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

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Abstract

Background. Interpretation is the process through which humans attribute meanings to the inputs they receive from their natural or social environment. Formulation and exchange of meanings (through natural language) are fundamental aspects of human behaviour and important neuroscience subjects. The current concepts mainly refer to conscious treating of incoming information; however, available data does not provide definitive answers and scientific comprehension of the interpretation process is still unsatisfactory. Our work proposes some contributions aimed to improve it.

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Methodology. Our field research involved a random sample of 102 adults. We submitted to the sample a real world-like written communication example using complete and 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 information content, they rather focus on the most varied and unpredictable components: certain physical features of the message (such as the message's period length) as well as meta-information like the position of a statement or even the lack of some content. Actually, just about 12% of the participants' indications point at the text's content; in addition, the reader's selective focusing appears a random picking-up of message components. Our data converge on the hypothesis that such observed behaviours could depend on automatic physiological reactions of the reader to the message components: the components would work like physical stimuli and the reactions would precede the conscious attribution of meaning to the message. So, interpretation would be a (learned) stimulus-reaction mechanism, before switching to information processing, and the basis of meaning could be perceptual/analogical, before logical/digital. We have carried out a first check of our hypothesis through focusing on its critical requisite: priority of automatic reaction over the conscious attribution of meaning. The employed example contained the emerging of a conflict and two versions (same content, ad-hoc different forms) of a reply to be sent at a certain point. We collected the participants'

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(independent) interpretations of the two versions; then, we asked them to choose which version could solve the conflict and we assessed (through a special indicator) the coherence between interpretations and choices. The study of the coherence level in the two subsamples revealed highly significantly different distributions ($p << 0.01$). Such difference seems to be linked to the choice, rather than to the previous interpretations; this result is consistent with the hypothesis that choice is based on an individual's automatic reactions and precedes conscious information processing.

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Introduction

Efficiency and effectiveness of human-environment interactions (with "environment" intended natural as well as social) have always been crucial surviving factors for humankind. Such interactions have something special, with regards to the other animals' ones: human behaviour is not restricted to appropriate reactions; it encompasses also conscious knowledge, achieved through the attribution of meanings (semantic aspect) to the received signals and stimuli, which turns into the related building of concepts. The other animals can perform sophisticated reactions to the environmental inputs; however, they do not "understand" them. At the most, possibly, they can socially exchange some elementary learnings through imitation (about this, a classic study in [1] and one recent example of research in [2]).

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 use has been studied almost since the dawn of humankind [3-5]; nevertheless, none of the hypotheses proposed about it up until the present times can be considered neither exhaustive [6] nor capable to solve the problem of interpretation.

Natural language is usually approached under its profile of symbol-based system; however, 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

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74 word/expression and the meaning attributed to it. This led a famous Italian linguist to
75 label natural language as structurally "equivocal" [7, 8]. Messages are (or, at least, they
76 appear) made up just of words; however, understanding a message always goes far
77 beyond the message's words. The available data does not give definite answers to the
78 researchers' questions and the way human beings switch from stimuli/signals/messages
79 to meanings remains a substantial mystery [9-11]; in fact, interpreting the interpretation
80 process is a challenge that modern science has not yet won. Our field research brings
81 some contributions to clarify such process and to connect it with the biological bases it
82 unavoidably must have.

83 *Research lines and ideas: a synthetic overview*. With reference to the incredible
84 amount of available scientific literature, some trends can be read out, the first of which is
85 the accelerating extension of these studies from the pure humanistic disciplines to science
86 field; recently, even a "hard" natural science like physics has generated a
87 "psychophysics" branch, specifically oriented to deepen the knowledge problem through
88 the instruments of that discipline. Another trend, thanks to the extraordinary development
89 of technology and informatics, is the enhancement of the studies that explore
90 interpretation inside the neural processes of the brain cortex; the neuron-level research
91 and the wide use of advanced imaging techniques (like fMRI) witness for this. All this
92 considered, we can roughly outline a picture with two main scientific research lines:

93 ▪ **Mind-centred approaches** – Understanding/interpretation is totally based on
94 abstract (conceptual) knowledge. Information feeds are provided through the
95 body (perception) but the "mind" [12-16] processes stimuli and incoming sig-

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nals 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 (for example 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 co-exists with conceptual knowledge. When an external stimulus/signal is perceived, it is firstly "understood" through a motor reaction that is automatic, involuntary; such reaction is then mentally mapped also in motor, and not only propositional, terms. Understanding is a sort of motor experience that goes along with conscious (rational) information 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.

In the first group we can gather a wide series of theories that, even if they differ in many details, consider the mind (or the brain, see [12]) through the metaphor of the computer, or even of simpler mechanisms. The range goes from the merely mechanical (and naïve) theories of psychoneural isomorphism ([13], pp. 293-294) and those inspired by the first electronic computers [17], to the various I.P. (information processing) models [18] and current cognitive science positions [19-21]. 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

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areas of the brain cortex [22-24]. 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 [25, 26] and Ideomotor principle [27-29].

The second group of theories (the body-centred ones) can be traced back, at least, to XIXth Century, up to the works of Lotze [30] and James [31], which present reflections on the relationships between perception and action. Other philosophers followed [32-36] up until a new series of neurophysiological studies appeared, in the second part of XXth Century (see [13], especially pages 299-300 about the relationships between perceptions and ideas, and [37-39]). Such researches gathered evidence that the sequential processing theory and the supposed totally passive role of motor system are untenable. However, a breakthrough has probably been accomplished with the discovery of mirror neurons [40] and the following studies on them [23, 24, 41, 42]. According to this theory, understanding would be firstly attained through a motor reaction of the body, "immediately and automatically" [43]. Cognition would be "embodied".

Embodiment of cognition, and its consequences on knowledge and interpretation process, are the object of a heated scientific dispute; some parts of our work will touch such question; then, it is worth referring to an example, in order to clarify out the different positions. In a review that critically examines the mirror neuron-based approach to cognition [44], the author proposes an example, aimed to dispute the embodied

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cognition hypothesis (direct reference to one of Rizzolatti's works [45]). He invites to imagine someone pouring a liquid from a bottle into a glass. Then, he continues arguing that, by following that hypothesis, an observer can "embodily" understand such action since, thanks to his mirror neurons, he undergoes a motor reaction "as if" himself was actually pouring (by the way, such reaction does not turn into any actual movement, it remains "virtual"). This said, the author replies that pouring "could be understood as *pouring*, *filling*, *emptying*, *tipping*, *rotating*, *inverting*, *spilling* (if the liquid missed its mark) or *defying/ignoring/rebelling* (if the pourer was instructed not to pour)…" (see [44], page 1240, italic by the author).

The contrast between these two positions has not yet been solved even though, with respect to its beginning, the debate has grown up far further. In particular, the hypotheses based on the mirror neurons discovery have been refined, for example through the concepts of Mirroring mechanisms (MM) and Embodied simulation (ES) proposed by Gallese [46-55]. About this ongoing dispute, one of the most interesting documents is a forum [56] inside which the most delicate and controversial questions are widely debated. The main ones, with regards to the subject of our work, are the following four: goal-dependency of mirror reactions, with references provided by upholders [57-59] and detractors [44, 60-62]; the nature of motor representations in the brain cortex and the hypothesis that action understanding obtained through mirror neurons would be a form of knowledge qualitatively different from the propositional and abstract ones (widely discussed in [56]); the interpretation of the human ability to understand actions that cannot be performed (for example the barking of a dog) [23, 44, 63]; the

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interpretation of neuropsychological evidence about the relationship among motor impairments and action recognition underperformances (with works that uphold one position, for example [64, 65], or the other, for example [21, 44]).

In the end, it is worth dedicating a special mention to the sector of psychophysics, in which researchers investigate cognition and semiosis through probabilistic models [66-68], in particular applying the Bayesian inference to reproduce mental processes and describe it through algorithms [69-72]. Such concepts are currently in use also in the Artificial Intelligence (AI) studies [73-81]. Inside psychophysics, a specific sector concentrates on what follows interpretation, that is confrontation among different "apprehensions" (conscious perceptions); the result of such confrontation is a "judgement", that is decision and conceptualization [82-85]. New concepts are introduced to investigate semiosis: semantic and non-semantic complexity [86], deterministic chaos [87, 88], inverse Bayesian inference [89], creativity as NON-bayesian process [90], quantum dynamics [91, 92] and the reference to Gödel's incompleteness theorem [74, 93, 94] as a limit to the possibility of understanding cognition "from inside" (since that, while studying cognition, we become a system that investigates itself).

As a general conclusion about the overview we have presented, we got the impression that, at present, the dominant approaches are (tacitly or expressly) based on a widely shared assumption: in the interactions through natural language, the semantic dimension is decisive and the reactions to signals and stimuli come as the result of cortical symbol treatment processes (mainly in propositional terms) which return

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184 operative commands to the body effectors. In short: the brain/the mind [12] represents
185 the "command centre" of the human organism and manages it thanks to its symbol
186 manipulation capacities. Our work presents data that contributes to outline a picture
187 having some different traits.
188

189 **Method**

190 One main reason why all this matter has not yet been cleared is that there are still
191 insuperable obstacles of technical and ethical nature [95-97]; such obstacles are
192 structural. Another difficulty is the complexity of natural language (its "equivocal"
193 nature [7, 8]) usually overcome through a laboratory approach, i.e. studying
194 interpretation as isolated from the interpreting organism and employing simple stimuli
195 (single words, simple and very short phrases; for instance [98]). We explored a different
196 path: a customized naturalistic approach. We have carried out observations and analyses
197 in conditions the closest as possible to the natural ones. About methodology, including
198 the question of reductionism and the necessity to experiment in conditions as close as
199 possible to real world, see [99-101]. In addition, two works about interactions inside
200 online collaborative groups [102, 103] made us appreciate the potential of scientific
201 observation on real-world communication cases.
202 On these bases, we carried out field research on a random 102 adult sample,
203 challenging them with a real world-like written communication case, using complete and
204 unabridged message texts and collecting the sample's interpretations through a specially
205 designed questionnaire. Further details about method in the Supporting Information,

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206 Section 0; a full documentation of the survey process, containing research guide-lines,
207 case description and research protocol, as well as the questionnaire, in the Supporting
208 Information (SI) Sections 1, 2, 3, 4 and Section 5 with Tables S1, S2. In addition: a
209 description of the sample and of the sub-samples drawn from it for control purposes in SI
210 Section 6 with Tables S3-S5; some quantitative aspects of collected data in SI Section 7;
211 quality check of the collected data, their compliance with the research necessities and
212 their suitability in SI Sections 8 and 9 with Tables S6, S7 and Fig. S1-S3.

213 Our work is not a clinical trial and no experimentations on the participants took
214 place. Our sample was not recruited in hospitals or any other institution; we gathered it
215 through the conductors' personal relationship network (details on sampling and survey
216 modalities in SI Section 3, particularly points j-m). In addition, no personal data was
217 collected or anyhow involved in the survey. Through our questionnaire, we just
218 collected, in a strictly anonymous way (details here below and in SI Section 3), the
219 participants' opinions about an exchange of written messages, in order to investigate the
220 process of message interpretation. The submitted case was a fiction based on some real
221 cases the authors had dealt with in their professional activities; its contents were totally
222 neutral with regards to the participants' lives and environments and did not touch any
223 sensitive subject. For these reasons, our research did not involve any critical issue related
224 to ethics; we anyway requested, and obtained, the approval of the Ethics Committee for
225 Scientific Research of the Association ARPA-Firenze. The Committee held a dedicated
226 session to our research (in 2012, april 2d) and its approval was given through a formal

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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 relation among participants and conductors prevented any possibility of unwilling contribution. By the other hand, a written consent would have implied a general database, whose creation and management would have increased the risks of an accidental information diffusion. Instead, our procedures made it impossible for everyone, all along the research work (and the same is at present and will be in the future), either to trace back participants by starting from the filled questionnaires or to recreate the participants' database. Along with its approval of the research guide-lines, the Ethics Committee for Scientific Research of the Association ARPA-Firenze approved also this informed consent procedure.

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

Results from the first part of the research

An important role in data collection and analysis has been played by the questions' structure. Actually, each question sends two inputs to the respondents: at first, they are requested to freely interpret specific aspects of the submitted messages; then, they are requested to account for their own interpretation process through indicating the "concrete elements" on which their interpretation was founded. On these bases, the results from our work's first part can be divided into two categories: purely qualitative results from the answers to the first input (analysis of the provided interpretations); quali-

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quantitative results from the answers to the second input (analysis of the provided indications about the "concrete elements").

Qualitative analysis: answers to the questions' first input. The answers to the first input have fully confirmed expectations: respondents' interpretations widely scatter. About interpretation scatter, we have quoted an example (taken from [44]) in our Introduction. In addition, some descriptions, referred to special cases and entailing divergence of interpretations, can be found in [104-107]. Inside our research, the respondents' answers to Question #2 return us a specific example of such scatter. 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: sixty-four stated XX's position as strengthened, 12 as weakened and 7 unchanged (although these seven, too, had answered "YES" to the first part of Question #2). In addition, we can find completely opposing statements in these specifications and we can see that scattering covers very different aspects of the XX-YY interaction (behaviours, emotions and so on, Table 1).

