

Literary Fiction's Influence On Social Cognitive Brain Activity

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Abstract

We think of reading fiction as mainly entertainment, but a recent study (Kidd & Castano, 2013) found that literary fiction, in comparison to popular fiction or nonfiction, improves Theory of Mind (ToM) skills in adults. ToM refers to the ability to accurately ascribe, predict, or understand others' perspectives, intentions, beliefs, mental states, and actions. The present study extends the previous research by examining the neurological aspects of ToM after exposure to literary or popular fiction using EEG analysis. Directly after reading either a popular fiction or literary fiction short story, college students engaged in an EEG task to measure neural activity. The results suggest that the brain areas involved in ToM skills are significantly more active not only while reading, but for some time after exposure to literary fiction compared to other types of writing. Implications of my research include the importance of reading for social cognitive development in early education and beyond, as well as potential benefits for individuals with social cognition disorders, such as those with autism spectrum disorders. No prior research has demonstrated the impact of reading literature on brain activity with respect to social cognition (e.g., Theory of Mind). This research is significant in that it ties a behavioral finding of improved social cognition after reading literature to an expansive set of neuroimaging studies related to the brain areas involved in social cognition.

Keywords: Theory of Mind, literary fiction, mirror neurons

1. Introduction

When reading literary fiction, individuals engage in the characters' lives and become subjective participants in the development of the characters' psyche, point of view, and actions (Giovannelli, 2009). The extent to which this occurs depends on how actively the reader is engaged (Barthes, 1974). Whereas the purpose of popular fiction, such as romance or adventure novels, is mainly to passively entertain readers, literary fiction aims to actively engage readers by requiring them to make inferences and attributions about characters' behaviors and thoughts (Bruner, 1986). Recently, Kidd and Castano (2013) found that engagement with literary fiction, compared to nonfiction or popular fiction, improves readers' ability to infer the beliefs and intentions of others, which is referred to as Theory of Mind (ToM). Theory of Mind skills, which include accurate interpretations and empathy toward others' intentions, beliefs, and emotions, are thought to originate in the mirror neuron system of the brain (Uddin, Iacobini, Lange, & Keenan, 2007). The present study examined how reading fiction (literary and popular) influences adults' Theory of Mind abilities through activation of mirror neurons as measured by mu-wave activity in the brain. Students in this study read a literary or popular short story before their brain activity was monitored by electroencephalograph (EEG) to measure mirror neuron activation. Our hypothesis was if the reader engages and identifies with a literary passage, mirror neurons would become active and influence subsequent ToM performance. The results indicate a significant suppression of Mu-wave activity in the central area of the brain after reading literary fiction. This project integrates the disciplines of English, psychology, and neuroscience by examining the psychological (Theory of Mind) and neural (mirror neurons) effects of literary reading, which may suggest interventions relevant to education and therapy.

2. Description

Literature allows the reader to engage mentally in behavior and actions outside of their personal lives or capabilities. Through reading, individuals become subjectively involved with the development of characters' personalities, actions, and points of view (Giovannelli, 2009). According to Barthes (1974) the extent to which this occurs depends on whether the genre of the material is "readerly" or "writerly." Whereas the general intent of readerly fiction, such as popular romantic and adventure best-sellers, is to entertain passive readers, writerly or literary fiction aims to actively engage readers by requiring them to consider multiple perspectives and to make inferences and attributions about characters' behavior and thoughts, which may run counter to stereotyped and scripted behavior (Bruner, 1986). Indeed, Miall and Kuiken (1994; 1999) argue that literary fiction, such as literature recognized by prestigious awards (e.g., the National Book Award; the Man Booker Prize) "defamiliarizes" the reader by disrupting and challenging existing expectations and thinking. Thus, literary fiction requires readers to actively consider alternative meanings and unfamiliar points of view and perspectives in order to understand characters' beliefs, feelings, and actions. Of interest in this research is how readers' mental engagement in literary fiction occurs at both the psychological and the neural levels and how, in turn, exposure and experience with literary fiction may influence adults' ability to identify and understand other individuals' thoughts and emotions.

In a recent study, Kidd and Castano (2013) questioned if reading literary fiction, which frequently requires making inferences about characters' thoughts, intentions, and actions, would improve readers' understanding of another individuals' thoughts and emotions. Psychologists refer to the ability to ascribe, predict, or understand others' perspectives, intentions, beliefs, mental states, and actions as Theory of Mind (ToM). Since we do not have direct access to the mind of another, ToM allows us to form predictions and understanding of another's subjective state and is believed to be crucial for the empathic responses needed to engage successfully in interpersonal interactions and complex social relationships (Astington, & Jenkins, 1995). Theory of Mind has been found to develop through exposure and practice observing and interacting with others, such as through play and social activities (Bretherton & Beehly, 1982). Kidd and Castano (2013) reasoned that engagement with literary fiction may increase our ability to understand others' intent, beliefs, and actions since reading requires consideration of multiple perspectives and judgments about others' subjective states, all of which involve ToM abilities. They hypothesized that ToM would be more enhanced by the active reading of literary fiction, in contrast to the more passive engagement required to comprehend nonfiction or popular fiction. Their findings indicated that reading literary fiction, in comparison to the other genres, enhanced both cognitive and affective ToM, specifically the ability to infer accurately others' beliefs and intent as well as the ability to identify others' emotional states. Furthermore, the more readers reported engagement in the readings, the greater the impact on their subsequent ToM performance.

