: Dilts
1017 R. 1998. *Modeling with NLP*. Capitola: Meta Publications.]

1018 Ferrari F, Rizzolatti G. 2014. Mirror neurons research: the past and the future. *Phil.*
1019 *Trans. R. Soc. B* **369**, 20130169 (published 28 April 2014). DOI: 10.1098/rstb.2013.0169.

1020 Ferri F, Riggio L, Gallese V, Costantini M. 2011. Objects and their nouns in peripersonal
1021 space. *Neuropsychologia* 49 (2011): 3519– 3524.

1022 Fowler CA, Galantucci B, Saltzman E. 2003. Motor theories of perception. In: Arbib
1023 MA, ed. *The handbook of brain theory and neural networks*. Cambridge: The MIT Press,
1024 2[d] edition, 705-707.

1025 Fox C, Stafford T. 2012. Maximum utility unitary coherent perception vs. the Bayesian
1026 brain. *Proceedings of the Annual Meeting of the Cognitive Science Society*, Sapporo 1-4
1027 August 2012. *Available:*
1028 *http://mindmodeling.org/cogsci2012/papers/0070/paper0070.pdf* (accessed 1 Sept 2014).

1029 Friedman BH. 2010. Feelings and the body: the Jamesian perspective on autonomic
1030 specificity of emotion. *Biological Psychology*, Jul;84(3):383-93. DOI:
1031 10.1016/j.biopsycho.2009.10.006. Epub 2009 Oct 29.

1032 Gallese V, Gernsbacher MA, Heyes C, Hickok G, Iacoboni M. 2011. Mirror Neurons
1033 Forum. *Perspectives on Psychological Science* 2011 6: 369. DOI:
1034 10.1177/1745691611413392.

1035 Gallese V, Rochat M, Cossu G, Sinigaglia C. 2009. Motor cognition and its role in the
1036 phylogeny and ontogeny of intentional understanding. *Developmental Psychology* 45:
1037 103–113.

1038 Gallese V, Sinigaglia C. 2011a. How the body in action shapes the self. *Journal of*
1039 *Consciousness Studies* 18: No. 7–8, 117–43.

1040 Gallese V, Sinigaglia C. 2011b. What is so special about embodied simulation? *Trends in*
1041 *cognitive neuroscience* 2011 Nov, 15(11): 512-9.

1042 Gallese V, Sinigaglia C. 2012. Response to de Bruin and Gallagher: Embodied
1043 simulation as reuse is a productive explanation of a basic form of mind-reading. *Trends*
1044 *in Cognitive Sciences* February 2012, Vol. 16, No 2: 99-100. DOI:
1045 10.1016/j.tics.2011.12.002.

1046 Gallese V. 2000. The inner sense of action. *Journal of Consciousness studies* 7, 10: 23-
1047 40.

1048 Gallese V. 2005. Embodied simulation: From neurons to phenomenal experience.
1049 *Phenomenology and the Cognitive Sciences* 4: 23–48.

1050 Gallese V. 2006. Intentional attunement: A neurophysiological perspective on social
1051 cognition and its disruption in autism. *Brain Research* 1079: 15–24.

1052 Gallese V. 2007. Before and below ‘‘theory of mind’’: Embodied simulation and the
1053 neural correlates of social cognition. *Philosophical Transactions of the Royal Society* B:
1054 Biological Sciences 362: 659–669.

1055 Gallese V. 2008 Mirror neurons and the social nature of language: The neural
1056 exploitation hypothesis. *Social Neuroscience* 3: 317–333.

1057 Gallese V. 2009a. Motor abstraction: A neuroscientific account of how action goals and
1058 intentions are mapped and understood. *Psychological Research* 73: 486–498.

1059 Gallese V. 2009b. Neuroscienze controverse: il caso dei neuroni specchio. Interview by
1060 Marco Mozzoni. *Brainfactor* 29/5/2009. *Available:* http://www.brainfactor.it/index.php?
1061 option=com_content&view=article&id=171 (accessed 1 Sept 2014).

1062 Gallese V. 2010. The Mirror Neuron Mechanism and Literary Studies. Interview by
1063 Hannah Chapelle Wojciehowski. *University of California eScholarship 2010. Available:*
1064 http://escholarship.org/uc/item/56f8v9bv (accessed 1 Sept 2014).

1065 Gallese V. 2011. Embodied Simulation Theory: Imagination and Narrative.
1066 *Neuropsychoanalysis* 2011, 13 (2).

1067 Gallese V. 2014. Bodily selves in relation: embodied simulation as second-person
1068 perspective on intersubjectivity. *Phil. Trans. R. Soc. B* **369**, 20130177 (published 28
1069 April 2014). DOI: 10.1098/rstb.2013.0177.

1070 Geymonat L. 1970. *Storia del pensiero filosofico e scientifico*. Milano: Garzanti, Vol. 1,
1071 Sez. I.

1072 Gibson E, Bergen L, Piantadosi ST. 2013. Rational integration of noisy evidence and
1073 prior semantic expectations in sentence interpretations. *Proceedings of the National*
1074 *Academy of Sciences* May 14, 2013, Vol. 110, n. 20: 8051-8056.

1075 Goldman A, de Vignemont F. 2009. Is social cognition embodied? *Trend in cognitive*
1076 *sciences* April 2009, 13(4): 154-9.

1077 Goldstein R. 2006. *Incompletezza: La dimostrazione e il paradosso di Kurt Gödel*.
1078 Torino: Codice Edizioni. [Or. ed.: Goldstein R. 2005. *Incompleteness: The proof and*
1079 *paradox of Kurt Gödel*. New York-London: Norton.]

1080 Gould SJ, Vrba ES. 1982. Exaptation: A missing term in the science of form.
1081 *Paleobiology* 8 (1): 4-15.

1082 Griffiths TL, Kemp C, Tenenbaum JB. 2008. Bayesian models of cognition. In: Ron Sun,
1083 ed. *Cambridge Handbook of Computational Cognitive Modelling*. Cambridge:
1084 Cambridge University Press.

1085 Grinder J, Bandler R. 1980. *La metamorfosi terapeutica: Principi di Programmazione*
1086 *Neurolinguistica*. Roma: Astrolabio-Ubaldini. [Or. ed.: Grinder J, Bandler R. 1979.
1087 *Frogs into princes: Neuro Linguistic Programming*. Moab: Real People Press.]

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1088 Gruber T, Zuberbühler K, Clément F, van Schaik C. 2015. Apes have culture but may not
1089 know that they do. *Frontiers in Psychology* 6:91. DOI: 10.3389/fpsyg.2015.00091.

1090 Guan CQ, Meng W, Yao R, Glenberg AM. 2013. The Motor System Contributes to
1091 Comprehension of Abstract Language. *PLoS ONE* 8(9): e75183. DOI:
1092 10.1371/journal.pone.0075183.

1093 Guastello SJ. 2013 (2002). *Managing emergent phenomena: nonlinear dynamics in work*
1094 *organizations.* Abingdon (UK): Taylor & Francis, Psychology Press.

1095 Hickok G, Hauser M. 2010. (Mis)understanding mirror neurons. *Current Biology* 20:
1096 R593–R594.

1097 Hickok G. 2009. Eight problems for the mirror neurons theory of action understanding in
1098 monkeys and humans. *Journal of Cognitive Neuroscience* 21:7: 1229-1243. DOI:
1099 10.1162/jocn.2009.21189.

1100 Hommel B, Müsseler J, Aschersleben G, Prinz W. 2001. The theory of event coding
1101 (TEC): A framework for perception and action planning. *Behavioural and brain sciences*
1102 24: 849-937.

1103 Horchak OV, Giger JC, Cabral M, Pochwatko G. 2014. From demonstration to theory in
1104 embodied language comprehension: a review. *Cognitive Systems Research* Volumes 29-
1105 30, September 2014: 66-85. DOI: 10.1016/j.cogsys.2013.09.002.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1106 Iacoboni M, Molnar-Szakacs I, Gallese V, Buccino G, Mazziotta JC, Rizzolatti G. 2005.
1107 Grasping the intentions of others with one's own mirror neuron system. *PLoS Biology*
1108 3(3): e79.

1109 Iacoboni M. 2008. *I neuroni specchio: Come capiamo ciò che fanno gli altri*. Torino:
1110 Bollati Boringhieri. [Or. ed.: Iacoboni M. 2008. *Mirroring People: The New Science of*
1111 *How We Connect with Others*. New York: Farrar, Straus & Giroux.]

1112 Ingram JN, Körding KP, Howard IS, Woolpert DM. 2008. The statistics of natural hand
1113 movements. *Experimental Brain Research* 188: 223–236. DOI 10.1007/s00221-008-
1114 1355-3.

1115 James W. 1890. *The principles of psychology*. New York: Holt.

1116 Jeannerod M, Arbib MA, Rizzolatti G, Sakata H. 1995. Grasping objects: Cortical
1117 mechanisms of visuomotor transformation. *Trends in Neuroscience* 18: 314-320.

1118 Khosravi H, Bina B. 2010. A survey on statistical relational learning. *Lecture Notes in*
1119 *Computer Science*, Volume 6085/2010: 256-268. DOI: 10.1007/978-3-642-13059-5_25.

1120 Krauss RM, Fussell SR. 1996. Social psychological models of interpersonal
1121 communication. In: Higgins ET, Kruglanski A, ed. *Social Psychology: A handbook of*
1122 *basic principles*. New York: Guilford, 655-701.

1123 Leavitt D. 2007. *L'uomo che sapeva troppo: Alan Turing e l'invenzione del computer.*
1124 Torino: Codice Edizioni. [Or. ed.: Leavitt D. 2006. *The man who knew too much: Alan*
1125 *Turing and the invention of the computer*. New York-London: Norton.]

1126 Liberman AM, Whalen DH. 2000. On the relation of speech to language. *Trends in*
1127 *Cognitive Neuroscience* 4: 187-196.

1128 Lobel T.2014. *Sensation: the new science of physical intelligence*. New York: Simon &
1129 Schuster/Atria Books.

1130 Locke JL. 2009. Evolutionary developmental linguistics: Naturalization of the faculty of
1131 language. *Language Sciences* 31 (2009) 33-59. DOI: 10.1016/j.langsci.2007.09.008.

1132 Lotze RH. 1852. *Medicinische psychologie oder physiologie der seele*. Leipzig:
1133 Weidmannsche Buchandlung.

1134 Mach E.1897. *Contributions to the analysis of the sensations*. Chicago: Open Court.

1135 Maffei R, Cavari L, Ranieri M. 2007. L'autre face du changement: Constants et
1136 structures dans la collaboration en ligne. *Proceedings of the Colloques TICE -*
1137 *Méditerranée 2007.* ISDM 29. *Available:* http://isdm.univ-
1138 tln.fr/PDF/isdm29/MAFFEI.pdf (accessed 1 Sept 2014).

1139 Maffei R. 2006. Questioni di stile: L'influenza dello stile di conduzione sui gruppi
1140 collaborativi online. *Proceedings of the Colloques TICE - Méditerranée 2006*. ISDM 25.

1141 *Available:* http://isdm.univ-tln.fr/PDF/isdm25/Maffei_TICE2006.pdf (accessed 1 Sept
1142 2014).

1143 Mahon B Z, Caramazza A. 2011. What drives the organization of object knowledge in
1144 the brain? *Trends in Cognitive Sciences*, Volume 15, Issue 3, 97-103, 14. DOI :
1145 10.1016/j.tics.2011.01.004.

1146 Mahon BZ, Caramazza A. 2008. A critical look at the Embodied Cognition Hypothesis
1147 and a new proposal for grounding conceptual content. *Journal of Physiology - Paris* 102:
1148 59-70. DOI:10.1016/j.jphysparis.2008.03.004.