Such a phenomenon can be observed for all the messages and for any part of them, even if accurately selected: it is impossible to find parts of a message that are interpreted in the same way by all the participants. The observed interpretation scatter can be represented through a "megaphone-shape" picture (Fig. 1): receivers take the same information into account but their final interpretations diverge [108]. We named

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this phenomenon "classic interpretation scatter" and tried to delve further into its process. 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 [7, 8]). Eventually, we focused on the answers to the questions' second input and tried a new approach.

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

- Summaries of the message texts and syntheses of the 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 could be provided also through pointing the beginning and the ending word of the quoted strings ("from… to…"). The string length could cover up to a whole paragraph of the message (from a keyboard "Enter" to the following).
- 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 [109], personal or professional titles used in the opening, the salutes used in the closing etc.

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- Items unrelated to the text semantic or to the message content; a tight selection is presented in Table 2. The list is indefinite, given that each item generally appears at low frequency while the range of possible items is extremely widespread. Items of this kind are actually unpredictable; even the **lack of some content** can be focused and reported as a source of meaning (Table 2, final row).
- References to some overall effects produced by the message on the respondent (see SI Section 8.a, final part, for details). In fact, in this kind of answers respondents state they cannot indicate any "concrete element"; the meaning they have attributed derives from a "general impression" received from the message or from its "general tone".

In the end, in so doing we have tackled the reading process as if the text was something *physical*, not logical; we have treated the indicated items independently of their content. Doing so, we have seen that the meaning can spring from aspects of the message bereft of any content, from aspects external to the text and even from the lack of content itself. In short: given a message, the source of its meaning can lie anywhere. "Anywhere" means also that it seems impossible to previously write up a "complete" list of the items that could become sources of meaning; any new reader can introduce new subjective criteria and detect sources totally unpredictable for the other readers. The question now is: how does all this work? How can we describe, and model, the process of interpretation, subjected to such uncertainty?

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In order to answer this question, we named "components" the items indicated in the answers to the questions' second input and went back to the questionnaires in order to tally the components present in our survey. We have tallied a total of 1,319 components clearly indicated by participants and we have displayed in Table 3 their absolute and relative amounts; further elaborations are synthesized in Figures 2 to 5. Indications that clearly focus on the information content constitute only a small minority (around 12%, see Table 3, "%" row, "Cont." column) while references to various 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).

Figures 2 to 5 represent a distribution analysis carried out about the components. This analysis returns a picture without any significant imbalance in data screen: sample's indications are uniformly distributed with respect to the different questionnaire's questions (Fig. 2) and quite-normally distributed with respect to the types of the components (Fig. 3). Similar results are obtained analysing the sample distribution with respect to the amount of component types employed and to the total indications provided by each respondent (Fig. 4, 5). In synthesis: the current ideas about interpretation mainly refer to a sequential taking into account of the message's information content (expressed through words) that goes along with reading and is accompanied by information processing; what we have found does not match such vision.

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356 In order to verify our statement, we have further checked our quantitative
357 analysis. Firstly, we considered that references to full sentences or periods (20.9% in the
358 total) could be another way used by participants for indicating contained information.
359 However, even in such case the sum of the two components would occupy just one third
360 (exactly, 33.1%) of the total indicated components' amount. Secondly, we carefully re-
361 examined the filled questionnaires about the information content component. We found
362 (Table 4) that one half of the sample (51 people) expresses, among the others, at least 1
363 reference to such component (no recordable similar hint by the other half). However,
364 only 7 respondents provide a balanced or prevalent amount of indications (50%, or more,
365 of the personal total) about information content. Among them, only one reaches 100%. In
366 fact, references to the information content confirm themselves as a definite minority in
367 participants' indications and the emerging picture is the following:

368 ▪ The reader's interpretation of an incoming message looks to be starting like a
369 selective and subjective picking up of (or focusing on) the most different com-
370 ponents, rather than being a systematic, rational scanning of the text's content
371 represented through words. Such behaviour is widely scattered: in the whole
372 research, with regards to each specific message, it is impossible to find two
373 identical combinations of focused on components.

374 ▪ Readers interpret a message indifferently picking up meaningful and meaning-
375 less components and subjectively combining them. While reading and text de-
376 coding go ahead sequentially, readers go on freely (randomly, from an extern-
377 al observer's point of view) isolating "chunks" of the text (as well as other

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components and even external context aspects) and assuming them as the foundation of the message's meaning.

- While the final meaning attributed to the message is justified through the selected components, no reason (at all, in any cases) is provided for that selection: the focused components suddenly appear, in the respondents' accounts; they are presented just as "given", and without any doubt [110].

At this point, we named "disassembling" the observed selective focusing and took two measures. At first, we hypothesized a new image for the interpretation process, inverted with respect to the "megaphone-shape" one. Our argument was that, if scatter manifests itself in the beginning (scattering of focus), a "funnel-shape" picture (Fig. 6) could be more suitable: people that select one same component are expected to interpret it in very similar ways. Secondly, we picked up an example of disassembling that seemed particularly interesting to us and we decided to check the "funnel-shape" picture through it.

A disassembling example in detail and a perceptual hypothesis. Question #1 requests evaluations with regards to sender-receiver positions and to the relationship between them, on the basis of Messages #1 and #2 (SI Section 4 for the messages' texts). We found that 53 people (52% of the sample) [111] had quoted an expression the sender (XX, see SI Sections 2, 4) used in Message #1: she premised her request of a technician inspection with the words "we would be pleased if at least once…". This simple expression, apparently trivial (also short, 8 words in a 67 word message, and in no way highlighted in comparison to the rest of the text), has collected 68 quotations (15 people

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expressed two, see [111]). Then, respondents have given such specific passage at least 22 divergent interpretations, summarized in Table 5.

This means that focusing on the same component does not imply convergent interpretations. As much as to say that the interpretation scatter manifests at both levels: the disassembling level (scattering of focusing on components) and the successive attribution of meaning (each sub-group, focused on a same component, provided scattered conscious interpretations). This means also that the "funnel-shape" picture, too, must be revised: what we observed could be better expressed through an "hourglass-shape" picture (Fig. 7). In fact, disassembling and classic interpretation scatter would co-exist and manifest themselves **in sequence**. Now, one aspect must be highlighted: the expression we are discussing appears to be a minor element in Message #1 text, something incidentally expressed; it is composed using common words and bears no inherent information content (once the passage gets isolated from the rest of the message, it is impossible to attribute it a univocal meaning). In short: it is a mere form component. So, how could respondents select such incidental passage? And what did they, exactly, grasp in it? What is more, given that the following interpretations are scattered, what did respondents, exactly, interpret, having started from an identical, spontaneous selection?

About the interpretations we have analysed, we can take for granted two things: first, each message sender has the intention to transmit one specific meaning; second, the message we have used in our research was always the same, invariable with regards to written form as well as to information content. Thus, if the interpretations of the readers are so scattered, this cannot depend on the message itself, it must depend on the

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receivers: they evidently give an active contribution in attributing meanings, they are not passive symbol decoders. Nothing new, so far: our observations confirm old ideas, for example the ones that the constructivist hypothesis proposed many years ago [112]. The question is: how can this happen? By one hand, respondents explain through the outcomes of "disassembling" the conscious attribution of meaning that follows; by the other hand, no accounts report about the source of disassembling. The selective focusing manifests "immediately and automatically" [43], apparently preceding and feeding the conscious processing that follows, and that is all.

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

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444 component to act like a stimulus depends on the subjective reactivity of each
445 receiver.
446 ▪ Then, the conscious processing of the collected inputs would start. Being the
447 steps set in a cascade, the "input" on which this third step would be carried out
448 should (mainly, at least) consist of the automatic reaction's outcomes and not
449 of the source message's content.

450 Our hypothesis is that the interpretation process structure can be represented with
451 a three-step (three sub-processes) model like the one in Fig. 8. It well gives account of
452 how respondents focused on the incidental passage and what they grasped from it: they
453 (automatically) reacted to a stimulus, presumably through unconsciously connecting it
454 with previous experiences that had involved something similar. One problem we have
455 been facing is the following: exactly, how can we label what a reader picks up when
456 he/she selectively focuses on meaningless/contentless components? We think we can
457 label it as **the fact that** one of these components is present in the message (Table 6); it
458 can be considered some meta-information to which readers can automatically react even
459 though it is not embedded inside the message words. This well explains what of the
460 incidental passage ("we would be pleased if at least once…") has triggered the
461 participants' reaction off: the fact that XX had (redundantly) placed it in a certain point
462 of the message [113].

463 In synthesis: interpretation process would firstly consist in a re-experiencing of
464 past situations through an analogical resounding at body-level, thanks to a stimulus-
465 reaction mechanism triggered off by perception. Such reaction would feed forward

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(presumably through proprioception) the following attribution of conscious meaning to the subjective experience (rather than to the source message).

Results from the second part of the research

Our research's second part represents a first check about our hypothesis. In this part, we started submitting to participants two alternative versions (Messages #4/H and #4/S) of a possible reply to Message #3. Then we asked them to, firstly, interpret (independently) the two versions (Questions #3 and #4); secondly, to choose between them (Final question) the one suitable, in their opinion, to origin the final XX's answer (Message #5, that seals the positive ending of the case; see SI Section 4 for messages' and questions' full texts; Section 5 and Tables S1, S2 for details about the reasons of the alternative). The choices indicated by the sample members are displayed in Table 7 (SI Section 6 and Tables S3-S5 for the sub-samples description) which shows a strong imbalance between "S" and "H" indications.

We set up our check in order to answer a fundamental question: what is the timing of the receiver's reaction (our model's second step) and the conscious information processing (third step). Current models (even many of those ascribable to the "body-centred approaches" research line, see Introduction) definitely privilege the idea of information processing preceding body reaction; our hypothesis is one of those that suggest the opposite. Now, if the current models are right (our "Hypothesis 0"), then the participants' final choices should be someway correlated with the interpretations given to the two alternative messages; otherwise, no correlation, or a different kind of correlation,

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488 should be found (our "Hypothesis 1"). The technical problem emerged of measuring such
489 correlation.

490 *The coherence between interpretation and choice*. At first, we compared the
491 interpretations of Message #4/H with those of Message #4/S (SI Section 4 for messages'
492 full texts). Source data (opened answers) was purely qualitative. However, answers were
493 easily classified into two main categories: predictions for the message inducing a solution
494 of the case (easing or solving the emerging conflict between the interlocutors);
495 predictions for the message inducing a surge, or escalation, in the conflict. We created
496 the dummy variable "Expected effects" and assigned it two values: "+" in the first
497 condition; "-" in the second one. Then, we labelled each questionnaire with these two
498 new symbols: one referred to Message #4/H (H+ or H-) and one to Message #4/S (S+ or
499 S-). The combination of the two symbols indicates the combined predictions each
500 participant expressed about the effects: H+/S+ (both the messages solving the conflict),
501 H+/S- (Message #4/H easing the conflict while Message #4/S escalating it), H-/S+ (the
502 opposite), H-/S- (both escalating). Finally, we arranged the symbols into a dichotomous
503 table (Table 8). There is a clear convergence on combination "H-/S+"; the strong
504 imbalance is fully confirmed by the distribution's statistical significance, checked
505 through chi-squared test ($p = 0.001988$, total sample; $p = 0.015600$, sub-sample "AGE";
506 $p = 0.003861$, sub-sample "EMPLOYMENT").

507 Then, we cross-checked the combinations with the final choices (Table 9). The
508 most frequent combination (H-/S+) is strongly associated to "S" choice; in addition, there
509 are differences, apparently relevant, between the distributions of "H" choosers and "S"

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choosers. Regarding to this last point, the significance tests (chi-squared) confirm the strong imbalance: $p = 0.000017$ (total sample); $p = 0.001174$ (sub-sample "AGE"); $p = 0.000383$ (sub-sample "EMPLOYMENT"). The impact powers of the two messages seem to be different (or, from a mirroring point of view, the reaction of the sample to the two messages has been strongly imbalanced). At this point, we created a "coherence indicator" starting from the following premises (SI Section 4 for messages' full texts):

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

On these premises, we have built a coherence indicator. We defined four coherence levels, increasing from L (low) to LM (low-medium), MG (medium-great) and

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G (great); the scale is fully presented in Table 10. In this way, it has been possible to arrange the sample distribution with respect to the coherence levels (Tables 11, 12, 13, referred to the total sample and the two sub-samples). Great differences between the distributions of "H" and "S" choosers are fully confirmed by significance test (chi-squared checked between the groups, for the total sample and the two main sub-samples, returns $p < 0.01$ in all cases). We delved further into this matter by using percent distribution histograms; for the reliability of comparison, we excluded data referred to the respondents having just primary education levels (only 4 in the total sample).

