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Suspense is the Key.

Narratology, Cognitive Neurosciences and Computer Technology

Stefano Calabrese - Sara Uboldi
Università di Modena e Reggio Emilia

Abstract

The new generation of narratology shows renewed heuristic scenarios, providing an intense dialogue among humanities, cognitive neuroscience and computer technology. The case of suspense is emblematic of this new dialogue: the pleasure that suspense exercises on the human mind can be precisely explained by identifying the mechanisms of reward provided by neurological and imaging studies. At the same time, patterns of automatically-generated narrative highlight the profound implications of a heated debate between narratology and computer technology, in order to understand the processes of reception and inference during the narrative immersion in storyworlds. At the end of an overview on a cross-disciplinary approach of suspense analysis, the authors report a case study considered of interest, provided by a North Carolina State University research group, called the Liquid Narrative Group.

Keywords

Feeling of Body Theory, Theory of Mind, Surprise Arousal, Prolepsis, Analepsis, Reader' Mind, Story Generation, Liquid Narrative Group.

Contacts

stefano.calabrese@unimore.it
sara.uboldi@unimore.it

Todorov called *narratology* or *science of narrative* a new type of theory that could be applied to all domains of narrative (2099 ff.). The neologism alluded to social and natural sciences, such as sociology and biology. In the contemporary 'narrative turn' introducing the application of narratological tools to extra-narratological research problems has become more and more widespread, resulting in a multitude of compound or subdomains. The post-structuralist approaches include methodological variants: natural narratology, critical narratology, cognitive narratology, etc., but also the discipline of cognitive poetics. Others focus on thematic and ideology-critical concerns, such as post-colonial narratology and feminist narratology.

In particular, cognitive narratology focuses on the human intellectual and emotional processing of narratives. This approach is not restricted to literary narratives: everyday "natural" and oral narratives are considered to represent an underlying anthropological competence in its original form (Fludernik 11 ff.). Cognitivist approaches also play a crucial role in AI research, the aim of which is to model or simulate human narrative intelli-

gence. Cognitive narratology focuses on the mental states, personal skills, and dispositions that provide grounds for narrative experiences. The research on the mind-narrative nexus contains multiple methods of analysis and different corpora including textual, fictional and nonfictional, and computer-mediated narratives such as interactive fictions, games and blogs, comics and graphic novels; cinematic narratives, but also storytelling in face-to-face interaction. By the same token, theorists who have been working in this area have adapted descriptive and explanatory tools from a variety of fields – in part because of the cross-disciplinary nature of research on the mind-brain itself. Source disciplines include linguistics, semiotics, computer science, philosophy, psychology, and other domains, in addition to narratology.

Approaches to narrative and mind continue to emerge, evolve, and cross-pollinate. The last border of post-classical narratology (a subdomain of cognitive narratology) is neuronarratology.

Neuronarratology is an emergent perspective which includes the linguistic and cognitive contributions to cognitive poetics and the neurological studies of human mind structure and function. This new approach – recognized and theorized by Stefano Calabrese (5 ss.) – makes use of Mirror Theory (Rizzolatti 661 ss.), thus of biological bases formed by mirror neurons in order to understand the empathic effects deriving from the meeting between author, reader and literary text.

The contribution of neurosciences research is relevant for this new concept of narrativity as anthropological competence and problem solving practice. The neurologic imaging studies point out as the principal cerebral areas involved in the stories production and fruition are the medial and prefrontal cortex, sites of working memory. Thanks to this area it is possible to image the development of the stories in time and space. The cingulate cortex connects the stories to a spatial dimension and makes mental images. The prefrontal areas delegated to the Theory of Mind (ToM) are the medial prefrontal cortex, the temper-parietal junction and a part of the temporal lobe. These areas are activated both in the social interaction of everyday life and in the narratives, during the meeting with the fictional characters. For this reason, stories supply tools for social acting. Stories increase empathic and social abilities. For example, neurobiology applied to narrative studies reveals that highly emotional stories improve the production of cortisol and oxytocin, the hormones of attention and affectionate relations.

