# Neuropragmatics: A foreword

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## *1. Introduction*

Consider the following utterances (and their interpretations): *John is a shark* ('he is very aggressive'), *She spilled the beans* ('she revealed the secret'), *I'd like a rose OR a book* ('just one of them'), *My soup is too cold to eat* ('bring me another one'), *The lights have been on since last night. The car doesn't start* ('because the battery is dead'). Such phenomena are known as metaphor, idiom, scalar implicature, indirect speech act and bridging inference, respectively. They are key notions in pragmatics, and they have been accounted for in philosophical and linguistic terms since at least the time of Grice. While being topics of multiple psycholinguistic investigations, today's cutting-edge research has turned to focusing on how the brain supports the above mentioned pragmatic phenomena and, more generally, context-dependent linguistic usage. This is what this Special Issue of the *Italian Journal of Linguistics* is all about, as a showcase for the emerging field known as "neuropragmatics".

This Special Issue brings together, for the first time, state-of-the-art overviews, original data and proposals of overarching principles regarding the brain mechanisms underlying a vast range of pragmatic phenomena. Each paper makes a significant contribution to the field, and these contributions are not simply juxtaposed. Although each paper can be appreciated separately, there is a tentative spatio-temporal elucidation of pragmatic processing that unfolds throughout the collection, an elucidation that keeps one eye on the available theoretical models and the other one on new paradigms to explore. The aim of this Special Issue, thus, is to provide not only a fairly comprehensive picture of prevailing individual research streams in neuropragmatics, but also a compact state-of-the-art with respect to the relationship between pragmatics and brain, with the ultimate hope of further helping define this emerging field. For those unfamiliar with neuropragmatics, this Special Issue may serve as a solid introduction, while for experts it will hopefully represent an accurate synthesis along with original data and promising ideas for the next research agenda.

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Below I present a concise historical sketch of the development of neuropragmatics. This is followed by a brief description of the work to be found here, broken down into three parts: the neuro-functional anatomy of pragmatic meaning resolution, real-time descriptions of such processes, and theoretical approaches or cognitive paradigms that can account for on-line pragmatic processing. Each part describes the articles in it.*

## *2. Scope and components of neuropragmatics*

If the neuroscience of language is defined as the study of the neural mechanisms underlying the cognitive and linguistic processes used by the human brain to produce and to understand language (Small 2008), then neuropragmatics is but an expansion of this and in the direction of the context of use: it focuses on the neural systems allowing us to behave in a pragmatically appropriate way (Stemmer 2008), or – in other words – on the brain machinery underlying context-appropriate meanings (Bambini & Bara *forthcoming*). Figurative meanings and discourse are the most common objects of study, as they crucially tax those mechanisms that presumably support appropriate pragmatic behavior and, thus, are likely to elicit results observable to the researchers. The key questions, however, are much wider: How do brains represent (and share) beliefs, knowledge and components of context in order to infer speaker's meanings and to engage in successful communication? What cognitive functions do pragmatic abilities rely upon? Where are these functions localized? How do they express themselves over time? And what is the cognitive architecture of pragmatics as a system (if a single system can be assumed)?

With respect to other domains of linguistic inquiry, pragmatics has a recent history, and the term "neuropragmatics" itself has started to circulate only in the last decade (Bara & Tirassa 2000; Stemmer & Schönle 2000). However, the study of these themes has a history dating back to the late 1970s, when clinicians brought to the fore the existence of communicative disorders that did not fall under the classic aphasic profiles. For example, right-hemisphere damaged patients were documented to produce rambling and tangential discourse, to lack the tone of a conversational exchange, to be unable to interpret figures of speech and to deal with jokes (Winner & Gardner 1977; Ross & Mesulam 1979; Wapner et al. 1981). Over the years, those early reports have been enriched by methodological advances in

cognitive neuroscience targeting a vast range of phenomena progressively subsumed under the umbrella of pragmatics (Paradis 1998 and Stemmer 1999 on the clinical side; Bookheimer 2002 on the imaging side; Bambini 2005 for a general review). There is now a considerable amount of available empirical evidence concerning pragmatics and its relation to the brain, and this area is enjoying a period of unprecedented attention in research journals. All this legitimizes the constitution of neuropragmatics as an autonomous field, employing the growing arsenal of neuroscience techniques and crucially interfacing with cognitive-theoretical modeling and the psycholinguistics of pragmatics. Below is a concise list of the building blocks of neuropragmatics.