1149 Mahon BZ, Caramazza A. 2009. Concepts and categories: A cognitive
1150 neuropsychological perspective. *Annual Review of Psychology* 60: 27-51. DOI:
1151 10.1146/annurev.psych.60.110707.163532.

1152 Mainardi D. 1988. *L'animale culturale*. Milano: Rizzoli, 3d edition.

1153 Marcus G. 2004. *La nascita della mente: Come un piccolo numero di geni crea la*
1154 *complessità del pensiero umano*. Torino: Codice Edizioni. [Or. ed.: Marcus G. 2004. *The*
1155 *birth of the mind: How a tiny number of genes creates the complexities of human*
1156 *thought.* New York: Basic Books.]

1157 Marian V, Kaushanskaya M. 2005. Autobiographical memory and language in bicultural
1158 bilinguals. In: Cohen J, McAlister KT, Rolstad K, MacSwan J, eds. *Proceedings of the 4th*
1159 *International Symposium on Bilingualism*. Somerville (MA): Cascadilla Press.

1160 Marino BFM, Gough P, Gallese V, Riggio L, Buccino G. 2011. How the motor system
1161 handles nouns: A behavioural study. *Psychological Research* (published online). DOI
1162 10.1007/s00426-011-0371-2.

1163 Massaro DW, Cowan N. 1993. Information Processing Models: Microscopes of the mind.
1164 *Annual Review of Psychology* 44: 383-425.

1165 Melcher T, Weidema M, Eenshuistra RM, Hommel B, Gruber O. 2008. The neural
1166 substrate of the ideomotor principle: An event-related fMRI analysis. *NeuroImage* 39:
1167 1274-1288. DOI: 10.1016/j.neuroimage.2007.09.049.

1168 Menchetti S, Costa F, Frasconi P, Pontil M. 2005. Wide coverage natural language
1169 processing using kernel methods and neural networks for structured data. *Science Direct*,
1170 *Pattern Recognition Letters* 26 (2005): 1896-1906. *Available:*
1171 *http://www.researchgate.net/publication/222681214_Wide_coverage_natural_language_*
1172 *processing_using_kernel_methods_and_neural_networks_for_structured_data* (accessed
1173 1 Sept 2014).

1174 Merleau-Ponty M. 1965. *La fenomenologia della percezione*. Milano: Il Saggiatore.
1175 [English ed.: Merleau-Ponty M. 1962. *Phenomenology of perception*. London-New York:
1176 Routledge.]

1177 Mitchell TM. 1997. *Machine learning*. New York: McGraw Hill.

1178 Mitchell TM. 2009. Brains, meaning and corpus statistics. *Google Tech Talks* March 27,
1179 2009. *Available:* http://www.youtube.com/watch?v=QbTf2nE3Lbw (accessed 1 Sept
1180 2014).

1181 Moro V, Urgesi C, Pernigo S, Lanteri P, Pazzaglia M, Aglioti SM. 2008. The neural basis
1182 of body form and body action agnosia. *Neuron* 60: 235–246.

1183 Moseley RL, Pulvermüller F. 2014. Nouns, verbs, objects, actions, and abstractions:
1184 Local fMRI activity indexes semantics, not lexical categories. *Brain and language* 132
1185 (2014): 28-42. DOI: 10.1016/j.bandl.2014.03.001.

1186 Muller CA, Cant MA. 2010. Imitation and traditions in wild banded mongooses. *Current*
1187 *Biology* 20: 1171–1175.

1188 Nardone G, Watzlawick P. 1990. *L'arte del cambiamento*. Milano: Ponte alle Grazie.

1189 Nathan DE, Guastello SJ, Prost RW, Jeutter DC. 2012. Understanding Neuromotor
1190 Strategy During Functional Upper Extremity Tasks Using Symbolic Dynamics.
1191 *Nonlinear Dynamics, Psychology, and Life Sciences* Vol. 16, Iss. 1 (January, 2012): 37-
1192 59.

1193 Negri GAL, Rumiati RI, Zadini A, Ukmar M, Mahon BZ, Caramazza A. 2007. What is
1194 the role of motor simulation in action and object recognition? Evidence from apraxia.
1195 *Cognitive Neuropsychology* 24(8): 795-816. DOI: 10.1080/02643290701707412.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1196 Newell A, Shaw JC, Simon HA. 1958. Elements of a theory of human problem solving.
1197 *Psychological Review* 65: 151-166. DOI 10.1037/h0048495.

1198 Pascolo PB, Budai R. 2013. Just how consistent is the mirror neuron system paradigm?
1199 *Progress in Neuroscience* 2013; 1 (1-4): 29-43. DOI: 10.14588/PiN.2013.Pascolo.29

1200 Pazzaglia M, Smania N, Corato E, Aglioti SM. 2008. Neural underpinnings of gesture
1201 discrimination in patients with limb apraxia. *Journal of Neuroscience* 28: 3030–3041.

1202 Perelman C. 1981. *Il dominio retorico: Retorica e argomentazione*. Torino: Einaudi. [Or.
1203 ed.: Perelman C. 1977. *L'empire rhétorique : Rhétorique et argumentation*. Paris: Vrin.]

1204 Perfors A, Tenenbaum JB, Griffiths TL, Xu F. 2011. A tutorial introduction to Bayesian
1205 models of cognitive development. *Cognition* Volume 120, Issue 3, September 2011: 302–
1206 321. DOI : 10.1016/j.cognition.2010.11.015.

1207 Pettigiani MG, Sica S. 2003. *La comunicazione interumana*. Milano: F. Angeli.

1208 Pezzulo G, Baldassarre G, Butz MV, Castelfranchi C, Hoffmann J. 2006. An analysis of
1209 the Ideomotor principle and TOTE. In: Butz MV, Sigaud O, Pezzulo G, Baldassarre G,
1210 ed. *Anticipatory Behavior in Adaptive Learning Systems: Advances in Anticipatory*
1211 *Processing*. Berlin: Springer, 73-93.

1212 Poincaré JH. 2003 (1902). *La scienza e l'ipotesi.* Milano: Bompiani. [English ed.:
1213 Poincaré JH.1905. *Science and Hypothesis*. London-Newcastle O. T.: Walter Scott
1214 Publishing.]

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1215 Poincaré JH.1997 (1908). *Scienza e metodo*. Torino: Einaudi. [English ed.: Poincaré JH.
1216 1914. *Science and method*. London-Edinburgh-Dublin-New York: Nelson.]

1217 Prinz W. 1997. Perception and action planning. *European Journal of Cognitive*
1218 *Psychology* 9 (2): 129-154.

1219 Pulvermüller F, Moseley RL, Egorova N, Shebani Z, Boulenger V. 2014. Motor
1220 cognition-motor semantics: Action-perception theory of cognition and communication.
1221 *Neuropsychologia* 55 (2014) 71-84. DOI: 10.1016/j.neuropsychologia.2013.12.002.

1222 Quasimodo S. 1947. *Giorno dopo giorno*. Milano: Mondadori.

1223 Range F, Viranyi Z, Huber L. 2007. Selective imitation in domestic dogs. *Current*
1224 *Biology* 17: 868–872.

1225 Rizzolatti G, Craighero L. 2004. The mirror-neuron system. *Annual review of*
1226 *Neuroscience* 27: 169-192. DOI: 10.1146/annurev.neuro.27.070203.144230.

1227 Rizzolatti G, Fabbri-Destro M. 2008. The mirror system and its role in social cognition.
1228 *Current Opinion in Neurobiology* 18: 1-6. DOI: 10.1016/j.conb.2008.08.001.

1229 Rizzolatti G, Fogassi L, Gallese V. 2001. Neurophysiological mechanisms underlying the
1230 understanding and imitation of action. *Nature Reviews Neuroscience* 2: 661-670. DOI:
1231 10.1038/35090060.

1232 Rizzolatti G, Sinigaglia C. 2006. *So quel che fai: Il cervello che agisce e i neuroni*
1233 *specchio*. Milano: Cortina.

1234 Rizzolatti G, Sinigaglia C. 2010. The functional role of the parieto-frontal mirror circuit:
1235 Interpretations and misinterpretations. *Nature Reviews Neuroscience* 11: 264–274.

1236 Rizzolatti G, Vozza L. 2008. *Nella mente degli altri*. Milano: Zanichelli.

1237 Rochat MJ, Caruana F, Jezzini A, Escola L, Intskirveli I, Grammont F, Gallese V,
1238 Rizzolatti G, Umiltà MA. 2010. Responses of mirror neurons in area F5 to hand and tool
1239 grasping observation. *Experimental Brain Research* 204: 605–616.

1240 Rose S. 2005. *Il cervello del XXI Secolo: Spiegare, curare e manipolare la mente.*
1241 Torino: Codice Edizioni. [Or. ed.: Rose S. 2005. *The 21st Century brain: Explaining,*
1242 *mending and manipulating the mind*. London: Jonathan Cape-Random House.]

1243 Sauser EL, Billard AG. 2006. Parallel and distributed neural models of the ideomotor
1244 principle: An investigation of imitative cortical pathways. *Neural networks* 19: 285-298.
1245 DOI: 10.1016/j.neunet.2006.02.003.

1246 Schachter S, Singer JE. 1962. Cognitive, social and physiological determinants of
1247 emotional state. *Psychological Review* Vol.69, No.5, September 1962.

1248 Sclavi M. 2003. *Arte di ascoltare e mondi possibili*. Milano: Bruno Mondadori.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1249 Speer NK, Reynolds JR, Swallow KM, Zacks JM. 2008. Reading stories activates
1250 neural representations of visual and motor experiences. *Psychological Science* 20/8: 989-
1251 999. DOI: 10.1111/j.1467-9280.2009.02397.x.

1252 Sperry RW. 1952. Neurology and the mind–brain problem. *American Scientist* 40: 290-
1253 312.

1254 Stekelenburg JJ, Vroomen J. 2012. Electrophysiological evidence for a multisensory
1255 speech-specific mode of perception. *Neuropsychologia* 50 (2012) 1425-1431. DOI:
1256 10.1016/j.neuropsychologia.2012.02.027.

1257 Stöcker C, Hoffmann J. 2004. The ideomotor principle and motor sequence acquisition:
1258 Tone effects facilitate movements chunking. *Psychological research* 68: 126-137. DOI:
1259 10.1007/s00426-003-0150-9.

1260 Suchak M, Eppley TM, Campbell MW, de Waal FBM. 2014. Ape duos and trios:
1261 spontaneous cooperation with free partner choice in chimpanzees. *PeerJ* 2:e417. DOI:
1262 10.7717/peerj.417.

1263 Tenenbaum JB, Kemp C, Griffiths TL, Goodman ND. 2011. How to Grow a Mind:
1264 Statistics, Structure, and Abstraction. *Science* 331 : 1279. DOI: 10.1126/science.1192788.

1265 Tettamanti M, Buccino G, Saccuman MC, Gallese V, Danna M, Scifo P, Fazio F,
1266 Rizzolatti G, Cappa SF, Perani D. 2005. Listening to action-related sentences activates
1267 fronto-parietal motor circuits. *Journal of Cognitive Neuroscience* 17(2): 273-281.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1268 Thibodeau PH, Boroditsky, L. 2011. Metaphors we think with: the role of metaphor in
1269 reasoning. *PLoS ONE* 6(2): e16782. DOI:10.1371/journal.pone.0016782.

1270 Thibodeau PH, Boroditsky, L. 2013. Natural language metaphors influence reasoning.
1271 *PLoS ONE* 8(1): e52961. DOI:10.1371/journal.-pone.0052961.

1272 Tsay CJ. 2013. Sight over sound in the judgement of music performance. *Proceedings of*
1273 *the National Academy of Sciences* 2013 110 (36) 14580-14585. DOI:
1274 10.1073/pnas.1221454110.