Therefore neuroscience studies and the new generation of narratology prove that narration is an embodied experience able to involve the deepest dimensions of the body. The FoB (Feeling of Body Theory) allows the perception of actions, states and emotions of fictional characters recording them in the bodies of the stories' users. The research on human attention and perception provide relevant indications about what is perceived as salient and attractive by the human brain. Recently, the element of suspense seems to have attracted scientists' attention considerably. During the fMRI tests, the researchers found that in the reception of a literary text with suspense areas of the brain which are associated with Theory of Mind and predictive inference are activated. In particular, the frontal-medial cortex, the bilateral frontal regions, the premotor lateral cortex and the temporal parietal and posterior temporal areas are enabled when the subjects adopt the perspective of the protagonist and influence his mental state (Lehne 118 ss.).

In other words, it seems that suspense is born and proliferates from the discrepancy between the protagonist's awareness and knowledge of a forced reader to resort to a Theory of Mind or Mind Reading and to a complex game of predictions and anticipations (Jin 142 ff.).

Nowadays, neuroscientists have switched to a redefinition of the phenomenon of suspense as: i) an affective state associated with conflict, dissonance, instability and uncertainty, selected to ii) create resolution and homeostasis, iii) grant an emotional meaning to events, iiiii) direct anticipation and predict events.

Against this background, the chapter will examine the most recent data in relation to the use of suspense produced by cognitive and neuroscientific studies, making reference to the relationship between this rhetorical device, music, cinema and the generation of stories through computational systems and new technologies (Story-based Systems or Technologies).

In particular, the results of research conducted by the Liquid Narrative Group, at North Carolina State University (Bae 156), will be taken into consideration.

The software developed for the generation of flashback and foreshadowing (Minstrel e Suspenser) provides data and models of interest for the new frontier of narratology, noticing significant aspects of the mechanism of fruition of the stories and users cognitive responses, in terms of suspense and surprise.

Homeostatic theory

If we imagine every narrative as a succession of questions and answers, more or less manipulated by narrator, we could say that the suspense lasts until such time as there are neither questions nor answers, and narrative tension goes out in the silence of certainty (Rabkin 63).

Xavier Pérez wrote that the story ends when the question “and what happens next?” no longer has meaning, when the full potential of exposed meanings from “once the time» was resolved with the successful closures, «and they lived happy and contented” (18).

Until this moment, the reader/spectator does not stop feeling a relentless desire to know, which coincides with the suspense.

Just on the basis of the open or closed definition of a fictional world, also because of a certain refractory to final closure in the twentieth century novels, the role and diffusion of suspense in the globalized present, has been addressed by major studies of neuro-cognitive and neuro-linguistics fields.

Already since the early twentieth century, the idea that the narrative suspense and dynamic stress phenomena could play a primary role in the definition of person’s emotional dimension was widespread in the scientific community; according the psychologist Wilhelm Wundt, tension (*Spannung*) and resolution (*Lösung*) were the two poles of the emotional constituent. Talking about emotions and literary texts, however, it is necessary to distinguish between emotions evoked by events (special topics such as murder, kidnapping, etc.) and plot structure at deep level (background) and the emotion aroused by less structural aspects of the text on the surface (foreground). In this latter case, the reference is to the words, the grammatical structure, the rhetorical effects (anacoluthon, for example), and all narratological devices able to perceive the phonetic structures, syntactic or semantic as familiar, thus capturing cognitive attention.

Now, the distinction between foreground and background has recently been taken up by Jacobs' Poetic Neurocognitive Model, which recognizes two different neuronal circuits specialized on background and foreground text analysis (Jacobs, 2013).

