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, Livia S Convertini, Sabrina Quatraro, Stefania Ressa, Annalisa Velasco

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

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Abstract

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26 controlled conditions through a specially designed questionnaire (closed and opened
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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

symbol-based consciously processed 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 intends to bring 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. Even a "hard" natural science like physics has generated (from XIXth Century) a "psychophysics" branch, originally aimed to scientifically study the relationship between perceptions and sensations, recently extended to the direct investigation of knowledge processes (see ahead). Another trend, thanks to the extraordinary development of

[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.

technology and informatics, is the enhancement of the studies that explore interpretation inside the neural processes of the brain cortex: the neuron-level research and the wide use of advanced imaging techniques witness for this. All this considered, we can roughly outline a picture with two main scientific research lines:

- **Mind-centred approaches** – Understanding/interpretation is totally based on abstract (conceptual) knowledge. Information feeds are provided through the body (perception) but the "mind"[3] processes stimuli and incoming signals at symbolic level, transforming them in propositional representations in the brain cortex and understanding them in terms of concepts. The answer to the inputs (reaction) is based on such comprehension and is shaped as a command to some effectors (typically the motor system). Knowledge is the result of a sort of computation; the mind is separated from the body and rules it. The role of the motor system is totally passive.
- **Body-centred approaches** – Understanding/interpretation is attained through a motor reaction of the body that can, at maximum, co-exist with conceptual knowledge. When an external stimulus/signal is perceived, it is firstly "understood" through a motor reaction which is automatic, involuntary and based on "mental maps" that are motorial, not (or not only) propositional. Understanding is a sort of motor experience that goes along with conscious (rational) in-

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

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 main features of the first group's theories 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

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".

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[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.

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

163 The contrast between these two positions has not yet been solved even though,
164 with respect to its beginning, the debate has grown up far further. In particular, the
165 hypotheses based on the mirror neurons discovery have been refined, for example
166 through the concepts of Mirroring mechanisms (MM) and Embodied simulation (ES)
167 (Gallese, 2005, 2006, 2007, 2008, 2009a; Gallese et al., 2009; Gallese & Sinigaglia,
168 2011a; Ferri, Gallese & Costantini, 2011; Marino et al., 2011; Gallese & Sinigaglia,
169 2012; Ferrari & Rizzolatti, 2014; Gallese, 2014). About this ongoing dispute, a summary
170 and a state-of-the-art outline can be found in Zipoli Caiani, 2013; apart from this, one of

171 the most interesting documents is a forum (Gallese et al., 2011) inside which the most
172 delicate and controversial questions are widely debated. The main ones, with regards to
173 the subject of our work, are the following four: goal-dependency of mirror reactions,
174 with references provided by upholders (Umiltà et al., 2008; Cattaneo et al., 2009; Rochat
175 et al., 2010) and detractors (Range, Viranyi & Huber, 2007; Hickok, 2009; Hickok &
176 Hauser, 2010; Muller & Cant, 2010); the nature of motor representations in the brain
177 cortex and the hypothesis that action understanding obtained through mirror neurons
178 would be a form of knowledge qualitatively different from the propositional and abstract
179 ones (widely discussed in Gallese et al., 2011); the interpretation of the human ability to
180 understand actions that cannot be performed, like the barking of a dog (Rizzolatti &
181 Sinigaglia, 2006; Hickok, 2009; Rizzolatti & Sinigaglia, 2010); the interpretation of
182 neuropsychological evidence about the relationship among motor impairments and action
183 recognition underperformances (with works that uphold one position, for example Moro
184 et al., 2008; Pazzaglia et al., 2008, or the other, for example Negri et al., 2007; Hickok,
185 2009).

186 In the end, it is worth dedicating a mention to a recent specialised research field
187 of psychophysics, in which researchers investigate cognition and semiosis through
188 probabilistic models (Chater, Tenenbaum & Yuille, 2006; Ingram et al., 2008;
189 Tenenbaum et al., 2011), in particular applying the Bayesian inference to reproduce
190 mental processes and describe it through algorithms (Griffiths, Kemp & Tenenbaum,
191 2008; Bobrowsky, Meir & Eldar, 2009; Perfors et al., 2011; Fox & Stafford, 2012). Such

192 concepts are currently in use also in the Artificial Intelligence (AI) studies[7]. Inside such
193 research field, a specific sector concentrates on what follows interpretation, that is
194 confrontation among different "apprehensions" (conscious perceptions); the result of
195 such confrontation is a "judgement", i.e. decision and conceptualization (Arecchi, 2010a;
196 2010b; 2010c; 2011a). New concepts are introduced to investigate semiosis: semantic
197 and non-semantic complexity (Arecchi, 2008), deterministic chaos (Guastello, 2002;
198 Arecchi, 2011b), inverse Bayesian inference (Arecchi, 2010d), creativity as NON-
199 bayesian process (Arecchi, 2010e), quantum dynamics (Arecchi & Kurths, 2009; Nathan
200 et al., 2012) and the reference to Gödel's incompleteness theorem as a limit to the
201 possibility of understanding cognition "from inside" (since that, while studying
202 cognition, we become a system that investigates itself)[8].
203
204 **Method**
205 All this matter has not yet been adequately cleared; one reason is that there are
206 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

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

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

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

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

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

79 [10] An authoritative confirmation comes from the Cornell University (2013) "IRB Decision Tree"
80 (https://www.irb.cornell.edu/documents/IRB%20Decision%20Tree.pdf) which reports (top right area of
81 the first page) the following example of research that does NOT require an IRB approval: "*The focus of*
82 *the project is only on products, methods, policies, procedures, organizations: e.g., interviewing*
83 *transportation staff and officials about parking or transportation policies and procedures*". Our research
84 exactly matches such example: we have not studied the sample's members personal characteristics;
85 rather, we have collected their opinions about some specific (totally neutral) objects (the messages

Committee for Scientific Research of the Association ARPA-Firenze. The Committee held a dedicated session to our research (in 2012, april 2[d]) and its approval was given 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

presented in the research's questionnaire) through gathering the answers they provided, willingly and anonymously, to the questionnaire.

287 Scientific Research of the Association ARPA-Firenze approved also this informed
288 consent procedure.

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

301

302 **The first part of the research: observing and hypothesizing**

303 The first level of our analysis regarded our research's first part and yielded
304 something expected and something unexpected. We remind that each questionnaire's
305 question sent two inputs to the respondents: at first, they were requested to freely
306 interpret some aspects of the submitted messages; then, they were requested to account
307 for their own interpretations through indicating the “concrete elements” on which these
308 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 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[11]. 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).

[11] 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).

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 can be represented through a "megaphone-shape" picture (Fig. 1): receivers take into account the same information but their final interpretations diverge[12]. 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

[12] 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).

("from… to…"). The string length could cover up to a whole paragraph of the message (from a keyboard "Enter" to the following).

- 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[13], 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 participant (see SI Section 8.a, final part, for details). In fact, in this kind of answers participants 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

[13] 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*.

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

383 In order to answer these questions, we named "components" the items indicated
384 in the answers to the questions' second input and went back to the questionnaires in order
385 to tally the components present in our survey. We have tallied a total of 1,319
386 components clearly indicated by participants and we have displayed in Table 3 their
387 absolute and relative amounts. Indications that clearly focus on the information content
388 constitute only a small minority (around 12%, see Table 3, "%" row, "Cont." column)

while references to different text components reach, on the whole, about 65% (Table 3, "%" row, sum of the first five column totals). The indications referred to some overall 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

411 information content. Among them, only one reaches 100%. In fact, references to the
412 information content are a definite minority in participants' indications.

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

416 ▪ The interpretation process looks to be starting like a selective and subjective
417 picking up of (or focusing on) the most different components, rather than be-
418 ing a systematic, conscious scanning of the text's content. Such behaviour is
419 widely scattered: in the whole research, with regards to each specific message,
420 it is impossible to find two identical combinations of focused on components.
421 ▪ Readers seem to interpret a message indifferently picking up meaningful and
422 meaningless components and subjectively combining them. While reading and
423 text decoding go ahead sequentially, readers go on freely (randomly, from an
424 external observer's point of view) isolating "chunks" of the text (as well as
425 other components and even external context aspects) and selecting them as the
426 foundation of the message's meaning.
427 ▪ While the final meaning attributed to the message is justified through the se-
428 lected components, no reason (at all, in any cases) is provided for that selec-
429 tion: in the respondents' accounts, the focused components suddenly appear;
430 they are presented just as "given", and without any doubt[14].

118 [14] The unique doubt expressed in the whole research is the following: 1 participant (out of 102)
119 declares uncertainties in his final choice writing that the final effect could be obtained with both the
120 messages under choice. It must be noted that, with regards to the other questions, also this special
121 participant's answers are totally doubt-free, like the rest of the participants' ones.

431 At this point, we named "disassembling" the observed selective focusing and took
432 two measures. At first, we hypothesized a new image for the interpretation process,
433 inverted with respect to the "megaphone-shape" (Fig. 1) one. Our argument was that, if
434 scatter manifests itself in the beginning (scattering of focus), a "funnel-shape" picture
435 (Fig. 6) could be more suitable: people that select one same component are expected to
436 interpret it in very similar ways. Secondly, we picked up from our data an example of
437 disassembling and decided to carry out an in-depth analysis of it.

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

448 This means that focusing on the same component does not imply convergent
449 interpretations. As much as to say that the interpretation scatter manifests at both levels:
450 the disassembling (scattering of focusing on components) and the following attribution of
451 meaning (each sub-group, focused on a same component, provides scattered conscious

124 [15] The 53 people have expressed their interpretations answering Question #1-a (23), #1-b (15) or both
125 the questions (15). See SI Section 4 for the questions' full texts.

452 interpretations). This means also that the "funnel-shape" picture, too, must be revised:
453 what we observed could be better expressed through an "hourglass-shape" picture (Fig.
454 7). In fact, disassembling and classic interpretation scatter would co-exist and manifest
455 themselves **in sequence**. We notice that the expression we are considering appears to be
456 a minor element in Message #1 text, something incidentally expressed; it is composed
457 using common words and bears no inherent information content (once the passage gets
458 isolated from the rest of the message, it is impossible to attribute it a definite meaning).
459 In short: it is a mere form component. So, how could respondents select such incidental
460 passage? And what did they, exactly, grasp in it? What is more, given that the following
461 interpretations are scattered, what did respondents, exactly, interpret, having started from
462 an identical, spontaneous selection?

463 Now, the message we have used in our research was always the same, invariable
464 with regards to written form as well as to information content. Thus, if the interpretations
465 of the readers are so scattered, this cannot depend on the message itself, it must depend
466 on the readers: they evidently give an active contribution in attributing meanings, they
467 are not passive symbol decoders. Nothing new, so far: our observations confirm old
468 ideas, for example the ones that the constructivist hypothesis proposed many years ago
469 (Watzlawick, 1984). The question is: how can this happen? By one hand, respondents
470 explain through the outcomes of "disassembling" the conscious attribution of meaning
471 that follows; by the other hand, no accounts report about the source of disassembling.
472 The selective focusing manifests "immediately and automatically", apparently preceding
473 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 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 with previous experiences that had involved something similar) and such stimulus oriented the following conscious process. One more question remains: exactly, how can we precisely identify what a reader picks up when he/she selectively focuses on meaningless/contentless components? We think we can label it as **the fact that** one of these components is present in the message; it can be considered some meta-information to which readers can automatically react even though it is not embedded inside the message words (Table 6). This can clarify the aspect of the incidental passage ("we would be pleased if at least once…") which triggered the participants' reaction off: the fact that XX had (redundantly) placed it in a certain point of the message[16].

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

The second part of the research: checking the hypothesis

Our research's second part represents a first check about our hypothesis. We started submitting to participants two alternative versions (Messages #4/H and #4/S) of a

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

516 possible reply to Message #3. Then we asked them (Questions #3 and #4) to, firstly,
517 interpret (independently) the two versions in terms of their effects on XX; secondly
518 (Final question), to choose between them the one suitable, in their opinion, to origin the
519 final XX's answer (Message #5, that seals the positive ending of the case; see SI Section
520 4 for messages' and questions' full texts; Section 5 and Tables S1, S2 for details about
521 the reasons of the alternative). Our rationale was the following: the participant's choice
522 could come as a result of the text information's conscious processing (cognitivism stance)
523 or as an automatic reaction independent of every conscious processing (embodied
524 cognition stance). In the first case (our "Hypothesis 0"), the final choices should be
525 outcomes of the interpretations given to the messages; thus, they should result somehow
526 correlated with them. In the second case, no correlation, or a different kind of correlation,
527 should be found (our "Hypothesis 1"). The problem emerged of measuring such
528 correlation.