The histogram that represents the whole sample (Figure 9, percent distributions from Table 11) shows that the distribution is the expected one except for the frequency of the low coherence bin, over-represented. Actually, we expected L frequency to be null or very close to null, anyway having the lowest frequency of all; on the contrary, we found L values higher than the LM ones and representing 11% of the sample. We decided to delve further into this point and built separated histograms for "H" choosers and "S" choosers, finding a surprising result. Histograms (Fig. 10, percent distributions from Table 11) show that the percent frequency of "S" choosers (white bins) increases regularly from L category to G, reminding (as expected) of certain power, or exponential, curves. At the opposite, the percent frequency of "H" choosers (grey bins) is arranged in an irregular, almost bimodal shape. We checked these distribution shapes by using many different sub-samples (selection displayed in Fig. 11-16), included the already mentioned "Age" (Fig. 15, data from Table 12) and "Employment" (Fig. 16, data from Table 13) sub-samples. We always obtained the same result for the variance between "H" and "S"

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choosers: the anomaly regarding the L frequency over-representation must be entirely attributed to the "H" choosers and the two distributions are significantly different ($9{,}5\text{x}10^{-5} \leq p \leq 1{,}6\text{x}10^{-3}$).

Such asymmetry, along with its permanence on different sub-samples, contrasts our "hypothesis 0": if the participants' final choice would be correlated with the interpretation given to the two alternative messages, then we would find the same shape (some kind of regular increasing from Low to Great coherence levels) in both the distributions. On the contrary, the observed difference suggests that, while dealing with the messages, "H" and "S" choosers' groups behave differently. As much as to say that, at group level and between the groups, the two behaviour patterns are correlated with the choice and not with the interpretation. Such conclusion is upheld by a control analysis: we have checked the statistical significance of the differences within the groups through applying the chi-squared test to all the "H" choosers' sub-samples, combined by two. The same we made with the "S" choosers' sub-samples. In both cases, we found that the distributions within the groups are very far from any possible significant difference ($0{,}424 \leq p \leq 0{,}983$ for "H" choosers and $0{,}418 \leq p \leq 0{,}968$ for "S" choosers). Our "Hypothesis 1" seems to be confirmed.

After this first conclusion, we set up a second indicator to further check our hypothesis. We started from the consideration that Message #4/H and Message #4/S contain the same text blocks (SI Sections 4, 5 and Tables S1, S2), while the order in which they are presented and their linguistic form is different in the two versions. Each block is identified as concerning a given content (SI Section 5 and Table S2) and we

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576 investigated about possible differences regarding the attention paid by "H" and "S"
577 choosers to different blocks, while answering to Questions #3 and #4 (SI Section 4 for
578 messages' full texts). The detection of some correlation between the expressed choice
579 and some specific block (i.e. specific content) could have weakened our "Hypothesis 1";
580 thus, we set up a "block preference" indicator and carried out the relative analysis. No
581 contradiction has been found with the previous results. For text length reasons, we
582 present details in SI, Section 10 with Tables S8-S11.
583

584 **Discussion**

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

589 *Summary of the research's main findings*. The current ideas about message
590 interpretation are mainly based on laboratory experiments carried out through submitting
591 isolated words/expressions (typically framed in pre-assigned categories of meaning, for
592 example [114, 115], especially the Method section) to the sample. Such ideas, even
593 though different from one another, generally share the reference to two sub-processes:
594 decoding of symbols (turning written signs or spoken sounds into words) and, in parallel,
595 conscious, sequential treating of the information embedded inside words (that leads to
596 the final conscious meaning attribution). The picture is returned of a unique, uniform
597 process of sequential, parallel operations; the meaning itself should be something

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598 embedded in the verbal components of the message and to be "extracted" from them
599 (actually, the verb "to extract" is frequently used in scientific publications, for instance
600 [116]). Our results outline a picture of discontinuity, with an interpretation process made
601 up of three discrete steps having different natures, working in different ways and being
602 set in a cascade. Our model supports, as sub-processes, either the sequential decoding or
603 the conscious treating of the message information content; however, it differs from
604 current ideas in what follows: (1) The sub-processes are set in a row and not in parallel;
605 (2) There is an intermediate, critical step ("disassembling") between decoding and
606 conscious processing; (3) The process structure entails a feeding chain, with the first
607 step (decoding) that feeds the second (disassembling) which, in turn, feeds the final one.

608 The following points synthesize our interpretation of the interpretation process,
609 i.e. the vision we built on our research's results and the details about how we conceive
610 the model we are proposing. In other words: here is our hypothesis, upheld by our work's
611 experimental outcomes (specified in italic).

612 ➢ In all circumstances, the interpretation of natural language is a complex,
613 global experience not reducible to the interpretation of isolated spoken or
614 written words. *Experimental reference to our quali-quantitative analysis of*
615 *the participants' answers to the questions presented in the questionnaire's*
616 *first part (particularly: description of the message non-word and meta-*
617 *information components, that prevail over verbal components and heavily*
618 *impact on the reader's interpretation)*.

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- The critical point of the proposed 3-step model would be the second step, "disassembling": while the first step (decoding) is the sequential application of a technique, disassembling is carried out randomly, in a way that is totally subjective. *Experimental reference to our quali-quantitative analysis of the participants' answers to the questions presented in the questionnaire's first part (particularly: observations about the sudden appearance, extreme individualization and unexplained origin of the widely divergent and unpredictable selective focusing).*

- Observable features, statistically analysed, lead to hypothesize "disassembling" like a stimulus-reaction mechanism following decoding and preceding conscious processing. *Experimental reference to our quali-quantitative detailed statistical analysis of a disassembling example (the case "we would pleased if at least once...") presented inside our general analysis of the participants' answers to the second input of the questions (first part of the questionnaire).*

- This means that each message's component would at first work like a physical stimulus, rather than an information carrier; in other words, it would trigger an automatic reaction off in the whole receiver's organism ("body" level) before the conscious processing of information content starts. *Our hypothesis, consistent with the data we collected and suitable to give account for our observations.*

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- Since "disassembling" feeds forward the third step (conscious processing), it orients the attribution of meaning: interpretation would be carried out on the organism's reaction, rather than on the source information. *Experimental reference to our quantitative statistical analysis of the participants' answers to the questions of our questionnaire's second part (coherence indicator, coherence level distributions and correlated significance checks; block preference indicator and related analysis). Results are consistent with our hypothesis of automatic reaction preceding conscious processing*.

- After disassembling, the receiver's contact with the original message would be lost. *Logical consequence of the "in a cascade" setting of our model's three steps; further details, with direct references to recent scientific paper consistent with such conclusion, in next paragraph, that situates our work in the current scientific research scenario* [117].

- 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. Evidence about a picture more complex than the pure "information processing" one have gone piling up since more than one century. Conscious thinking following (rather than preceding) "body" reaction (in our case: conscious attribution of meaning following "disassembling") can be traced back up to the hypotheses of Nineteenth Century philosopher and psychologist William James. In one of his examples (the "James's bear", see [31], Chapter XXV),

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James explains his theory of emotions suggesting that, for example (our synthesis), we do not run away from a bear because we have seen it, we were scared of it and, consequently, we consciously decided to run (as common sense would sustain). Conversely, we feel like we are afraid because we find ourselves (consciously and successively) 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 know that James's theory (exactly: James-Lange theory) has been criticized and opposed through several alternative theories (for example [118, 119]); nevertheless, we do refer to it because recent scientific research and reviews seem to suggest some re-consideration of the matter (for example, [120]). 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 [121], 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" [122-125]. Conceived inside a psychoanalytic context, they all (especially one of them [126-130]) put perception and stimuli at the centre of their

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684 attention and reverse the relationship between action and thought using action (rather
685 than thought) to induce training and therapeutic effects. We find no important
686 contradictions among our hypotheses and such models; rather, we find complementarity:
687 they show how physical stimuli can act like messages; our results tell that words can act
688 like physical stimuli. What is more, we can suggest an explication of an unsolved point
689 related to them: the biological foundations of the "aspect of relation" in human
690 communication [123]. On the basis of our results, this aspect could be exactly the body-
691 level automatic reaction which precedes the conscious information processing.

692 In present Century, focusing on reading, some researches on related neural
693 phenomena show that such action definitely involves the motor system [131-135]. The
694 role of this last is not yet clear; however, our hypothesis is consistent with those
695 observations: we conceive "disassembling" as an automatic body reaction to words
696 acting like stimuli. A body reaction independent from previous information processing is
697 proposed also by the mirror neuron theories [23, 24, 39-42, 45-59, 63, 96, 97, 100, 101].

698 About the relevance of unconscious processes in human behaviour, some
699 clarification is provided by a review of experimental works that re-examines the disputed
700 question of the passage from perception to action [136]. The authors compare the
701 traditional Sensory-motor Principle (SMP [18, 137]) and Ideomotor Principle (IMP [27-
702 29, 138] and, for a synthesis, [97], Chapter 2, pp. 56-57 of Italian edition) positions. In so
703 doing, they show how certain stimuli (images, solid objects or even written words),
704 intentionally added to an experimental setting, can alter the sample behaviours, even if
705 such stimuli are not consciously detected: "under certain conditions, actions are initiated

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706 even though we are unconscious of the goals to attain… [and] goal pursuit can… operate
707 unconsciously" [136]. They also sustain that arguments frequently presented as rational
708 motivations for action are, actually, *ex-post* justifications of unconsciously performed
709 behaviours. Our data exactly indicates precedence of perception-reaction with regards to
710 conscious processing.

711 In the end, we would situate our research with respect to the current dispute
712 among neurophysiologists and cognitivists (embodied vs. conceptual knowledge
713 processes, a selection of recent publications in [114, 115, 139-142]). Our results could
714 easily integrate both the positions. About such dispute, we have already cited (in
715 Introduction) an example proposed against the mirror neurons hypothesis [44] and a
716 recent direct confrontation [56] among opponents; we will discuss this point by
717 recovering the example in [44]. About the capacity of an observer to understand the
718 action of pouring performed by someone, the author highlights that the "embodied
719 cognition" hypothesis cannot explain the fact that the observer can interpret such action
720 "as *pouring*, *filling*, *emptying*, *tipping*, *rotating*, *inverting*, *spilling* (if the liquid missed
721 its mark) or *defying/ignoring/rebelling* (if the pourer was instructed not to pour)…" (see
722 [44], page 1240, italic by the author). The author also anticipates the counter-argument of
723 a supposed mirror neuron theorist, i.e. that mirror neurons codify the goals, or intentions,
724 of the actor: "But a goal, say to fill a glass with water, can be accomplished with any
725 number of individual actions or sequence of actions: pouring from a pitcher, turning a
726 spigot, dipping a glass in a lake, setting the glass in the rain…" (*ibidem*).

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In our opinion, embodied cognition hypothesis looks at the act of pouring in its **purely motor** nature; conversely, understanding it, for example, as "pouring" or "filling", requires the interpretation of a **situation** which is not limited to the act for itself. In order to attribute the "pouring" meaning, one must focus on the liquid flow direction (inside to outside, from the bottle); for the "filling" meaning, one must focus on the glass receiving the liquid; for the "emptying" meaning, one must focus on the dynamic status of the bottle content. An operation must be preceding the attribution of a conscious meaning. It is something closely resembling what, in the manuscript, we named "disassembling".

Our conclusion is that the opponents are not precisely speaking of the same thing. However, their positions seem to have something in common: they both "see" only a part of the process. They try to fit the whole process inside a single step and, since the steps they focus are different, the two ideas reject each other. Our hypothesis holds both the steps, so that it can agree with both positions. In fact, the second sub-process (perception/automatic reaction, i.e. "disassembling") of our scheme (Fig. 8) appears to be consistent with the mirror system theory. In particular, the most advanced formulations of the mirror neuron hypothesis (in particular, the embodied simulation idea [56, 141, 142]) hypothesize the co-existence of two different types of knowledge: one would be "warm and coloured", coming from inside and embodied; the other would be cold and abstract. At the same time, the third step of our model (conscious processing, in which information treatment really matters) is consistent with the cognitivism hypothesis. However, our hypothesis presents also some specificities that differentiate it from the

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749 other two: (1) Its sub-processes are in a cascade while in the mirror neuron concept they
750 are rather thought as proceeding in parallel; (2) our data indicates that a "body" reaction
751 could precede abstract operations of conceptual nature, while cognitivism approach states
752 the opposite.

753 *Some possible consequences*. One main consequence of our results, once they
754 will be confirmed, would concern the nature of words. We are used to consider words
755 quite exclusively in their symbolic nature; however, our research shows that they could
756 have a double nature: they could work like symbols as well as physical stimuli. In a
757 specific circumstance, which of the two natures will be active depends on the subjective
758 "disassembling" performed by the receiver, rather than on the sender's intentions. This
759 implies that which nature is in action will become observable only at the moment of the
760 receiver's interaction with the message. This is very similar to what happens in certain
761 physics phenomena, for example the double nature of light (waves/particles) or the
762 uncertainty about some features of many atomic particles: the ambivalence is solved just
763 in the process of measuring the phenomena ([143] for a discussion about the case of
764 photons and [144] for a recent point of view about such ambivalence).

765 All this entails what follows:

766 ➢ There is a structural uncertainty in the human communication general process:
767 when a sender sends a message, he/she has the intention to produce some
768 effects on the receiver (his/her communication has a goal, this is the
769 pragmatic aspect); however, the actual effects the message will produce will
770 depend on a sub-process (interpretation) that is under control by the receiver,

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not by the sender. Uncertainty is linked to the irreducible subjectivity of the receiver's "disassembling".