In particular, the deep circuit is solicited by a so-called subliminal suspense – the state of hope and uncertainty induced by macro-structural levels of the text – as appears from a series of fMRI tests (Functional magnetic resonance imaging). These studies have tested that literary and musical suspense activate similar responses in the brain involving the limbic and paralimbic systems. Music is able to generate sequences of expectations causing a state of tension similar to that triggered in the skilful narrative plot manipulation and script activations in daily life (Kolsch, 2012). In evolutionary terms, the dynamic tension of suspense corresponds to the need for psychological homeostasis, or to the innate human tendency toward resolution of dissonance, interpretative conflicts and cognitive uncertainty, in order to restore a state of brain neurochemical balance.

The pleasure generated by suspense therefore acts as a reward and incentive during the exercise of the essential function of generating expectations anticipation.

Predictive activities stimulate dopamine production, while the degree of uncertainty is strongly related to the pleasure generated by the resolution; this makes the effects of suspense similar to the biochemical conditions that characterize extreme sports.

Suspense is therefore a homeostatic tool that intervenes in a process that has been described by different models, also based on the fact that many people are permeable to suspense even in the face of repeated exposure. For example, the philosopher Noël Carroll has subjected to fifty viewings of the film *King Kong* noting every time a strong and repeated increase in suspense, thereby giving rise to different hypotheses about the possible manipulation of memory during the tension states.

More specifically, the fMRI investigations have revealed that the areas activated by suspense are associated with mind reading or Theory of Mind (ToM), and predictive areas. In fact, the prefrontal cortex, the bilateral frontal regions, the lateral premotor cortex and temporal-parietal areas were activated when subjects engaged in reading stories with suspense. They were brought to adopt the protagonist's perspective and infer his mental state.

So, suspense intervenes in relation to the discrepancy between the protagonist and the reader, using the instrument of Mind Reading.

Suspense carries a cognitive function and intelligence.

Recently, Lisa Zunshine spoke of this as a pedagogical tool to be introduced in programs of primary and secondary education (Zunshine, 2014) capable of improving the predictive ability of children and adolescents.

The tensional devices of the detective story (novel or film, both modes were tested) have proven able to intervene directly in the language areas (in particular, the rift posterior temporal areas interfering with specialized circuits in acoustic-phonetic processing, orthographic mapping and semantic integration of information), which once more marked an involvement of suspense in the neuronal processes of prediction and anticipation (Fitch, 2009)

Cinema and Neuronal Control

Based on these results, it is possible to redefine the value of suspense, as an affective state associated with conflict dissonance, instability and uncertainty selected in human evolution:

- Step 1: to create homeostasis after event resolution
- Step 2: give the event a potential emotional meaning
- Step 3: direct the anticipation processes

In this regard, the experiments conducted between 2004 and 2008 by a group of cinema researchers and neuroscientists are crucial. In these tests, participants were subjected to Magnetic Resonance during viewing of various types film sequences: frames of Hitchcock (*Bang You're Dead*), Sergio Leone's *The Good and the Bad*, TV frames and, finally, film scenes of a city park (Hassan 26).

The brain activities of each subject were monitored and the results showed highly surprising activation in the area of vision and in the time and sequences activations.

The results show that the cognitive and emotional responses of users are, to some extent, predictable. In a linear trend, tests have shown that the subjects react similarly before highly structured texts, such as the films of Hitchcock, while the simple exposure to filmed images of real life events sequences were not sufficient to obtain verifiable responses of activation in the same neuronal areas; test results in Collective Engagement Power of the images orienting the reactions of the viewers indicated that in the Hitchcock case over 65% of the cortex reacted in the same way, 45% in the Leone, 18% for the TV serial, and less than 5% for the real life film (Hassan 24).

In fact, Hitchcock works are still able to guide the neuronal responses of the audience and provide crucial neuroscientific evidence to explain the success and the emotionally manipulative power exercised by suspense, of which Hitchcock is a master unreachable.

Contrary to many of the realism-oriented art films – that, according to a famous formulation by André Bazin (24), like to leave the viewer free and direct it away using for instruments such as the sequence plan, range focalization, multi-spatial composition, or other agreements to guarantee the viewer a space of judgment – distance and flexible interpretations.