First, neuropragmatics can count on a well-established body of starting-point notions put forward by pragmaticists and psychologists of communication, among which are implicature and explicature, presupposition, metaphor, irony, indirect speech act, reference and indexicals, but also adjacency pairs, politeness, etc. (Grice 1989; Levinson 1983; Sperber & Wilson 1986/1995; Bertuccelli Papi 2000; Levinson 2000; Carston 2002; Bertuccelli Papi 2003; Bianchi 2004; Wilson & Sperber 2004; Bara 2010). While acknowledging that pragmatics is a repository of separable topics, there are many points of contact among pragmatic phenomena (Verschueren 2009). They draw upon basic primitives such as inference, speaker's meaning, intention, common ground, context and use; they are guided by norms of rational communicative behavior and principles such as maxims of conversation and relevance: on this basis, they can be reasonably assumed to share at least some brain mechanisms. It is primarily this body of starting-point notions which gives cohesion to the field of neuropragmatics, at least in its current, emerging stage.

Second, over the last ten years, researchers have been combining theorizing with empirical investigations of pragmatic features of language and communication. Although investigations of pragmatic features have been around for some time, experiments aimed at testing specific theories and claims (mainly from Gricean and Neogricean pragmatics as well as Relevance Theory) have occurred more recently. By putting armchair theories to the test, this paradigm – known as "experimental pragmatics" – has shown the importance of the interaction between pragmatic theorizing and experimental research and has been exemplified by work in the field of scalars (Noveck & Sperber 2004; Noveck & Reboul 2008). Neuropragmatics follows and strengthens this empirical turn in pragmatic studies and benefits from the theoretical refinements it has instigated as well as from the genuine psychological discoveries produced in experimental pragmatics.

Also worth mentioning is the school of thought known as Cognitive Linguistics, which shares some topics of interest with pragmatics, especially metaphor and meaning construction (Coulson & Matlock 2005; Evans 2009): operational notions differ from those used in pragmatics and include "frames", "mapping", "blending" and "embodiment", although with possible room for complementarity (Tendahl & Gibbs 2008). Attempts to gather experimental evidence for the Cognitive Linguistics models are currently being carried out, which will be of some interest for neuropragmaticists (e.g., Coulson 2007).

Third, neuropragmatics builds upon a robust tradition of neuropsychological studies, sometimes referred to as "clinical pragmatics" (Perkins 2003; Cummings 2009). While early studies concentrated on pragmatic impairments in populations with focal lesions (Kasher et al. 1999), more recent investigations have concerned a broader range of pathologies, especially dementia (Papagno et al. 2003; Monetta & Pell 2007; Amanzio et al. 2008) and developmental syndromes (Adams 2002; Norbury 2005; Annaz et al. 2009). Moreover, the study of pragmatic disruptions is moving from the descriptive to the causal level, in the attempt to identify multiple and disorder-specific explanations, from mind-reading deficits in autistic patients to executive dysfunction in the Alzheimer's population (Martin & McDonald 2003; Perkins 2005; McDonald 2008). Besides social implications for treatment, the importance of this research turn lies in the precious insights that it can bring to the study of pragmatics as a system, by highlighting the constellation of functions needed for efficient and successful communicative behavior.