- Such subjectivity is not just a question of interpretation scatter, with regards to pre-definable message components; the question is that it is impossible to foresee what components, exactly, will trigger the receiver's automatic reaction off (receiver's reactivity is an absolutely individual feature).
- What is more, the selective focusing, by the receiver, on specific message components, seems to be a creative act, rather than a simple recognition of something contained inside the message. So that 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 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 only on its filtering by the receiver's life experience expressed through the body reaction. Such feature could heavily impact on the possibility to reproduce human interpretation process on digital

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793 computers, regardless of their calculation power and data storage capacity; the two
794 systems could result not only different, rather incompatible. We are not the first to
795 propose such observation (for example [84-86] on the non-algorithmic nature of
796 knowledge and intelligence). In the end, all this could lead to an operative definition of
797 "meaning" (expressing the meaning of "meaning") beyond the possible abstract ones:
798 *The meaning attributed to a message is the receiver's synthetic conscious report on the*
799 *final state of his/her organism after experiencing the interaction with the message*.

800 Other possible consequences of our results are the following:

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

811 *Opened questions*. We have provided some data upholding our hypothesis and
812 our discussion; at the same time, we are conscious that our results and our conclusions
813 need to be confirmed. Among the undoubtedly several points to be checked, we highlight
814 two main questions. The first one is linked to the matter of analogical vs. digital nature of

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815 the processes that contribute to meaning and knowledge building. Following our
816 hypothesis, both the natures would be playing a role, each in a specific step of the
817 interpretation process: “disassembling” has an analogical nature while the conscious
818 processing has a digital one. The main question is the timing of these two steps: if
819 conscious processing precedes, then the current models would be confirmed; if
820 disassembling precedes, then our hypothesis would be confirmed. The problem is just to
821 find a way in order to definitely answer such question, and it does not seem something
822 easy.

823 The second one regards the reasons of the observed radical difference between
824 the “H” choosers and “S” choosers group behaviours in terms of interpretation/choice
825 coherence; about this, we think there are two possible hypotheses: (1) The two
826 subsamples follow different paths in interpreting natural language messages (“S”
827 choosers would base their choices on rational information processing, which would
828 precede action, while “H” choosers would react instinctively and choose before
829 analyzing the available information); (2) The two subsamples actually follow the same
830 path (automatic reaction preceding conscious information processing, in our opinion) and
831 the difference they show is linked to the differences in their automatic reaction schemes
832 (“S” choosers’ reaction would privilege the attention to the relational aspects while “H”
833 choosers’ reaction would privilege the content aspects). We consider relevant such matter
834 and we will not engage ourselves in extemporaneous considerations about it; rather, we
835 have already begun to think to a dedicated specific research.
836

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837 **Conclusion**

838 Human behaviour (communication through natural language and "understanding"
839 included) must be rooted into biology. Such position can be considered as established,
840 even though many details still need to be cleared and it is not yet universally accepted.
841 We share this idea and, for this, our results will have to pass the crucial test: valid
842 compliance with the evolution theory [145-151]. Specifically, we must ask ourselves if a
843 conscious organism that reacts before rationally thinking (what our work seems to
844 confirm) could be a valid outcome of the evolution process.

845 At present times, human beings live inside sophisticated societies; however, their
846 biology is the result of natural selection and represents the best fitting in a **natural**
847 **hostile environment**. Biologically, we are "still the ones of the stone and of the sling"
848 [152, 153] even though, from a cultural slant, we can describe ourselves as being
849 something very different. Rational thinking is, undoubtedly, much slower, in comparison
850 to intuitive reactions, even though we could agree it produces better final results. At the
851 same time, in a natural environment, fast reaction capacities are a critical surviving
852 factor; thus, reaction preceding reflection appears to be consistent with the evolution
853 theory. Human communication and culture could have begun by employing the new
854 feature of language through such general rule, thanks to structures and processes mirror-
855 system-like: at first, perception would not start complex (and slow) information
856 treatment; rather, the entire organism automatically would change and, "resounding"
857 similar situations, would be primed for immediate action. Then, rational thinking would
858 follow. Another possible example of the "exaptation" process [154].

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Summing up all the data, researches 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 their organisms react to the inputs they receive, orienting the following sub-process of conscious interpretation. On this line, the second is that, if human semantic approach to the surrounding environment could ever be represented through a computational model, then the "computer" should be the organism as a whole, not the sole brain cortex. As a consequence, what really could prevent present times computers from imitating human thought would not be insufficient data processing power or data storage capacity; rather, it could be the lack of a special peripheral unit: a human body.

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902 [9] Material regarding the attempts to explain human communication and the questions
903 of meaning and interpretation is really countless. Specific works will be indicated
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973 regards to introduction chapter, on the impossibility to have a knowledge of the
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1152 Torino: Codice Edizioni. [Or. ed.: Goldstein R. 2005. *Incompleteness: The proof*
1153 *and paradox of Kurt Gödel*. New York-London: Norton.]
1154 [95] About the technical difficulties of data collecting: experimental techniques used on
1155 macaque monkeys (electrodes direct insertion inside single neurons) return very
1156 accurate measuring, but on small brain cortex surfaces. About ethic difficulties:
1157 these techniques are quite impossible to be used on humans, and only indirect

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techniques as fMRI (functional Magnetic Resonance Imaging), MEG (Magnetoencephalography), PET (Positron Emission Tomography) or TMS (Transcranial Magnetic Stimulation) are systematically employed. They cover wider brain cortex surfaces but with an inferior accuracy; moreover, they present difficulties with regards to instrument positioning and image interpretation. For a survey of these difficulties see [23], chapters 2, 6, 7, and [96], *passim*. A recent thread of research is investigating the connections among single neurons activity and the total effects detectable through indirect techniques (see [97], chapter 7). In addition to all this, data interpretation and comparing are intrinsically difficult, considering also differences in macaque and human brain cortex and the associated problem to check reliable correspondences.

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

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

[99] One strong point of neurophysiological research at Parma University, which facilitated the discovery of mirror neurons, is the researchers' preference for a naturalistic-like approach: Rizzolatti's team let observed macaque monkeys freely interact with available objects, rather than stimulate them with selected artificial

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1180 stimuli only (see [23], p. 3). About the reductionism question, and the distinction
1181 between methodological and ontological reductionism, see [24], p. 26, and [100,
1182 101].

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1185 *http://www.brainfactor.it/index.php?option=com_content&view=article&id=171*
1186 (accessed 1 Mar 2014).
1187 [101] Gallese V. 2010. The Mirror Neuron Mechanism and Literary Studies. Interview by
1188 Hannah Chapelle Wojciehowski. *University of California eScholarship 2010.*
1189 *Available:* *http://escholarship.org/uc/item/56f8v9bv* (accessed 1 Mar 2014).
1190 [102] Maffei R. 2006. Questioni di stile: L'influenza dello stile di conduzione sui gruppi
1191 collaborativi online. *Proceedings of the Colloques TICE - Méditerranée 2006*.
1192 ISDM 25. *Available:* *http://isdm.univ-tln.fr/PDF/isdm25/Maffei_TICE2006.pdf*
1193 (accessed 1 Mar 2014).
1194 [103] Maffei R, Cavari L, Ranieri M. 2007. L'autre face du changement: Constants et
1195 structures dans la collaboration en ligne. *Proceedings of the Colloques TICE -*
1196 *Méditerranée 2007.* ISDM 29. *Available:* *http://isdm.univ-*
1197 *tln.fr/PDF/isdm29/MAFFEI.pdf* (accessed 1 Mar 2014).
1198 [104] Some special cases, highlighting divergence of interpretations in human
1199 communication, are described in [105], pp. 390-394 (analysis of a real
1200 communication event); [106], pp. 4-6 (communicative meanings as joined
1201 constructions); [107], pp. 93-98 (the "cumulex" play).

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1205 [106] Bara BG, Tirassa M. 1999. A mentalist framework for linguistic and extralinguistic
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1208 [107] Sclavi M. 2003. *Arte di ascoltare e mondi possibili*. Milano: Bruno Mondadori.
1209 [108] In the exact same way of the example drawn from [44] and presented in
1210 Introduction: in that case a physical action was described as interpretable in very
1211 different ways (by different observers as well as by only one who is observing from
1212 different points of view). However, there is no question about the action *per se*. In
1213 our case, the reading of the same message by different people evokes very different
1214 interpretations, but the message information content cannot be under question
1215 (being the message typed and having a unique editing).
1216 [109] In one of the two pilot-sessions of the survey, one message contained an
1217 exclamation mark (successively removed); it was specifically identified, and noted
1218 as a meaningful component *per se*, by one of the participants. For this reason, it was
1219 removed in order to limit influencing respondents. In fact, other respondents
1220 successively picked up, from questionnaires now bereft of that exclamation mark,
1221 quotation marks (used in certain passages of the submitted messages) as a
1222 meaningful component *per se*.

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1223 [110] Just 1 participant (out of 102) declares uncertainties in his final choice. He writes
1224 that the final effect could be obtained with both the messages under choice. This is
1225 the unique doubt expressed in the whole research. In addition, it must be noted that,
1226 while answering the other questions, also this special participant expresses himself
1227 in a totally doubt-free way, like the rest of the participants.
1228 [111] The 53 people have expressed their interpretations answering Question #1-a (23),
1229 #1-b (15) or both the questions (15). See SI Section 4 for the questions' full texts.
1230 [112] Watzlawick P, a cura di. 1988. *La realtà inventata - Contributi al costruttivismo*.
1231 Milano: Feltrinelli. [Or. ed.: Watzlawick P, ed. 1984. *The invented reality*. New
1232 York: Norton.]
1233 [113] It is particularly interesting to note that the expression "the fact that…" is
1234 spontaneously used by several respondents in their answers. For example, in the
1235 collected questionnaires we can find expression like the following: "the fact that the
1236 arguments are presented through a dotted list"; "the fact that XX is referring to
1237 public money".
1238 [114] Bedny M, Caramazza A, Pascual-Leone A, Saxe R. 2012. Typical Neural
1239 Representations of Action Verbs Develop without Vision. *Cerebral Cortex*
1240 February 2012, 22: 286-293. DOI: 10.1093/cercor/bhr081.
1241 [115] Bedny M, Caramazza A, Grossman E, Pascual-Leone A, Saxe R. 2008. Concepts
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1243 October 29, 2008, 28(44):11347-11353. DOI: 10.1523/JNEUROSCI.3039-08.2008.

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1245 in the brain? *Trends in Cognitive Sciences*, Volume 15, Issue 3, 97-103, 14. DOI :
1246 10.1016/j.tics.2011.01.004.

1247 [117] Our data led us to conclude that such contact can be recovered (like a sort of "fourth
1248 step" after the three sub-processes of our model) only later and just in peculiar
1249 conditions; however, this is another story and, in this article, we will not delve
1250 further into it. In our research, one example of this can be the intervention of XX's
1251 colleague in the case. Even though the used case is a fiction, it is very close to
1252 observed real cases in which the process would resemble what follows: firstly,
1253 through reading the H version of Message #4 (first step), an external expert would
1254 **become alarmed** (automatic reaction, second step). Then, his/her feelings would
1255 come to conscience and would lead him/her to attribute that version a negative
1256 assessment (third step). At this point, he/she would start the analysis of the case
1257 (our presumed "fourth step") through recovering the source message and analyzing
1258 it from a different point of view and through a different approach. The final result
1259 would be the S version of Message #4, aimed to replace the H one.

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1267 10.1016/j.biopsycho.2009.10.006. Epub 2009 Oct 29.

1268 [121] Bateson G. 1976. *Verso un'ecologia della mente*. Milano: Adelphi. [Orig. ed.:
1269 Bateson G. 1987 (1972). *Steps to an Ecology of Mind: Collected Essays in*
1270 *Anthropology, Psychiatry, Evolution, and Epistemology*. Northvale: Aronson.]

1271 [122] The "pragmatic models" we refer to are Pragmatic of Human Communication
1272 (Pra.C., [123]), Transactional Analysis (T. A., [124]) and Neuro Linguistic
1273 Programming (NLP, [125]).

1274 [123] Watzlawick P, Beavin Bavelas J, Jackson DD. 1971. *Pragmatica della*
1275 *comunicazione umana.* Roma: Astrolabio-Ubaldini. [Or. ed.: Watzlawick P, Beavin
1276 Bavelas J, Jackson DD. 1967. *Pragmatics of human communication*. New York:
1277 Norton.]

1278 [124] Berne E. 1971. *Analisi transazionale e psicoterapia*. Roma: Astrolabio-Ubaldini.
1279 [Or. ed.: Berne E. 1961. *Transactional analysis*. New York: Grove.]

1280 [125] Bandler R, Grinder J. 1981. *La struttura della magia*. Roma: Astrolabio-Ubaldini.
1281 [Or. ed.: Bandler R, Grinder J. 1975. *The structure of magic*. Palo Alto: Science &
1282 Behaviour Books.]