The Hitchcock Hollywood style tends to get the most possible control of the viewer through the use of such filmic conventions as suspense, in which the cognitive and emotional response falls in 'the trap'.

The psychologists believe that the test results obtained permit the formulation of a taxonomy of control operating in the narrative on the mind, where finally we find the vision of real life sequences. At one end, these sequences are unconnected asemantic and inconsistent. At the other end is a strict control so that if it is not accompanied by a tense performance, implied an over- simplification is implied.

The authors add that different styles and genres (drama, thriller, comedy) can activate different areas of the brain even in the presence of the suspense mechanism. This difference may be formed in relation to different segments of the same movie, or even for individual scenes without mounting, or syntax. In Hitchcock's films, for example, sequences longer than two minutes show an increased level on neuronal correlation in subjects toward 2/3 of segment, namely at the climax of the episode, in particular, by activating the dorsolateral prefrontal cortex, the area designated to higher cognitive functions.

Suspense, pleasure and stress: immunoprophylaxis

Recently, suspense seems to have attracted even greater attention of neuroscientists, who in the course of fMRI investigations revealed that the reception of a literary text with a suspenseful structure areas associated with the Theory of Mind and inference are activated. In particular, the medial frontal cortex, the bilateral frontal regions, the lateral premotor cortex, the temporal-parietal and posterior temporal areas) are activated, especially

when the subjects adopted the perspective of the protagonist to infer details of their mental state (Lehne 118).

In other words, it seems that suspense is born and proliferates from the discrepancy among the protagonist's awareness and knowledge of a player forced, at the point, to resort to the Theory of Mind or Mindreading, and a complex game of prediction and anticipation (Jin 142 ss.).

Now neuroscientists have formed a new definition of the suspense phenomenon as an affective state associated with conflict, dissonance, instability and uncertainty activated by the need to create resolution and homeostasis, grant an emotional meaning to events, and direct the processes of anticipation and prediction.

In order to understand the homeostatic power of suspense, scientists refer to anxiety as a kind of surrogate primary emotion of fear, which we feel when facing a dangerous situation during which the brain receives information from external stimuli necessary for an emergency (Koelsch et al. 49 ss.).

The amygdala collects data directly from eyes, mouth, thermal and pressure receptors and compares their input with information already stored in memory and those from the automatic nervous system. Note that this type of feedback is also activated in the states of mental simulation, or memory, imagination or immersion in fictional worlds with risk representations.

The difference between fear and anxiety lies in the value or potential of a hazardous event, in the sense that the first takes over when the danger is imminent, the second when the risk is merely potential.

During states of uncertainty and tension, the central nervous system reacts by releasing hormones that mediate both the immediate response (such as adrenaline and norepinephrine), and medium term response (corticotropin, adrenocorticotropic and cortisol).

While the first group of substances acts at the level of the muscles, through the reaction (fight or flight) or immobilization (freezing), the second acts on the energy reserves, the balance of body fluids and the transformation of complete proteins into simple sugars.

These changes create stress which, as is well-known, can lead to a progressive weakening of the immune system, cognitive and neuro-vegetative activities, but it must be remembered that stress is also a tool aimed at the restoration of an adaptive balance, or rather than the establishment of a new corporal and cognitive asset.

Since the term indicates stress factors that disturbs an initial balance, we might consider any positive or negative event these comes unexpected or new as stress.

It is interesting to note that in scientific language and in standard language, stress terms indicate whether the event that produces the answers in the same sequence, so things could be as follows:

Step 1: the predictive orientation of an initial factor should be considered as a baseline disturbed by a event aimed at generating uncertainty and anxiety

Step 2: the disturbing element is a definable strain, a term borrowed from physics that indicates the degree of deformation of a plane

Step 3: the strain causes stress in the plane

Step 4: the plain tries to resist deformation

Step 5: stress-produced resistance tends to re-establish a balance

If this model has the advantage of showing stress (Macri, Capogrossi, Colognesi 36) – in our case, then suspense – as a factor that helps restore a balance of reassurance for subject can also provide us with an exploration of its genesis. Some kinds of stress, in fact, is capable of enhancing the cognitive abilities and adapting to the situations, promoting alternative life history strategies and therefore making man the most creature ‘plastic’ of the organic world.