529 *The coherence between interpretation and choice*. Firstly, we displayed (Table 7)
530 the choices indicated by the sample members (SI Section 6 and Tables S3-S5 for the sub-
531 samples description) and found out a strong imbalance between "S" and "H" indications.
532 Secondly, we compared the interpretations of Message #4/H with those of Message #4/S
533 (SI Section 4 for messages' full texts). Source data (opened answers) was purely
534 qualitative. However, answers were easily classifiable into two main categories:
535 predictions for the message inducing a solution of the case (easing or solving the
536 emerging conflict between the interlocutors); predictions for the message inducing a
537 surge, or escalation, in the conflict. We created the dummy variable "Expected effects"

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

551 Then, we cross-checked the combined predictions with the final choices (Table
552 9). The most frequent combined prediction (H-/S+) appears to be strongly associated to
553 "S" choice; indeed, the significance tests (Chi-squared) show that some further relations
554 do exist between combined predictions and choice (p = 0.000017, total sample;
555 p = 0.001174, sub-sample "AGE"; p = 0.000383, sub-sample "EMPLOYMENT"). Such
556 results led us facing the core-question related to our hypothesis: given the existence of
557 some correlations between choice and combined predictions, which is its direction? We
558 mean: do the interpretations (the predictions) drive the choice (cognitivism stance) or,
559 oppositely, does the choice precede and somehow drive, or overcome, the interpretations

560 (embodied cognition stance)? To delve further into such subject, we created a "coherence
561 indicator" starting from the following premises (SI Section 4 for messages' full texts):

562 ▪ The final Message #5 clearly indicates XX's satisfaction; therefore, the con-
563 flict has come to its end.
564 ▪ Now, let us figure a respondent whose answers to Questions #3 and #4, for ex-
565 ample, return a combined prediction H+/S- (Message #4/H solving the con-
566 flict, Message #4/S escalating it). Then we expect that this respondent indic-
567 ates Message #4/H in his final choice (answer to Final question). Such com-
568 bination (H+/S- & "H" choice) would represent the maximum coherence
569 level.
570 ▪ If another respondent provides the same combined prediction but indicates
571 Message #4/S in his final choice (combination H+/S- & "S" choice), this
572 would represent the minimum coherence level.
573 ▪ Given the natural variability always recorded in human samples, we expected
574 to find also intermediate coherence levels, based on the other possible com-
575 binations (H+/S+ and H-/S-). These could be also due to the predictable scat-
576 tering of interpretations about the final Message #5: someone could interpret it
577 as something different from the sign of the conflict's ending (what happened
578 in a fistful of cases).

579 We defined four coherence levels, increasing from L (low) to LM (low-medium),
580 MG (medium-great) and G (great); the scale is fully presented in Table 10. In this way, it
581 has been possible to study the final choice with respect to the coherence levels (Table

582 11). The percent distribution histogram of the whole sample (Figure 9, data from Table
583 11) shows that the distribution is the expected one except for the frequency of the low
584 coherence bin, over-represented. Actually, we expected L frequency to be null or very
585 close to null; anyway, it should show the lowest frequency of all. On the contrary, we
586 found L values higher than the LM ones and representing 11% of the sample.

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

600 Now, Chi-squared tests and graphic representations clearly indicate the existence
601 of a correlation between the participants' choice and the coherence level; but what about
602 its strength and its direction? In order to investigate the strength, we calculated the odds
603 ratio. Our success item was the L level, our failure items all the other levels of coherence.

Using data from Table 12, we can find ODDS1 = 0.346 ("H" choosers, 1 success every about 2 failures) and ODDS2 = 0.028 ("S" choosers, 1 success every about 36 failures). The final result is ODDS RATIO = 18,9 which highlights a strong correlation between the "H" choice and the L coherence level. As much as to say that, if you choose message #4/H, it is much more likely (with respect to message #4/S choosers) that your choice is inconsistent with your interpretations of the two messages. About the direction of such correlation (the interpretations precede and drive the choice or the choice is independent of interpretations), we think the first position is not tenable; indeed, it could be confirmed just in case of general consistence between interpretations and choice.

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

Discussion

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

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

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

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

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

- 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 second part's 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[17]. C*onsequence of the "in a cascade" setting of our model's three steps (further details, with direct references to recent scientific paper consistent*

[17] 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

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

The divergence between the two approaches can be synthesized as follows (for further reference see, for example, Bedny et al., 2008; Rizzolatti & Fabbri-Destro, 2008; Goldman & de Vignemont, 2009; Gallese, 2011; Gallese & Sinigaglia, 2011b; Bedny et al., 2012): cognitivism upholds the sequential processing idea, i.e. cognition being conceptual and resulting from a sequence of perception / symbolic processing of the incoming information / (motor) reaction. Oppositely, the embodiment theories uphold the concept of direct connections among cortical sensorial and motor areas ("sensorimotor grounding" of cognition, Guan et al., 2013). In this sense, cognition would be embodied[18]. Now, how could our work be positioned in such picture? In a third position, we would say. In fact, both theories are based on the implicit idea that human communication is a continuous, homogeneous process. On the contrary, we hypothesize

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

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

708 Actually, in our opinion, the embodied concept's features are clearly akin to our
709 second step ("disassembling", see Fig. 8): an immediate and automatic reaction that
710 precedes conscious processing of information. This last (our third step, Fig. 8) is clearly
711 akin to the cognitivist hypothesis, that refers to a conscious processing of the inputs with
712 subsequent conceptual output. We must add that such overlapping is just one aspect of
713 the question; our proposal entails at least one important difference with respect to the two
714 theories: the discrete, in-a-cascade structure of our process implies a feeding chain, with
715 the first step (decoding) that feeds the second (disassembling) which, in turn, feeds the
716 final one. This results, after "disassembling", in the loss of the contact with the source
717 message and in the conscious processing performed on the body-reaction signals
718 (presumably received through proprioception). The real object of our (first level, see
719 Footnote 17) knowledge would not directly be the outer world; rather, it would be our
720 instinctive reactions to it (the outer inputs combined with our inner world). This is a
721 relevant point, and we have selectively examined some of the available literature for a
722 first check of it.

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

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

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

action and thought using action (rather than thought) to induce training and therapeutic effects[19]. We find no important contradictions among our hypotheses and such models; rather, we find complementarity: they show how physical stimuli can act like messages; our results tell that words (even if only written) can act like physical stimuli. In addition, we can propose an explication of an unsolved point related to them: the biological foundations of the "aspect of relation" in human communication (Watzlawick, Beavin Bavelas & Jackson, 1967). On the basis of our results, this aspect could be exactly the body-level automatic reaction which precedes the conscious information processing.

About the relevance of unconscious processes in human behaviour, some fundamental clarification is provided by Custers & Aarts, 2010 through a review of experimental works that re-examines the disputed question of the passage from perception to action. The authors compare the traditional positions of Sensory-motor Principle (SMP, for example Massaro & Cowan, 1993; and, for a presentation and discussion about the sequential processing of stimuli conceived as the foundation of human/environment interactions see also Rizzolatti & Sinigaglia, 2006, chapters 1, 2) and Ideomotor Principle (IMP, Stöcker & Hoffmann, 2004; Pezzulo et al., 2006; Melcher et al., 2008; and, for a synthesis, Iacoboni, 2008, Chapter 2, pp. 56-57 of Italian edition).

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

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

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

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

789 pourer was instructed not to pour)…" (see Hickcok, 2009, page 1240, italic by the
790 author). The author also anticipates the counter-argument of a supposed mirror neuron
791 theorist, i.e. that mirror neurons codify the goals, or intentions, of the actor: "But a goal,
792 say to fill a glass with water, can be accomplished with any number of individual actions
793 or sequence of actions: pouring from a pitcher, turning a spigot, dipping a glass in a lake,
794 setting the glass in the rain…" (*ibidem*).

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

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

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"[20].
- 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

[20] 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).

something contained inside the message. So, it would be impossible to 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*

(through natural language) on the final state of his/her organism after experiencing the interaction with the message.

Other possible consequences of our results are the following:

- 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

874 disassembling precedes, then our hypothesis would be confirmed. The problem is just to
875 find a way in order to definitely answer such question, what does not seem easy.
876 The second point to be checked regards the reasons of the observed radical
877 difference between the "H" choosers and "S" choosers group behaviours in terms of
878 interpretation/choice coherence; about this, we think there are two possible hypotheses:
879 (1) The two subsamples follow different paths in interpreting natural language messages
880 ("S" choosers would base their choices on rational information processing, which would
881 precede action, while "H" choosers would react instinctively and choose before analysing
882 the available information); (2) The two subsamples actually follow the same path
883 (automatic reaction preceding conscious information processing, in our opinion) and the
884 difference they show is linked to the differences in their automatic reaction schemes ("S"
885 choosers' reaction would privilege the attention to the relational aspects while "H"
886 choosers' reaction would privilege the content aspects). We consider relevant such matter
887 and we will not engage ourselves in extemporaneous considerations about it; rather, we
888 have already begun to think to a dedicated specific research.
889
890 **Conclusion**
891 Human behaviour (communication through natural language and "understanding"
892 included) must be rooted into biology. We consider established and thoroughly share this
893 idea; for this, our results have to pass the crucial test: valid compliance with the evolution
894 theory. Specifically, we must ask ourselves if a conscious organism that reacts before

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

At present times, human beings live inside sophisticated societies; however, their biology is the result of natural selection and represents the best fitting in a **natural hostile environment**. Biologically, we are "still the ones of the stone and of the sling"[21] even though, from a cultural slant, we can account for ourselves in different ways. Rational thinking is, undoubtedly, much slower in comparison to intuitive reactions; at the same time, in a natural environment, fast reaction capacities are a critical surviving factor. Thus, reaction preceding reflection appears to be consistent with the evolution theory. Human communication and culture could have begun by employing the new feature of language through such general rule: at first, perception would not start complex (and slow) information treatment; rather, the entire organism automatically would change its state and, "resounding" similar situations, would be primed for immediate action. Then, rational thinking would follow. Another possible example of the "exaptation" process (Gould & Vrba, 1982).

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

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

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

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References

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

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

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

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

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

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

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

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

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

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

955 Aziz-Zadeh L, Damasio A. 2008. Embodied semantics for actions: Findings from
956 functional brain imaging. *Journal of Physiology – Paris*. DOI:
957 10.1016/j.jphysparis.2008.03.012.

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

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

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

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

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

971 Bateson G. 1976. *Verso un'ecologia della mente*. Milano: Adelphi. [Orig. ed.: Bateson G.
972 1987 (1972). *Steps to an Ecology of Mind: Collected Essays in Anthropology,*
973 *Psychiatry, Evolution, and Epistemology*. Northvale: Aronson.]

974 Bedny M, Caramazza A, Grossman E, Pascual-Leone A, Saxe R. 2008. Concepts are
975 more than percepts: The case of action verbs. *The Journal of Neuroscience*, October 29,
976 2008, 28(44):11347-11353. DOI: 10.1523/JNEUROSCI.3039-08.2008.

977 Bedny M, Caramazza A, Pascual-Leone A, Saxe R. 2012. Typical Neural
978 Representations of Action Verbs Develop without Vision. *Cerebral Cortex* February
979 2012, 22: 286-293. DOI: 10.1093/cercor/bhr081.

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

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

985 Bobrowski O, Meir R, Eldar YC. 2009. Bayesian filtering in spiking neural networks:
986 noise, adaptation, and multisensory integration. *Neural Computation* 2009 May, 21(5):
987 1277-320.

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

990 Cannon WB. 1927. The James-Lange theory of emotions: a critical examination and an
991 alternative theory. *The American Journal of Psychology* Vol 39, 1927, 106-124. DOI:
992 10.2307/1415404.

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

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

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

1000 Christian B. 2012. *Essere umani: che cosa ci dice di noi il test di Turing*. [Or. ed.:
1001 Christian B. 2011. *The most human human: What talking with computers teaches us*
1002 *about what it means to be alive*. New York-London: Doubleday – Random House.]

1003 Costa A, Foucart A, Hayakawa S, Aparici M, Apesteguia J, Heafner J, Keysar B. 2014.
1004 Your Morals Depend on Language. *PLoS ONE* 9(4): e94842. DOI:
1005 10.1371/journal.pone.0094842.

1006 Crepaldi D, Aggujaro S, Arduino LS, Zonca G, Ghirardi G, Inzaghi MG, Colombo M,
1007 Chierchia G, Luzzatti C. 2006. Noun-verb dissociation in aphasia: the role of
1008 imageability and functional locus of the lesion. *Neuropsychologia* 2006; 44 (1): 73-89.
1009 PMID: 15922372.

1010 Custers R, Aarts H. 2010. The unconscious will. *Science* 329: 47-50. DOI:
1011 10.1126/science.1188595.

1012 De Mauro T. 2003 (1980). *Guida all'uso delle parole*. Roma: Editori Riuniti.

1013 Deacon T W. 2012. *Natura incompleta: Come la mente è emersa dalla materia.* Torino:
1014 Codice Edizioni. [Or. ed.: Deacon T W. 2012. *Incomplete nature: How mind emerged*
1015 *from matter.* New York: W. W. Norton & Company.]

1016 di Pellegrino G, Fadiga L, Fogassi L, Gallese V, Rizzolatti G.1992. Understanding motor
1017 events: A neurophysiological study. *Experimental brain research* 91: 176-180. DOI :
1018 10.1007/BF00230027.

1019 Dilts R. 2003. *Creare modelli con la PNL.* Roma: Astrolabio – Ubaldini. [Or. ed.: Dilts
1020 R. 1998. *Modeling with NLP*. Capitola: Meta Publications.]

1021 Ferrari F, Rizzolatti G. 2014. Mirror neurons research: the past and the future. *Phil.*
1022 *Trans. R. Soc. B* **369**, 20130169 (published 28 April 2014). DOI: 10.1098/rstb.2013.0169.

1023 Ferri F, Riggio L, Gallese V, Costantini M. 2011. Objects and their nouns in peripersonal
1024 space. *Neuropsychologia* 49 (2011): 3519– 3524.

