

To avoid any and all post-NCC confounds, we have argued to use inattention paradigms, where a potential NCC can be fully dissociated from cognitive access and attention. In that case, the risk of including unconscious processes is, obviously, even larger, and combining such paradigms with report-based paradigms is even more important.

An alternative promising avenue for elucidating the presence or absence of perceptual states in the cases of full inattention and inability to report [7] are theoretical approaches, such as integrated information theory [8], that should in principle be able to predict the contents of consciousness without relying on report. While such theoretical approaches are still in their infancy, recent approaches have started to test such mathematical formulations against measured neuronal activity [9].

Finally, Overgaard and Fazekas propose to refine post-NCC through manipulation of introspection. We agree that this is a promising idea and we have already highlighted a few methods along this line: (i) varying sensory inputs in subtle ways, such as contrasting between forward versus backward masking at a comparable task performance [10]; (ii) manipulating the history of stimulus presentation using perceptual adaptation, prior exposure of a subset of stimuli, or the order of presentation [11]; and (iii) manipulating decision criterion to report independently of stimulus visibility to disentangle neural processes of perception, decision making, and report [12].

Overall, using no-report paradigms and contrasting them with report-based paradigms gives rise to promising experimental designs to study the NCC that control for some of the major confounds. Importantly, such approaches also ask scientists to pay closer attention to conscious experience or phenomenology itself, rather than taking what subjects report at face value. Without reports, do we

really lose consciousness? Taking phenomenology seriously is the basic and first step towards identifying the neural basis of consciousness.

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## Forum

### Caring About Dostoyevsky: The Untapped Potential of Studying Literature

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**Should cognitive scientists and neuroscientists care about Dostoyevsky? Engaging with fiction is a natural and rich behavior, providing a unique window onto the mind and brain, particularly for mental simulation, emotion, empathy, and immersion. With advances in analysis techniques, it is time that cognitive scientists and neuroscientists embrace literature and fiction.**

Literature has been rooted firmly in the territory of the humanities for centuries. Scholars from the humanities have studied the great works of literary writers, and it may seem unlikely that literature could be part of the academic lexicon of cognitive scientists. In the final part of this paper we argue against an often heard reason against the neurocognitive study of literature, namely that it is technically impossible. We begin by showcasing four subdisciplines of cognitive science for which the study of fiction is relevant and has provided interesting insights. Note that we use the terms ‘fiction’ and ‘literature’ loosely for ease of reading.

#### Mental Simulation of a Fiction World

It is often assumed that we mentally simulate a fictional world [1] (Box 1). For example, it was observed that cortical areas implicated in actual motion perception are also activated when participants read descriptions of motion in a narrative

### Box 1. Mental Simulation and Mental Imagery

An important aspect of (literary) fiction is mental simulation of the content of a story. We follow this definition of simulation: "Process P is a simulation of another process P'. P duplicates, replicates, or resembles P' in some significant respects (significant relative to the purpose of the task)" [12]. The activation of modality-specific cortical regions during reading about sensorimotor content is an example of mental simulation.

Simulation during reading is sometimes described as the evocation of images in the mind, but we believe that an important distinction needs to be made. Visual imagery is the deliberate creation of a fairly detailed image. A classical example is to ask people to close their eyes and take a mental journey through their house, counting the number of doors and windows. This task requires forming a detailed image of the house, which is cognitively costly, and takes too long to be a feasible mechanism during language comprehension.

Instead, in mental simulation during reading we form a much more underdetermined sensorimotor representation, as literary scientists have argued repeatedly. Understanding the nature of mental simulation should be an important research topic for future studies.

[2]. Such mental simulation of sensorimotor language content has been observed repeatedly before, also outside a narrative context. In an important study this view was extended by showing that sensorimotor simulation is stronger during reading of a full narrative as compared to when reading unconnected sentences from the same narrative [3]. This suggests that presenting participants with typical laboratory-based stimuli (single words, sentences) may lead to an impoverished view of mental simulation during language comprehension. It also suggests that using full-fledged narratives to study mental simulation leads to richer results that are more relevant owing to their increased ecological validity.

### Emotions

An important feature of literature is that it evokes emotions in readers and thus represents an ecologically valid stimulus to overcome the language–emotion gap in cognitive-linguistic theorizing [4]. Indeed, several studies found neural and peripheral physiological evidence for emotional responses during reading and listening to fiction [5]. Evoking strong and complex emotions via narrative is a step forward from the use of more simplistic isolated stimuli (e.g., single words, pictures, or faces) and may help to solve the intriguing issue of commonalities and differences between 'real world' feelings and those generated through reading fiction.

### Mental Perspective Taking and Empathy

It has been postulated that a core function of fiction is to train social abilities [1]. This idea is rooted in the fact that engaging with fictional characters allows one to see the world through the eyes of someone else. Children also learn to understand intentions and beliefs of others by being the observer in a fictional world, which can be a benefit in the real world [6]. Using short narratives and functional near infra-red spectroscopy (fNIRS) to study the development of cognitive and affective empathy in children aged 4–8 years, it was found that empathizing with a character not only entails understanding why the other person is happy or sad, but also the ability to experience these emotions with her or him [7]. The observed brain activation in medial and bilateral orbitofrontal cortex suggests a possible neural underpinning of the positive effect of fiction reading on performance in mentalizing tests [6]. Another recent experiment used functional magnetic resonance imaging (fMRI) and excerpts of fiction to study individual differences in mental perspective-taking and sensorimotor simulation during language comprehension in adults [8].