In conclusion, suspense gives us a coefficient of lower middle stress that improves the process of memory, make us more alert, creates new categorical connections, enables us to deal promptly with potentially dangerous stimuli and last but not less, helps to protect us from massive doses of stress.

The individual adapts quickly to minor exposures to stress developing a strong reliance, just as an exposure to minor stressful events of acts as a vaccine against actual stress.

In this sense, the pleasure given by the immersion in detective stories, thrillers or other narratives with suspended structure seems to be justified by the value of the adaptive stress, because our brains would exploit the stories to stimulate the tools of Theory of Mind and arouse anxiety only for the purpose of training exercises to simulation and immunophylaxis.

Info-generation of suspense: the aid of neuronarratology

In 2008, researchers at North Carolina State University, the founders of the Liquid Narrative Group, examined the possibility of providing effects of retrospections, also called *prolepsis* or *flashforward*, through devices of Artificial Intelligence (AI), on the assumption that such effects are instrumental to obtaining emotions such as excitement, curiosity and surprise (Bae 159).

Researches began from the canonical distinction including story time (fable) and discourse time (plot), but opposed the distinction between a flashback and foreshadowing. While the latter implicitly alludes to a future event in such a manner that does not allow the reader to know what will happen to the end, the *flashforward* explicitly presents a future event in such a way to tell the reader what will happen in details.

In short, *foreshadowing* is an example of explicitly mentioning in advance, while the *flashforward* is an example of advance information in explicit form, whereby in a movie if the flashforward is usually lighting a backstage or a subplot in support to the narrative main line which the *foreshadowing* provides incomplete or implied.

In the case of incompleteness, it can be understood only retrospectively (this entails a double movement forward and backward). In the case of partial incompleteness, the attention of the reader or viewer tends to be focused on a certain event in order to make him wish that the interactive virtual environments focused on narratives. The interaction with a virtual character activities multiple forms of foreshadowing, that *foreshadowing* of possible outcomes of current actions.

When we read a story, we want not only to gather information but also to be rewarded in some way or stimulate an emotional interest. The psychologist Keith Oatley has identifies internal or external effects generated by the reading of a narrative.

The internal affects are produced through the reader’s empathy with the characters in a story and are always of an emotional type.

The external affects are produced thanks to the readers’ consideration of the text’s enunciation and are always of the cognitive type, such as curiosity and surprise.

On one hand, we have therefore the emotional interest generated by highly structured organization patterns, but it may also be useful to examine the notion of *postdictability*, which contributes to the value of the cognitive interest, with no regard for the type of story told.

Postdictability is a form of systemic understanding and closing of a story when multiple threads are knotted resulting in a compact, uniform «well-warp-tissue»: we could then also translate the word as «macro-structural decoding» (Oatley 29).

Now, as cognitive interest is defined as surprise or curiosity in relation to totally unexpected events, but without any relation to postdictability, cognitive interest cannot take place, as it would fail to build a logical-sequential structure. The Liquide Narrative Group scholars discuss of postdictable surprise (which is AN unexpected form of decoding) as the same condition for a virtuous transgression of the reader's expectation.

In conclusion, considering the perception of surprise evoked by reading suspenseful narratives, the authors attach great importance to the cognitive relevant role which postdictability assumes in our retroactive building of the story.

In fact, the Liquid Narrative Group intend to develop an integrated system for the generation of stories, namely software capable of «creating a sense of inevitability and unity in history anticipation unexpected events» on the system does not have memory (Bae 159).