1275 Turing A.1950. Computing machinery and intelligence. *Mind* 59: 433-460. DOI:
1276 10.1093/mind/LIX.236.433. *Available:*
1277 *http://www.csee.umbc.edu/courses/471/papers/turing.pdf* (accessed 1 Sept 2014).

1278 Umiltà MA, Escola L, Intskirveli I, Grammont F, Rochat M, Caruana F, Jezzini A,
1279 Gallese V, Rizzolatti G. 2008. When pliers become fingers in the monkey motor system.
1280 *Proceedings of the National Academy of Sciences* USA 105: 2209–2213.

1281 Verbeke M, Van Asch V, Morante R, Frasconi P, Daelemans W, De Raedt L. 2012. A
1282 statistical relational learning approach to identifying evidence based medicine categories.
1283 *Proceedings of the 2012 Conference on Empirical Methods in Natural Language*
1284 *Processing and Computational Natural Language Learning (EMNLP-CoNLL 2012)*,
1285 Jeju, Korea July 12–14, 2012. *Available:*
1286 *https://lirias.kuleuven.be/bitstream/123456789/350664/1/VerbekeEtAl_EMNLP2012.pdf*
1287 (accessed 1 Sept 2014).

1288 Vitevitch MS, Sereno J, Jongman A, Goldstein R. 2013. Speaker Sex Influences
1289 Processing of Grammatical Gender. *PLoS ONE* 8(11): e79701. DOI:
1290 10.1371/journal.pone.0079701.

1291 von Baeyer HC. 2013. Can Quantum Bayesianism Fix the Paradoxes of Quantum
1292 Mechanics? *Scientific American*, June 2013.

1293 Watzlawick P, a cura di. 1988. *La realtà inventata - Contributi al costruttivismo*. Milano:
1294 Feltrinelli. [Or. ed.: Watzlawick P, ed. 1984. *The invented reality*. New York: Norton.]

1295 Watzlawick P, Beavin Bavelas J, Jackson DD. 1971. *Pragmatica della comunicazione*
1296 *umana.* Roma: Astrolabio-Ubaldini. [Or. ed.: Watzlawick P, Beavin Bavelas J, Jackson
1297 DD. 1967. *Pragmatics of human communication*. New York: Norton.]

1298 Watzlawick P. 1987. If you desire to see, learn how to act. In: Zeig JK, ed. *The evolution*
1299 *of psychotherapy.* New York: Brunner/Mazel, 91-100.

1300 Zeilinger A. 2012. *La danza dei fotoni – Da Einstein al teletrasporto quantistico*. Torino,
1301 Codice. [Or. ed.: Zeilinger A. 2010. *Dance of the Photons – From Einstein to quantum*
1302 *teleportation*. New York: Farrar Straus & Giroux.]

1303 Zeki S. 2010. *Splendori e miserie del cervello: L'amore, la creatività e la ricerca della*
1304 *felicità.* Torino: Codice Edizioni. [Or. ed.: Zeki S. 2009. *Splendours and miseries of the*
1305 *brain: Love, creativity and the quest for human happiness.* Chichester: Wiley-Blackwell.]

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1306 Zhong CB, Bohns VK, Gino F. 2010. Good lamps are the best police: darkness increases
1307 dishonesty and self-interested behaviour. *Psychological Science* Published online 29
1308 January 2010. DOI: 10.1177/0956797609360754.

1309 Zipoli Caiani S. 2013. Cognizione incorporata. *APhEx – Portale italiano di filosofia*
1310 *analitica (Periodico online – ISSN 2036-9972)* 8, 2013. *Available:*
1311 *http://www.aphex.it/public/file/Content20140103_APhEx8,2013Cognizioneincorporata-*
1312 *Zipoli.pdf* (accessed 1 Sept 2014).

1313 Zuberbühler K. 2005. The phylogenetic roots of language: evidence from Primate
1314 communication and cognition. *Current directions in psychological science* 2005, 14:126.
1315 DOI: 10.1111/j.0963-7214.2005.00357.x.

1316

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Figures

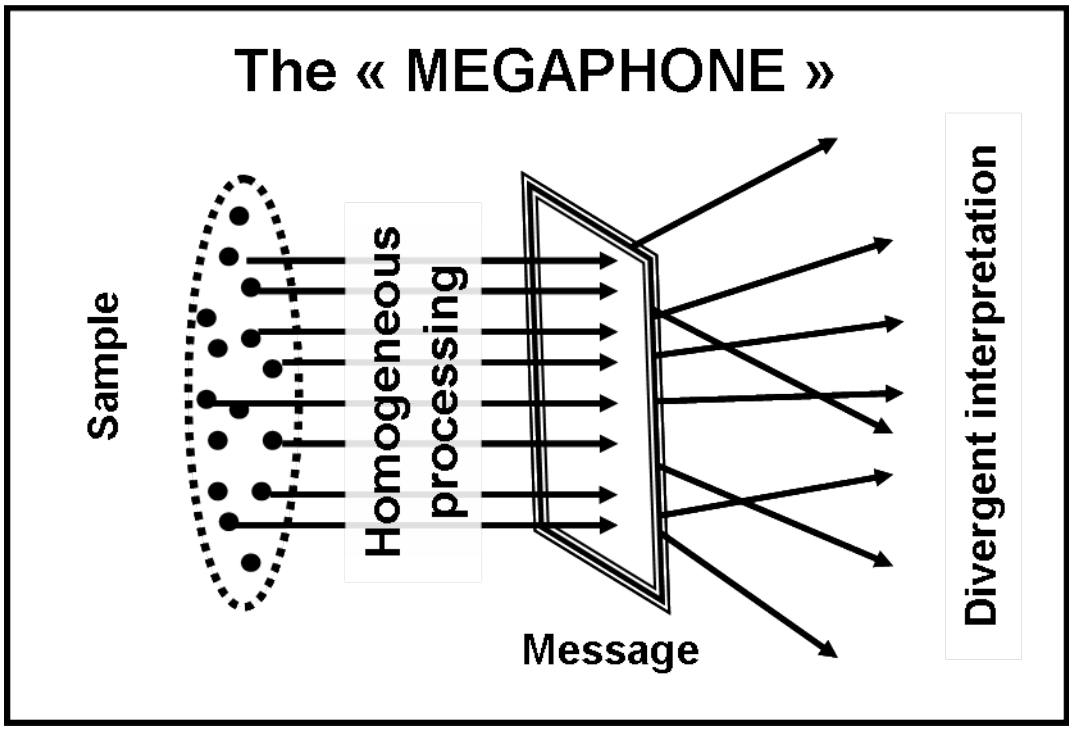
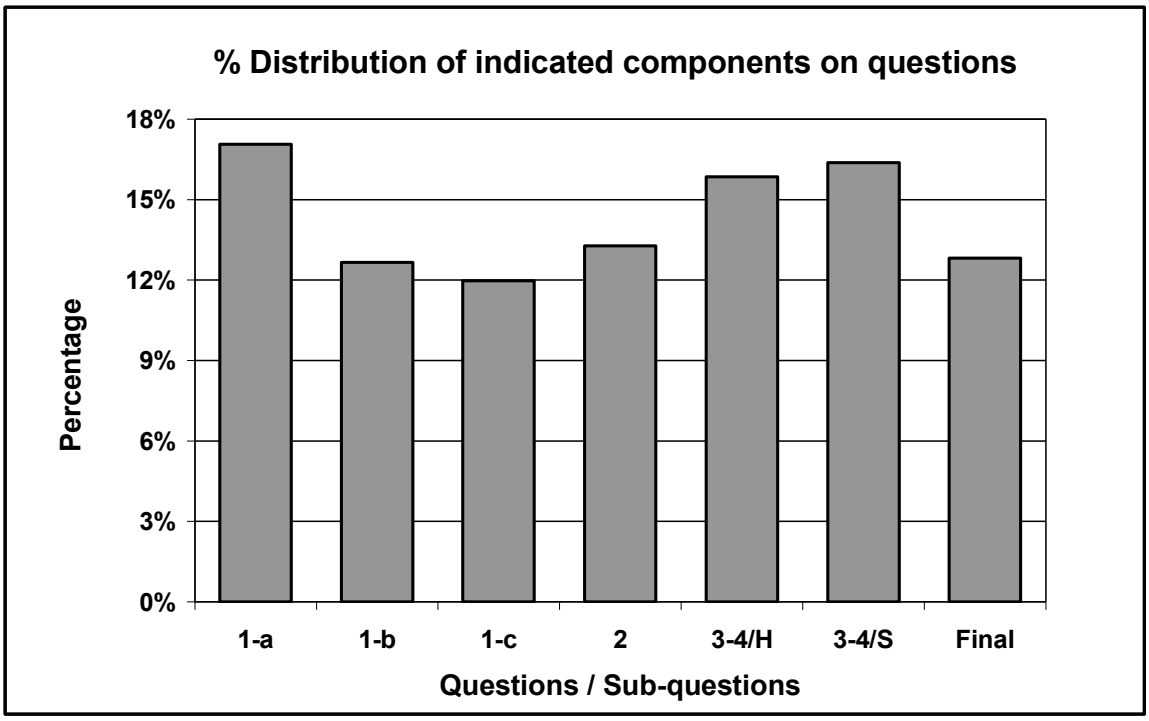


Figure 1: The "megaphone-shape" model.

If the interpretation of a message should be linked only to the processing of its information content, then we would expect a uniform interpretation, given that the source information is absolutely identical for all the participants. On the contrary, a wide scatter is always observed and its process can be represented with a "megaphone-shape" model: information would be homogeneously processed but differently interpreted.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1328



1330

1331 **Figure 2: Percent distribution of total indications with respect to questions/sub-**

1332 **questions.**

1333 With respect to questions, the respondents' total indications about the focused

1334 components present a flat-like percent distribution (differences in a range around 5%,

1335 from 12% to 17% about, source data from Table 3, "%" column). The range reduces to

1336 around 3.6% (from 12.8% to 16.4% about) if we group together the three sub-questions

1337 of Question #1 and consider their mean (the reason is that the answers to Questions #1-b

1338 and #1-c are often given in short, indicating reference to the already provided answer to

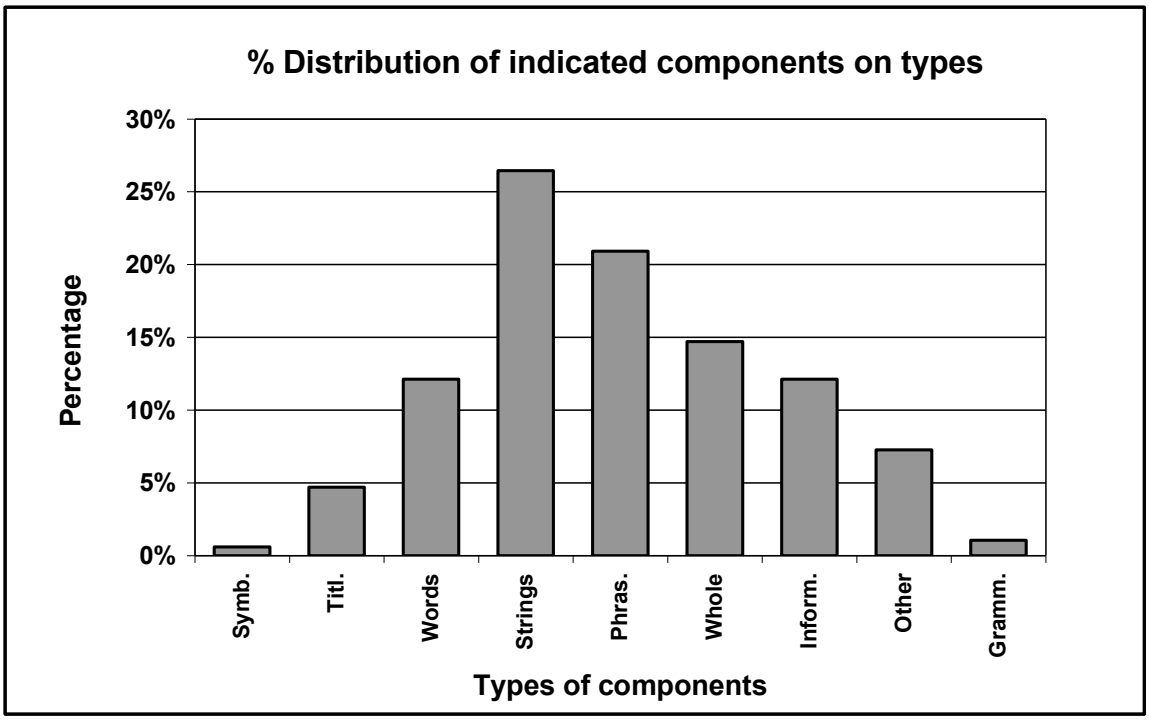
1339 Question #1-a). The indications are distributed without any significant imbalance among

1340 the different questions of the questionnaire. The approach through subjective selective

1341 focusing does not definitely advantage any question or item.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1342



1344

1345 **Figure 3: Percent distribution of total indications with respect to types of components.**

1346

1347 [Legend: Symb. = Punctuation marks; Titl. = Title/salutes (opening and closing
1348 expressions); Phras. = Complete phrases/periods; Whole = References to the message as
1349 a whole; Inform. = Information content; Gramm. = Grammar notations (verb tense etc.)]