1025 Fowler CA, Galantucci B, Saltzman E. 2003. Motor theories of perception. In: Arbib
1026 MA, ed. *The handbook of brain theory and neural networks*. Cambridge: The MIT Press,
1027 2[d] edition, 705-707.

1028 Fox C, Stafford T. 2012. Maximum utility unitary coherent perception vs. the Bayesian
1029 brain. *Proceedings of the Annual Meeting of the Cognitive Science Society*, Sapporo 1-4
1030 August 2012. *Available:*
1031 *http://mindmodeling.org/cogsci2012/papers/0070/paper0070.pdf* (accessed 1 Sept 2014).

1032 Friedman BH. 2010. Feelings and the body: the Jamesian perspective on autonomic
1033 specificity of emotion. *Biological Psychology*, Jul;84(3):383-93. DOI:
1034 10.1016/j.biopsycho.2009.10.006. Epub 2009 Oct 29.

1035 Gallese V, Gernsbacher MA, Heyes C, Hickok G, Iacoboni M. 2011. Mirror Neurons
1036 Forum. *Perspectives on Psychological Science* 2011 6: 369. DOI:
1037 10.1177/1745691611413392.

1038 Gallese V, Rochat M, Cossu G, Sinigaglia C. 2009. Motor cognition and its role in the
1039 phylogeny and ontogeny of intentional understanding. *Developmental Psychology* 45:
1040 103–113.

1041 Gallese V, Sinigaglia C. 2011a. How the body in action shapes the self. *Journal of*
1042 *Consciousness Studies* 18: No. 7–8, 117–43.

1043 Gallese V, Sinigaglia C. 2011b. What is so special about embodied simulation? *Trends in*
1044 *cognitive neuroscience* 2011 Nov, 15(11): 512-9.

1045 Gallese V, Sinigaglia C. 2012. Response to de Bruin and Gallagher: Embodied
1046 simulation as reuse is a productive explanation of a basic form of mind-reading. *Trends*
1047 *in Cognitive Sciences* February 2012, Vol. 16, No 2: 99-100. DOI:
1048 10.1016/j.tics.2011.12.002.

1049 Gallese V. 2000. The inner sense of action. *Journal of Consciousness studies* 7, 10: 23-
1050 40.

1051 Gallese V. 2005. Embodied simulation: From neurons to phenomenal experience.
1052 *Phenomenology and the Cognitive Sciences* 4: 23–48.

1053 Gallese V. 2006. Intentional attunement: A neurophysiological perspective on social
1054 cognition and its disruption in autism. *Brain Research* 1079: 15–24.

1055 Gallese V. 2007. Before and below ‘‘theory of mind’’: Embodied simulation and the
1056 neural correlates of social cognition. *Philosophical Transactions of the Royal Society* B:
1057 Biological Sciences 362: 659–669.

1058 Gallese V. 2008 Mirror neurons and the social nature of language: The neural
1059 exploitation hypothesis. *Social Neuroscience* 3: 317–333.

1060 Gallese V. 2009a. Motor abstraction: A neuroscientific account of how action goals and
1061 intentions are mapped and understood. *Psychological Research* 73: 486–498.

1062 Gallese V. 2009b. Neuroscienze controverse: il caso dei neuroni specchio. Interview by
1063 Marco Mozzoni. *Brainfactor* 29/5/2009. *Available:* http://www.brainfactor.it/index.php?
1064 option=com_content&view=article&id=171 (accessed 1 Sept 2014).

1065 Gallese V. 2010. The Mirror Neuron Mechanism and Literary Studies. Interview by
1066 Hannah Chapelle Wojciehowski. *University of California eScholarship 2010. Available:*
1067 http://escholarship.org/uc/item/56f8v9bv (accessed 1 Sept 2014).

1068 Gallese V. 2011. Embodied Simulation Theory: Imagination and Narrative.
1069 *Neuropsychoanalysis* 2011, 13 (2).

1070 Gallese V. 2014. Bodily selves in relation: embodied simulation as second-person
1071 perspective on intersubjectivity. *Phil. Trans. R. Soc. B* **369**, 20130177 (published 28
1072 April 2014). DOI: 10.1098/rstb.2013.0177.

1073 Geymonat L. 1970. *Storia del pensiero filosofico e scientifico*. Milano: Garzanti, Vol. 1,
1074 Sez. I.

1075 Gibson E, Bergen L, Piantadosi ST. 2013. Rational integration of noisy evidence and
1076 prior semantic expectations in sentence interpretations. *Proceedings of the National*
1077 *Academy of Sciences* May 14, 2013, Vol. 110, n. 20: 8051-8056.

1078 Goldman A, de Vignemont F. 2009. Is social cognition embodied? *Trend in cognitive*
1079 *sciences* April 2009, 13(4): 154-9.

1080 Goldstein R. 2006. *Incompletezza: La dimostrazione e il paradosso di Kurt Gödel*.
1081 Torino: Codice Edizioni. [Or. ed.: Goldstein R. 2005. *Incompleteness: The proof and*
1082 *paradox of Kurt Gödel*. New York-London: Norton.]

1083 Gould SJ, Vrba ES. 1982. Exaptation: A missing term in the science of form.
1084 *Paleobiology* 8 (1): 4-15.

1085 Griffiths TL, Kemp C, Tenenbaum JB. 2008. Bayesian models of cognition. In: Ron Sun,
1086 ed. *Cambridge Handbook of Computational Cognitive Modelling*. Cambridge:
1087 Cambridge University Press.

1088 Grinder J, Bandler R. 1980. *La metamorfosi terapeutica: Principi di Programmazione*
1089 *Neurolinguistica*. Roma: Astrolabio-Ubaldini. [Or. ed.: Grinder J, Bandler R. 1979.
1090 *Frogs into princes: Neuro Linguistic Programming*. Moab: Real People Press.]

1091 Gruber T, Zuberbühler K, Clément F, van Schaik C. 2015. Apes have culture but may not
1092 know that they do. *Frontiers in Psychology* 6:91. DOI: 10.3389/fpsyg.2015.00091.

1093 Guan CQ, Meng W, Yao R, Glenberg AM. 2013. The Motor System Contributes to
1094 Comprehension of Abstract Language. *PLoS ONE* 8(9): e75183. DOI:
1095 10.1371/journal.pone.0075183.

1096 Guastello SJ. 2013 (2002). *Managing emergent phenomena: nonlinear dynamics in work*
1097 *organizations.* Abingdon (UK): Taylor & Francis, Psychology Press.

1098 Hickok G, Hauser M. 2010. (Mis)understanding mirror neurons. *Current Biology* 20:
1099 R593–R594.

1100 Hickok G. 2009. Eight problems for the mirror neurons theory of action understanding in
1101 monkeys and humans. *Journal of Cognitive Neuroscience* 21:7: 1229-1243. DOI:
1102 10.1162/jocn.2009.21189.

1103 Hommel B, Müsseler J, Aschersleben G, Prinz W. 2001. The theory of event coding
1104 (TEC): A framework for perception and action planning. *Behavioural and brain sciences*
1105 24: 849-937.

1106 Horchak OV, Giger JC, Cabral M, Pochwatko G. 2014. From demonstration to theory in
1107 embodied language comprehension: a review. *Cognitive Systems Research* Volumes 29-
1108 30, September 2014: 66-85. DOI: 10.1016/j.cogsys.2013.09.002.

1109 Iacoboni M, Molnar-Szakacs I, Gallese V, Buccino G, Mazziotta JC, Rizzolatti G. 2005.
1110 Grasping the intentions of others with one's own mirror neuron system. *PLoS Biology*
1111 3(3): e79.

1112 Iacoboni M. 2008. *I neuroni specchio: Come capiamo ciò che fanno gli altri*. Torino:
1113 Bollati Boringhieri. [Or. ed.: Iacoboni M. 2008. *Mirroring People: The New Science of*
1114 *How We Connect with Others*. New York: Farrar, Straus & Giroux.]

1115 Ingram JN, Körding KP, Howard IS, Woolpert DM. 2008. The statistics of natural hand
1116 movements. *Experimental Brain Research* 188: 223–236. DOI 10.1007/s00221-008-
1117 1355-3.

1118 James W. 1890. *The principles of psychology*. New York: Holt.

1119 Jeannerod M, Arbib MA, Rizzolatti G, Sakata H. 1995. Grasping objects: Cortical
1120 mechanisms of visuomotor transformation. *Trends in Neuroscience* 18: 314-320.

1121 Khosravi H, Bina B. 2010. A survey on statistical relational learning. *Lecture Notes in*
1122 *Computer Science*, Volume 6085/2010: 256-268. DOI: 10.1007/978-3-642-13059-5_25.

1123 Krauss RM, Fussell SR. 1996. Social psychological models of interpersonal
1124 communication. In: Higgins ET, Kruglanski A, ed. *Social Psychology: A handbook of*
1125 *basic principles*. New York: Guilford, 655-701.

1126 Leavitt D. 2007. *L'uomo che sapeva troppo: Alan Turing e l'invenzione del computer.*
1127 Torino: Codice Edizioni. [Or. ed.: Leavitt D. 2006. *The man who knew too much: Alan*
1128 *Turing and the invention of the computer*. New York-London: Norton.]

1129 Liberman AM, Whalen DH. 2000. On the relation of speech to language. *Trends in*
1130 *Cognitive Neuroscience* 4: 187-196.

1131 Lobel T.2014. *Sensation: the new science of physical intelligence*. New York: Simon &
1132 Schuster/Atria Books.

1133 Locke JL. 2009. Evolutionary developmental linguistics: Naturalization of the faculty of
1134 language. *Language Sciences* 31 (2009) 33-59. DOI: 10.1016/j.langsci.2007.09.008.

1135 Lotze RH. 1852. *Medicinische psychologie oder physiologie der seele*. Leipzig:
1136 Weidmannsche Buchandlung.

1137 Mach E.1897. *Contributions to the analysis of the sensations*. Chicago: Open Court.

1138 Maffei R, Cavari L, Ranieri M. 2007. L'autre face du changement: Constants et
1139 structures dans la collaboration en ligne. *Proceedings of the Colloques TICE -*
1140 *Méditerranée 2007.* ISDM 29. *Available:* http://isdm.univ-
1141 tln.fr/PDF/isdm29/MAFFEI.pdf (accessed 1 Sept 2014).

1142 Maffei R. 2006. Questioni di stile: L'influenza dello stile di conduzione sui gruppi
1143 collaborativi online. *Proceedings of the Colloques TICE - Méditerranée 2006*. ISDM 25.

1144 *Available:* http://isdm.univ-tln.fr/PDF/isdm25/Maffei_TICE2006.pdf (accessed 1 Sept
1145 2014).

1146 Mahon B Z, Caramazza A. 2011. What drives the organization of object knowledge in
1147 the brain? *Trends in Cognitive Sciences*, Volume 15, Issue 3, 97-103, 14. DOI :
1148 10.1016/j.tics.2011.01.004.

1149 Mahon BZ, Caramazza A. 2008. A critical look at the Embodied Cognition Hypothesis
1150 and a new proposal for grounding conceptual content. *Journal of Physiology - Paris* 102:
1151 59-70. DOI:10.1016/j.jphysparis.2008.03.004.

1152 Mahon BZ, Caramazza A. 2009. Concepts and categories: A cognitive
1153 neuropsychological perspective. *Annual Review of Psychology* 60: 27-51. DOI:
1154 10.1146/annurev.psych.60.110707.163532.

1155 Mainardi D. 1988. *L'animale culturale*. Milano: Rizzoli, 3d edition.

1156 Marcus G. 2004. *La nascita della mente: Come un piccolo numero di geni crea la*
1157 *complessità del pensiero umano*. Torino: Codice Edizioni. [Or. ed.: Marcus G. 2004. *The*
1158 *birth of the mind: How a tiny number of genes creates the complexities of human*
1159 *thought.* New York: Basic Books.]

1160 Marian V, Kaushanskaya M. 2005. Autobiographical memory and language in bicultural
1161 bilinguals. In: Cohen J, McAlister KT, Rolstad K, MacSwan J, eds. *Proceedings of the 4th*
1162 *International Symposium on Bilingualism*. Somerville (MA): Cascadilla Press.

1163 Marino BFM, Gough P, Gallese V, Riggio L, Buccino G. 2011. How the motor system
1164 handles nouns: A behavioural study. *Psychological Research* (published online). DOI
1165 10.1007/s00426-011-0371-2.

1166 Massaro DW, Cowan N. 1993. Information Processing Models: Microscopes of the mind.
1167 *Annual Review of Psychology* 44: 383-425.

1168 Melcher T, Weidema M, Eenshuistra RM, Hommel B, Gruber O. 2008. The neural
1169 substrate of the ideomotor principle: An event-related fMRI analysis. *NeuroImage* 39:
1170 1274-1288. DOI: 10.1016/j.neuroimage.2007.09.049.

1171 Menchetti S, Costa F, Frasconi P, Pontil M. 2005. Wide coverage natural language
1172 processing using kernel methods and neural networks for structured data. *Science Direct*,
1173 *Pattern Recognition Letters* 26 (2005): 1896-1906. *Available:*
1174 *http://www.researchgate.net/publication/222681214_Wide_coverage_natural_language_*
1175 *processing_using_kernel_methods_and_neural_networks_for_structured_data* (accessed
1176 1 Sept 2014).

1177 Merleau-Ponty M. 1965. *La fenomenologia della percezione*. Milano: Il Saggiatore.
1178 [English ed.: Merleau-Ponty M. 1962. *Phenomenology of perception*. London-New York:
1179 Routledge.]