At this point, the scholars automatically entered moments of flashback and foreshadowing of the stories intended to cause cognitive surprise perceptions in the reader.

It is interesting to note that, for these researches, the software is based on a player model that simulated the reasoning of a 'model-reader' of the story. In fact, because the human skill of planning depends on a set of preferences, constraints on basic and textual knowledge already acquired, and memories of memories, software will take all of this into rigorous account in order to simulate reader inferences..

It should be remembered that the purpose of the Liquid Narrative Group is the computer generation of suspense by using gaming or designing narrative itineraries that can improve cognitive anxiety of users and their 'waiting emotions'.

The system evaluates its effectiveness in producing effects of surprise through the manipulation of event expectations and postdictability by flashback and foreshadowing.

In particular, for these scholars, surprise is characterized by the sudden occurrence of an unexpected turn, when events are presented after the fact, or even omitted – and thus resemble curiosity, with the difference that in this last case the reader is aware of how the initiating events (IE) are absent or not fully described.

As regards the flashback, the software connects a series of crucial events (Significant Event or SE) to the purposes of the fable and identifies the set of initiator events for determining their separation, in order to find the possibility to omit them without creating misunderstandings related to the crucial events (SE) indicated previously.

Next, the software selects initiating events (IE) which are potentially more effective and have lower impact on the narrative rhythm delaying the event time after the appearance of initiating events (IE).

A model of «surprising» story building by software consists of a story in which a criminal named Jack is developing biological weapons and he decides to kidnap the famous scientist Cohen, imprisoning him in the fortress of Skeleton Island (Bae 158-9).

Story background: The criminal known as Jack has been developing biological weapons of devastating proportions. To accomplish the final stages of weapon development, he kidnapped the famous scientist, Dr. Cohen, and brought him to his private fortress on Skeleton Island. Jack expected that the FBI would soon send Smith, their top agent, to rescue Dr. Cohen. To keep the troublesome Smith out of his hair, Jack ordered his own agent, Erica, to monitor Smith and capture him if he is assigned to Dr. Cohen's rescue operation.

Story structure:

- Step 1: Erica installs a wiretap in Smith's home while he is away
- Step 2: Erica eavesdrops on the phone conversation in which Smith is given the order to rescue Dr. Cohen
- Step 3: Erica meets with Smith
- Step 4: Erica tells Smith that her father was kidnapped by Jack and taken to Skeleton Island, and she asks Smith to save her father.
- Step 5: Erica gives Smith the blueprints of Jack's fortress, with her father's cell marked.
- Step 6: Erica provides Smith with a boat for transportation to Skeleton Island
- Step 7: Before going to the island, Smith hides a diamond in his shoe
- Step 8: Smith goes to the port containing Erica's boat
- Step 9: Smith rides the boat to Skeleton Island
- Step 10: Smith sneaks into the cell marked on the map containing Erica's father
- Step 11: Jack and his guard capture Smith as he enters the cell
- Step 12: The guard disarms Smith
- Step 13: The guard locks Smith into the cell
- Step 14: Smith bribes the guard with the diamond in his shoe
- Step 15: The guard unlocks the door
- Step 16: Smith leaves the cell
- Step 17: Smith sneaks to the lab where Dr. Cohen is captured
- Step 18: Smith fights the guards in the lab
- Step 19: Smith takes Dr. Cohen from the lab
- Step 20: Smith and Dr. Cohen ride the boat to shore.

The researchers say such that the steps 7 and 14 are (IE) separable from the crucial event 15 (SE), so their omission does not affect any event preceding step 15.

The reader is, in fact, unaware of the absence of steps 7 and 14 before 15 is executed, so the software confirms their postdicibility checking that the reader cannot infer 15 before seeing 7 and 14.

Only then will a preview partially showing step 7 (minimum allusion, farthest from 15) be implemented, for example, showing only the diamonds or shoes or someone who hides something.

