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Irene Orlandazzi

Università degli Studi di Milano

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Review of Arthur M. Jacobs, *Neurocomputational Poetics. How the Brain Processes Verbal Art* (Anthem Press, 2023)

Irene Orlandazzi
Università degli Studi di Milano

Nowadays, an important empirical turn and an increasingly concrete and systematic transdisciplinary dialogue are affecting literary studies. In the last decade of the 20th century in fact, when important discoveries were made in all that concerns human nature considered in its complex totality, the boundary between the humanities and the hard sciences was definitively crossed, and new possible perspectives opened up in every field of knowledge. Neuroscientist Vittorio Gallese and the entire Parma team that discovered mirror neurons, for example, have begun to explain the strong correlation between motor-neural processes and imagination, revealing the strong connection between two worlds that previously seemed completely unconnected:

> What about imagination? Mirror mechanisms are just *one* instantiation of embodied simulation: when mirror mechanisms are activated, the simulation process is triggered by perception, like when observing someone performing an action, expressing an emotion, or undergoing a somatosensory stimulation. However, embodied simulation can also occur when we imagine perceiving something or imagine doing something. (116)

To study imagination, therefore, a transdisciplinary perspective is strictly necessary.

Thanks to these necessary dialogues between disciplines and scholars, literature studies see nowadays new horizons that otherwise would have not been visible, as for instance the one of the recent studies focusing on the reader-response, with particular reference to the emotional and cognitive effects that reading elicits at the same time in the reader's mind and body. These research horizons are extremely stimulating but also – and maybe it is exactly this second characteristic that makes them so much stimulating – extremely complex, because the main object which is common to all the different perspectives, disciplines, and studies – the human nature – is characterized in the first instance by an inexhaustible but fascinating complexity. Nowadays, the transdisciplinary dialogues connecting the Humanities with the quantitative methods of the exact sciences and all the teamwork promoted by new interdepartmental, transdisciplinary research centres are therefore indispensable elements to face that complexity and make it a way to discover the richness and all the deepest aspects of the human nature. However, this complexity also has unavoidable dark sides, hence the scepticism towards the adoption of a transdisciplinary perspective and other practical difficulties related to the high costs of the laboratory instruments required to conduct this kind of research.

Arthur M. Jacobs' latest volume, *Neurocomputational Poetics. How the Brain Processes Verbal Art* (Anthem Press, 2023), takes up the challenge opened up by today's empirical and transdisciplinary turn in literature, maintaining a delicate balance between an intimate and sincere awareness of the complexity inherent to this research field and of the still unexplored richness that offers, nevertheless, pregnant avenues to explore. Jacobs recognises in neurocomputational poetics a fertile ground for cultivating and investigating the transdisciplinary entanglements

that are increasingly affecting the literary field, rooted in the principle – recognized and sustained by Jacobs himself – that «spoken and written words produce emotions, create pleasure and pain and can change persons or move masses» (xiv). Therefore, in neurocomputational poetics converge different theories and methods coming from the main disciplines on which it is based: reading psychology, cognitive and computational poetics, and cognitive and computational neuroscience, all aiming at the same and complex goal «to develop or find methods to best assess and predict measurable aspects of the reading act at all levels of scientific enquiry, that is, neuronal, experiential and behavioural» (xiii). The beating heart of the book is thus Jacob's intention to bring together different perspectives from the traditional humanities and the methods of today's hard sciences, while maintaining, despite the obvious and ineradicable complexity of this task, a simple and explanatory tone, which is one of the main strengths of his book.

From the beginning to the end of the volume, in fact, the reader is always accompanied through the various chapters and the many difficult and innovative themes and theories by the voice of the author himself, who does not try to hide his personal perspective under an artificial and impersonal veil of scientific objectivity. On the contrary, Jacobs' voice always emerges explicitly, with the important aim of guiding the reader through the concreteness of a personally constructed and experienced research activity. Indeed, Jacobs openly reveals the ups and downs of his experience as a researcher in the field of the empirical study of literature, articulated by successes but also by many failures and closed doors, always interpreted as new challenges. The copresence of highs and lows, successes and failures is exactly what makes Jacobs' experience so real, making easier also for the reader to identify with it and overcome the intrinsic complexity of the themes that are presented. In a few words, Jacobs' book appears as a living creature still in progress, making the content believable for the readers and applicable in their own research experience.