1350

1351 The respondents' indications have been grouped in bins by type. The presented percent
1352 distribution (source data from Table 3, "%" row) has been built through the ranking of
1353 the first six types (from "Symbols" to "Whole") by increasing size of the text "chunks"
1354 considered. The remaining three types (Information content, Other components and
1355 Grammar notations) have been added ranking them by decreasing values. The highest
1356 frequencies correspond to middle-sized "chunks" of the messages.

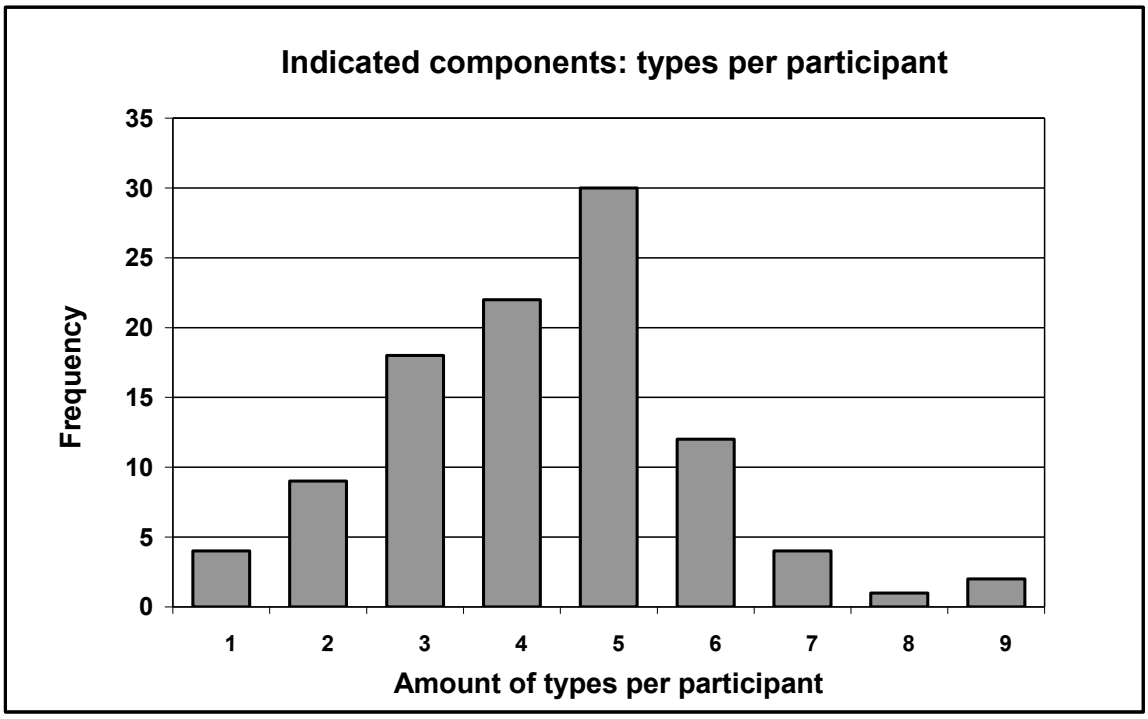


Figure 4: Sample distribution with respect to the amount of component types indicated by participants.

Respondents have been grouped in bins by the amount of types they indicated. The histogram shows the sample's distribution; it presents the highest frequencies on the 3-4-5 types-per-participant bins and has an almost "bell curve" shape. The main statistical indexes of the distribution are the following:

Mean = 4.3; SD = 1.6; Skewness = 0.25; Kurtosis = 0,49.

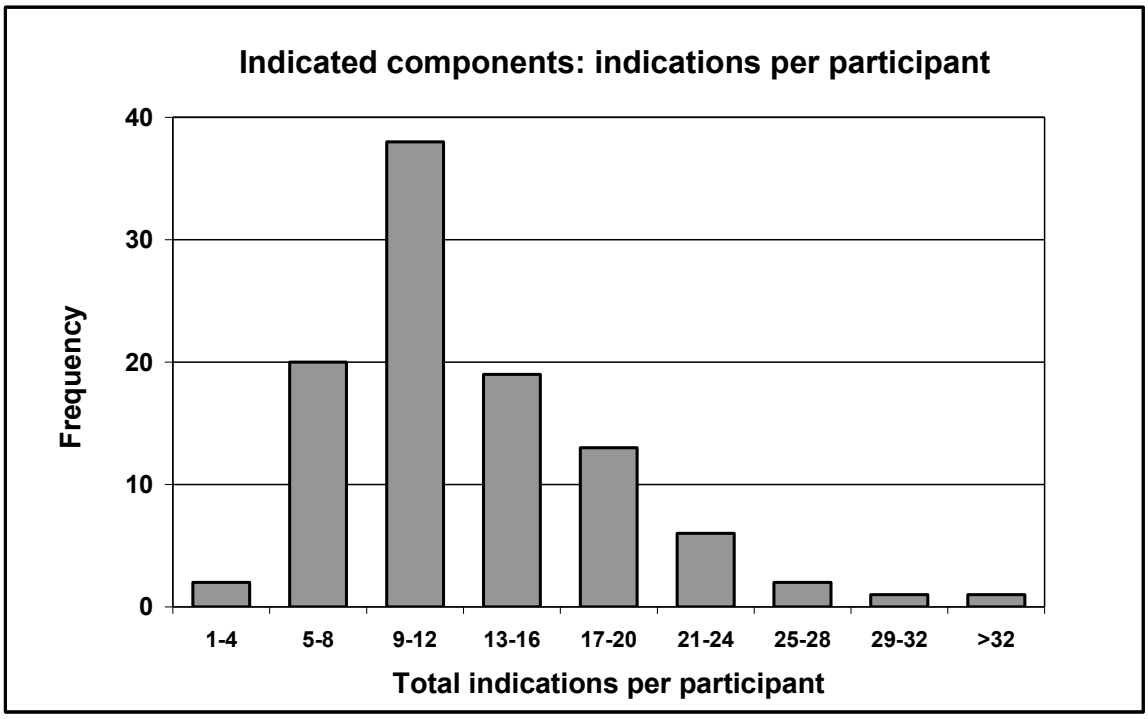


Figure 5: Sample distribution with respect to the total indications provided by participants.

Respondents have been grouped in bins by the amount of total provided indications. The histogram shows the sample's distribution; it presents the highest frequencies on the second, third and fourth bins and has an almost "bell curve" shape (even if it is clearly shifted towards the left side). The main statistical indexes of the distribution are the following:

Mean = 12.9; SD = 6.2; Skewness = 1.93; Kurtosis = 7.18.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

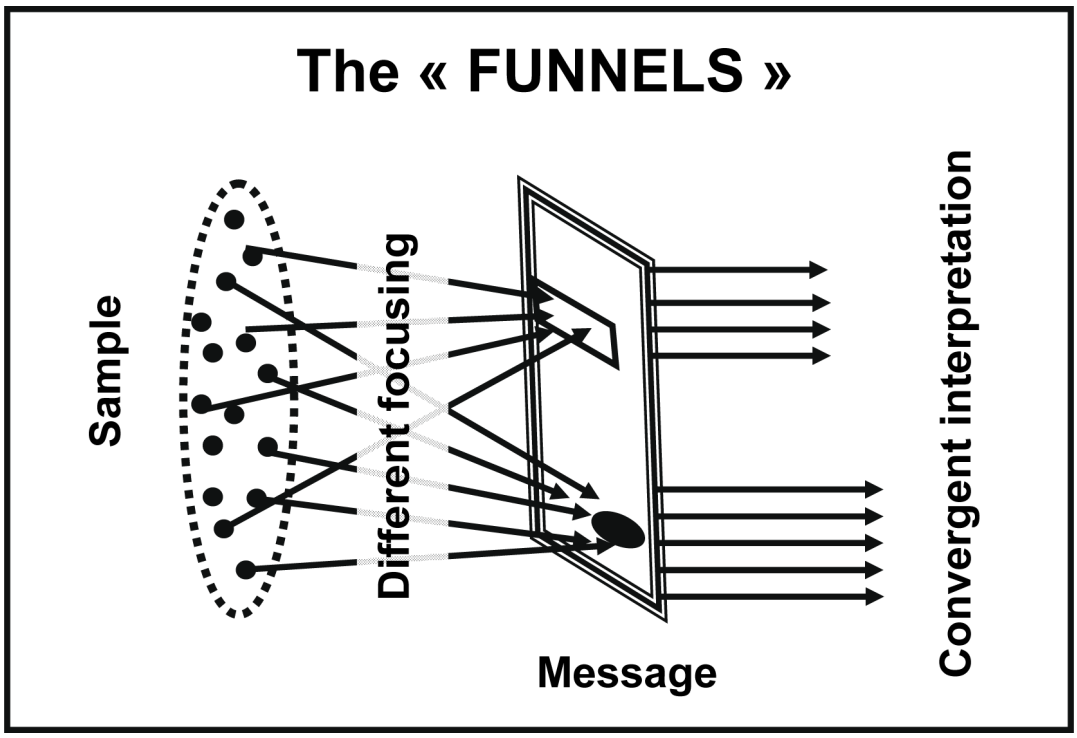


Figure 6: The "funnel-shape" model.

If the always observed "classic" interpretation scatter should be based on the scattering detected in "disassembling" operation, we could expect that the focusing on one same component would be followed by a convergent interpretation of it, as shown in this figure. This kind of process would prove itself as the opposite of the "megaphone-shape" model shown in Fig. 1.