Finally, recent years have seen significant progress in the application of haemodynamic (especially functional magnetic resonance imaging, fMRI) and electrophysiological imaging techniques (especially event-related brain potentials, ERPs) on a range of specific topics that are genuinely pragmatic in nature, from metaphor comprehension (for reviews, see Giora 2007; Coulson 2008; Schmidt & Seger 2009) to discourse processing (Mason & Just 2006; Schmalhofer & Perfetti 2007; Ferstl et al. 2008; Perfetti & Frishkoff 2008) and the recognition of communicative intentions (Kampe et al. 2003; Walter et al. 2004; Frith & Frith 2010). Also, ERP and fMRI investigations on clinical populations are beginning to appear, especially concerning autism (Wang et al. 2006; Tesink et al. 2009) and schizophrenia (Ditman & Kuperberg 2010). All this probably represents the most vital core of neuropragmatics research; nevertheless, the term "pragmatics" sometimes goes unmentioned in this literature and cross-references to different yet kindred context-dependent phenomena are

scant, leaving the impression that this field is fragmented.

The time is ripe to unify these approaches to pragmatic phenomena into a concerted enterprise converging on context-aware mind/brain processes rather than artificially isolated ones. Neuropragmatics is the best candidate to gather together the above-mentioned research trends, in order to provide relevant and global insights into the way the brain processes the pragmatic aspects of communication. This Special Issue is intended to represent a first step in this direction, by bringing together in a single volume different research programs converging toward the neural basis of pragmatics. The nine articles included here were solicited from researchers who – while coming from different backgrounds – are working at the forefront of advancing our understanding of the brain and communication. The phenomena studied, the methods used, and the research goals are diverse yet rather complementary. Although a collection of nine papers cannot represent all the research done in neuropragmatics, I believe this sample offers one of the best possible snapshots of pragmatic processing in the brain, given our current state of knowledge.

## *3. Brief overview of the content*

### *3.1. Localization and beyond*

Historically speaking, mapping the *localization* of pragmatic processes in the brain is the fundamental quest in the field of neuropragmatics. About three decades of neuropsychological studies led to the view that the right hemisphere plays a critical, selective role in processing the pragmatic aspects of language (Joanette et al. 1990; Joanette & Brownell 1990; Tompkins 1995). Figurative meaning was the privileged territory for such investigations, but also dimensions beyond the sentence, i.e., pertaining to discourse and conversation, were taken into account (Paradis 1998; Beeman & Chiarello 1998; Johns et al. 2008). With the recent development of more sensitive clinical investigations and especially with the massive advent of brain imaging methodologies, the Right Hemisphere Hypothesis has progressively suffered a fall from favor. On the one hand, left hemisphere activations showed up in pragmatic tasks; on the other hand, right hemisphere activations for standard linguistic tasks provided a "big surprise" (Gazzaniga et al. 2002: 364). Currently, most fMRI studies on pragmatics report bilateral patterns of activations (predominantly in the frontal lobes), which are usually described in terms of net-

works: while the right hemisphere's specific role is still unclear, it is clear that the right side does not work alone (Bambini et al. *submitted*). As a general trend, interest is moving beyond debates over the right versus left hemispheres as researchers aim to better understand the functional architecture of the brain networks activated by pragmatic processes. Indeed, models of language comprehension are beginning to include – in addition to components devoted to the processing of the structural components of language – neural workspaces for the integration of contextual features, among which are world knowledge, discourse and speaker's characteristics (Hagoort et al. 2009; Menenti et al. 2009). Progress promises to come from anatomical and functional connectivity studies in order to identify the processing pathways that integrate pragmatic-sensitive brain networks. These themes are reflected in the first four papers of this Special Issue, which present overviews, new models and original data.