1180 Mitchell TM. 1997. *Machine learning*. New York: McGraw Hill.

1181 Mitchell TM. 2009. Brains, meaning and corpus statistics. *Google Tech Talks* March 27,
1182 2009. *Available:* http://www.youtube.com/watch?v=QbTf2nE3Lbw (accessed 1 Sept
1183 2014).

1184 Moro V, Urgesi C, Pernigo S, Lanteri P, Pazzaglia M, Aglioti SM. 2008. The neural basis
1185 of body form and body action agnosia. *Neuron* 60: 235–246.

1186 Moseley RL, Pulvermüller F. 2014. Nouns, verbs, objects, actions, and abstractions:
1187 Local fMRI activity indexes semantics, not lexical categories. *Brain and language* 132
1188 (2014): 28-42. DOI: 10.1016/j.bandl.2014.03.001.

1189 Muller CA, Cant MA. 2010. Imitation and traditions in wild banded mongooses. *Current*
1190 *Biology* 20: 1171–1175.

1191 Nardone G, Watzlawick P. 1990. *L'arte del cambiamento*. Milano: Ponte alle Grazie.

1192 Nathan DE, Guastello SJ, Prost RW, Jeutter DC. 2012. Understanding Neuromotor
1193 Strategy During Functional Upper Extremity Tasks Using Symbolic Dynamics.
1194 *Nonlinear Dynamics, Psychology, and Life Sciences* Vol. 16, Iss. 1 (January, 2012): 37-
1195 59.

1196 Negri GAL, Rumiati RI, Zadini A, Ukmar M, Mahon BZ, Caramazza A. 2007. What is
1197 the role of motor simulation in action and object recognition? Evidence from apraxia.
1198 *Cognitive Neuropsychology* 24(8): 795-816. DOI: 10.1080/02643290701707412.

1199 Newell A, Shaw JC, Simon HA. 1958. Elements of a theory of human problem solving.
1200 *Psychological Review* 65: 151-166. DOI 10.1037/h0048495.

1201 Pascolo PB, Budai R. 2013. Just how consistent is the mirror neuron system paradigm?
1202 *Progress in Neuroscience* 2013; 1 (1-4): 29-43. DOI: 10.14588/PiN.2013.Pascolo.29

1203 Pazzaglia M, Smania N, Corato E, Aglioti SM. 2008. Neural underpinnings of gesture
1204 discrimination in patients with limb apraxia. *Journal of Neuroscience* 28: 3030–3041.

1205 Perelman C. 1981. *Il dominio retorico: Retorica e argomentazione*. Torino: Einaudi. [Or.
1206 ed.: Perelman C. 1977. *L'empire rhétorique : Rhétorique et argumentation*. Paris: Vrin.]

1207 Perfors A, Tenenbaum JB, Griffiths TL, Xu F. 2011. A tutorial introduction to Bayesian
1208 models of cognitive development. *Cognition* Volume 120, Issue 3, September 2011: 302–
1209 321. DOI : 10.1016/j.cognition.2010.11.015.

1210 Pettigiani MG, Sica S. 2003. *La comunicazione interumana*. Milano: F. Angeli.

1211 Pezzulo G, Baldassarre G, Butz MV, Castelfranchi C, Hoffmann J. 2006. An analysis of
1212 the Ideomotor principle and TOTE. In: Butz MV, Sigaud O, Pezzulo G, Baldassarre G,
1213 ed. *Anticipatory Behavior in Adaptive Learning Systems: Advances in Anticipatory*
1214 *Processing.* Berlin: Springer, 73-93.

1215 Poincaré JH. 2003 (1902). *La scienza e l'ipotesi.* Milano: Bompiani. [English ed.:
1216 Poincaré JH.1905. *Science and Hypothesis*. London-Newcastle O. T.: Walter Scott
1217 Publishing.]

1218 Poincaré JH.1997 (1908). *Scienza e metodo*. Torino: Einaudi. [English ed.: Poincaré JH.
1219 1914. *Science and method*. London-Edinburgh-Dublin-New York: Nelson.]

1220 Prinz W. 1997. Perception and action planning. *European Journal of Cognitive*
1221 *Psychology* 9 (2): 129-154.

1222 Pulvermüller F, Moseley RL, Egorova N, Shebani Z, Boulenger V. 2014. Motor
1223 cognition-motor semantics: Action-perception theory of cognition and communication.
1224 *Neuropsychologia* 55 (2014) 71-84. DOI: 10.1016/j.neuropsychologia.2013.12.002.

1225 Quasimodo S. 1947. *Giorno dopo giorno*. Milano: Mondadori.

1226 Range F, Viranyi Z, Huber L. 2007. Selective imitation in domestic dogs. *Current*
1227 *Biology* 17: 868–872.

1228 Rizzolatti G, Craighero L. 2004. The mirror-neuron system. *Annual review of*
1229 *Neuroscience* 27: 169-192. DOI: 10.1146/annurev.neuro.27.070203.144230.

1230 Rizzolatti G, Fabbri-Destro M. 2008. The mirror system and its role in social cognition.
1231 *Current Opinion in Neurobiology* 18: 1-6. DOI: 10.1016/j.conb.2008.08.001.

1232 Rizzolatti G, Fogassi L, Gallese V. 2001. Neurophysiological mechanisms underlying the
1233 understanding and imitation of action. *Nature Reviews Neuroscience* 2: 661-670. DOI:
1234 10.1038/35090060.

1235 Rizzolatti G, Sinigaglia C. 2006. *So quel che fai: Il cervello che agisce e i neuroni*

1236 *specchio*. Milano: Cortina.

1237 Rizzolatti G, Sinigaglia C. 2010. The functional role of the parieto-frontal mirror circuit:

1238 Interpretations and misinterpretations. *Nature Reviews Neuroscience* 11: 264–274.

1239 Rizzolatti G, Vozza L. 2008. *Nella mente degli altri*. Milano: Zanichelli.

1240 Rochat MJ, Caruana F, Jezzini A, Escola L, Intskirveli I, Grammont F, Gallese V,

1241 Rizzolatti G, Umiltà MA. 2010. Responses of mirror neurons in area F5 to hand and tool

1242 grasping observation. *Experimental Brain Research* 204: 605–616.

1243 Rose S. 2005. *Il cervello del XXI Secolo: Spiegare, curare e manipolare la mente.*

1244 Torino: Codice Edizioni. [Or. ed.: Rose S. 2005. *The 21st Century brain: Explaining,*

1245 *mending and manipulating the mind*. London: Jonathan Cape-Random House.]

1246 Sauser EL, Billard AG. 2006. Parallel and distributed neural models of the ideomotor

1247 principle: An investigation of imitative cortical pathways. *Neural networks* 19: 285-298.

1248 DOI: 10.1016/j.neunet.2006.02.003.

1249 Schachter S, Singer JE. 1962. Cognitive, social and physiological determinants of

1250 emotional state. *Psychological Review* Vol.69, No.5, September 1962.

1251 Sclavi M. 2003. *Arte di ascoltare e mondi possibili*. Milano: Bruno Mondadori.

1252 Speer NK, Reynolds JR, Swallow KM, Zacks JM. 2008. Reading stories activates
1253 neural representations of visual and motor experiences. *Psychological Science* 20/8: 989-
1254 999. DOI: 10.1111/j.1467-9280.2009.02397.x.

1255 Sperry RW. 1952. Neurology and the mind–brain problem. *American Scientist* 40: 290-
1256 312.

1257 Stekelenburg JJ, Vroomen J. 2012. Electrophysiological evidence for a multisensory
1258 speech-specific mode of perception. *Neuropsychologia* 50 (2012) 1425-1431. DOI:
1259 10.1016/j.neuropsychologia.2012.02.027.

1260 Stöcker C, Hoffmann J. 2004. The ideomotor principle and motor sequence acquisition:
1261 Tone effects facilitate movements chunking. *Psychological research* 68: 126-137. DOI:
1262 10.1007/s00426-003-0150-9.

1263 Suchak M, Eppley TM, Campbell MW, de Waal FBM. 2014. Ape duos and trios:
1264 spontaneous cooperation with free partner choice in chimpanzees. *PeerJ* 2:e417. DOI:
1265 10.7717/peerj.417.

1266 Tenenbaum JB, Kemp C, Griffiths TL, Goodman ND. 2011. How to Grow a Mind:
1267 Statistics, Structure, and Abstraction. *Science* 331 : 1279. DOI: 10.1126/science.1192788.

1268 Tettamanti M, Buccino G, Saccuman MC, Gallese V, Danna M, Scifo P, Fazio F,
1269 Rizzolatti G, Cappa SF, Perani D. 2005. Listening to action-related sentences activates
1270 fronto-parietal motor circuits. *Journal of Cognitive Neuroscience* 17(2): 273-281.

1271 Thibodeau PH, Boroditsky, L. 2011. Metaphors we think with: the role of metaphor in
1272 reasoning. *PLoS ONE* 6(2): e16782. DOI:10.1371/journal.pone.0016782.

1273 Thibodeau PH, Boroditsky, L. 2013. Natural language metaphors influence reasoning.
1274 *PLoS ONE* 8(1): e52961. DOI:10.1371/journal.-pone.0052961.

1275 Tsay CJ. 2013. Sight over sound in the judgement of music performance. *Proceedings of*
1276 *the National Academy of Sciences* 2013 110 (36) 14580-14585. DOI:
1277 10.1073/pnas.1221454110.

1278 Turing A.1950. Computing machinery and intelligence. *Mind* 59: 433-460. DOI:
1279 10.1093/mind/LIX.236.433. *Available:*
1280 *http://www.csee.umbc.edu/courses/471/papers/turing.pdf* (accessed 1 Sept 2014).

1281 Umiltà MA, Escola L, Intskirveli I, Grammont F, Rochat M, Caruana F, Jezzini A,
1282 Gallese V, Rizzolatti G. 2008. When pliers become fingers in the monkey motor system.
1283 *Proceedings of the National Academy of Sciences* USA 105: 2209–2213.

1284 Verbeke M, Van Asch V, Morante R, Frasconi P, Daelemans W, De Raedt L. 2012. A
1285 statistical relational learning approach to identifying evidence based medicine categories.
1286 *Proceedings of the 2012 Conference on Empirical Methods in Natural Language*
1287 *Processing and Computational Natural Language Learning (EMNLP-CoNLL 2012)*,
1288 Jeju, Korea July 12–14, 2012. *Available:*
1289 *https://lirias.kuleuven.be/bitstream/123456789/350664/1/VerbekeEtAl_EMNLP2012.pdf*
1290 (accessed 1 Sept 2014).

1291 Vitevitch MS, Sereno J, Jongman A, Goldstein R. 2013. Speaker Sex Influences
1292 Processing of Grammatical Gender. *PLoS ONE* 8(11): e79701. DOI:
1293 10.1371/journal.pone.0079701.

1294 von Baeyer HC. 2013. Can Quantum Bayesianism Fix the Paradoxes of Quantum
1295 Mechanics? *Scientific American*, June 2013.

1296 Watzlawick P, a cura di. 1988. *La realtà inventata - Contributi al costruttivismo*. Milano:
1297 Feltrinelli. [Or. ed.: Watzlawick P, ed. 1984. *The invented reality*. New York: Norton.]

1298 Watzlawick P, Beavin Bavelas J, Jackson DD. 1971. *Pragmatica della comunicazione*
1299 *umana.* Roma: Astrolabio-Ubaldini. [Or. ed.: Watzlawick P, Beavin Bavelas J, Jackson
1300 DD. 1967. *Pragmatics of human communication*. New York: Norton.]

1301 Watzlawick P. 1987. If you desire to see, learn how to act. In: Zeig JK, ed. *The evolution*
1302 *of psychotherapy.* New York: Brunner/Mazel, 91-100.

1303 Zeilinger A. 2012. *La danza dei fotoni – Da Einstein al teletrasporto quantistico*. Torino,
1304 Codice. [Or. ed.: Zeilinger A. 2010. *Dance of the Photons – From Einstein to quantum*
1305 *teleportation*. New York: Farrar Straus & Giroux.]

1306 Zeki S. 2010. *Splendori e miserie del cervello: L'amore, la creatività e la ricerca della*
1307 *felicità.* Torino: Codice Edizioni. [Or. ed.: Zeki S. 2009. *Splendours and miseries of the*
1308 *brain: Love, creativity and the quest for human happiness.* Chichester: Wiley-Blackwell.]

1309 Zhong CB, Bohns VK, Gino F. 2010. Good lamps are the best police: darkness increases
1310 dishonesty and self-interested behaviour. *Psychological Science* Published online 29
1311 January 2010. DOI: 10.1177/0956797609360754.

1312 Zipoli Caiani S. 2013. Cognizione incorporata. *APhEx – Portale italiano di filosofia*
1313 *analitica (Periodico online – ISSN 2036-9972)* 8, 2013. *Available:*
1314 *http://www.aphex.it/public/file/Content20140103_APhEx8,2013Cognizioneincorporata-*
1315 *Zipoli.pdf* (accessed 1 Sept 2014).

1316 Zuberbühler K. 2005. The phylogenetic roots of language: evidence from Primate
1317 communication and cognition. *Current directions in psychological science* 2005, 14:126.
1318 DOI: 10.1111/j.0963-7214.2005.00357.x.