The volume is structured in nine chapters, beginning from a general perspective, and accompanying the reader into the theme of neurocomputational poetics, gradually increasing the complexity and specificity of the arguments. The first chapter introduces the theme of the reading activity from the innovative perspective of the empirical studies, revealing the aspects that will be the object of experimental investigation in the following parts of the volume. These aspects are tied to two main cognitive and affective processes: immersion – particularly connected to the reading of prose –, and aesthetic feeling – particularly connected to the reading of poetry –, which involve the reader's mind and body. In this sense, from the very beginning the author makes clear the concrete and tangible effects of the literary experience: «the magic of the letters lies in the fact that despite being only ink blobs on a page they can re-ignite the sensory fire of the original objects in readers' mind» (3). Jacobs intends therefore to explain through this book the possible means to investigate this 'magic', that is to say the processes of immersion and aesthetic pleasure that are at the basis of the whole literary experience. The means and tools described by Jacobs come from the different disciplines composing neurocomputational poetics, and represent in this way the authentic essence of the empirical study of literature:

> Applying the theoretical and quantitative methodological tools of these sciences to the study of questions on literature reception led to a wealth of data which still await theoretical integration and unification, while comprehensive models of aesthetic for non-verbal art have guided empirical studies for some time. The advent of neuroaesthetics with the introduction of the methods of cognitive neuroscience – primarily neuroimaging – to investigate the evolutionary and biological underpinning of aesthetic experiences then primed the development of Neurocomputational Poetics that led to this book. (10)

On the basis of these premises and thanks to his whole research experience, Jacobs exposes in the second chapter the Neurocognitive Poetics Model of Literary Reading (NCPM), a theoretical model of verbal-art reception that serves to organize empirical knowledge about reading literature into a unified framework. This offers a set of related hypotheses and allows to make qualitative and quantitative predictions about reading prose and poetry, that are then put to test in computational and empirical studies (cf. 15). The innovation and originality of Jacobs' model is not to find however in the possibility of processing general verbal information as quantitative and measurable 'cold' data but it is to find instead in the possibility to deduce from these data important information about the reader's emotional, immersive and aesthetic processes, experiential aspects and mental states. These are in fact the beating heart of verbal art reception but, due to their high complexity and subjective value, they have never been considered into a possible quantitative, 'objective' measurement. In a few words, the NCPM «tries to explain how we come to understand and like literature» (21).

Jacobs' model is based on the assumption – experimentally proved at the end of the Twentieth century by neuroscientists as Antonio Damasio and more and more demonstrated by today's theories and studies – of the fundamental interdependence and co-determination of emotion and cognition in human mind and body. This concerns all everyday actions and decisions and every process concerning art creation and reception, in which cognition and emotion become an inextricable mixture resulting in the literary experience that Jacobs wants to study and try to measure also from a quantitative point of view. In the second chapter, the author tries to make clear all the different processes that are activated during literary reading – immersion, suspense, empathy, identification, and the aesthetic pleasure deriving from the deviations from the norm that are common in literary language – which, if considered together, constitute the core of the meaning making process activated in every phase of the literary experience. Jacobs has identified a *mesomodel*, where all these processes are divided into two main categories – background and foreground –, which in turn correspond to two different *routes* activated during reading: the fast route and the slow route. The first is activated in correspondence of the background elements of the text, in which the reader can easily identify and feel familiar with; the second is activated instead in correspondence with the foregrounded elements of the text, which are unfamiliar to the reader and thus require a bigger cognitive effort to be processed. It is exactly this effort, however, that causes the aesthetic pleasure during reading.

The main aim of Jacobs' NCPM presented in the book is therefore to set a framework within to predict and interpret the background and foreground effects and their neural correlates, and this is first of all an empirical question (cf. 37). The Neurocomputational Poetics presented by Arthur Jacobs in the other chapters of the volume serves thus to test the hypothesis and quantitative predictions made within this framework, and it combines methods analysing the reading materials, the reader, and the reading act.