An extensive and accurate synthesis of data across research techniques – from neuropsychological tests to neurophysiological and neuroimaging experiments – is offered by *Costanza Papagno & Leonor J. Romero Lauro* with special attention to the case of idiom processing. In reviewing previous work, Papagno and Romero Lauro highlight that the idioms employed in the clinical literature are far from homogeneous: they vary in syntactic and semantic properties, as well as in the degree of contextual presentation. This, along with differences in tasks and populations, motivates the heterogeneity in the results. Based on evidence from multiple sources, a strong claim is made toward the bihemispheric involvement in idiom processing. The final section incorporates data on both functional specialization and functional integration and proposes a model of idiom processing, with the bilateral prefrontal cortex retrieving multiple meanings from semantic memory in the bilateral temporal cortex, and maintaining them until prefrontal areas select the one that appropriately matches with context. This proposal represents the first integrated model of idiom processing, from which future research on the neuropragmatics of figurative meaning should proceed.

Idioms are not homogeneous and neither are metaphors. Nonliteral meaning is indeed a continuum of cases, which vary along a scale of conventionalization, and brain correlates are modulated accordingly (Mashal & Faust 2009). In between idioms and brand-new metaphors are conventional metaphors, which are the focus of the paper by *Beatriz Mejía-Constaín, Oury Monchi, Nathalie Walter, Marianne Arsenault, Noureddine Senhadji & Yves Joanette*. They report a novel fMRI study investigating the processing of polysemous

words when they enter literal versus conventionalized metaphorical relations (*heat* with *oven* versus *heat* with *passion*). Relative to literal uses, metaphorical uses elicit greater activations in the superior frontal cortex bilaterally. An important and innovative aspect of this study is that the experiment was carried out, not only on young participants but also, on elderly adults. Interestingly, in older adults the network spreads more widely, encompassing left inferior frontal and cingulated cortex. These findings not only further support the claim for bilateral involvement but also suggest that brain recruitment for non-literal processing might be subject to reorganization in normal aging. Researchers should consider this piece of evidence, especially when comparing imaging data on healthy subjects with clinical data on elderly patients. Although the motivations for the changes in interhemispheric cooperation across the life span are still unclear (perhaps due to compensation or to changes in strategy), this study opens the way to considering how brain recruitment for pragmatic processing varies with age. Along this avenue, neuropragmaticists cannot but immediately think how much future research could improve if other subject-specific variables were also taken into account, such as gender, literacy, experience and culture, since they are part of the broad notion of speaker's context and conceivably influence brain processing (see Kutas 2006 for similar considerations).

*Evelyn C. Ferstl* moves the realm of pragmatic mapping in the brain up to the dimension of text/discourse, where cohesion and coherence are established, inferences are drawn out, situation models are built and jokes are grasped. In previous work, based on the quantitative meta-analysis of a large number of imaging studies run up to 2005, Ferstl contributed to a description of the functional anatomy of the extended language network (ELN) responsible for text and pragmatics processing. Here Ferstl starts from where she left off, by reviewing post-2005 studies, whose results confirm the ELN architecture and enrich it with new pragmatic-sensitive modulations. Within this network, which includes left-sided perisylvian areas but extends to many others – again, in a bilateral fashion –, Ferstl puts special emphasis on dorso-medial prefrontal cortex for inference and coherence building, the parieto-medial cortex for the updating of situational and discourse representation, and the anterior temporal lobes for integrating clausal information. This is a useful *vade-mecum* for neuropragmaticists searching their way through the multitude of brain areas activated by pragmatic phenomena, a companion enriched with insights for sketching the neuropragmatics research agenda. Among these, Ferstl highlights emotional factors

and Theory of Mind mechanisms, two components which are further developed in the next contributions.