1283 [126] By one hand, it is worth mentioning a special work coming from NLP founders
1284 [127]: it appears quite different from the work that founded this theory [125] and
1285 that has successively been developed by NLP specialists (an example in [128]). As
1286 a matter of fact, that work gives a central role to perception and to physical stimuli

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(not mediated by language) as a possible communication and therapeutic instrument (see, in particular, the concept of "sensorial anchors" in [127]). By the other hand, we should remind a Watzlawick's work on the modern evolution of psychotherapy [129] that represents a severe critic to the classic approach and reverses the relation between action and thought (an Italian translation is retrievable in [130], chapter 1). Not only thought drives action, also actions shape thoughts (and can produce therapeutic effects) through the stimulation of the Central Nervous System. See also [130], chapter 2, on perception as the main source of psychopathology.

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

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1308 [132] Tettamanti M, Buccino G, Saccuman MC, Gallese V, Danna M, Scifo P, Fazio F,
1309 Rizzolatti G, Cappa SF, Perani D. 2005. Listening to action-related sentences
1310 activates fronto-parietal motor circuits. *Journal of Cognitive Neuroscience* 17(2):
1311 273-281.
1312 [133] Aziz-Zadeh L, Wilson SM, Rizzolatti G, Iacoboni M. 2006. Congruent embodied
1313 representations for visually presented actions and linguistic phrases describing
1314 actions. *Current Biology 16* (September): 1818-1823. DOI:
1315 10.1016/j.cub.2006.07.060.
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1317 neural representations of visual and motor experiences. *Psychological Science* 20/8:
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1323 10.1126/science.1188595.
1324 [137] For a presentation and discussion, about the sequential processing of stimuli
1325 conceived as the foundation of human/environment interactions, see [23], chapters
1326 1, 2.
1327 [138] Stöcker C, Hoffmann J. 2004. The ideomotor principle and motor sequence
1328 acquisition: Tone effects facilitate movements chunking. *Psychological research*
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1334 *cognitive sciences* April 2009, 13(4): 154-9.
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1336 *Neuropsychoanalysis* 2011, 13 (2).
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1338 *Trends in cognitive neuroscience* 2011 Nov, 15(11): 512-9.
1339 [143] Zeilinger A. 2012. *La danza dei fotoni – Da Einstein al teletrasporto quantistico*.
1340 Torino, Codice. [Or. ed.: Zeilinger A. 2010. *Dance of the Photons – From Einstein*
1341 *to quantum teleportation*. New York: Farrar Straus & Giroux.]
1342 [144] von Baeyer HC. 2013. Can Quantum Bayesianism Fix the Paradoxes of Quantum
1343 Mechanics? *Scientific American*, June 2013.
1344 [145] Evolution theory is another research field whose literature is really countless. We
1345 can indicate [146] for a modern presentation of the theory; [147, 148] for a
1346 theoretical survey and discussion, in addition to advanced interpretations
1347 (gradualism vs. punctuated equilibrium); [149, 150] for a survey and the attempt to
1348 outline the state of the art about human evolution. In addition, chapters 17-20 of
1349 [151] for a discussion, at biochemical level, about the interaction between
1350 spontaneous variability and environmental changes as the basic process of

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1351 evolution (especially the concept of "selective optimization" and the probability of
1352 life-phenomenon as we know it).
1353 [146] Carroll SB. 2008. *Al di là di ogni ragionevole dubbio: La teoria dell'evoluzione*
1354 *alla prova dell'esperienza*. Torino: Codice Edizioni. [Or. ed.: Carroll SB. 2006.
1355 *The Making of the Fittest: DNA and the Ultimate Forensic Record of Evolution.*
1356 New York: W. W. Norton & Co.]
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1358 *The selfish gene*. Oxford: Oxford University Press.]
1359 [148] Gould SJ. 2002. *The structure of evolutionary theory*. Harvard: Harvard University
1360 Press.
1361 [149] Biondi G, Rickards O. 2005. *Il codice Darwin*. Torino: Codice Edizioni.
1362 [150] Gibbons A. 2009. *Il primo uomo: L'avventura della scoperta dei nostri antenati.*
1363 Torino: Codice Edizioni. [Or. ed.: Gibbons A. 2006. *The first human: The race to*
1364 *discover our earliest ancestors.* New York (USA): Doubleday.]
1365 [151] de Duve C. 2008. *Alle origini della vita*. Milano: Longanesi. [Or. ed.: de Duve C.
1366 2005. *Singularities: Landmarks on the pathways of life*. Cambridge (UK):
1367 Cambridge University Press.]
1368 [152] From the poem *Uomo del mio tempo* (Man of my age), of Italian poet (1959 Nobel
1369 Prize) Salvatore Quasimodo [153]: *Sei ancora quello della pietra e della fionda, /*
1370 *uomo del mio tempo…* [You are still the one of the stone and of the sling, / Man of
1371 my Age…]. A complete text of the poem (original language) is *available at*

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1372 *http://www.incontroallapoesia.it/poesie%20salvatore_quasimodo.htm* (accessed 1
1373 Mar 2014).

1374 [153] Quasimodo S. 1947. *Giorno dopo giorno*. Milano: Mondadori.

1375 [154] Gould SJ, Vrba ES. 1982. Exaptation: A missing term in the science of form.
1376 *Paleobiology* 8 (1): 4-15.

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Figures

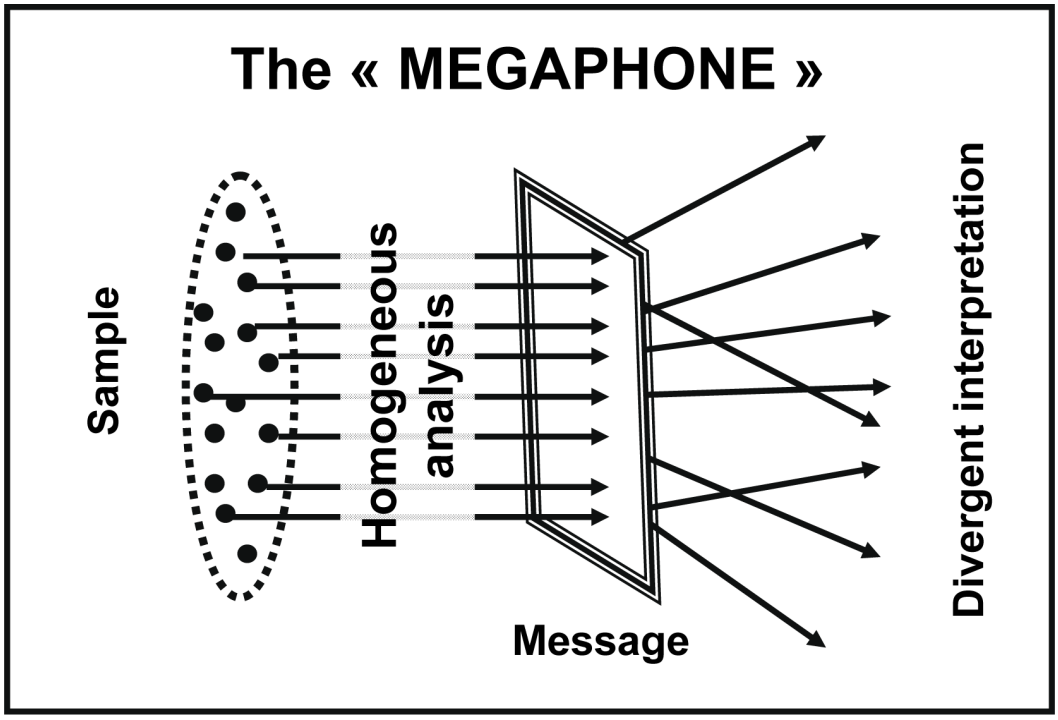

Figure 1: The "megaphone-shape" model.

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 taken into account but differently interpreted.

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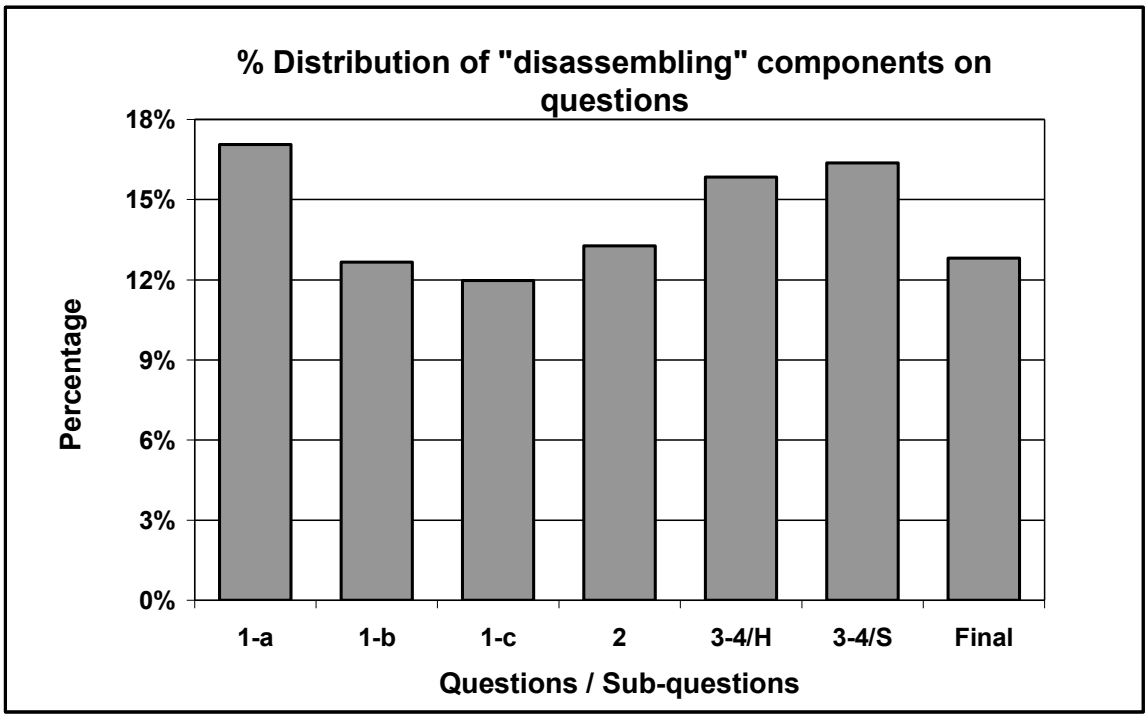

Figure 2: Percent distribution of total indications with respect to questions/sub-questions.

With respect to questions, the respondents' total indications about the focused components present a uniform-like percent distribution (differences in a range around 5%, from 12% to 17% about, source data from Table 3 "%" column). The range reduces to around 3.6% (from 12.8% to 16.4% about) if we group together the three sub-questions of Question #1 and consider their mean (the reason is that the answers to Questions #1-b and #1-c are often given in short, indicating reference to the already provided answer to Question #1-a). The indications are distributed without any significant imbalance among the different questions of the questionnaire. The approach through subjective selective focusing does not definitely advantage any question or item.

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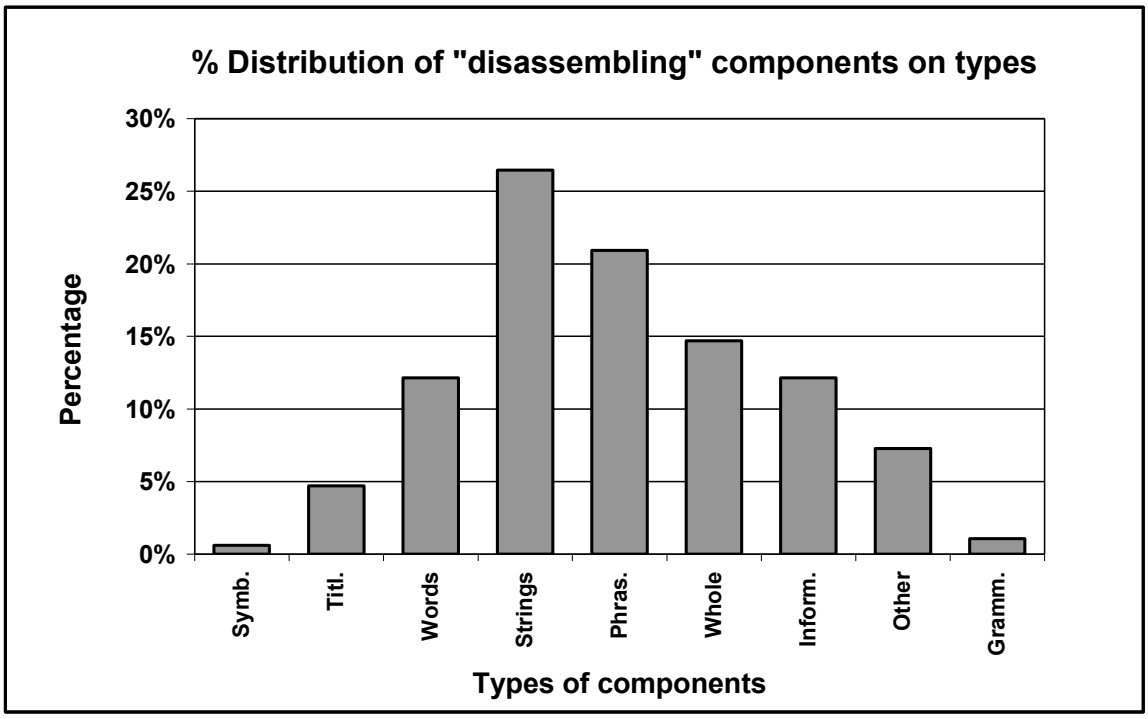

Figure 3: Percent distribution of total indications with respect to types of components.