The third chapter of the volume is devoted to the reading material, that is to say to text analysis. Jacobs presents texts as compositional elements, in which simple units combine to form more complex ones, which is precisely why they constitute the perfect material for quantitative analysis. In the context of this reflection, Jacobs argues that, alongside the traditional close reading, humanities and today literary studies should consider the need for a complementary distant reading, based on the quantitative analysis of features and ready to supplement insights from hermeneutics alone with empirically verifiable predictions:

> Using powerful computers and algorithms to try to automatize, approximate and complement 'from a distance' what a literary scholar or critic with hermeneutic skills can do by close reading appears justified in the face of the myriad of possibly relevant text features appearing in the wealth of the world's books and poetry collections. (58)

The Neurocomputational Poetics goes precisely in this direction, offering a toolbox for text analysis – as feature engineering, semantic models, and methods to predict the comprehensibility and likeability of literary texts – that can help the reader to *support* – not to replace! – the intuitions coming from close reading with objective data coming from distant reading. The author exemplifies these statements through his personal research activity and experiences, which are an indispensable ingredient of the whole book, making concrete, more tangible, and even easier all the innovative perspectives that are presented. Sometimes this presence of Jacobs' voice through the pages emerges in the first-person singular *I*, making the reader much closer to the author, who states himself that: «this book is just another attempt at changing things towards an open-minded, truly cooperative cross-disciplinary science of verbal art» (70).

Through some examples taken from the analysis of Jane Austen and Charles Dickens' books, Jacobs proves the usefulness of distant reading and Neurocomputational Poetics in measuring and predicting the comprehensibility and the likeability of literary texts, combining analysis of the syntactic and semantic complexity, literariness and foregrounding, and sentiment analysis. The combination of all these factors, with particular reference to the last one, is fundamental to measure the *emotion potential* of texts, that is what makes the reader develop immersive processes and feelings of aesthetic pleasure during the receptive experience. In order to measure this kind of potential, transdisciplinary perspectives and methods are indispensable: literature comes in contact with data science, statistics and with cognitive and affective neuroscience, which lends important instruments and methods (as for instance fMRI, eye tracking, EEG, measurement of somatic parameters) to analyse and measure the emotions that are woven – here the etymological meaning of *text* – as in a real *textus*. To summarize, Jacobs shows how his NCPM is able to propose a computational sub-model of perceived book beauty, reinforcing and integrating the speculation coming from traditional close reading.

What is particularly important to notice when approaching Jacobs' book, is that all these reflections, theories and models apply to the reader considered in the complexity and totality of his/her rational, affective, and somatic dimensions: mind and body *together* are at the centre of the Neurocomputational Poetics, making the literary experience much more concrete and closer to our everyday life. In the fourth chapter, the author analyses indeed the literary experience considering the reader and the reading act in their totality and complexity. Jacobs particularly emphasises the strong and important relationship between the personality of the reader and the act of reading, two factors that influence each other: in fact, not only the reader interprets what he/she reads *through* the lens of his/her personality and cognitive and emotive experience, but Jacobs also sustains and proves that in turn also «verbal art can shape personality» (90).

On the basis of this assumption, the author shows the different methods to analyse the personality and cognitive profile of the reader, as through questionnaires, empathy and trait-absorption scales, computational reader-specific language models using corpora, tests of reading proficiency and collecting experiential and behavioural response data, as through eye movement parameters. In parallel, he describes the sophisticated methods with which to analyse the reading act itself, measuring once again the bodily, neurocomputational, experiential and behavioural responses during (online methods) or after (offline methods) the performance. In this perspective, the choice of the materials and of the adequate reader-response measure gains a primary importance, but Jacobs reassures his readers saying that in this regard there is no gold standard yet, and that on the contrary it is important to combine different materials and methods in order to reach results as complete and objective as possible.

In a more concrete and empirical perspective, Jacobs presents in the fifth and sixth chapter the possible applications of computational poetics: first the simple applications and then the more sophisticated ones. In chapter five he states that he wants first of all to make people who

love literature understand that «the pleasures of reading are constructed in the brain in response to a myriad of simple features that, in concert produce a complex symphony» (113), and to show also people how to apply simple tools to analyse complex texts offering insights about verbal art and permitting to do testable predictions for scientific studies.