If anything at all is shared by all pragmatic phenomena, it is certainly intention recognition, which is the very engine of the communicative process and lies at the core of each model of communication. *Bruno G. Bara & Angela Ciaramidaro*'s paper brings to the fore this crucial theme, conjoining sound theoretical-cognitive modeling with brain data. Indeed, intention recognition is not confined to linguistic exchanges, but involves all types of communicative interaction (including non-linguistic ones) nor is it confined to communicative settings (including private situations). In this respect, Bara and Ciaramidaro present a useful distinction between individual intention and social intention, where the latter can be further specified in the communicative intention (shared in the present) and the prospective intention (shared in the future). Then, the chapter summarizes a series of fMRI experiments employing a cartoon completion task, whose results not only lend strong support to the theoretical taxonomy but also confirm the distinctive nature of communicative intentions with respect to the other types. While individual intentions and prospective intentions are supported by specific regions (right temporo-parietal junction and precuneus, and medial prefrontal cortex, respectively), the communicative type recruits the whole network for intention recognition (the above regions plus the left temporo-parietal junction). They also present experimental evidence from patients diagnosed with paranoid schizophrenia and tested on the same cartoon completion protocol. One of the novel findings from this work is that the paranoid group recruited the intentional network also when cartoons involved no intentions at all, but simply physical causality (like a stone rolling down a hill). Schizophrenic patients are hyperactive in attributing intentions, tending to treat objects as intentional agents and possibly exhibiting the mirror-image profile of autistic patients, whose hypointentionality is well known.

### *3.2. Time-course*

The second group of papers addresses the *time-course* of pragmatic enrichment in the brain. The topic has quite a long history in the psycholinguistic tradition, where a large quantity of behavioral data on figurative meaning and scalars has been produced. We have learned that, given an equal amount of context, pragmatic meanings take more time and more effort than encoded meanings (McElree & Nordlie 1999 for metaphor; Bott & Noveck 2004 for scalars), but we

have also learned that supportive context can drastically reduce the difference between literal and non-literal interpretation (Gibbs 1994; Breheny et al. 2006), as do several other lexico-semantic variables (Giora 2003). ERP measures provide neat on-line signatures of pragmatic facts. A number of studies have been published in the last decades, showing an N400 modulation in response to pragmatic manipulations, mainly for figurativity and for beyond-the-single-sentence phenomena (Coulson 2004; Van Berkum 2009). These findings have been interpreted in terms of an early influence of context, against the traditional, Grice-inspired hypothesis that pragmatic processing occurs after an initial, literal elaboration stage. The precise temporal signature of pragmatic inferencing, however, is still a matter of debate. Recently, evidence has emerged that pragmatic facts are reflected not only (and not always) through the N400 but also through later P600-like components (Schumacher *in press*; Regel 2010). The debate is open. The next two papers present original ERP data for two quite unexplored phenomena in the ERP literature: indirect request and scalar implicature.

When expressed to a dinner companion, an utterance such as *My soup is too cold to eat* is likely to be interpreted as a literal statement about the temperature of the soup; when uttered to a waiter, however, it becomes an indirect request to heat up the soup. *Seana Coulson & Christopher Lovett* examine how neural activity varies across the two conditions, by registering both phasic ERPs at each sentence word and slow cortical potentials over the whole sentence, two quite unexplored measures that have been coupled here in order to provide converging indices on when and how indirect requests are interpreted in the unfolding discourse. Results reveal a larger late positivity component in the 700-900 time window after the onset of the second and the third words of the indirect requests as compared to literal interpretations, probably indexing the retrieval of contextual (i.e., situational) elements and their integration into a situation model in order to infer the speaker's intended meaning. Situation model building is indeed a crucial function supporting pragmatic behavior – and the reader can refer to Ferstl's paper for fMRI evidence. These data speak against the idea that pragmatics is a wrap-up, late-occurring adjustment, being instead consistent with models postulating an immediate effect of context (such as the Direct Access Model and the Constraint Satisfaction Model). Another important result is that slow cortical potentials diverge at the second word of the sentence, with a larger low frequency positivity for literal statements, indicating that, given enough context, non-literal readings might be even easier than literal ones.