In virtual environments characteristic of interactive videogames, retrospection and anticipation are normally associated with the knowledge of a person moved by the user, who can decide to a degree of explicitness fully satisfying their curiosity and their surprise: exactly what readers of detective stories have tried to do and appreciated since the editorial release of Edgar Allan Poe's tales.

References

Bae, Byung-Chu e R. Michael Young. "A Use of Flashback and Foreshadowing for Surprise Arousal in Narrative using a Plan-based Approach." *Proceeding of the International Conference on Interactive Digital Storytelling (ICIDS08)*. Erfurt: 2008. 156-167. Stampa.

Bazin, André. *Che cos'è il cinema*. Milano: Garzanti, 1967. Stampa.

Calabrese, Stefano. *Neuronarratologia*. Bologna: Archetipolibri, 2009. Stampa.

Fitch, W. Tecumseh, Antje von Graevenitz e Eric Nicolas. "Bio-Aesthetic, dynamics and Aesthetic Trajectory: A Cognitive and Cultural Perspective." *Neuroaesthetic*. Ed. Martin Snov e Oshin Varatarian. Amitylle: Baywood Publishing Company, 2009. 59-102. Stampa.

Fludernik, Monika. *An Introduction to Narratology*. London-New York: Routledge, 2009. Stampa.

Hassan, Uri A., Eunice Yang, Ignatio Vallines, David J. Heeger e Nava Rubin. "A Hierarchy of Temporal Receptive Windows in Human Cortex." *Journal of Neuroscience* 28.10 (2008): 2539-2550. Stampa.

Koelsch, Stephan et al. "The roles of superficial amygdala and auditory cortex in music-evoked fear and joy." *Neuroimage* 81 (2013): 49-60. Web.

Koelsch, Stephan. *Brain and Music*. West Sussex: John Wiley & Sons, 2012. Stampa.

Jacobs, Arthur M. "Neurocognitive Models of Literary Reading." *Gehirn und Gedicht. Wie wir unsere Wirklichkeiten konstruieren*. Eds. Raoul Schrott and Arthur Jacobs. München Hansen, 2011. Simplified English version on ResearchGate. <https://www.researchgate.net/publication/235952745_Neurocognitive_Model_of_Lit_era>.

Jin, Hua, Ho-Ling Liu, Lei Mo, Shin-Yi Fang, John X. Zhang e Chong-De Lin. "Involvement of the left inferior frontal gyrus in predictive inference making." *International Journal of Psychophysiology* 71.3 (2009): 142-148. Stampa.

Lehne, Moritz e Stephan M. Koelsch. "Tension Resolution Patterns as a Key Element of Aesthetic Experience: Psychological principles and underlying brain mechanism." *Art, Aesthetic and the Brain*. Ed. Joseph P. Huston. New York: Oxford University Press, 2014. 122-138. Stampa.

Macri, Sara e Simone Capogrossi Colognesi. *Che cos'è lo stress*. Roma: Carocci, 2001. Stampa.

Oatley, Keith. "A Taxonomy of the Emotions of the Literary Response and a Theory of Identification in Fictional Narrative." *Poetics* 9.23 (1994): 53-74. Stampa.

Pérez, Xavier. *La suspense cinematografica*. Roma: Editori Riuniti, 2001. Stampa.

Rabkin, Eric S. *Narrative Suspense. "When Slim Turned Sideways"*. New York: Ann Arbor, 1963. Stampa.

Rizzolatti, Giacomo, Leonardo Fogazzi e Vittorio Gallese. "Neurophysiological Mechanism Underlying the Understanding and Imitation of Action". *Nature Review Neuroscience* 2 (2001): 661-669. Web.

Todorov, Tvetan. "Structural Analysis of Narrative." *The Norton Anthology of Theory and Criticism*. Ed. Vincent B. Leitch. New York-London, 2001. 2099-2016. Stampa.

Zunshine, Lisa. "Theory of Mind as a Pedagogical Tool." *Interdisciplinary Literary Studies* 16.1 (2014): 89-105. Stampa.