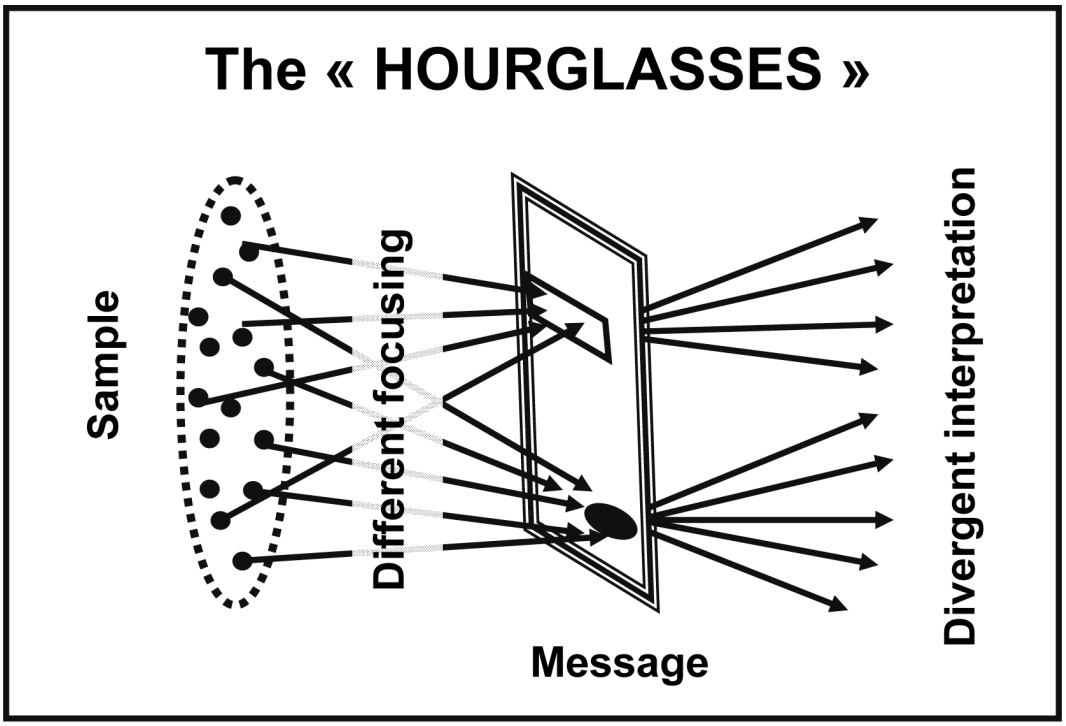


Figure 7: The "hourglass-shape" model.

This figure is a possible representation of the observed process of message interpretation. Two kinds of scatter co-exist, manifesting themselves in sequence: the first one regards dispersion during the focusing on the components ("disassembling" operation) and the second one regards the interpretation of the focused components ("classic" interpretation scatter).

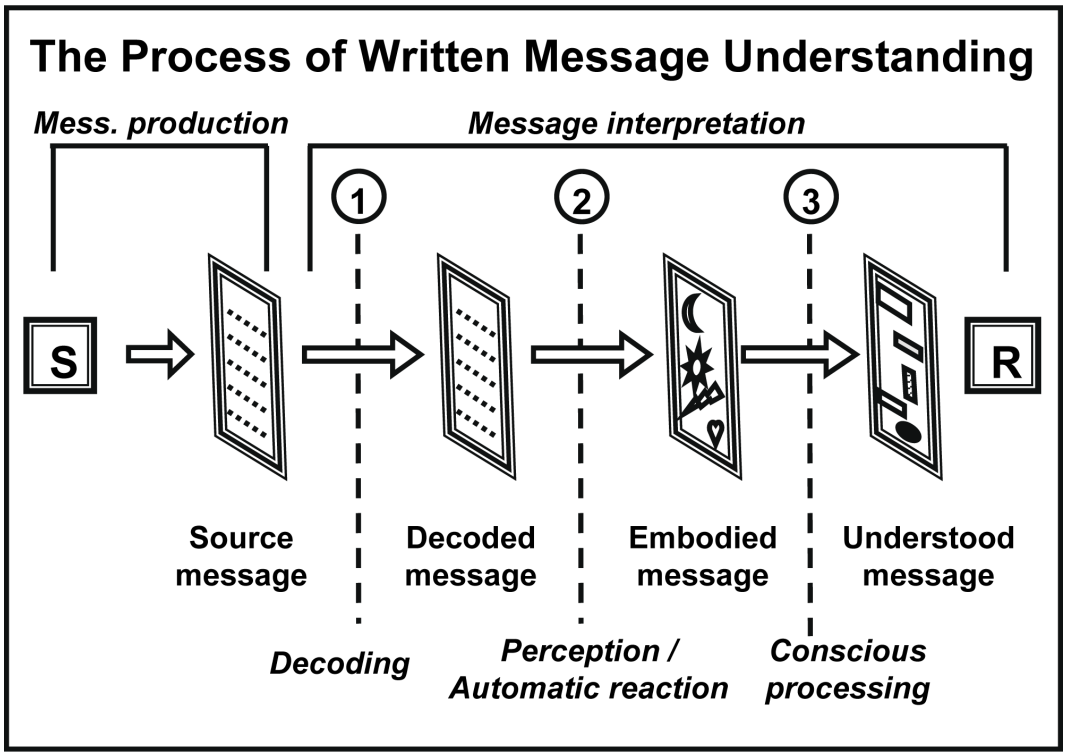


Figure 8: Scheme of the process of written message interpretation (how messages are understood).

[Legend: S = Sender; R = Receiver; 1-2-3 = Progressive steps of the process]

This figure presents our hypothesis to answer the question: "How is a written message understood by the receiver?". Message production (performed by the sender) is not deepened. The process of interpretation is made up by three sub-processes, in a cascade. The automatic reaction on perceptual basis (step #2) is followed by the conscious information processing (step #3). The step #1 is decoding, given that the words must be recognized, at first, in order to be interpreted.

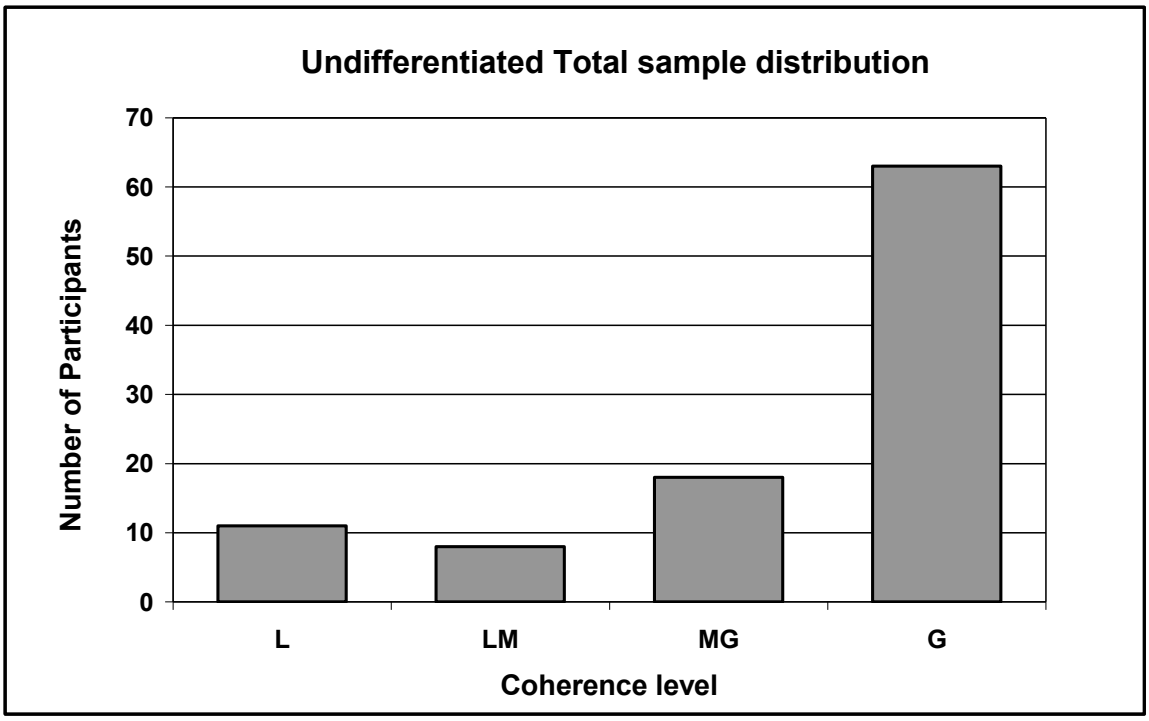


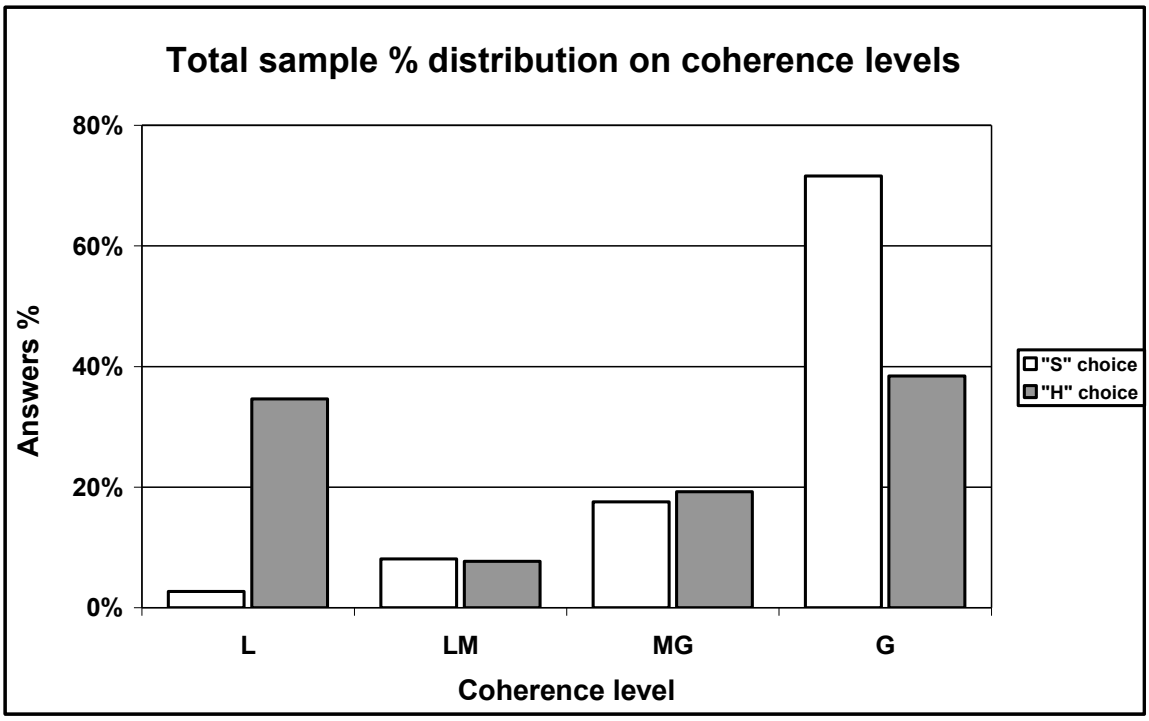
Figure 9: Sample distribution with respect to coherence levels / Undifferentiated Total Sample

[Legend / Coherence indicator:

L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

This histogram shows the distribution of ALL respondents according to the coherence (expressed through the coherence indicator) between, by one hand, their interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown for the undifferentiated total sample. The L level results over-represented with respect to what expected.