Now take the connective *or*: logically speaking, the interpretation is inclusive, while the exclusive reading may come as a pragmatic inference (viz., a scalar implicature) which makes the sentence more informative in specific contexts. For a sentence like *I'd like a rose or a book*, uttered in a situation where the hearer knows that the speaker doesn't want him to spend too much money on a present, the exclusive interpretation is the most informative reading to be derived (otherwise she would have used *and*). One possible way of prompting the pragmatic reading is to exploit the pragmatics/prosody interface: *Coralie Chevallier, Mathilde Bonnefond, Jean-Baptiste Van der Henst & Ira A. Noveck* report on the electrophysiological response with respect to computing scalar implicatures conveyed by *or*, when marked by a contrastive accent, as in *There is an A OR a B* to describe the letters in the word *TABLE*. In addition to a P3a component associated with contrastiveness in general, cases in which the prosodic emphasis leads to a pragmatic interpretation also elicit a P600-like component as well as a Left Anterior Negativity. These results are of great interest to the experimental pragmatics debate over the nature of implicatures: Are they generated by default (as predicted by Levinson's Neogricean account) or do they require a deeper, context-sensitive analysis (as predicted by Relevance Theory)? Larger ERP components for pragmatic as opposed to literal interpretations for indicating enriched readings suggest extra effort and bring support to the Relevance Theory account.

Together, the findings from these two articles provide substantial evidence for the hypothesis that pragmatic processes correlate with a late positive shift in brain potential, appearing perhaps as down-stream in sentence processing but not necessarily confined to wrap-up stages. They appear to surface as early as the context enters the comprehension procedure. Future research is warranted to further investigate this late positivity and to characterize it with respect to other components involved in pragmatic processing, which is likely to becomes relevant at several different stages during interpretation.

Moreover, the two papers above illustrate that the high temporal resolution of ERP methodology makes it especially suitable not only for illuminating the time-course of pragmatic processes in the brain, but also for discriminating between theoretical-cognitive models. It is right here that neuropragmatics and the experimental pragmatics paradigm overlap and shape each other because both aim to clarify theoretical approaches to pragmatics. While Grice's primary intention was to provide a rational reconstruction of the primitives at stake in

dealing with pragmatic meanings, his work was not meant to provide for a psychological model. Nevertheless, his maxims and cooperative principle did give rise to psychological hypotheses which are still taken as a standard for research. Seen in this vein, the Gricean model (along with at least Levinson's Neogricean model) appears to come out weakened. On the other hand, Relevance Theory, which is intrinsically endowed with psychological plausibility, appears capable of handling a wide swatch of empirical results. Indeed, Relevance Theory is very much alive and amenable in principle to neuropragmatic testing. Neuropragmatics is in turn open to incorporating Relevance Theory notions, along with other ones, which leads us to the issue of principles and paradigms, addressed in the third part.

*3.3. Principles and paradigms*

The third set of papers asks questions about the types of operations that make up pragmatic functioning, with proposals that either spring from cognitive-theorizing and leave room for 'neuro' testing (Carston) or inversely develop from discoveries about brain organization (Van Berkum) and living systems (Bertuccelli) to reach pragmatic phenomena and processing.

Behind *Robyn Carston*'s paper is Relevance Theory, which accounts for the non-isomorphism between encoded meaning and speaker's meaning by positing relevance-driven inferential mechanisms which bridge the gap. In recent years Relevance theorists have zoomed in on the lexical level, investigating the processes by which word meanings are modified in use, a branch of studies known as "lexical pragmatics". Carston has greatly contributed to the account of such processes, by describing how, constrained by considerations of optimal relevance, the lexically-encoded meaning interacts with other concepts encoded in the utterance and with the context in the inference of an *ad hoc* concept (i.e., a concept inferred for that specific occasion). Here, Carston further explores how *ad hoc* concepts are derived in communication starting from concepts which – along the Fodorian line – are taken to be atomic, stable mental entities in individual minds. The reader will find an illustration of the operations occurring at the interface of words, our thinking apparatus and communication. *Ad hoc* concept formation is assumed to play a crucial role in metaphor understanding: in *John is a shark*, the word *shark* points to the concept SHARK, but via pragmatic adjustments is recognized as expressing the broader *ad hoc* concept SHARK*, which ultimately contributes to the intended meaning. A list of potentially