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

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

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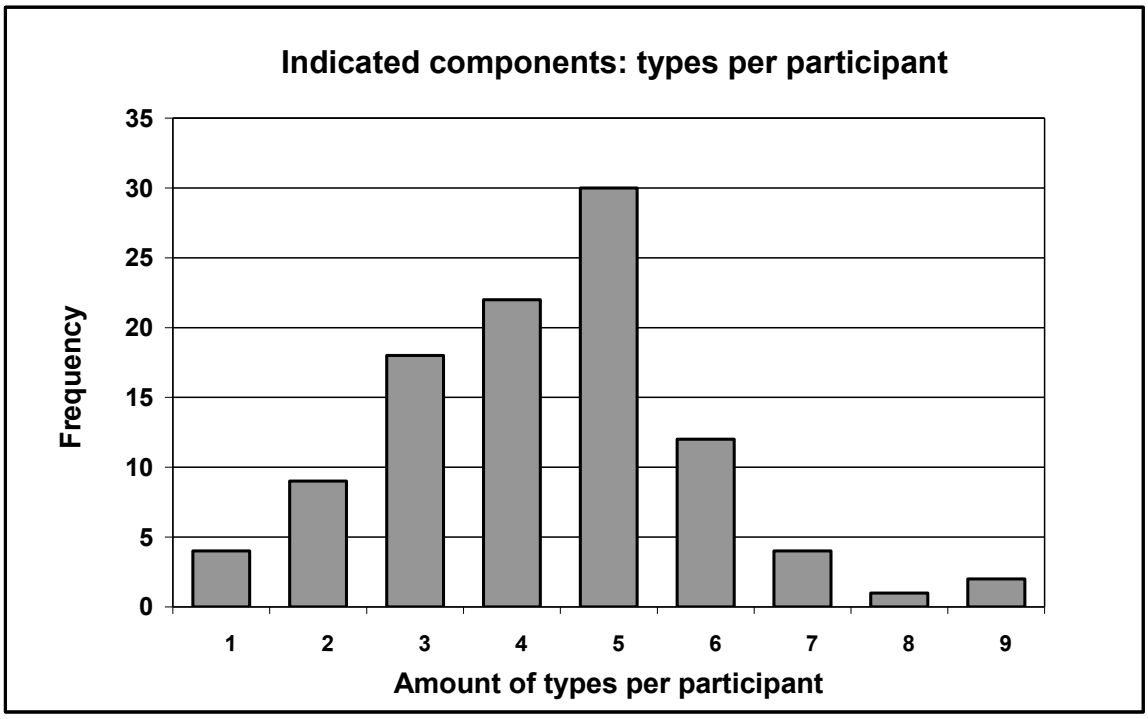

Figure 4: Sample distribution with respect to the amount of component types indicated by participants.

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

Mean = 4.3; Median = 4; Mode = 5; SD = 1.6; CV(%) = 37.01%.

Skewness = 0.25; Kurtosis = 0,49.

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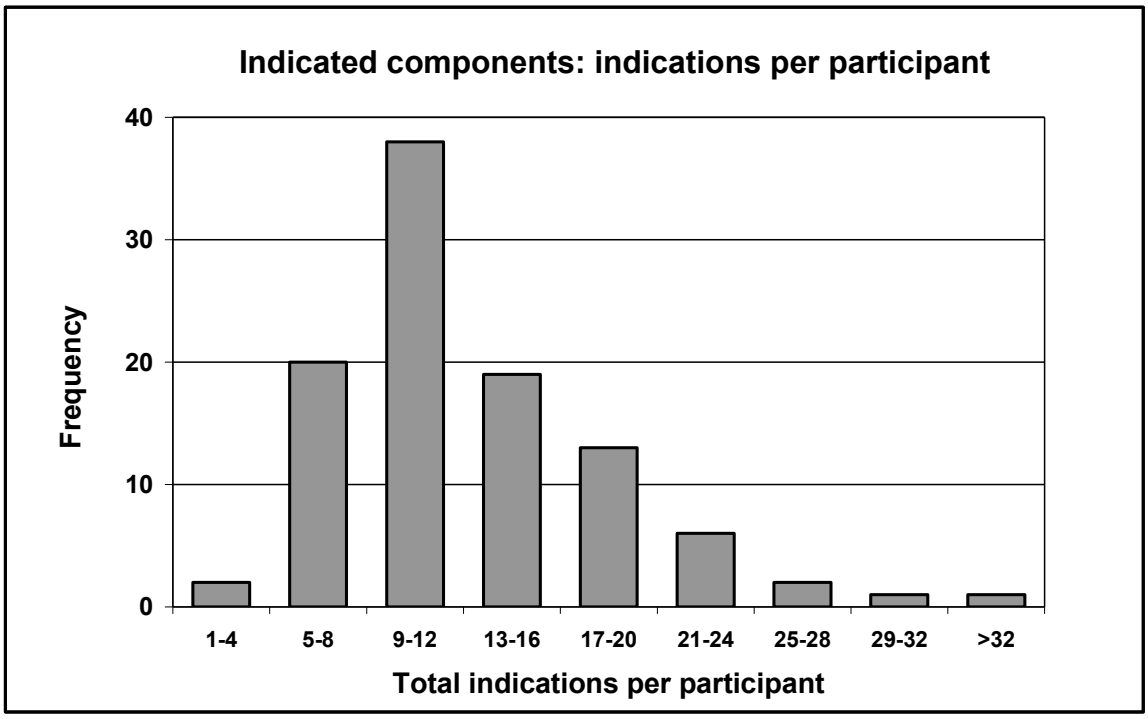

Figure 5: Sample distribution with respect to the total indications provided by participants.

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

Mean = 12.9; Median = 11; Mode = 9-12 bin; SD = 6.2; CV (%) = 47.99%.

Skewness = 1.93; Kurtosis = 7.18.

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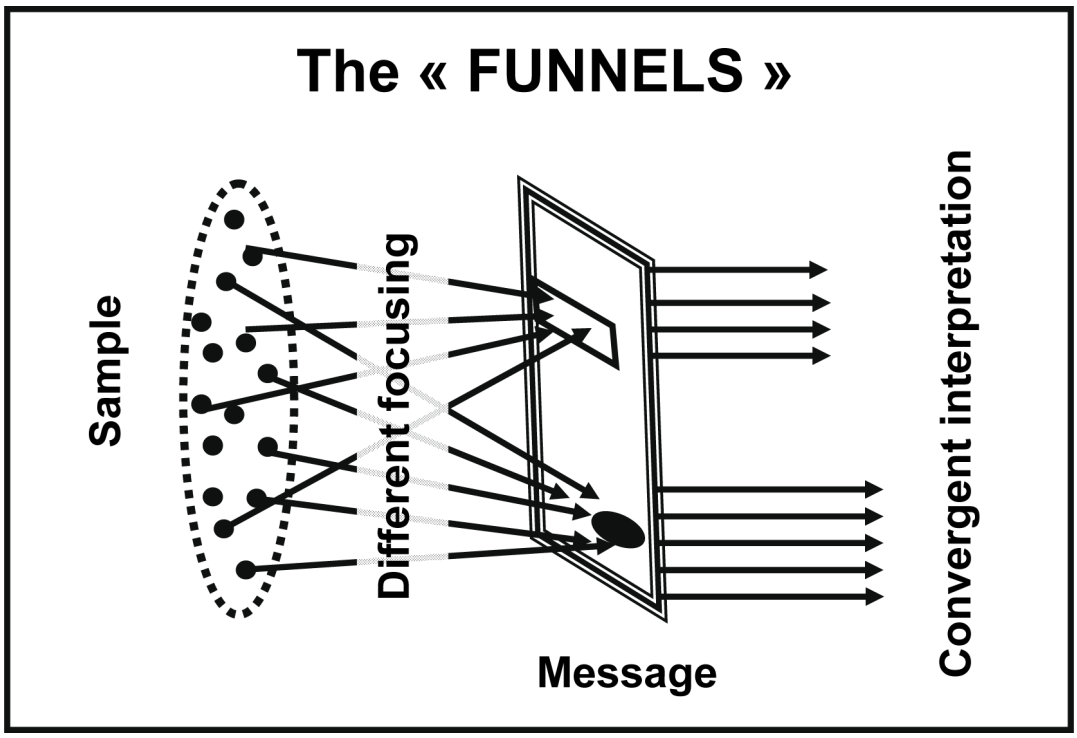

Figure 6: The "funnel-shape" model.

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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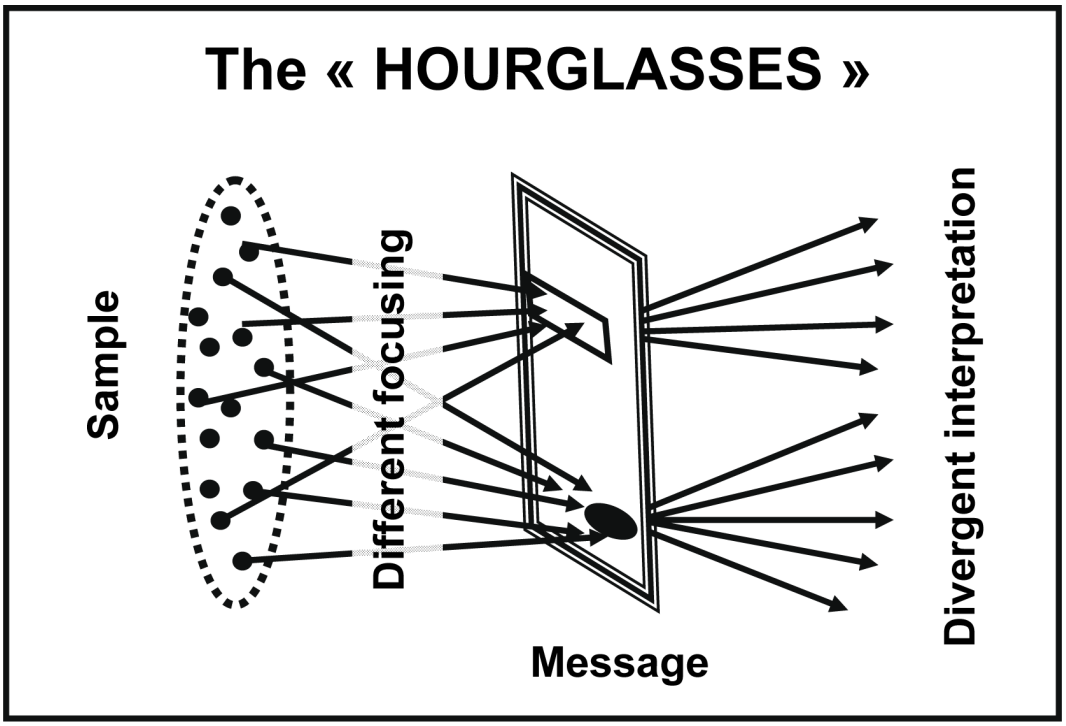

Figure 7: The "hourglass-shape" model.

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

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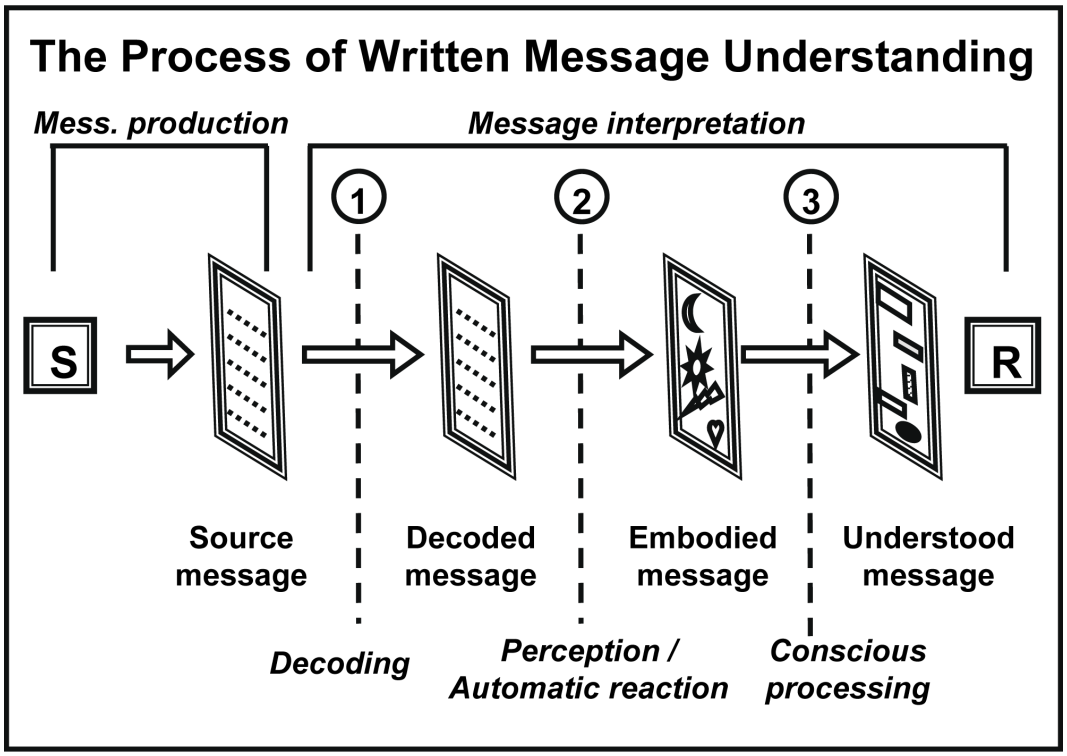

Figure 8: Scheme of the process of written message interpretation (how messages are understood).