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Figures

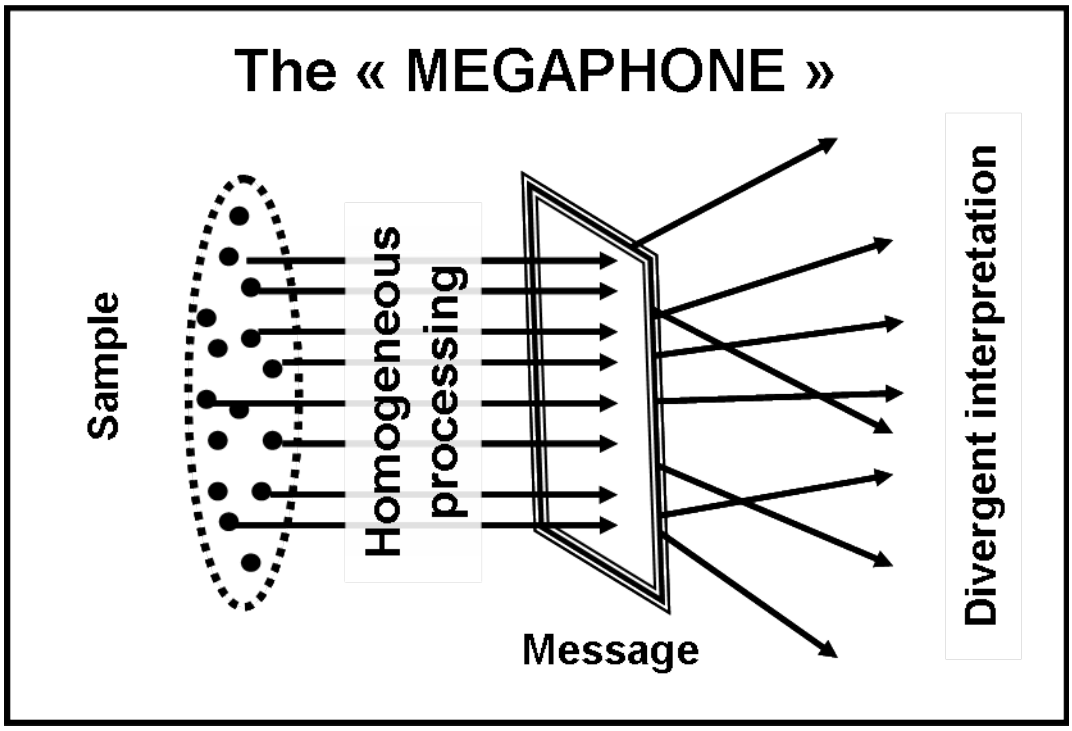

Figure 1: The "megaphone-shape" model.

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.

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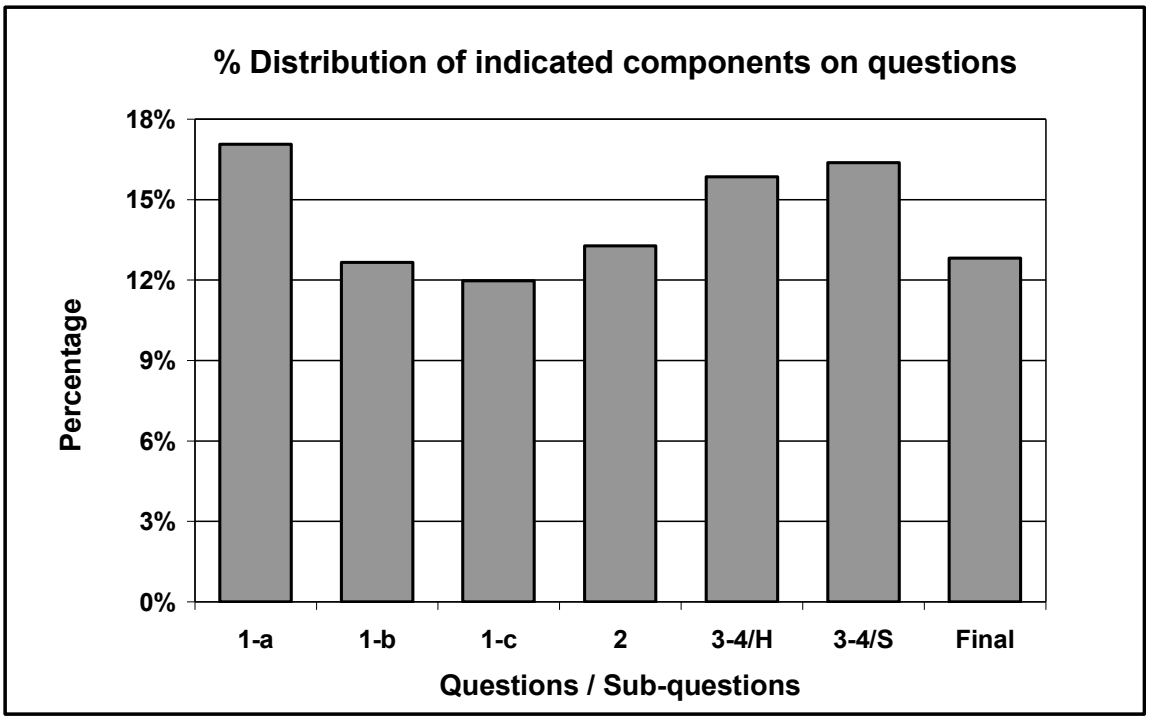


1333

1334 **Figure 2: Percent distribution of total indications with respect to questions/sub-**

1335 **questions.**

1336 With respect to questions, the respondents' total indications about the focused

1337 components present a flat-like percent distribution (differences in a range around 5%,

1338 from 12% to 17% about, source data from Table 3, "%" column). The range reduces to

1339 around 3.6% (from 12.8% to 16.4% about) if we group together the three sub-questions

1340 of Question #1 and consider their mean (the reason is that the answers to Questions #1-b

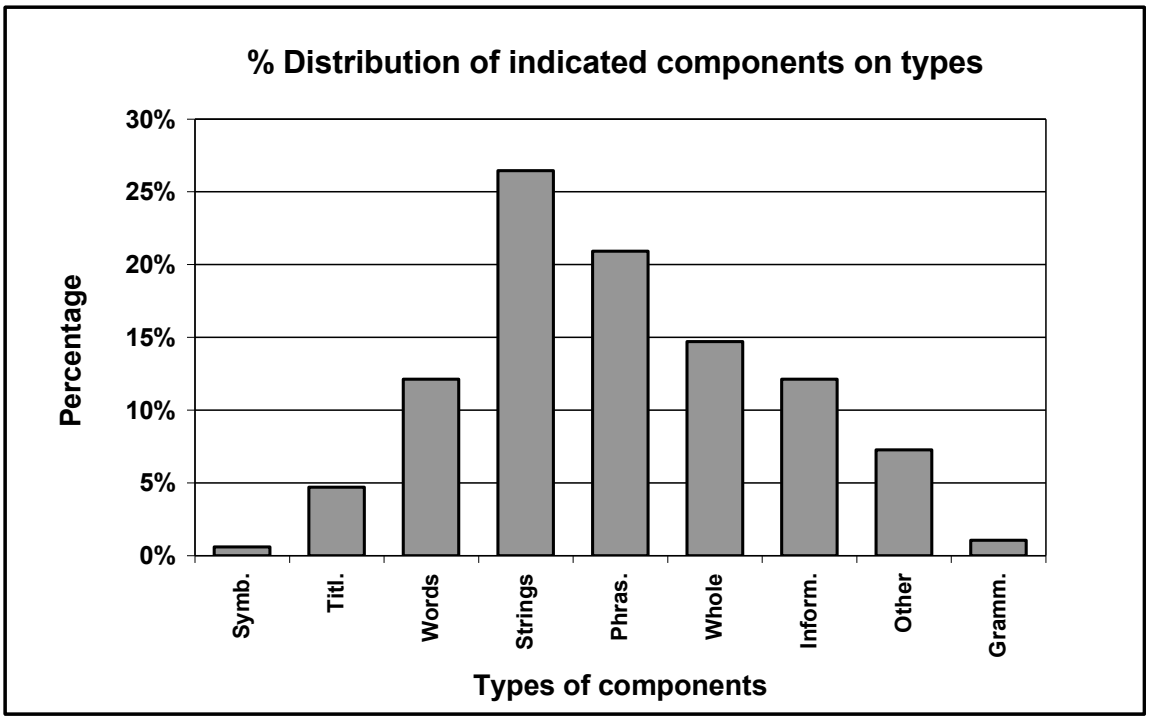
1341 and #1-c are often given in short, indicating reference to the already provided answer to

1342 Question #1-a). The indications are distributed without any significant imbalance among

1343 the different questions of the questionnaire. The approach through subjective selective

1344 focusing does not definitely advantage any question or item.

1345



1347

1348 **Figure 3: Percent distribution of total indications with respect to types of**

1349 **components.**

1350 [Legend: Symb. = Punctuation marks; Titl. = Title/salutes (opening and closing

1351 expressions); Phras. = Complete phrases/periods; Whole = References to the message as

1352 a whole; Inform. = Information content; Gramm. = Grammar notations (verb tense etc.)]

1353

1354 The respondents' indications have been grouped in bins by type. The presented percent

1355 distribution (source data from Table 3, "%" row) has been built through the ranking of

1356 the first six types (from "Symbols" to "Whole") by increasing size of the text "chunks"

1357 considered. The remaining three types (Information content, Other components and

1358 Grammar notations) have been added ranking them by decreasing values. The highest

1359 frequencies correspond to middle-sized "chunks" of the messages.

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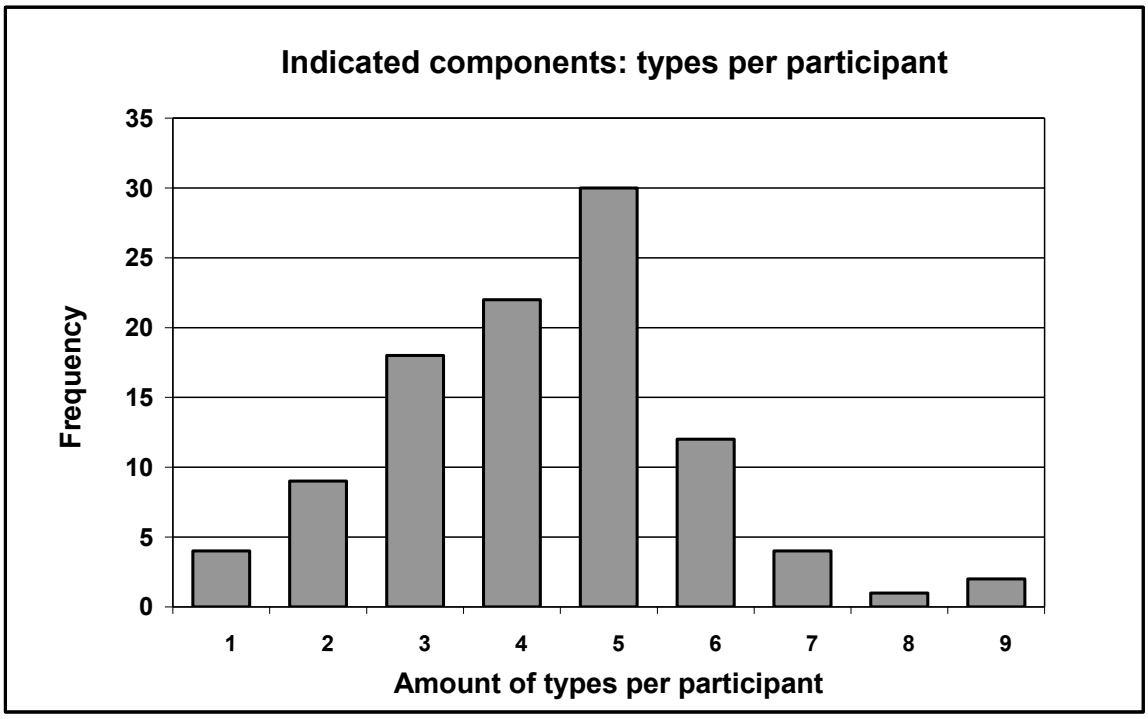

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1363 **Figure 4: Sample distribution with respect to the amount of component types**

1364 **indicated by participants.**

1365 Respondents have been grouped in bins by the amount of types they indicated. The

1366 histogram shows the sample's distribution; it presents the highest frequencies on the 3-4-

1367 5 types-per-participant bins and has an almost "bell curve" shape. The main statistical

1368 indexes of the distribution are the following:

1369 **Mean = 4.3; SD = 1.6; Skewness = 0.25; Kurtosis = 0,49.**

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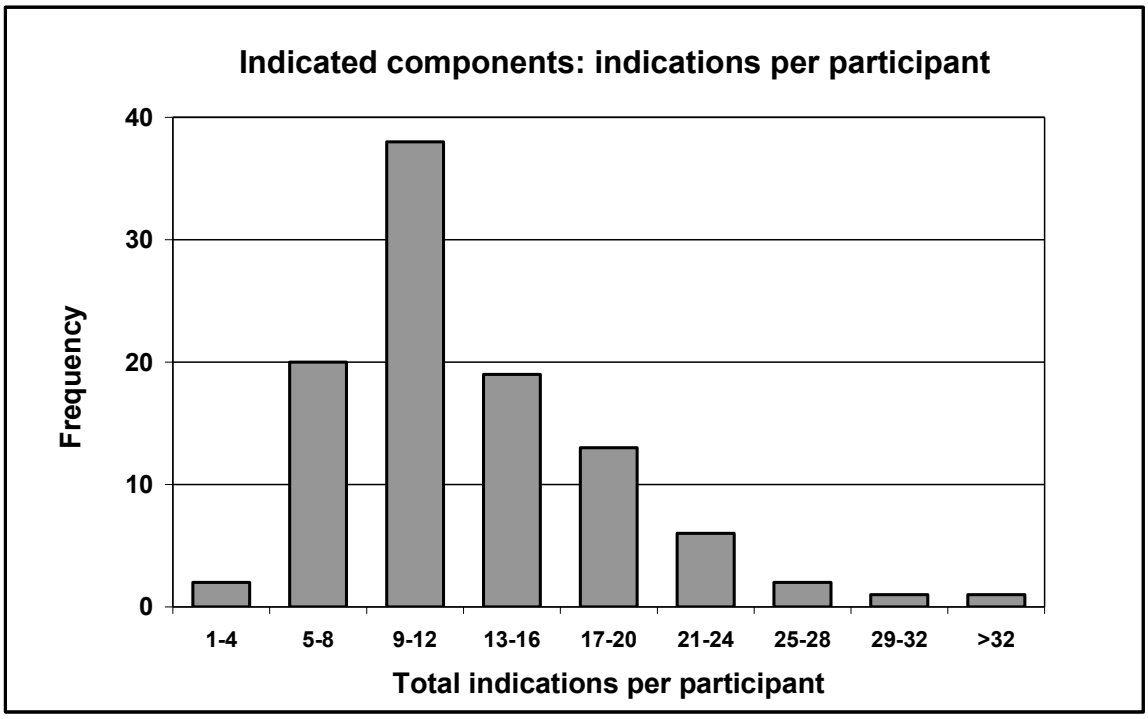

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1374 **Figure 5: Sample distribution with respect to the total indications provided by**

1375 **participants.**

1376 Respondents have been grouped in bins by the amount of total provided indications. The

1377 histogram shows the sample's distribution; it presents the highest frequencies on the

1378 second, third and fourth bins and has an almost "bell curve" shape (even if it is clearly

1379 shifted towards the left side). The main statistical indexes of the distribution are the

1380 following:

1381 **Mean = 12.9; SD = 6.2; Skewness = 1.93; Kurtosis = 7.18.**

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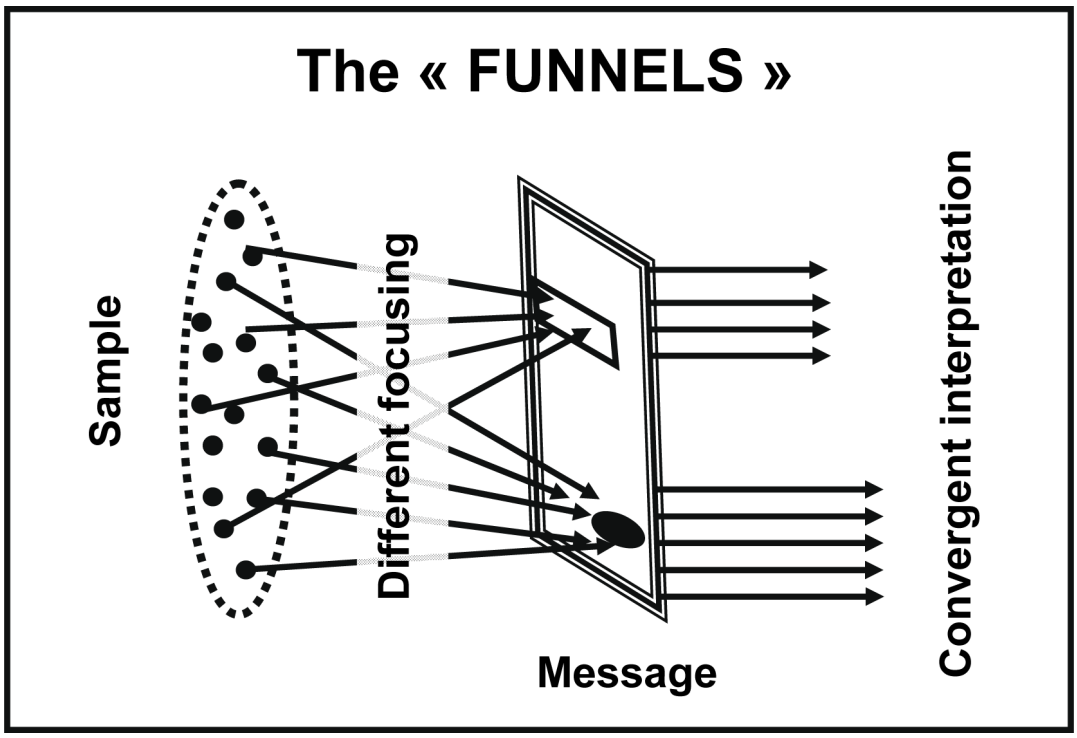

Figure 6: The "funnel-shape" model.

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.

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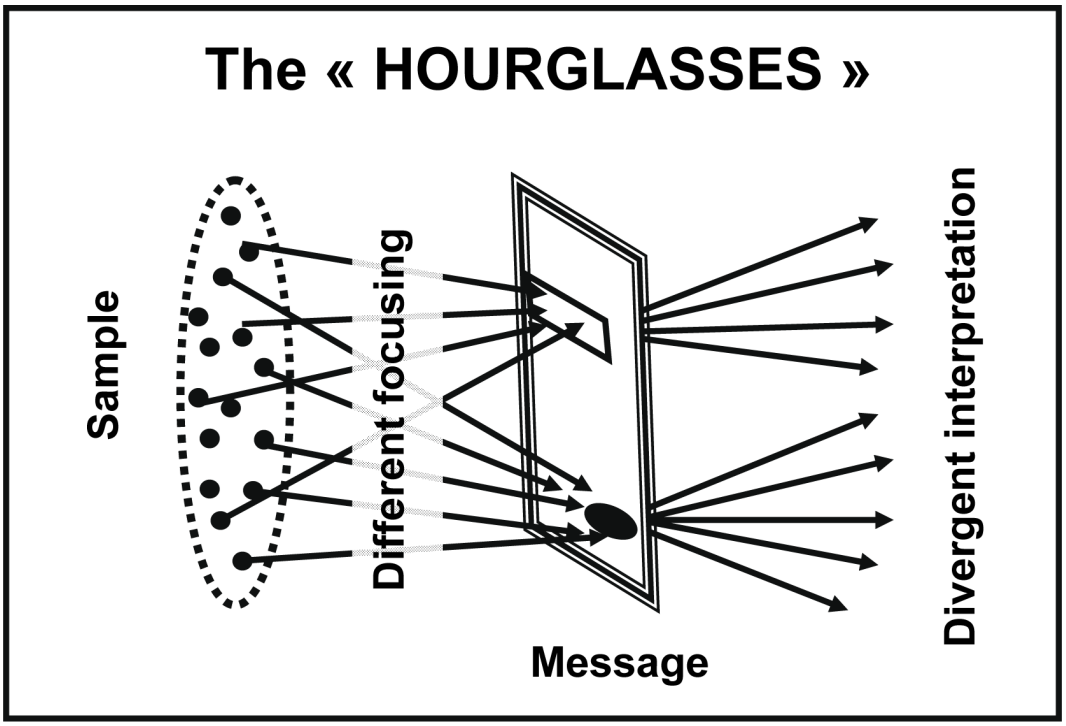

Figure 7: The "hourglass-shape" model.

1439 This figure is a possible representation of the observed process of message interpretation.

1440 Two kinds of scatter co-exist, manifesting themselves in sequence: the first one regards

1441 dispersion during the focusing on the components ("disassembling" operation) and the

1442 second one regards the interpretation of the focused components ("classic" interpretation

1443 scatter).

1444

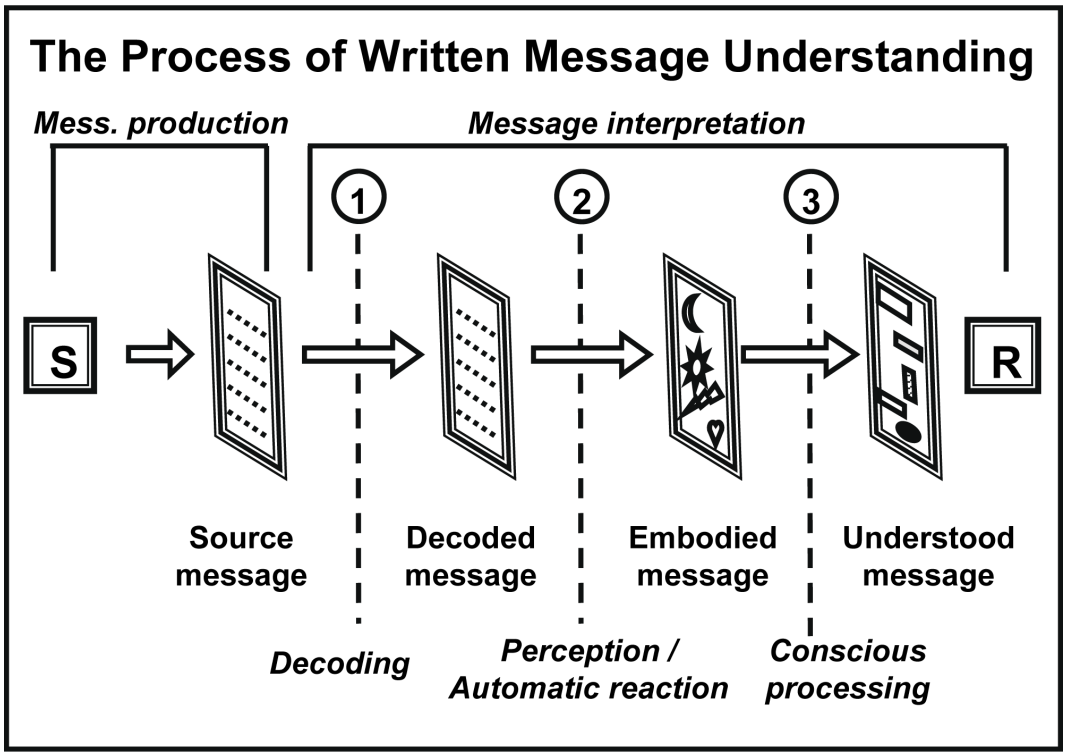

Figure 8: Scheme of the process of written message interpretation (how messages are understood).

[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.

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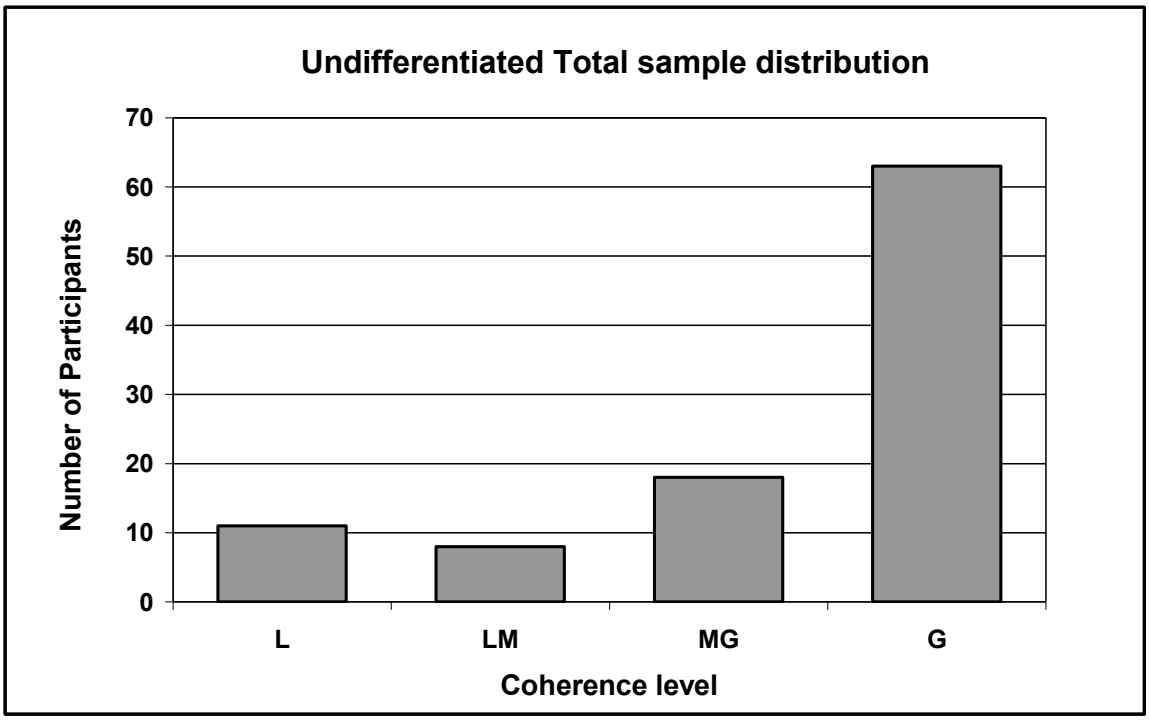

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1480 **Figure 9: Sample distribution with respect to coherence levels / Undifferentiated**

1481 **Total Sample**

1482 [Legend / Coherence indicator:

1483 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1484

1485 This histogram shows the distribution of ALL respondents according to the coherence

1486 (expressed through the coherence indicator) between, by one hand, their interpretations of

1487 Messages #4/H and #4/S; by the other hand, their final choice. Data is shown for the

1488 undifferentiated total sample. The L level results over-represented with respect to what

1489 expected.