experimentally tractable questions that derive from the cognitive-theoretical account above is included. Finally, Carston treads new ground by pointing to the case of extended metaphors, including poetic instances, which appear to be processed differently from conversational metaphors, by initially staying with the literal meaning, which is projected to an imaginative, 'meta'-representational level, from which implicated speaker meaning is finally derived. This glimpse is both highly innovative and inspiring, and promises to be able to capture not only how we process the speaker's message, but also what gives this use of language its particular aesthetic effects.

*Jos J. A. Van Berkum* marks a new research departure for pragmaticists: if we want to 'go neuro', and not only in an instrumental sense (i.e., to enrich theory with neural evidence) but also in an ontological sense (i.e., in a joint enterprise of cognitive theorizing and discoveries about the brain), we should also start out from principles of brain functioning. Among these, Van Berkum draws attention to the fact that the brain is a predicting machine evolved as such to interact with complex and dynamic environments. There is currently a growing interest in anticipatory mechanisms at all levels of cognition, from motor behavior to mind-reading. Van Berkum gives a bird's eye overview of this literature, and then goes on to exemplify how a great deal of the available ERP results on language processing could be explained in terms of expectation-consistency versus expectation-inconsistency: from gender agreement to referential pronouns, including several lexical/semantic manipulations giving rise to standard N400 effects. The author convincingly argues that many pragmatic notions include prediction (isn't prediction what is at stake in adjacency pairs or turn-taking?) and that, conceivably, in solving pragmatic gaps the brain is guided by fine-grained expectations from a vast range of (contextual) sources. As a second point, Van Berkum shifts the emphasis to the strong affective connotation of the human brain, which not only anticipates, but also feels and experiences the environment by assigning positive and negative valence to the world, and to the words, as recent findings on the processing of moral terms show. The message for neuropragmatics is to incorporate emotional factors into the study of the language/brain relation, as part of meaning in context.

This Special Issue concludes with *Marcella Bertuccelli Papi*'s paper, where an even more overarching proposal is put forward: What if a way to capture pragmatic facts in the mind/brain came from a theoretical framework elaborated in the biological and social sciences, namely in the form of a complex systems paradigm? Complexity theories have been developed over the last two decades to describe

sophisticated forms of living and social organizations, from body cells to ant colonies and the stock market: principles of complexity account for the change of the system in response to environmental stimuli, a change occurring over time (dynamicity) and at all levels and scales (multidimensionality), resulting in movement from temporary and relative stability through adaptive behaviors to the emergence of new patterns. In the past few years, complexity theories have reached linguistic research: several language domains have been argued as best construed as complex adaptive systems, especially language acquisition and language change. Grounded in theoretical observation, Bertuccelli Papi vividly describes pragmatic facts as complex dynamic units which are under the pressure of many variables in interaction – of context, in a word – yet avoiding chaos. It is mostly in providing a framework to account for the affordances and constraints of these variables that the complex systems perspective might help in the modeling of (and possibly the predicting of) pragmatic processes. The author applies the lens of complex systems to suggest new directions of research that could lead to overcoming the theoretically-debated and experimentally-unsolved literal/figurative dichotomy: there are no principled boundaries between literal and figurative meaning, but rather literal meaning is an epiphenomenon resulting from statistically relevant and repeated configurations, which – in response to specific environmental, i.e., contextual, conditions – might not necessarily be psychologically perceived as existing, resulting in alternative processing paths (maybe direct to figurative meaning). While waiting for mathematical characterization, the complex systems perspective for pragmatics stands out as both consistent with paradigms adopted in other sciences and promising in its descriptive potential.