[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) precedes 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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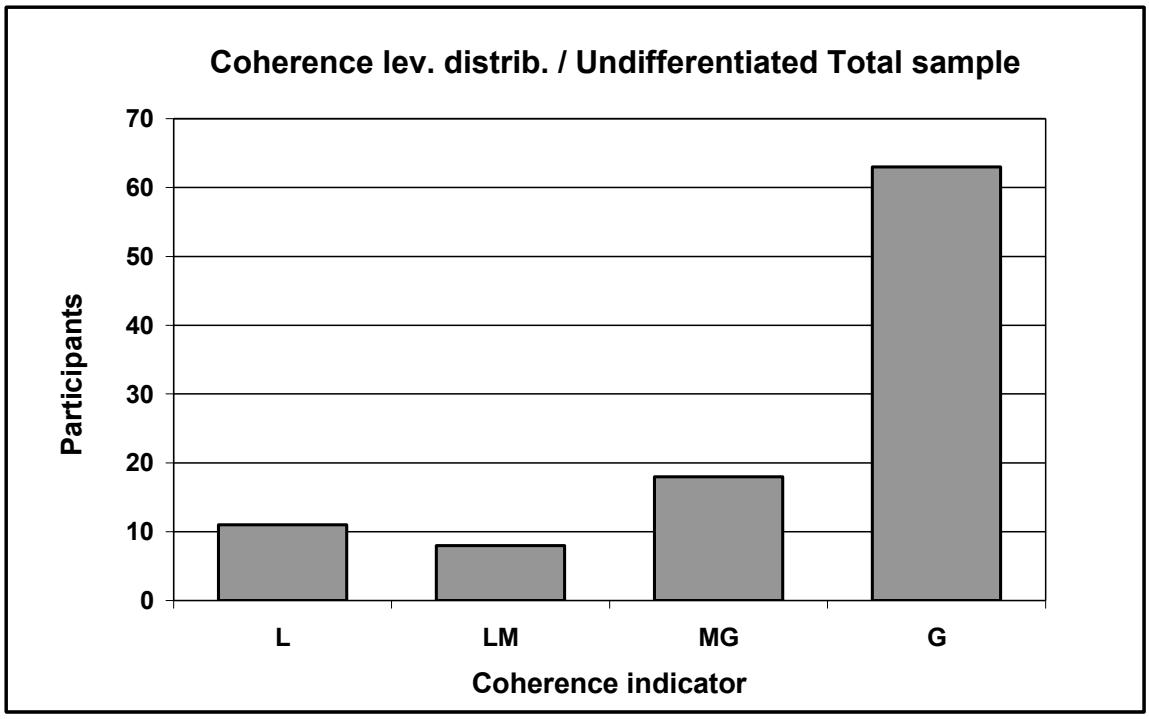

Figure 9: Sample distribution with respect to coherence levels / Undifferentiated Total Sample

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

This histogram shows the distribution of ALL respondents according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown for the whole sample.

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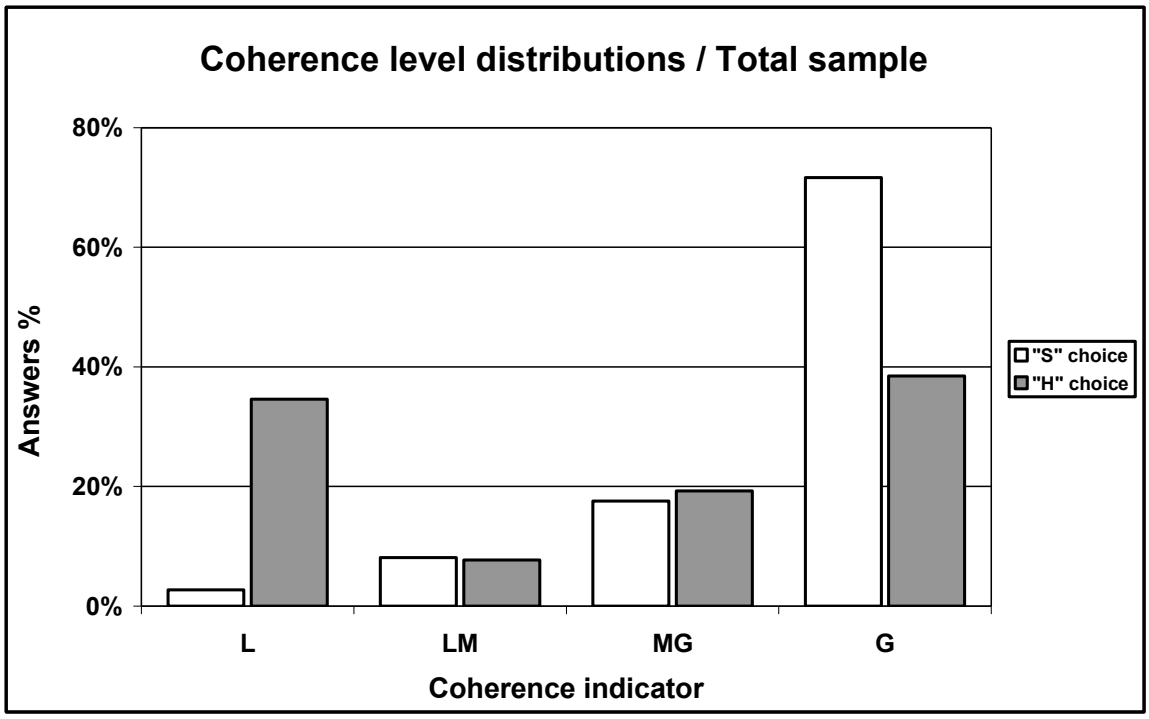

Figure 10: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Total Sample

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

This histogram shows the percent distribution of ALL respondents according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes are very different and their discrepancies are statistically highly significant (chi-squared test: p=0.000095).

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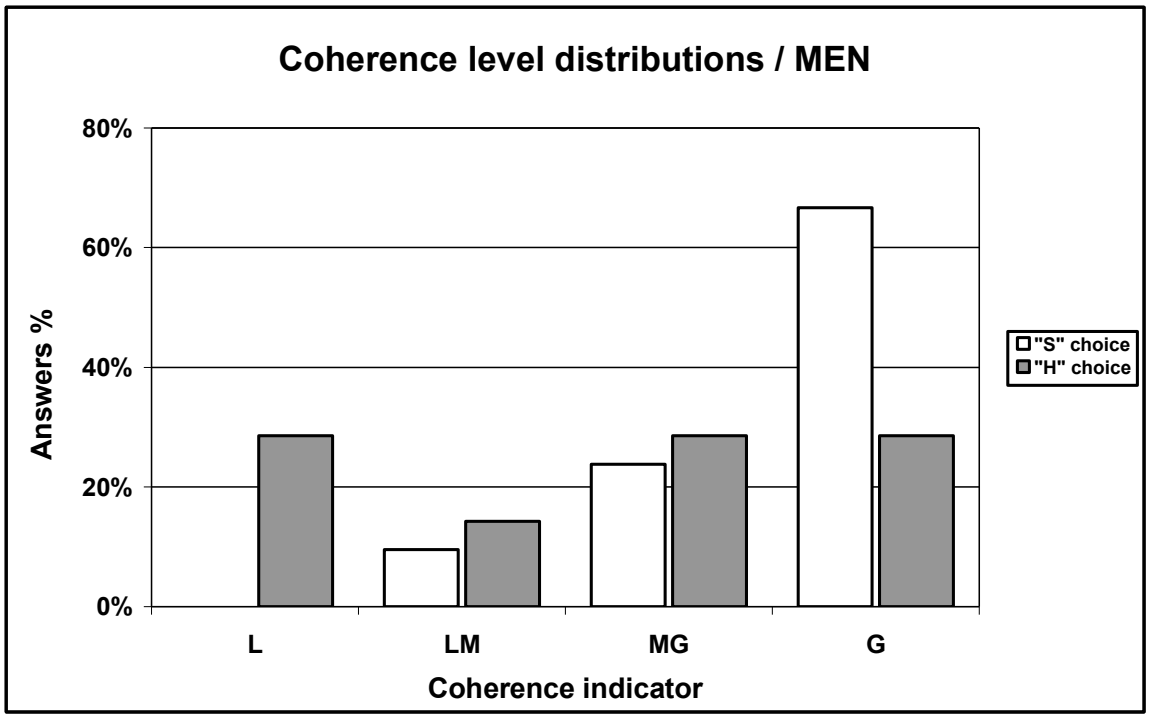

Figure 11: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Subsample MEN

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

This histogram shows the percent distributions of MALE respondents according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes appear remarkably different; however, the significance of their differences cannot be estimated (chi-squared test unsuitable for the presence of a zero value).

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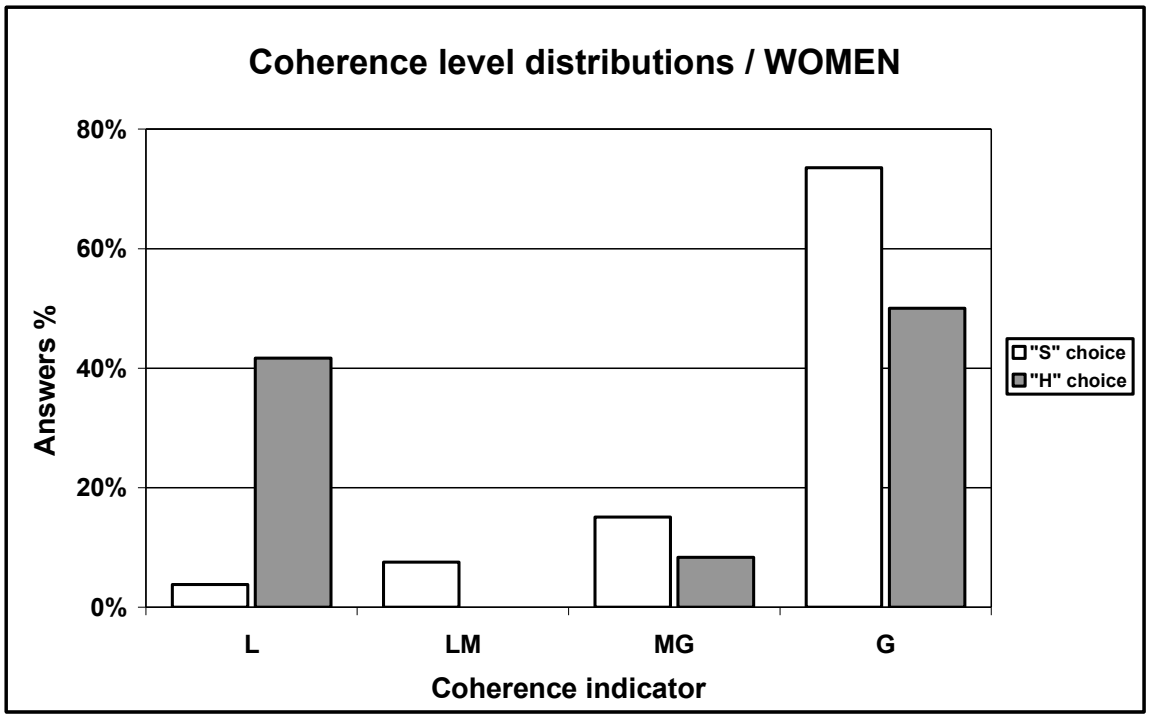

Figure 12: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Subsample WOMEN

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

This histogram shows the percent distributions of FEMALE respondents according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes are very different; however, the significance of their differences cannot be estimated (chi-squared test unsuitable for the presence of a zero value).