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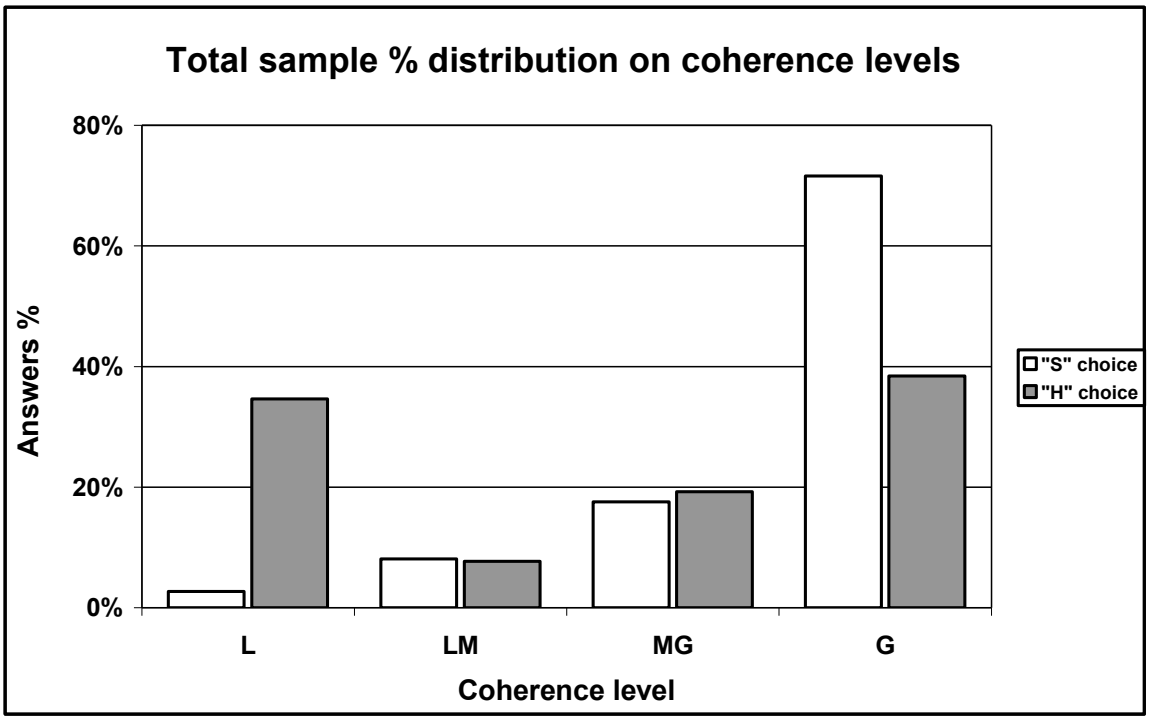
1491



1493

1494 **Figure 10: Sample percent distribution with respect to coherence levels / Comparing**

1495 **"H"/"S" choosers - Total Sample**

1496 [Legend / Coherence indicator:

1497 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1498

1499 This histogram shows the percent distribution of ALL respondents according to the

1500 coherence (expressed through the coherence indicator) between, by one hand, their

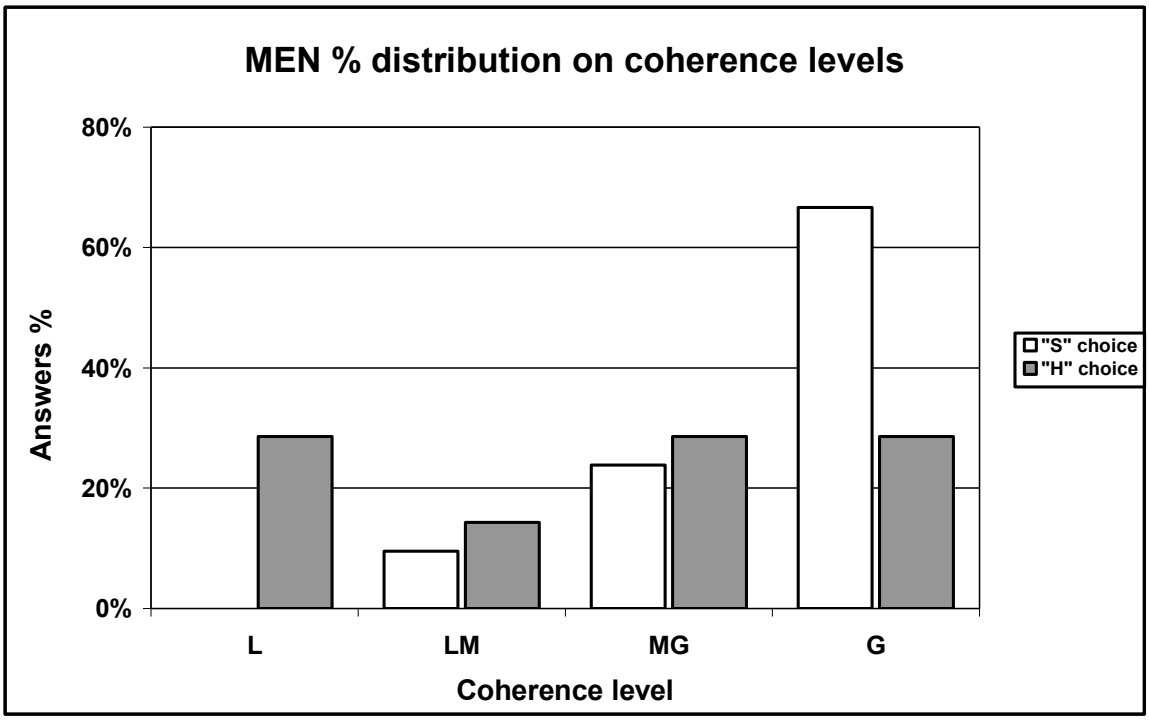
1501 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1502 shown separately for "H" and "S" choosers. Distributions result significantly different

1503 (Chi-squared test: p=0.000095).

1504

1505



1507

1508 **Figure 11: Sample percent distribution with respect to coherence levels / Comparing**

1509 **"H"/"S" choosers - Subsample MEN**

1510 [Legend / Coherence indicator:

1511 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1512

1513 This histogram shows the percent distributions of MALE respondents according to the

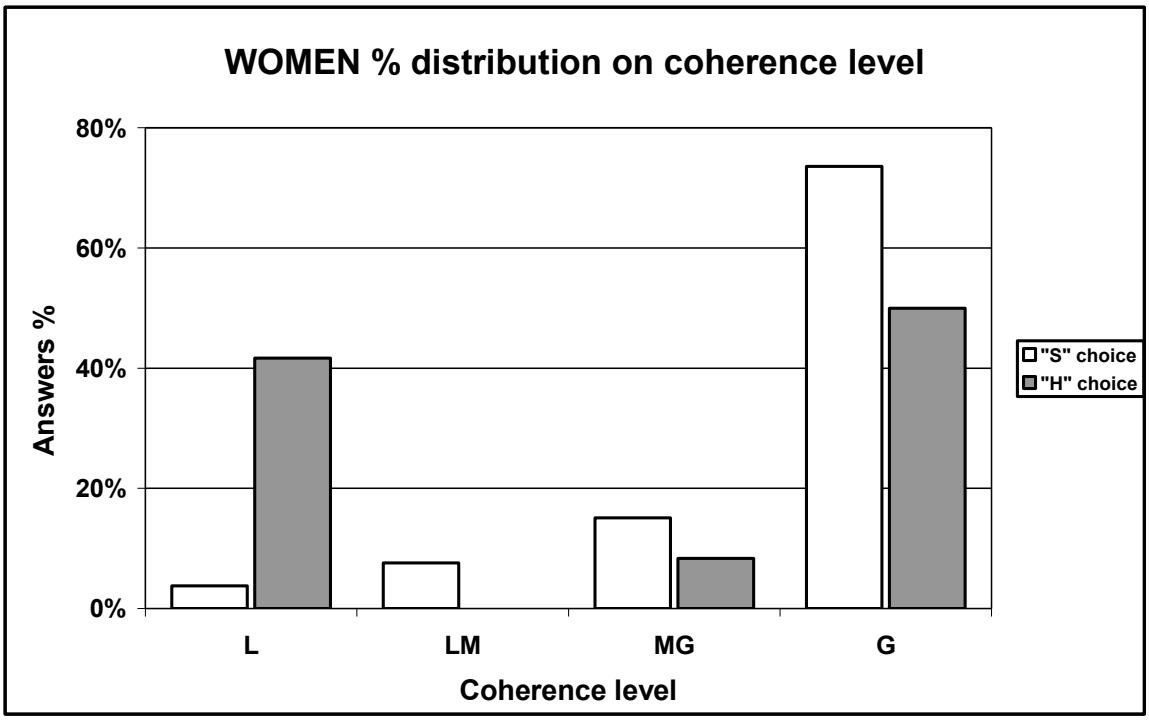
1514 coherence (expressed through the coherence indicator) between, by one hand, their

1515 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1516 shown separately for "H" and "S" choosers. Chi-squared test unsuitable for the presence

1517 of a zero value.

1518



1520

1521 **Figure 12: Sample percent distribution with respect to coherence levels / Comparing**

1522 **"H"/"S" choosers - Subsample WOMEN**

1523 [Legend / Coherence indicator:

1524 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1525

1526 This histogram shows the percent distributions of FEMALE respondents according to the

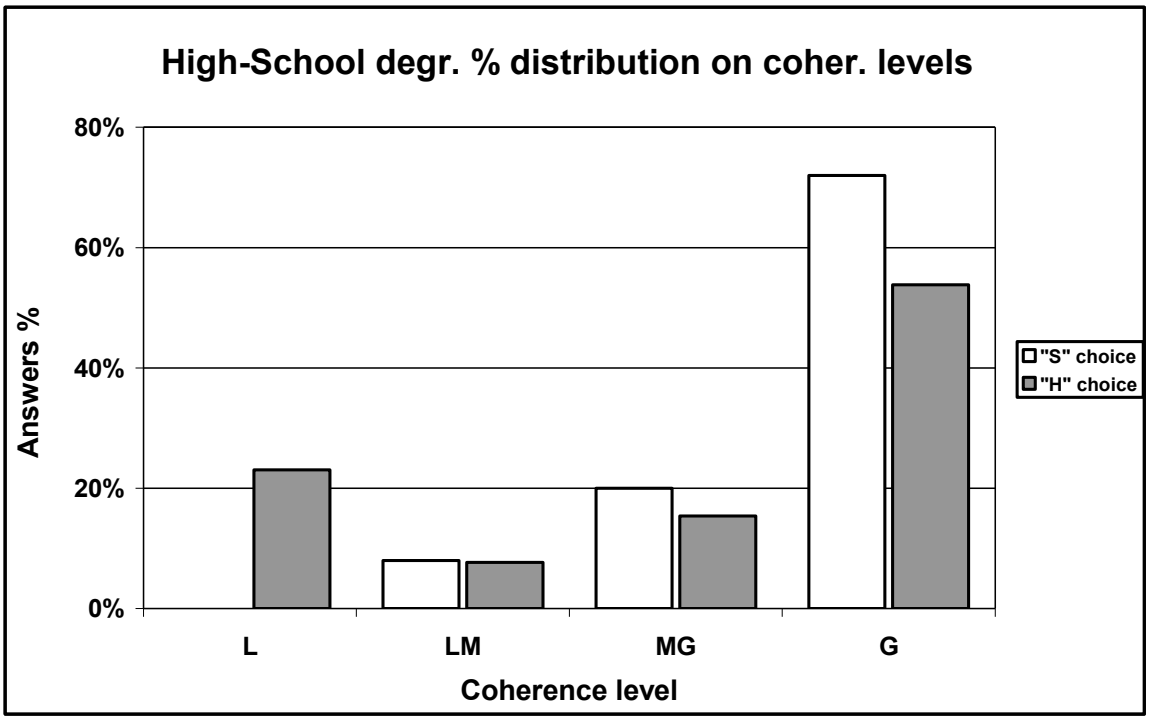
1527 coherence (expressed through the coherence indicator) between, by one hand, their

1528 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1529 shown separately for "H" and "S" choosers. Chi-squared test unsuitable for the presence

1530 of a zero value.