1488



1490

1491 **Figure 10: Sample percent distribution with respect to coherence levels / Comparing**

1492 **"H"/"S" choosers - Total Sample**

1493 [Legend / Coherence indicator:

1494 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1495

1496 This histogram shows the percent distribution of ALL respondents according to the

1497 coherence (expressed through the coherence indicator) between, by one hand, their

1498 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

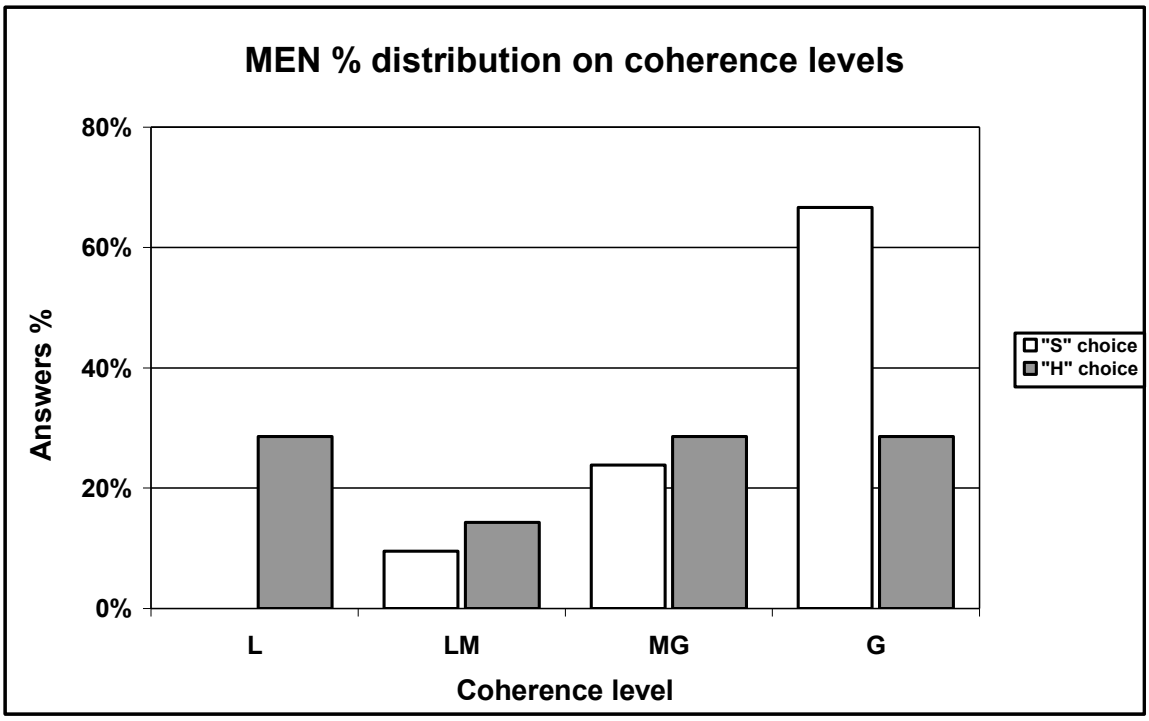
1499 shown separately for "H" and "S" choosers. Distributions result significantly different

1500 (Chi-squared test: p=0.000095).

1501

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1502



1504

1505 **Figure 11: Sample percent distribution with respect to coherence levels / Comparing**

1506 **"H"/"S" choosers - Subsample MEN**

1507 [Legend / Coherence indicator:

1508 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1509

1510 This histogram shows the percent distributions of MALE respondents according to the

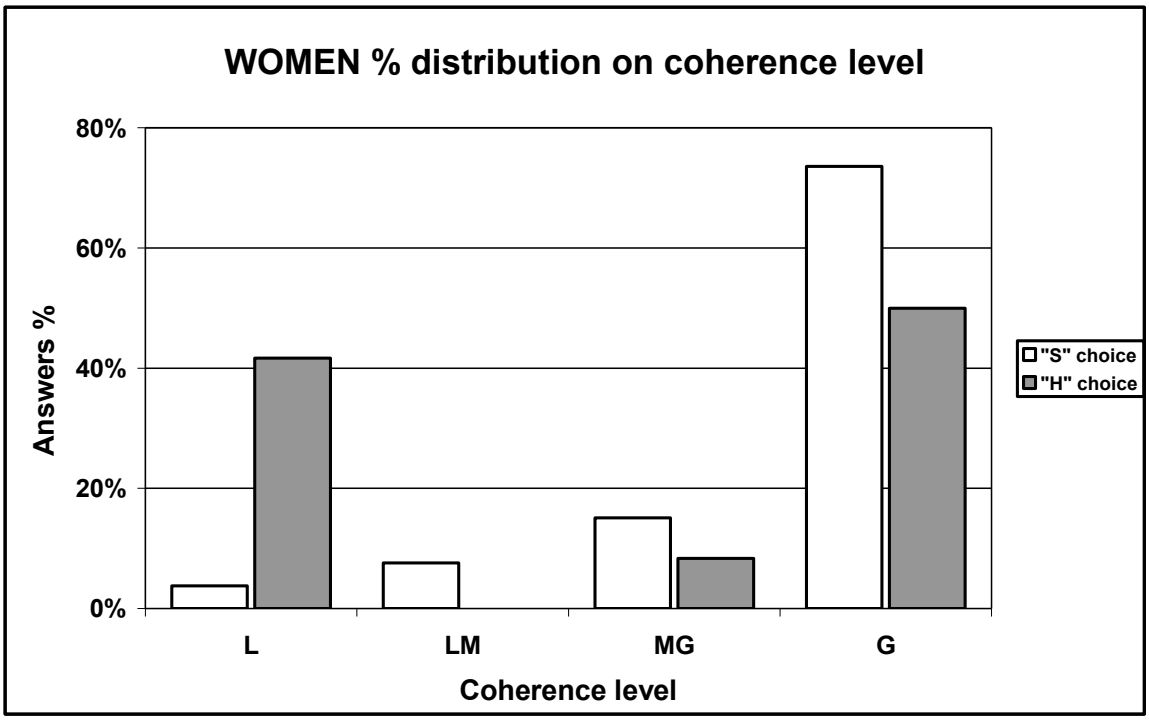
1511 coherence (expressed through the coherence indicator) between, by one hand, their

1512 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1513 shown separately for "H" and "S" choosers. Chi-squared test unsuitable for the presence

1514 of a zero value.

1515



1517

1518 **Figure 12: Sample percent distribution with respect to coherence levels / Comparing**

1519 **"H"/"S" choosers - Subsample WOMEN**

1520 [Legend / Coherence indicator:

1521 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1522

1523 This histogram shows the percent distributions of FEMALE respondents according to the

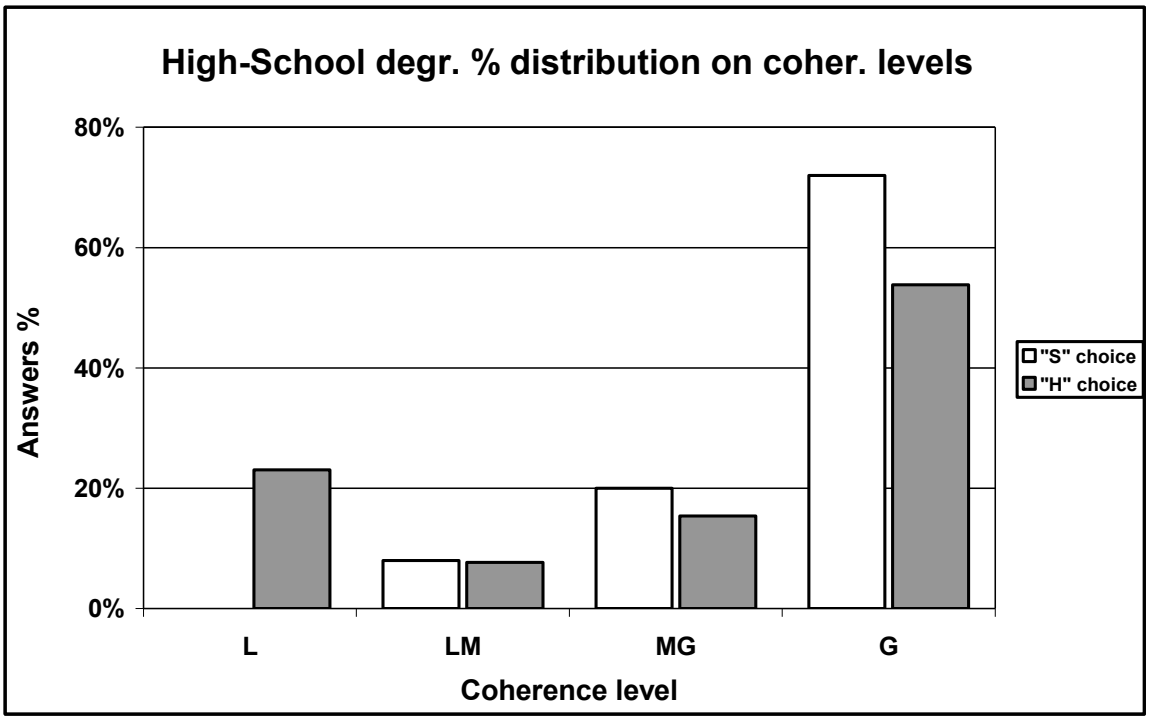
1524 coherence (expressed through the coherence indicator) between, by one hand, their

1525 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1526 shown separately for "H" and "S" choosers. Chi-squared test unsuitable for the presence

1527 of a zero value.

1528



1530

1531 **Figure 13: Sample percent distribution with respect to coherence levels / Comparing**

1532 **"H"/"S" choosers - Subsample High School**

1533 [Legend / Coherence indicator:

1534 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1535

1536 This histogram shows the percent distributions of HIGH-SCHOOL degree granted

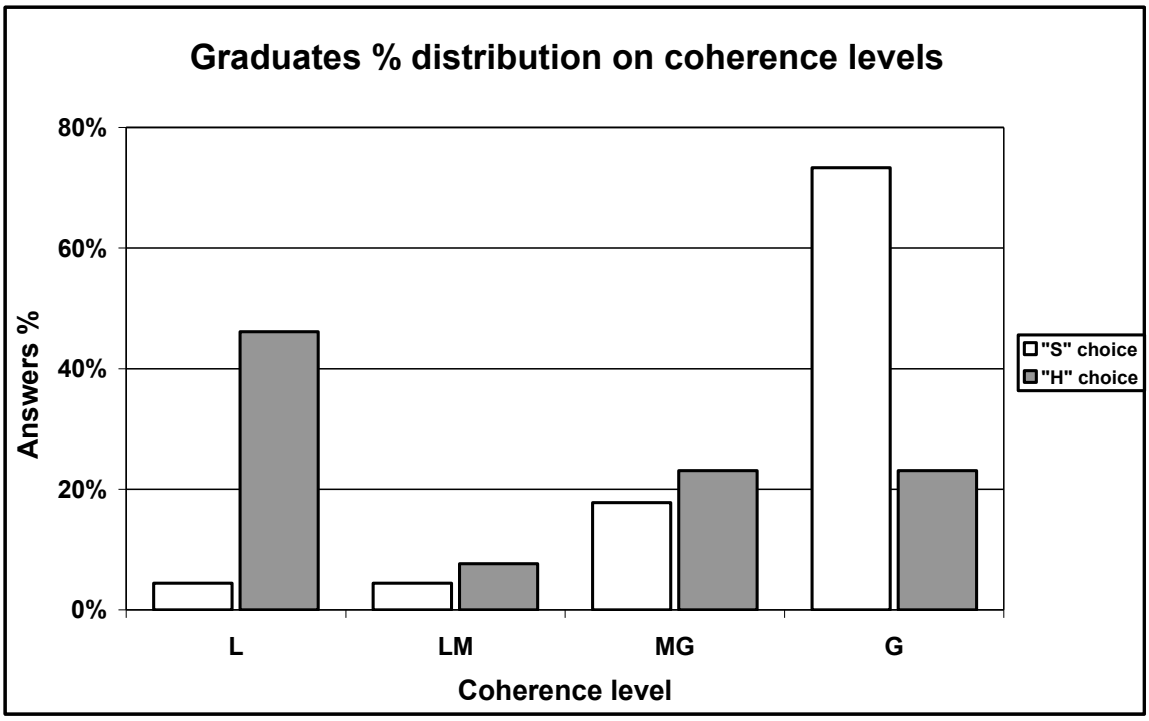
1537 respondents according to the coherence (expressed through the coherence indicator)

1538 between, by one hand, their interpretations of Messages #4/H and #4/S; by the other

1539 hand, their final choice. Data is shown separately for "H" and "S" choosers. Chi-squared

1540 test unsuitable for the presence of a zero value.