The author then provides explanations and examples of how simple applications of computational poetics can be used to calculate the 'value' of individual words, measuring, for example, their euphony and eusemy, i.e. the beauty of sound and meaning, with the help of special software and other methods of various disciplines, such as cognitive neuroscience. To compute eusemy, Jacobs detects and explains the Affective-Aesthetic Potential (AAP), «a lexico-semantic feature based on the association between a word and a set of special *labels*» (119), which are associated affectively and aesthetically with positive or negative things. Jacobs gives examples of how this can be measured through the *SentiArt* tool, another software providing the AAP scores for hundreds of thousands of words in Dutch, English and German. But what is the main utility of these measurements? «These values allow the NCPM to make quantitative predictions with regard to the most probable key associations (pre-)activated in readers' minds that codetermine whether they like a word or sentence, or a line of poetry, or not» (121). Moreover, he shows how with algorithms and other computing tools it is possible to measure also multiword expressions, metaphors, the word order, stress pattern and rhythm, together with rhymes, schemes, and tropes, i.e. elements determining the overall meaning of a text. Through his studies and experiments, Jacobs has shown that the computational tool predicting reader response have an accuracy of around 80 per cent, appearing thus as innovative and reliable methods to study literature *also* from a quantitative point of view.

In the sixth chapter, the applications of computational poetics become more complex, as they are not used to analyse simple words or expressions, but entire stories, focusing on their component elements such as plots, characters, events, places, and actions. In this regard, Jacobs demonstrates through three different empirical studies how human rating data deriving from an expert close reading can be predicted or successively validated through computational methods, as more precisely once again the *SentiArt* tool, used in this case to predict human valence rating data on entire chapters or books. Jacobs highlights indeed that

> neurocomputational research […] has produces ample evidence that the emotions readers experience during narrative comprehension depend upon psychological processes such as identification with a protagonist, or empathy and sympathy for story characters. The *likeability* of stories greatly depends on this. (158)

Therefore, it is nowadays fundamental to develop instruments and methods to recognize and analyse these processes, encouraging transdisciplinary dialogues and research in order to find and exploit the most appropriate technologies and theories for this main aim.

Although computational poetics is not an exact science – thus abandoning the ideal of perfect predictive accuracy – it represents a great step forward in literary studies to predict and calculate the characteristics of text and stories, always relating them to the reader's response. This is the core of Jacobs' model: literary experience can be considered in its complexity and totality, developing tools to observe and study the entire neurohermeneutic circle and its single components. In the next two chapters of the book, in fact, the author combines computational analysis with experiential, behavioural and neuronal analysis, showing how his NCPM can be a composite and reliable tool to study that circle in its entirety. More specifically, how previously stated, Jacobs individuates two possible *routes* that are activated during reading, and he presents them in chapters six and seven, which are based on the hypothesis of the NCPM mesomodel:

> Texts that have clearly more background than foreground elements likely trigger immersive experiences through activation of the brain's automatic reading network and implicit processing leading to a fluent reading mode. In contrast, those with a low background/foreground elements ratio tend to evoke an aesthetic trajectory associated with the operation of larger neural network including more right-hemispheric regions and explicit processing resulting in a dysfluent reading mode, that is, they activate the lower route. (175)

In the seventh chapter, Jacobs gives example of upper route studies, analysing stories that elicit in the reader empathic processes with the characters and immersion in the story world, due above all to the emotional content of the narration itself. Summing up, the author proves from an empirical and experimental point of view the *fiction feeling hypothesis*, stating that narratives with an emotional content make reader empathise and immerse in the story much more than it happens with narratives with a neutral content. Applying neuroimaging to the study of some narratives like *Harry Potter* or *The Sandman*, Jacobs proves here the existence of a direct correlation between some characteristics of a text, – as for instance their emotion potential, suspense, lexical and interlexical affective features, the presence of autobiographical emotional memories – and their neural correlates during reading. The reader can thus have a demonstration of how the brain responds to certain characteristics of the text and the subjective sensations arising from it, and thus, more generally, see how the literary experience is something very concrete and tangible, involving and connecting our mind with all the smallest nerves and fibres of our body. Hence the strong need today to study literature from a transdisciplinary point of view.