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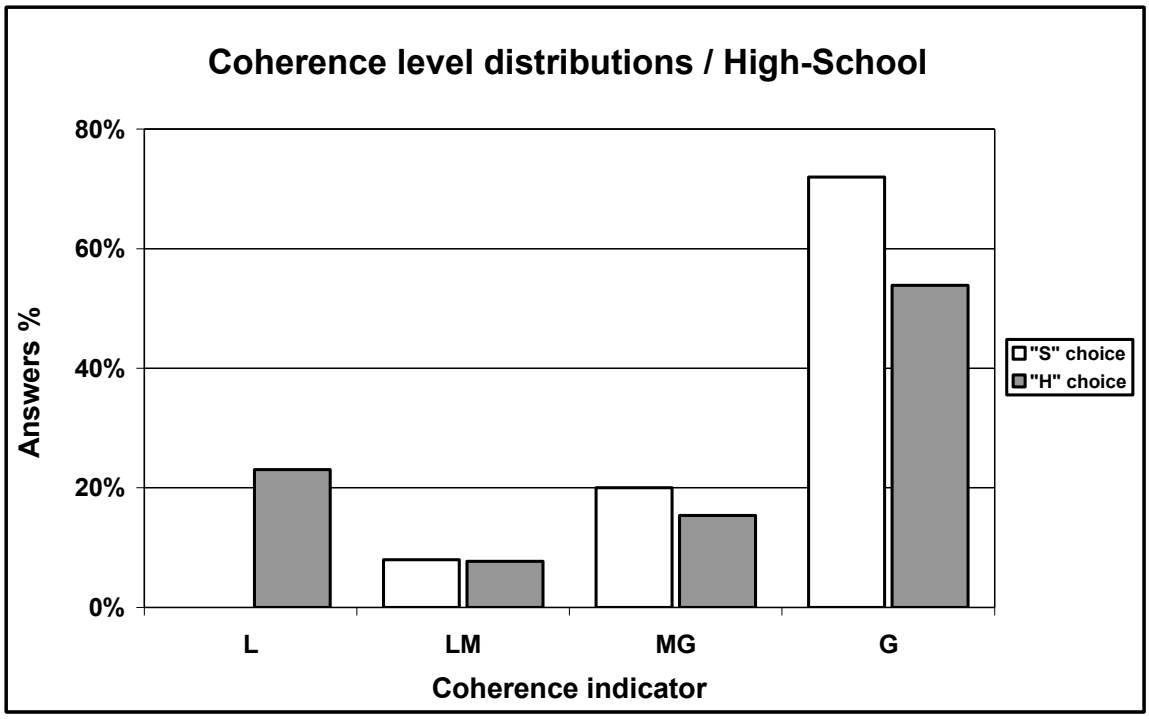

Figure 13: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Subsample High School

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

This histogram shows the percent distributions of HIGH-SCHOOL degree granted respondents according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes appear markedly different; however, the significance of their differences cannot be estimated (chi-squared test unsuitable for the presence of a zero value).

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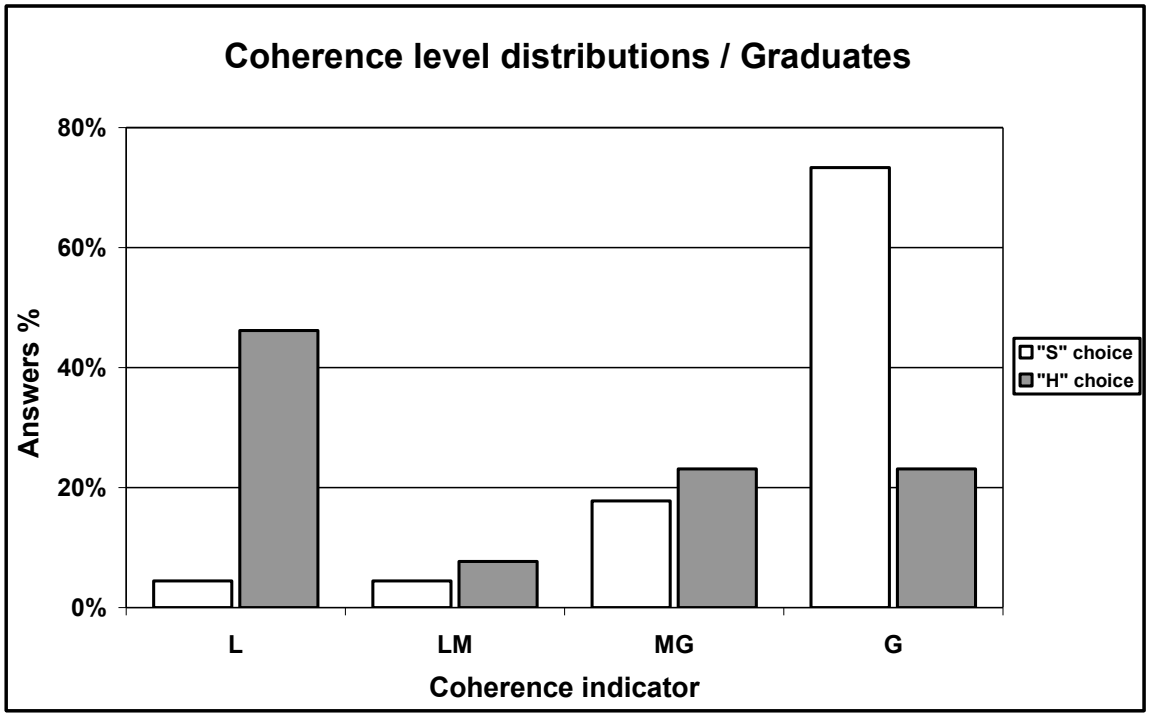

Figure 14: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Subsample Graduates

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

This histogram shows the percent distribution of GRADUATED respondents according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes are very different and their differences are statistically highly significant (chi-squared test: p=0.000649).

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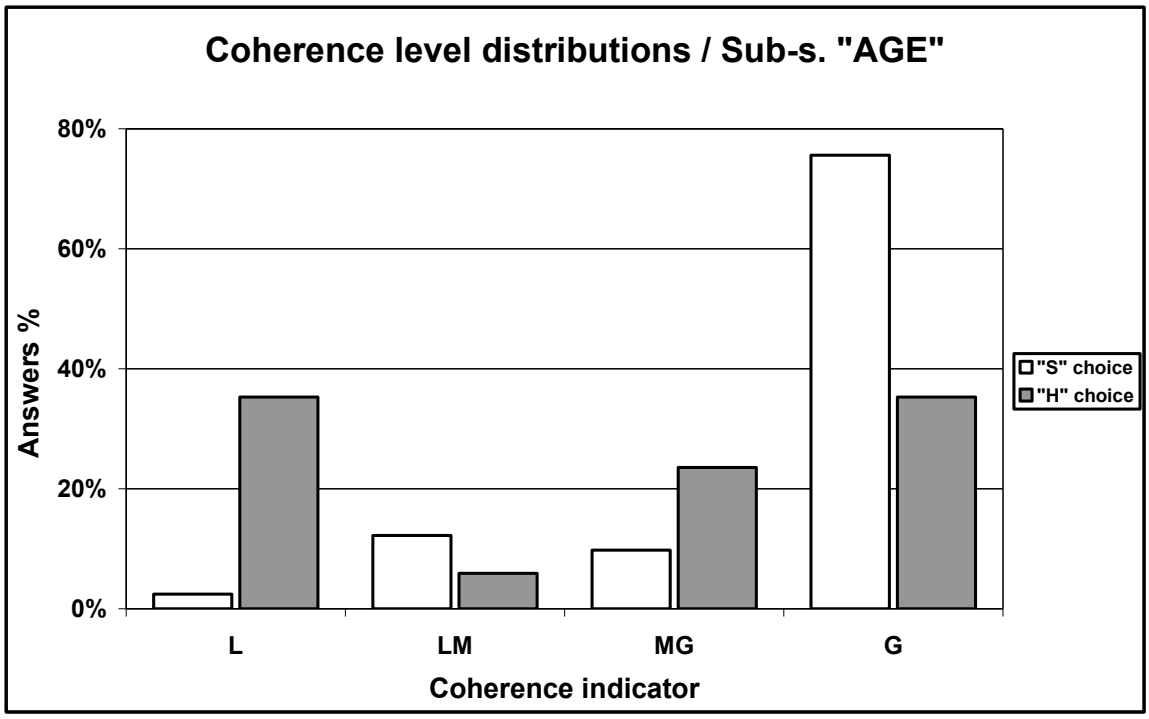

Figure 15: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Subsample "AGE"

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

This histogram shows the percent distribution of respondents belonging to subsample "AGE" (30 years, and over, old persons) according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes are very different and their differences are statistically highly significant (chi-squared test: p=0.001174).

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Figure 16: Sample percent distribution with respect to coherence levels / Comparing "H"/"S" choosers - Subsample "EMPLOYMENT"

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

This histogram shows the percent distribution of respondents belonging to sub-sample "EMPLOYMENT" (workers only, students and unemployed excluded) according to the coherence level (expressed through the coherence indicator) between, by one hand, their interpretation of Messages #4/H and #4/S; by the other hand, their final choice. Data is shown distinctively for "H" and "S" choosers. Distribution shapes are very different and their differences are statistically highly significant (chi-squared test: p=0.001560).

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1673 **Tables**

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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

1678

1679 **Table 1: An example of interpretation scatter from our research.**

1680 Sixty-one individuals (60% of the sample), after having compared XX's Messages #1 and
1681 #3, answered "YES" to Question #2 and provided 83 specifications for the changes they
1682 had detected in XX's position toward YY. The table classifies the specifications into 4
1683 main categories and provides some examples for each one of them.

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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 phrase	*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 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.*

1688

1689 **Table 2: A selection in messages' "other components" that readers may focus on.**

1690 The table displays a tight selection in the messages' "other components" focused by

1691 respondents. These components are unlinked to the information content and, in most

1692 cases, to the message text. They are extremely various, indeed unpredictable, and return

1693 the impression that the receivers' preferences could be totally rule less.

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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%	

1697

1698 **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 single 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

1699

1700 The table displays a descriptive statistical analysis of what the respondents look at inside the messages. The information
1701 content is focused by 12.1% of respondents only (“Cont.” column, “%” row). Even if we suppose that reference to complete
1702 phrases/periods could actually mean reference to their content, the sum of “Cont.” and “Phras.” column % totals would amount
1703 to 33% of respondents, again a clear minority.

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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%

1705

1706 **Table 4: Sample distribution with regards to the indicated components referred to**

1707 **information content.**

1708 Answering to the second part of the questionnaire's questions (requesting to indicate the

1709 "concrete elements" on which the interpretation was based), just the exact half of the

1710 sample indicated, at least once, information content components. In this table, the sample

1711 is distributed with respect to the percentage that the indicated information content

1712 components represent on the personal total of the pèrovided indications. Just for 7 people

1713 out of 102 the indications on information content balance the others or prevail (50% or

1714 more); just 1 people among them indicates information content components only.

1715

1716

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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.

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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 carefully weighed 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*

1730

1731 **Table 6: Examples of possible stimulus-factors.**

1732 The table displays examples, drawn from the filled questionnaires, of one category of
1733 possible stimulus-factors inside the messages. The capability of these factors to work as
1734 stimuli is not linked to the information they might contain, but to "the fact that" they are
1735 present within the message, in a certain form and/or at a certain point.

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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%*

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

The table displays (for the total sample and the two control sub-samples) the frequency of the answers to the Final question (the choice between Message “H” and Message “S” as the solution of the case). A strong imbalance is shown, as indications of Message #4/S overwhelm the Message #4/H ones, in all cases.

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	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). Its significance is checked through chi-squared test: p=0.001988, total sample; p=0.015600, sub-sample "AGE"; p=0.003861, sub-sample "EMPLOYMENT".

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

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

In this table the combined predictions of Message #4/H and Message #4/S effects (see Table 8) are crossed with the final choices of the respondents (all the variables are independent). The result demonstrates the association (for the total sample and the two control sub-samples) between the most frequent combination “H-/S+” and “S” as final choice. The differences between the “H” choice and “S” choice distributions, tested through chi-squared test, show statistical high significance: p=0.000017 (total sample); p=0.001174 (sub-sample “AGE”); p=0.000383 (sub-sample “EMPLOYMENT”).

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	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 rating.

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.

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"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***

1782

1783 **Table 11: Sample distribution with respect to coherence levels (total sample).**

1784 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1785 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1786 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1787

1788 The table displays (for the total sample) the distribution of participants with respect to the

1789 different levels of coherence. "H" choosers and "S" choosers distributions appear to be

1790 very different. Chi-squared test confirms highly significant differences (p<0.01).

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"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***

1792

1793 **Table 12: Sample distribution with respect to coherence levels (Sub-sample "Age").**

1794 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1795 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1796 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1797

1798 The table displays (for the sub-sample "Age", >29yy-old people only) the distribution of

1799 participants with respect to the different levels of coherence. "H" choosers and "S"

1800 choosers distributions appear to be very different. Chi-squared test confirms highly

1801 significant differences (p<0.01).

1802

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1803

"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***

1804

1805 **Table 13: Sample distribution with respect to coherence levels (Sub-sample**

1806 **"Employment").**

1807 [Legend: L = Low; LM = Low-medium, MG = Medium-great, G = Great level of

1808 coherence between predictions and choice; H/S = Versions of Message #4; +/- = type of

1809 predicted effect (resolution or escalation of the conflict) of the messages on XX.]

1810

1811 The table displays (for the sub-sample "Employment", people with a regular employment

1812 only) the distribution of participants with respect to the different levels of coherence. "H"

1813 choosers and "S" choosers distributions appear to be very different. Chi-squared test

1814 confirms highly significant differences (p<0.01).

1815
1816

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