1541



1543

1544 **Figure 14: Sample percent distribution with respect to coherence levels / Comparing**

1545 **"H"/"S" choosers - Subsample Graduates**

1546 [Legend / Coherence indicator:

1547 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1548

1549 This histogram shows the percent distribution of GRADUATED respondents according

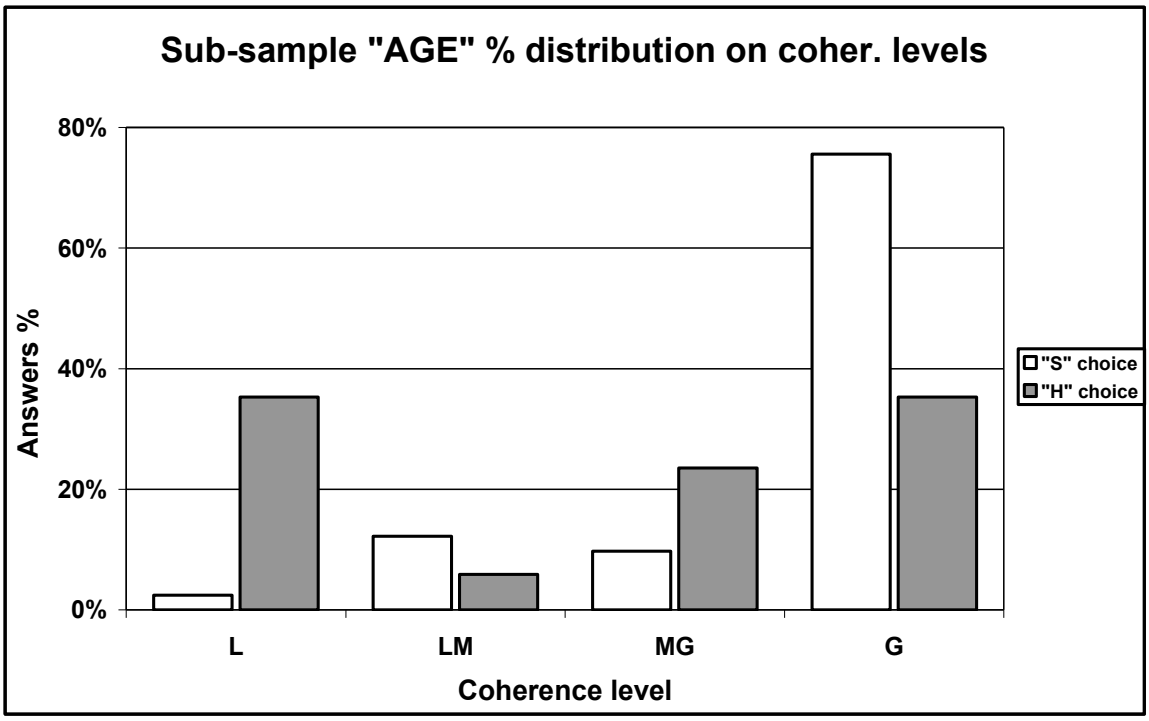
1550 to the coherence (expressed through the coherence indicator) between, by one hand, their

1551 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1552 shown separately for "H" and "S" choosers. Distributions result significantly different

1553 (Chi-squared test: p=0.000649).

1554



1556

1557 **Figure 15: Sample percent distribution with respect to coherence levels / Comparing**

1558 **"H"/"S" choosers - Subsample "AGE"**

1559 [Legend / Coherence indicator:

1560 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1561

1562 This histogram shows the percent distribution of respondents belonging to subsample

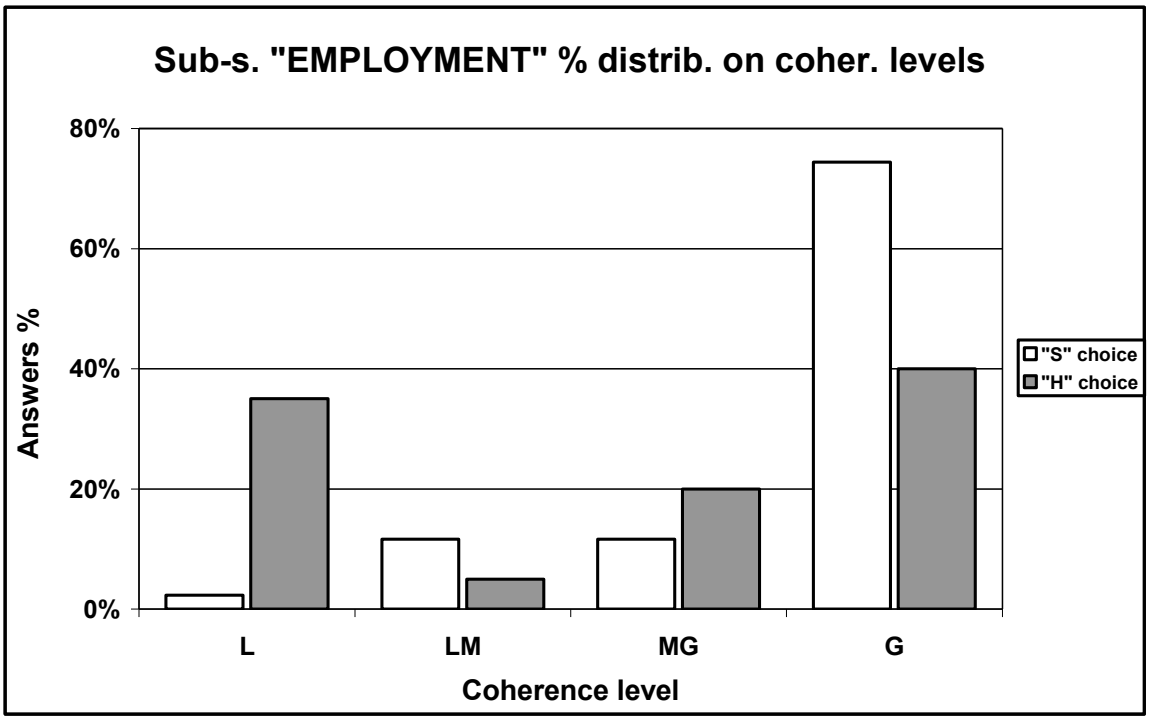
1563 "AGE" (30 years, and over, old persons) according to the coherence (expressed through

1564 the coherence indicator) between, by one hand, their interpretations of Messages #4/H

1565 and #4/S; by the other hand, their final choice. Data is shown separately for "H" and "S"

1566 choosers. Distributions result significantly different (Chi-squared test: p=0.001174).

1567



1569

1570 **Figure 16: Sample percent distribution with respect to coherence levels / Comparing**

1571 **"H"/"S" choosers - Subsample "EMPLOYMENT"**

1572 [Legend / Coherence indicator:

1573 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1574

1575 This histogram shows the percent distribution of respondents belonging to sub-sample

1576 "EMPLOYMENT" (workers only, students and unemployed excluded) according to the

1577 coherence (expressed through the coherence indicator) between, by one hand, their

1578 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1579 shown separately for "H" and "S" choosers. Distributions result significantly different

1580 (Chi-squared test: p=0.001560).

1581 **Tables**

1582

1583

Category	Sub-category	Examples of participants' interpretations
Behaviours [7 answers]	---	XX requests for an intervention
		She reports flaws
		She is just sending a duty communication
Emotions [16 answers]	XX is:	Angry, Disturbed, Worried, Aggressive, Discouraged
		Brave, Impatient, Afraid
Relations XX-YY [41 answers]	XX expresses:	Assertiveness, Aggressiveness, Superiority, Subordination
	XX takes a position:	Tough, Technical, Neutral
	XX:	Demands a solution
		Recalls YY to his duty
		Thwarts YY's plans
Message form [19 answers]	Msg #3 is more:	Concrete, Correct, Detailed
		Direct, Effective

1584

1585 **Table 1: An example of interpretation scatter from our research.**

1586 Sixty-one individuals (60% of the sample), after having compared XX's Messages #1 and

1587 #3, answered "YES" to Question #2 and provided 83 specifications for the changes they

1588 had detected in XX's position toward YY. The table classifies the specifications into 4

1589 main categories and provides some examples for each one of them.

1590

1591

1592
1593

Components	Examples
The POSITION of a statement	*XX explains her absence **at the beginning** of Msg #3 to forestall possible criticism.* *YY scoffs at XX, expressing a little courtesy **just at the end** of Msg #4/H.*
The LENGTH of a text	*Msg #4/H **being long** / Msg #5 **being short** have an underlying meaning.*
Dotted lists	***The use of it** in Msg #4/H has a meaning.*
Type of lexicon	*The use of **technical words / expressions** imply precision, but also suggest the intention to keep one's distance.* ***Thanking and reassuring expressions** have détente effects.*
The relational or social roles of characters	*Some interpreted Msg #4/H as an attack to XX **being a woman**.*
The professional roles of characters	*XX not being an Account, **she would not cheat**.*
Grammatical observations	*The **verbs' tense is noted** as having an underlying meaning.*
LACK of content	*YY **does NOT wonder** why XX requests a control.* *YY announces a solution **NOT clarifying** what it will be.*

1594

1595 **Table 2: A selection of messages' "other components" that readers may focus on.**

1596 The table displays a tight selection of the messages' "other components" focused by
1597 respondents. These components are independent of the information content and, in most
1598 cases, of the message text. They are extremely various, indeed unpredictable, and return
1599 the impression that the receivers' preferences could be totally rule less.

1600
1601

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1602

Quest.	Sym.	Titl.	Words	Incid.	Phras.	Whole	Cont.	Other	Gram.	TOT	%
1-a	1	7	46	55	53	16	29	14	4	225	17.1%
1-b	1	7	26	53	27	18	20	12	3	167	12.7%
1-c	0	6	22	58	34	13	11	12	2	158	12.0%
2	4	5	22	52	32	17	34	7	2	175	13.3%
3-4/H	0	1	13	49	54	35	31	24	2	209	15.9%
3-4/S	0	22	14	52	48	45	29	5	1	216	16.4%
Final	2	14	17	30	28	50	6	22	0	169	12.8%
TOT	8	62	160	349	276	194	160	96	14	*1,319*	100%
%	0.6%	4.7%	12.1%	26.4%	20.9%	14.7%	12.1%	7.3%	1.1%	100%	

1603

1604 **Table 3: Statistics on indicated components.**

LEGEND	
Sym. = Symbols (punctuation marks)	Whole = General tone of the message / Blocks of text
Titl. = Titles – Salutes (starting/closing expressions)	Cont. = Information content of the message
Words = Meaningful isolated words/expressions	Other = Other components of the message
Incid. = Incidental passages, meaningless *per se*	Gram. = Grammar notations, like verbs tense and similar
Phras. = Complete phrases/periods	TOT = Totals; % = Percentage on totals

1605

1606 The table displays a descriptive statistical analysis of what the respondents look at inside the messages. The information
1607 content is focused by 12.1% of respondents only (“Cont.” column, “%” row). Even if we suppose that reference to complete
1608 phrases/periods could actually mean reference to their content, the sum of “Cont.” and “Phras.” column % totals would amount
1609 just to 33% of respondents, again a clear minority.

Bins (% on personal total)	N. of respondents	%
0%	51	50,0%
1%-24%	31	30,4%
25%-49%	13	12,7%
50%-99%	6	5,9%
100%	1	1,0%
TOTAL	102	100,0%

Table 4: Sample distribution with regards to the indicated components referred to information content.