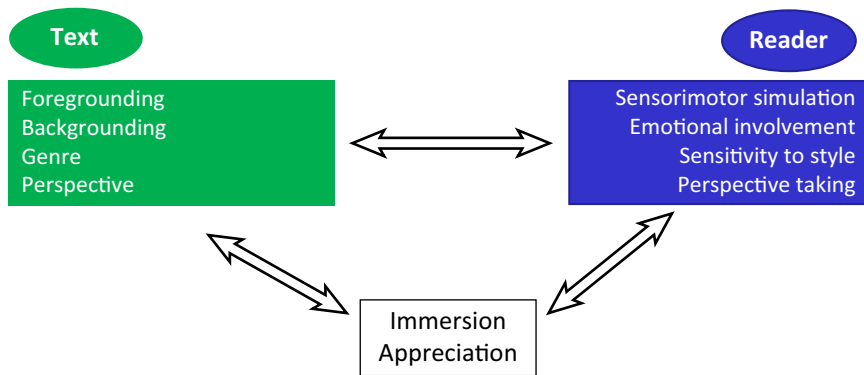
### Immersion

Mental simulation of fictitious events, and empathy or vicarious feelings for fictitious characters, all seem to contribute to what is a most intriguing phenomenon associated with fiction: immersion [4]. Readers

can become so lost in a story that the world around them disappears for some time. This experience is one of the primary reasons we buy and read books. Recent experiments using narratives have begun to uncover the neural correlates of immersive processes. For instance, increased activity in mid-cingulate cortex was interpreted as meaning that immersion is related to the motor component of affective empathy [9]. Such studies can motivate follow-up research on mental states associated with potentially addictive activities such as playing video games or engaging in virtual reality.

### Is Studying the Brain Basis of Literature Feasible?

It is a commonly held belief among cognitive scientists that 'we would like to study the neural basis of what happens when we read literature, but this is technically impossible'. One concern is the quasi-experimental nature of studying literary reading. Researchers typically do not alter literary texts, in order not to make crucial changes to the carefully crafted original [10]. This is in contrast to most cognitive neuroscience experiments in which the variable of interest is manipulated in the materials. Instead, in the study of literary texts researchers rely on the natural occurrence of the phenomena of interest. What the best way is to strike the optimal balance between ecological validity (not altering literary texts) and experimental control (explicitly manipulating the factor of interest) is a matter of continuing debate. Instead of absolutely advocating one approach over the other, we want to stress the need for converging evidence from both approaches. Findings from more typical laboratory-based studies would ideally complement findings using literary texts. Another concern is the sluggish nature of the blood oxygenation level dependent (BOLD) signal measured with fMRI. Typically, relatively long delays are inserted between stimuli to account for this delay. Pioneering work in the past decade provides many examples of successful study of neural signals in response to



## Trends in Cognitive Sciences

**Figure 1. A Rough Sketch for the Empirical Study Of Literary Reading.** Literary reading can be most fruitfully studied empirically by viewing it as an interaction between text features (left) and features concerning the reader (right). We list some of these features as examples, a list which is intended only as an illustration and by no means aims to be exhaustive. 'Foregrounding' and 'backgrounding' refer to the use of stylistic elements in literary writing. The main tenet of the research scheme is to use empirical methods to obtain a better understanding of how text- and reader-related factors work together to influence immersion and appreciation of literary works.

continuously presented stimuli, making this concern less serious than one may think [11].

### Concluding Remarks and Future Directions

We feel that the future is bright for a cognitive neuroscience perspective to literature. Not only would the cognitive neuroscience study of literature increase our understanding of a fundamental human behavior – engaging with narrative – but it would also provide richer and ecologically more valid insights into already studied cognitive and affective processes, their development, and inter-individual differences (Figure 1). This being said, the current state of the field is one in which the finesses of literature are not considered seriously enough. For instance, studies have used a wide range of texts, ranging from fairy tales to teen fiction, poems, and parts of literary novels. Together with the limited focus on particular aspects of fiction (sensorimotor simulation, emotions), it is an understatement to conclude that the research so far has not done justice to the richness of literature. A full picture of the story-liking nature of the human mind calls for a much more intimate collaboration between cognitive scientists and scholars in the humanities (e.g., [5]). It

requires that scientists not be guided by the traditional division between academic cultures, but to be united in their common goal to understand the workings of the human mind. In closing, cognitive neuroscientists should start caring about Dostoyevsky and other ingenious writers, and take advantage of the strong human affinity for narrative.

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## Spotlight

### Is Birdsong More Like Speech or Music?

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Music and speech share many acoustic cues but not all are equally important. For example, harmonic pitch is essential for music but not for speech. When birds communicate is their song more like speech or music? A new study contrasting pitch and spectral patterns shows that birds perceive their song more like humans perceive speech.

Human speech is a complex acoustic signal containing amplitude, timing, and spectral cues. Which of these cues are most important for speech recognition? Research with cochlear implants (an auditory prosthesis for the deaf) has shown that speech recognition only requires a small subset of the acoustic cues. Although speech and music share many acoustic features, we now know that music requires a different set of acoustic