1531



1533

1534 **Figure 13: Sample percent distribution with respect to coherence levels / Comparing**

1535 **"H"/"S" choosers - Subsample High School**

1536 [Legend / Coherence indicator:

1537 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1538

1539 This histogram shows the percent distributions of HIGH-SCHOOL degree granted

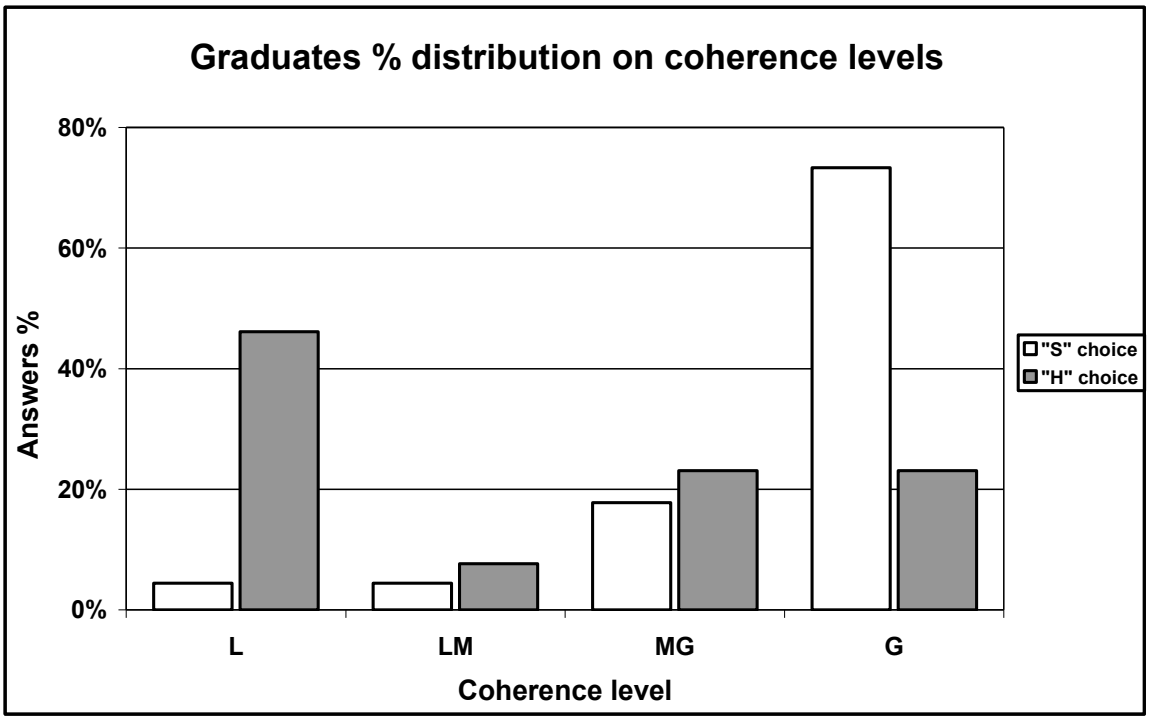
1540 respondents according to the coherence (expressed through the coherence indicator)

1541 between, by one hand, their interpretations of Messages #4/H and #4/S; by the other

1542 hand, their final choice. Data is shown separately for "H" and "S" choosers. Chi-squared

1543 test unsuitable for the presence of a zero value.

1544



1546

1547 **Figure 14: Sample percent distribution with respect to coherence levels / Comparing**

1548 **"H"/"S" choosers - Subsample Graduates**

1549 [Legend / Coherence indicator:

1550 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1551

1552 This histogram shows the percent distribution of GRADUATED respondents according

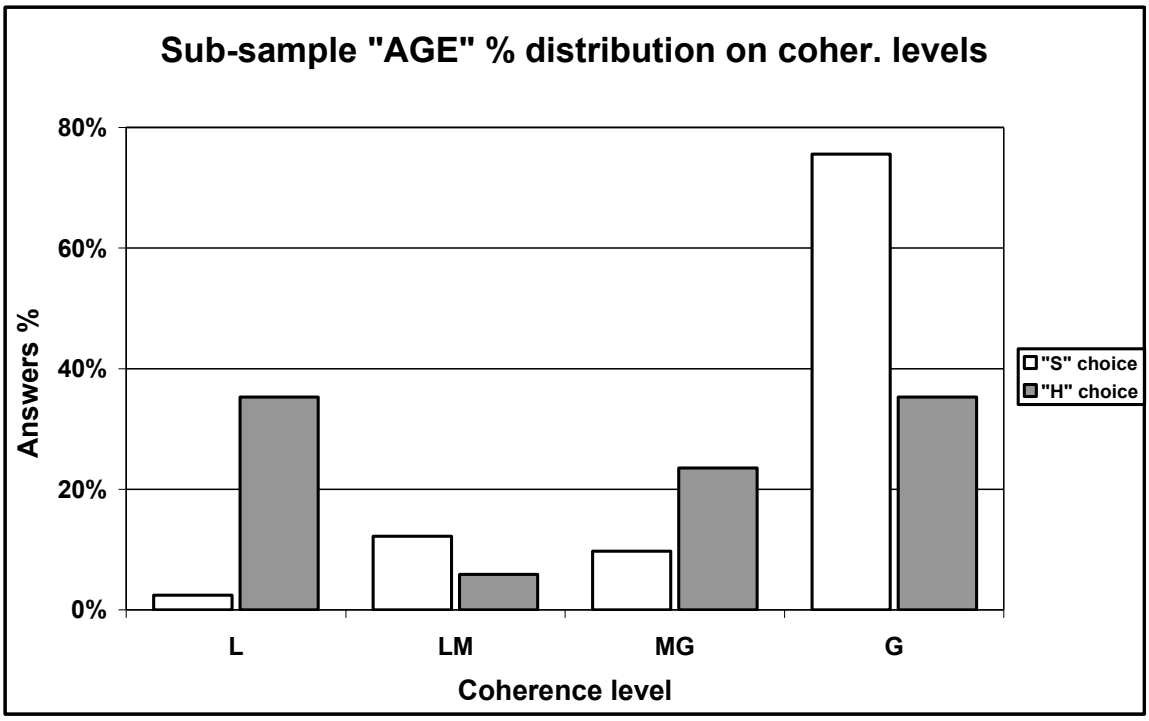
1553 to the coherence (expressed through the coherence indicator) between, by one hand, their

1554 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1555 shown separately for "H" and "S" choosers. Distributions result significantly different

1556 (Chi-squared test: p=0.000649).

1557



1559

1560 **Figure 15: Sample percent distribution with respect to coherence levels / Comparing**

1561 **"H"/"S" choosers - Subsample "AGE"**

1562 [Legend / Coherence indicator:

1563 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1564

1565 This histogram shows the percent distribution of respondents belonging to subsample

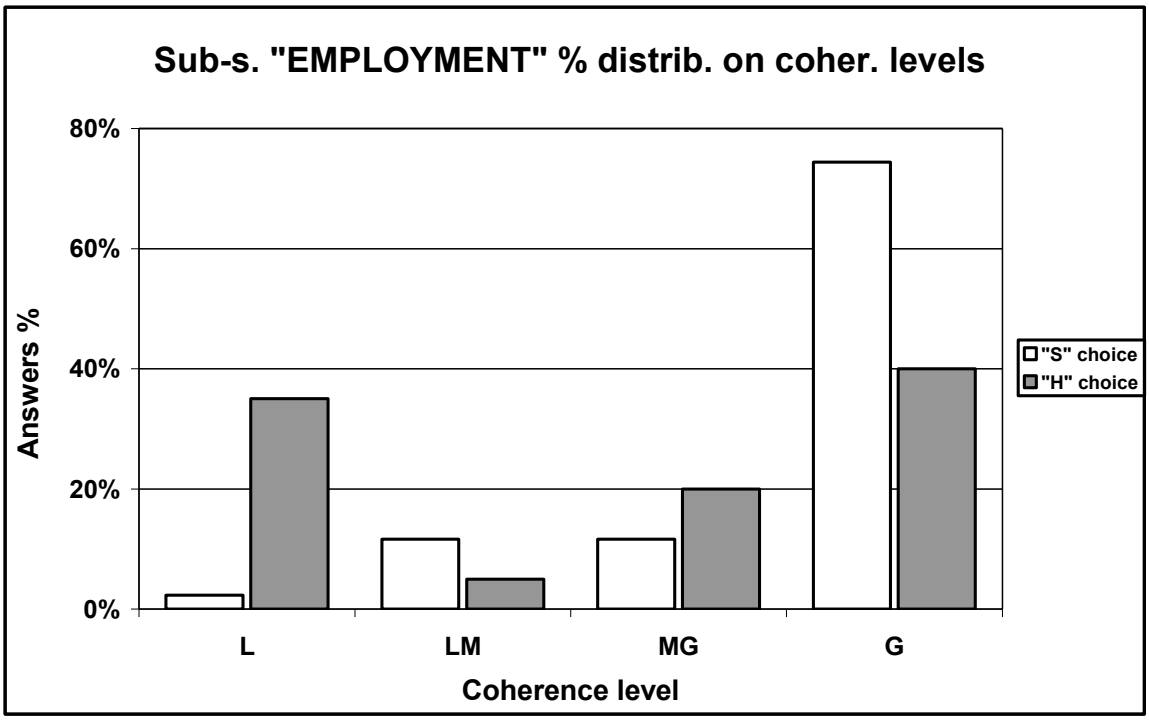
1566 "AGE" (30 years, and over, old persons) according to the coherence (expressed through

1567 the coherence indicator) between, by one hand, their interpretations of Messages #4/H

1568 and #4/S; by the other hand, their final choice. Data is shown separately for "H" and "S"

1569 choosers. Distributions result significantly different (Chi-squared test: p=0.001174).

1570



1572

1573 **Figure 16: Sample percent distribution with respect to coherence levels / Comparing**

1574 **"H"/"S" choosers - Subsample "EMPLOYMENT"**

1575 [Legend / Coherence indicator:

1576 L = Low; LM = Low-Medium; MG = Medium-Great; G = Great level of coherence]

1577

1578 This histogram shows the percent distribution of respondents belonging to sub-sample

1579 "EMPLOYMENT" (workers only, students and unemployed excluded) according to the

1580 coherence (expressed through the coherence indicator) between, by one hand, their

1581 interpretations of Messages #4/H and #4/S; by the other hand, their final choice. Data is

1582 shown separately for "H" and "S" choosers. Distributions result significantly different

1583 (Chi-squared test: p=0.001560).

1584 **Tables**

1585

1586

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

1587

1588 **Table 1: An example of interpretation scatter from our research.**

1589 Sixty-one individuals (60% of the sample), after having compared XX's Messages #1 and

1590 #3, answered "YES" to Question #2 and provided 83 specifications for the changes they

1591 had detected in XX's position toward YY. The table classifies the specifications into 4

1592 main categories and provides some examples for each one of them.

1593

1594

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.*

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

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

1605

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%**	

1606

1607 **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

1608

1609 The table displays a descriptive statistical analysis of what the respondents look at inside the messages. The information
1610 content is focused by 12.1% of respondents only (“Cont.” column, “%” row). Even if we suppose that reference to complete
1611 phrases/periods could actually mean reference to their content, the sum of “Cont.” and “Phras.” column % totals would amount
1612 just to 33% of respondents, again a clear minority.

1613

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%

1614

1615 **Table 4: Sample distribution with regards to the indicated components referred to**

1616 **information content.**

1617 Answering to the second part of the questionnaire's questions (requesting to indicate the

1618 "concrete elements" on which the interpretation was based), just the exact half of the

1619 sample indicated, at least once, information content components. In this table, the sample

1620 is distributed in bins defined through the percentage that the components referred to

1621 information content represent on the personal total of the provided indications. Just for 7

1622 people out of 102 the indications pointing at information content balance the others or

1623 prevail (50% or more); just 1 people among them indicates information content

1624 components only.

1625
1626

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.

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.

1648

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%*

1649

1650 **Table 7: Statistical distribution of the answers to the Final question (H/S choice).**

1651 The table displays (for the total sample and the two control sub-samples) the frequencies

1652 of the answers to the Final question (the choice between Message “H” and Message “S”

1653 as the solution of the case). A strong imbalance is shown, as indications of Message #4/S

1654 overwhelm the Message #4/H ones in all cases.

1655

1656 ...

1657 ...

	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”.

1669
1670

	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***					

1671

1672 **Table 9: Cross-table of combined predictions and final choices between Message #4H and Message #4S.**

1673 In this table the combined predictions of Message #4/H and Message #4/S effects (see Table 8) are crossed with the final
1674 choices of the respondents (all the variables are independent). Data shows the association (for the total sample and the two
1675 control sub-samples) between the most frequent combination “H-/S+” and “S” as final choice. In addition, some correlations
1676 between the two choices is underlined by Chi-squared test: p=0.000017 (total sample); p=0.001174 (sub-sample “AGE”);
1677 p=0.000383 (sub-sample “EMPLOYMENT”).

	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.

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.

1704

"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***

1705

1706 **Table 12: Sample distribution with respect to coherence levels and expressed choice**

1707 **(total sample).**

1708 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1709 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1710 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1711

1712 The table displays (for the total sample, and separately for the H and S choosers) the

1713 distribution of participants with respect to the different levels of coherence. Data

1714 highlights some correlations between the two variables coherence and choice: Chi-

1715 squared test returns high significance (p<0.01).

1716

"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***

1717

1718 **Table 13: Sample distribution with respect to coherence levels and expressed choice**

1719 **(Sub-sample "Age").**

1720 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1721 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1722 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1723

1724 The table displays (for the sub-sample "Age", >29yy-old people only, and separately for

1725 the H and S choosers) the distribution of participants with respect to the different levels

1726 of coherence. Data highlights some correlations between the two variables coherence and

1727 choice: Chi-squared test returns high significance (p<0.01).

1728

1729

"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***

1730

1731 **Table 14: Sample distribution with respect to coherence levels and expressed choice**

1732 **(Sub-sample "Employment").**

1733 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1734 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1735 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1736

1737 The table displays (for the sub-sample "Employment", people with a regular employment

1738 only, and separately for the H and S choosers) the distribution of participants with respect

1739 to the different levels of coherence. Data highlights some correlations between the two

1740 variables coherence and choice: Chi-squared test returns high significance (p<0.01).

1741