Answering to the second part of the questionnaire's questions (requesting to indicate the "concrete elements" on which the interpretation was based), just the exact half of the sample indicated, at least once, information content components. In this table, the sample is distributed in bins defined through the percentage that the components referred to information content represent on the personal total of the provided indications. Just for 7 people out of 102 the indications pointing at information content balance the others or prevail (50% or more); just 1 people among them indicates information content components only.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Category	Examples of participants' interpretations
"… we'd be pleased…" [32 quotations]	Aggressiveness; Office duty expression; Informality; Irony
	Just a request; Sarcasm; Highlighting XX's subordinate role
	Expression of alternative visions
"… if at least once…" [17 quotations]	Conflict; Doubt on YY's reliability; Expression of courtesy
	Taunting; Request for attention; Request for information
	A reminder; Stimulus to organization top management
"… we'd be pleased… … if at least once…" [19 quotations]	Expression of XX's fear, because she doesn't feel safe
	Insignificant (just a normal office communication)
	Complaint/claim
	Reprimand/reproach, by XX to YY
	XX's clarification request
	Information exchange

Table 5: Interpretation scatter referred to one component (the incidental passage of Message #1).

The table displays the result of classifying the interpretations given by a subset of 53 individuals (52% of the sample) to one component of Message #1. These respondents, even though focusing on that same component (the incidental passage "…we would be pleased if at least once…"), have nonetheless dispersed their interpretations. This means that not even the "funnel-shape" model (Fig. 6) could result acceptable.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Factors	Examples
Form of address	*Using or not titles indicates formality level*
Use of idiomatic expressions	*Sign of familiarity, informality*
Regards / greetings form	*Length and presence/absence of thanks are taken into account and interpreted as sign of attention, carelessness, respect, defiance…*
Reply quickness	*Courtesy / promptness sign*
Use of technical terms	*Sign of intention to keep a distant role*
Amount / level of details provided	*Sign of major / minor accuracy or interest*
Quantifying information	*Sign of quibbling, coldness*
Referring to rules / laws	*Taken as sign of escalation in formality*

Table 6: Examples of possible stimulus-factors.

The table displays examples, drawn from the filled questionnaires, of one category of possible stimulus-factors inside the messages. The capability of these factors to work as stimuli is not linked to the information they might contain, but to "the fact that" they are present within the message, in a certain form and/or at a certain point.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1645

Variable	Total Sample		Sub-sample AGE		Sub-sample EMPLOYMENT	
	Answers	%	Answers	%	Answers	%
"H" choice	26	*25.7%*	17	*28.8%*	20	*31.2%*
"S" choice	75	*74.3%*	42	*71.2%*	44	*68.8%*
Total	**101**	*100%*	**59**	*100%*	**64**	*100%*

1646

1647 **Table 7: Statistical distribution of the answers to the Final question (H/S choice).**

1648 The table displays (for the total sample and the two control sub-samples) the frequencies

1649 of the answers to the Final question (the choice between Message “H” and Message “S”

1650 as the solution of the case). A strong imbalance is shown, as indications of Message #4/S

1651 overwhelm the Message #4/H ones in all cases.

1652

1653 ...

1654 ...

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

	Total sample						Sub-sample "AGE"						Sub-sample "EMPLOYMENT"					
	S+		S-		*TOTALS*		S+		S-		*TOTALS*		S+		S-		*TOTALS*	
H+	18	*22.5%*	12	*57.1%*	30	*29.7%*	8	*17.8%*	7	*50.0%*	15	*25.4%*	9	*18.8%*	9	*56.3%*	18	*28.1%*
H-	62	*77.5%*	9	*42.9%*	71	*70.3%*	37	*82.2%*	7	*50.0%*	44	*74.6%*	39	*81.3%*	7	*43.8%*	46	*71.9%*
Totals	***80***	*100.0%*	***21***	*100.0%*	***101***	*100.0%*	***45***	*100.0%*	***14***	*100.0%*	***59***	*100.0%*	***48***	*100.0%*	***16***	*100.0%*	***64***	*100.0%*
Gen. Total	***101***						***59***						***64***					

Table 8: Distribution of predictions about Message #4/H and Message #4/S effects.

Predictions about Message #4/H and Message #4/S effects are independently expressed, by each member of the sample, through answering to Questions #3 and #4. Answers are classified through the dummy variable “Expected effects” (possible values “+”, if respondents point out that the message will solve the XX-YY contrast, or “-“, in the opposite case). The table shows that all the possible combinations of predictions (for the total sample and the two control sub-samples) are present. Distribution is clearly imbalanced (definite preference on “H-/S+” combination). Significance is checked through Chi-squared test: p=0.001988, total sample; p=0.015600, sub-sample “AGE”; p=0.003861, sub-sample “EMPLOYMENT”.

	Total sample						Sub-sample "AGE"						Sub-sample "EMPLOYMENT"					
	"H" Choice		"S" Choice		Totals		"H" Choice		"S" Choice		Totals		"H" Choice		"S" Choice		Totals	
H+ / S+	5	*19.2%*	13	*17.6%*	18	*18.0%*	4	*23.5%*	4	*9.8%*	8	*13.8%*	4	*20.0%*	5	*11.6%*	9	*14,3%*
H+ / S-	10	*38.5%*	2	*2.7%*	12	*12.0%*	6	*35.3%*	1	*2.4%*	7	*12.1%*	8	*40.0%*	1	*2.3%*	9	*14,3%*
H- / S+	9	*34.6%*	53	*71.6%*	62	*62.0%*	6	*35.3%*	31	*75.6%*	37	*63.8%*	7	*35.0%*	32	*74.4%*	39	*61,9%*
H- / S-	2	*7.7%*	6	*8.1%*	8	*8.0%*	1	*5.9%*	5	*12.2%*	6	*10.3%*	1	*5.0%*	5	*11.6%*	6	*9,5%*
Totals	***26***	*100.0%*	***74***	*100.0%*	***100***	*100.0%*	***17***	*100.0%*	***41***	*100.0%*	***58***	*100.0%*	***20***	*100.0%*	***43***	*100.0%*	***63***	*100,0%*
Gen. Total	***100***						***58***						***63***					

Table 9: Cross-table of combined predictions and final choices between Message #4H and Message #4S.

In this table the combined predictions of Message #4/H and Message #4/S effects (see Table 8) are crossed with the final choices of the respondents (all the variables are independent). Data shows the association (for the total sample and the two control sub-samples) between the most frequent combination “H-/S+” and “S” as final choice. In addition, some correlations between the two choices is underlined by Chi-squared test: p=0.000017 (total sample); p=0.001174 (sub-sample “AGE”); p=0.000383 (sub-sample “EMPLOYMENT”).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

	L (*low coherence*)	LM (*low-medium c.*)	MG (*med.-great c.*)	G (*great coherence*)
"H" choice	**H- / S+**	**H- / S-**	**H+ / S+**	**H+ / S-**
"S" choice	**H+ / S-**	**H- / S-**	**H+ / S+**	**H- / S+**

Table 10: Plot of the coherence level scale.

The table shows the scale of the coherence levels expressed through the coherence indicator; four levels of coherence are defined and ranked. The indicator rates the degree of coherence among the predictions one respondent expressed about the "H" and "S" versions effects (answers to Questions #3 and #4) and the final choice he/she made ("H" or "S", answer to the Final question). All the questions were independent. The predictions are represented through the dummy variable "Expected effects" and labelled "+" if they indicate that the message will ease or solve the contrast between XX and YY, "-" in the opposite case.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

Coherence level	Total sample		Sub-sample "AGE"		Sub-sample "Employm."	
	Values	*%*	*Values*	*%*	*Values*	*%*
L	11	*11.0*	7	*12.1*	8	*12.7*
LM	8	*8.0*	6	*10.3*	6	*9.5*
MG	18	*18.0*	8	*13.8*	9	*14.3*
G	63	*63.0*	37	*63.8*	40	*63.5*
Total	**100**	***100.0***	**58**	***100.0***	**63**	***100.0***

Table 11: Sample distribution with respect to coherence levels.

[Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of predicted effect (resolution or escalation of the conflict) of the messages on XX.]

The table displays, for the total sample and the two subsamples "Age" and "Employment", the distribution of participants with respect to the different levels of coherence (see Table 10). The L level results over-represented with respect to what expected.

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1701

"H" Choosers			"S" Choosers			Total	
Coherence level	*Values*	*%*	*Coherence level*	*Values*	*%*	*Values*	*%*
L (H-/S+)	9	*34.6*	**L** (H+/S-)	2	*2.7*	11	*11.0*
LM (H-/S-)	2	*7.7*	**LM** (H-/S-)	6	*8.1*	8	*8.0*
MG (H+/S+)	5	*19.2*	**MG** (H+/S+)	13	*17.6*	18	*18.0*
G (H+/S-)	10	*38.5*	**G** (H-/S+)	53	*71.6*	63	*63.0*
Total	**26**	***100.0***	***Total***	**74**	***100.0***	**100**	***100.0***

1702

1703 **Table 12: Sample distribution with respect to coherence levels and expressed choice**

1704 **(total sample).**

1705 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1706 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1707 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1708

1709 The table displays (for the total sample, and separately for the H and S choosers) the

1710 distribution of participants with respect to the different levels of coherence. Data

1711 highlights some correlations between the two variables coherence and choice: Chi-

1712 squared test returns high significance (p<0.01).

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1713

"H" Choosers			**"S" Choosers**			**Total**	
Coherence level	***Values***	***%***	***Coherence level***	***Values***	***%***	***Values***	***%***
L (H-/S+)	6	*35.3*	**L** (H+/S-)	1	*2.4*	7	*12.1*
LM (H-/S-)	1	*5.9*	**LM** (H-/S-)	5	*12.2*	6	*10.3*
MG (H+/S+)	4	*23.5*	**MG** (H+/S+)	4	*9.8*	8	*13.8*
G (H+/S-)	6	*35.3*	**G** (H-/S+)	31	*75.6*	37	*63.8*
Total	**17**	***100.0***	***Total***	**41**	***100.0***	**58**	***100.0***

1714

1715 **Table 13: Sample distribution with respect to coherence levels and expressed choice**

1716 **(Sub-sample "Age").**

1717 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1718 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1719 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1720

1721 The table displays (for the sub-sample "Age", >29yy-old people only, and separately for

1722 the H and S choosers) the distribution of participants with respect to the different levels

1723 of coherence. Data highlights some correlations between the two variables coherence and

1724 choice: Chi-squared test returns high significance (p<0.01).

1725

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015

1726

"H" Choosers			**"S" Choosers**			**Total**	
Coherence level	***Values***	***%***	***Coherence level***	***Values***	***%***	***Values***	***%***
L (H-/S+)	7	*35.0*	**L** (H+/S-)	1	*2.3*	8	*12.7*
LM (H-/S-)	1	*5.0*	**LM** (H-/S-)	5	*11.6*	6	*9.5*
MG (H+/S+)	4	*20.0*	**MG** (H+/S+)	5	*11.6*	9	*14.3*
G (H+/S-)	8	*40.0*	**G** (H-/S+)	32	*74.4*	40	*63.5*
Total	**20**	***100.0***	***Total***	**43**	***100.0***	**63**	***100.0***

1727

1728 **Table 14: Sample distribution with respect to coherence levels and expressed choice**

1729 **(Sub-sample "Employment").**

1730 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1731 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1732 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1733

1734 The table displays (for the sub-sample "Employment", people with a regular employment

1735 only, and separately for the H and S choosers) the distribution of participants with respect

1736 to the different levels of coherence. Data highlights some correlations between the two

1737 variables coherence and choice: Chi-squared test returns high significance (p<0.01).

1738

PeerJ PrePrints | http://dx.doi.org/10.7287/peerj.preprints.358v4 | CC-BY 4.0 Open Access | rec: 7 Mar 2015, publ: 7 Mar 2015