## *4. Conclusions*

> 'That's a great deal to make one word mean,' Alice said in a thoughtful tone.
> 'When I make a word do a lot of work like that,' said Humpty Dumpty, 'I always pay it extra.'
>
> (Lewis Carroll, *Through the Looking-Glass*)

Just as snails carry their home, so pragmatic phenomena carry their context. Whether this costs the brain more is uncertain (it may cost less indeed), but for sure context makes the difference. When our object of study shifts, for instance, from lexical access to lexical access

in different contexts, from sentence processing to discourse processing, so will the brain's response with respect to space and time, both in healthy and in pathological conditions. What we have learned in the neuroscience of language needs to be revised once we consider the context in which language is used. Although definitive conclusions are premature at this stage, this Special Issue bears clear witness to the fact that a thoughtful consideration of the links between pragmatics and the brain is not only possible, but also worthy of investigation in a concerted fashion, rather than in a fragmented way as in the past.

Besides realizing the prospective utility of neuropragmatics, we have also gained some solid outcomes over the years, although sometimes outside the rubric of what I have been calling neuropragmatics. Most of these outcomes show up as converging evidence throughout this collection. The neural workspace for pragmatics extends over a wide set of cortical areas (among which the involvement of inferior frontal regions seems undisputed), which are not functionally specific to pragmatics but mediate pragmatic processes by means of networks. The temporal signature of pragmatics manifests itself over different components, mainly the N400 and the P600. A number of contextual variables, from speaker's status to previous discourse, have been spelled out, and, for each of these, specific brain responses have been identified. With the help of cognitive theorizing, a set of operations has been postulated to guide processing.

As much as this Special Issue answers important questions, it raises new ones. Some are directly related to what we already know: brain networks need to be further specified, especially with respect to their functional divisions and their functional integration, and the processes indexed by ERP components require further clarification as well. Other questions address new and quite untouched issues, from subject-specific variables to the interface with emotional and embodiment processes. These and other important new research perspectives are disseminated in this collection, and there is no need to add more words here, apart from noting an observation made by virtually all the contributors, which is the promise and vitality of this newly emerging field of neuropragmatics.

The vitality of neuropragmatics is reflected also by the fact that the element it revolves around – namely, context – resonates in many other domains of cognitive neuroscience. Language is not the only research topic that has recently been better appreciated in context: after decades of studies on processing objects in isolation, attention is turning toward how the brain elaborates on objects in and through environment, be they linguistic, visual or social. For instance, the neu-

roscience of vision is exploring how context influences object perception (by comparing the brain response to objects strongly associated with a context, e.g., a traffic light, versus objects not associated with a unique context in particular, e.g., a camera; Bar & Aminoff 2003). Another case in point comes from social neuroscience, which is studying the brain correlates of individual behavior with respect to the plethora of elements that make up social context (identities, attitudes, norms, beliefs, intentions, etc.; Cacioppo & Berntson 2006). Context is also pursued in terms of the ecological validity of the experimental setting. A superb example is naturalistic audiovisual stimulation, as in free viewing of movie sequences coupled with inter-subject correlation of brain activity (Hasson et al. 2004). While multimodal protocols being developed by neuroscientists of language are not specifically focused on pragmatics, researchers are aware that it is important to investigate the brain mechanisms of language understanding in its context of use (Small & Nusbaum 2004; Skipper et al. 2009).

In its infinite variation, context permeates information processing: regularities in the way the brain integrates and exploits context might bypass the distinctions among cognitive modules, while maintaining the distinctiveness of each faculty. Indeed, we might be facing a point here where language and other systems share mechanisms that developed evolutionarily in response to environmental demands. So, in order to get a full account of processing pragmatic facts in the brain, one cannot exclude that neuropragmatics should dialogue with other context-sensitive 'neuro' disciplines and become even more interdisciplinary.

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*Notes*

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