The main conclusion of Jacobs' studies and experiments is that at the core of the reading experience and related brain activity is the emotional potential of words, something that connects the text itself with the entire experiential, emotional and cognitive universe of the specific reader immersed in that text. In this regard, the author states:

> Single words also have a meaning beyond the specific context we find them embedded in: we have encountered these words in many other contexts before, and out semantic representation of these words potentially contains traces of all these different contexts, giving them complex emotional connotations. (187)

That is why emotions are at the centre of the literary experience and, how it is demonstrated today by cognitive neuroscience studies and experiments, at the centre of all our thoughts, decisions, and actions.

In the eighth chapter Jacobs focuses on the study of the lower route of the NCPM, elicited by a combination of affective-aesthetic processes. In particular, in the *sound studies* he shows to the reader how syllables and in general word phonemes determine the «phonological affective potential (PAP) of words» (194), which, according to his studies, have a direct effect on the neural system and on the bodily reactions of the reader: «Empirical observations showing that sensorimotor networks of the brain can be associated with rhythmic patterns and are responsive to poetic stimuli lend support to embodied theories of literary reading suggesting that it reaches deep into neural circuits» (200). Moreover, analysing and studying from an empirical point of view the affective-aesthetic potential of single words and multiword expressions as compounds, idioms, proverbs and anti-proverbs, Jacobs proves that the sound of words is strongly connected with their semantics, and that these two elements together contribute to give words, expressions and entire poems or narratives their beauty. This, in turn, has direct effects on the neural correlates of the reader. In the final part of this chapter, through an eye tracking study on three Shakespeare sonnets, he shows indeed «how a team of researchers can successfully apply a multimethod middle reading approach to learn about the text features and processes that determine how people come to understand and like poetry» (232). This leads

directly to the final chapter of the volume, in which the author summarises the most important reflections arising from all the studies presented, opening some possible future perspectives for the study of literature. Therefore, following the rhythm of Jacobs' concluding remarks, we take the opportunity here to find a space for some general reflections on what it means to study literature today.

Jacobs concludes the volume by stating that his NCPM offers a comprehensive general tool with which to measure all aspects of verbal art and, as the title also states, to analyse how the brain processes all these different aspects. The future of literary studies lies in the continuation and improvement of neurocomputational models and methods with which to observe how the reader reacts with his/her own mind and body during the reception of the text. In order to do so, it is fundamental to «extend and intensify cross-disciplinary collaborations» (234), going beyond the traditional borders between humanities and hard sciences by exploiting the many important and big opportunities that arise from their concrete and systematic dialogue. As this volume accurately demonstrates, Jacobs has done and is still doing a great deal in this direction, with the aim of increasing the 'objectivity' of the study of literature, opening the door to future innovative applications of hard science methods to the study of the (neuro)hermeneutic circle which links text, author, and reader. Would this all together maybe sounds too ambitious?

In his *Six Memos for the Next Millenium*, published in 1988, Italo Calvino wrote:

> Overambitious projects may be objectionable in many fields, but not in literature. Literature remains alive only if we set ourselves immeasurable goals, far beyond all hope of achievement. Only if poets and writers set themselves tasks that no one else dares imagine will literature continue to have a function.
> Since science has begun to distrust general explanations and solutions that are not sectorial and specialized, the grand challenge for literature is to be capable of weaving together the various branches of knowledge, the various 'codes' into a manifold and multifaceted vision of the world. (112)

We are now in 'the next millenium', and Arthur Jacobs has made Calvino's hope real. This volume, in all its variety and complexity, is always leading the reader thanks to the human voice of the author which emerges from the pages. Jacobs' last book openly reveals the highs and lows of his personal research experience, and it actually shows how literature – weaving together the various branches of knowledge – offers a way to better understand the human nature in its fascinating complexity and the whole material world determining and surrounding it. This might certainly seem an immeasurable goal, far beyond all hope of achievement, but it is exactly thanks to this new transdisciplinary perspective – as greatly shown and demonstrated by Jacobs and his Neurocomputational Poetics, able to observe and measure how the brain processes verbal art – that nowadays literature is so alive.

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