The present study examines how reading fiction (literary or popular) influences adults' cognitive and affective Theory of Mind abilities through activation of mirror neurons as measured by mu-wave activity in the brain. Research with humans suggests mirror neurons not only have evolved for the physical aspects of actions, but also for understanding others' intentions, thoughts, and feelings (Molenburghs, Cunnington, & Mattingley, 2012; Oberman, et al. 2007; Uddin, Iacoboni, Lange, & Keenan. 2007). These specialized neurons are activated not only when executing an action, but also while observing that action performed by another. To investigate mirror neuron activation in humans, researchers have used electroencephalography (EEG) to measure mu frequency band oscillations. Mu suppression as an indication of mirror neuron activity is supported by physiological and anatomical evidence (Oberman et al., 2007). Thus, changes in mu suppression allowed for a non-invasive method to assess mirror neuron performance. This study incorporated the same methods used by Kidd and Constano (2013) but additionally assessed mirror neuron activity as measured by mu-wave suppression after exposure to literary fiction or popular fiction to explore the neural basis for the enhancement of ToM abilities. I hypothesized that reading literary fiction will lead to more mu wave-suppression and better Theory of Mind performance compared to reading popular fiction, thereby linking ToM performance to its underlying neural substrate.

3. Methods

Thirty-one undergraduates (14 male; 17 female; age $M = 20.83$, $SD = 0.64$) read either a popular or literary fiction short story directly completing a face-emotion recognition task to engage the MNS, while using EEG to measure MNS activity, followed by assessments of ToM. Participants were first administered a version of the Questionnaire of Cognitive and Affective Empathy (Reniers, Corcoran, Drake, Shryane, & Vollm, 2011), retitled as Attitudes About

Others and Different Situations. The questionnaire consists of 31 four-point Likert scale items that ask participants to assess how others' perspectives or affect influence them and how well they understood others' cognitive and affective states before participating in this study (baseline empathy scale). Participants read either a popular or literary short fiction story. Directly after reading the randomly assigned story participants engaged in an EEG Mu-wave suppression task to measure mirror neuron activity. A 32-Channel Biosemi EEG was used for collecting Mu-wave suppression data. For the Mu-wave suppression task, each participant watched five-second movies of females making either sad or happy faces. Participants determined if positive or negative was presented and pressed a key indicating their decision. The percent change of Mu-wave suppression was individually analyzed from baseline task that showed consecutive sets of rotating, grey geometric shapes; MNS should not be activated for this task. Of interest was the variation across the two different types of fiction in the amount of Mu-wave suppression as an indication of mirror neuron activity.

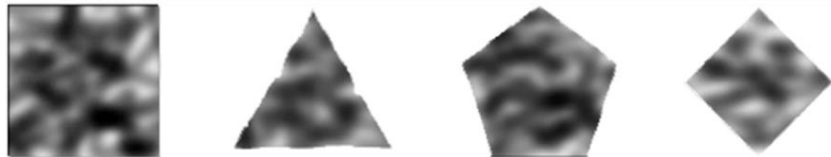


Figure 1: Mu-wave suppression baseline task.

Participants were also administered tasks to assess affective Theory of Mind by engaging in a Reading the Mind in the Eyes Test (RMET), and a Yoni Test for testing cognitive and affective ToM. In the “Yoni” ToM task (Shamay-Tsoory & Aharon-Peretz, 2007), a series of 48 scenarios were presented, each of which contained four images surrounding a central figure (named Yoni) and participants, using visual cues indicated by the depiction of Yoni (such as direction of gaze), were asked to choose one of the four images that best reflects Yoni’s cognitive or affective state by clicking on a computer screen. To further assess affective ToM, participants were also be administered the Reading the Mind in the Eyes Test (RMET) (Baron-Cohen, Wheelwright, Hill, Rast, & Plumb, 2001), consisting of 36 trials, in which participants identified which of four emotions is expressed in an image displaying only the eyes of an actor. Participants were also administered questionnaires to assess engagement in the readings and familiarity with authors.

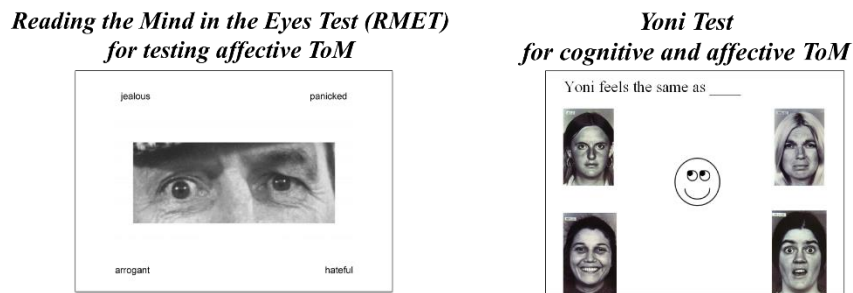


Figure 2: Example of the RMET and Yoni test.

3.1 EEG Analysis

EEG task was analyzed using fast-Fourier transform to produce a spectral density plot. The Mu-wave power was assessed as area under the power spectral density between 8-13 hertz. The Mu-wave power was averaged over regions of cortex, forming several regions-of-interest (ROIs): frontal, central, posterior, and occipital.

4. Results

Results revealed that students assigned to the literary fiction condition had a significant difference in MNS activity in the frontal and central regions of the brain when completing the facial recognition task, whereas students in the popular

fiction condition did not show this increase in MNS activity. This research ties an important set of behavioral findings of improved ToM after reading literary fiction to an expansive set of neuroimaging studies related to brain activity underlying social-cognitive abilities. Implications include the importance of reading literature for social-cognitive development as well as the potential to benefit individuals with social cognition disorders, such as those with autism spectrum disorders.

Mu-Wave Activity During Facial Expression Task

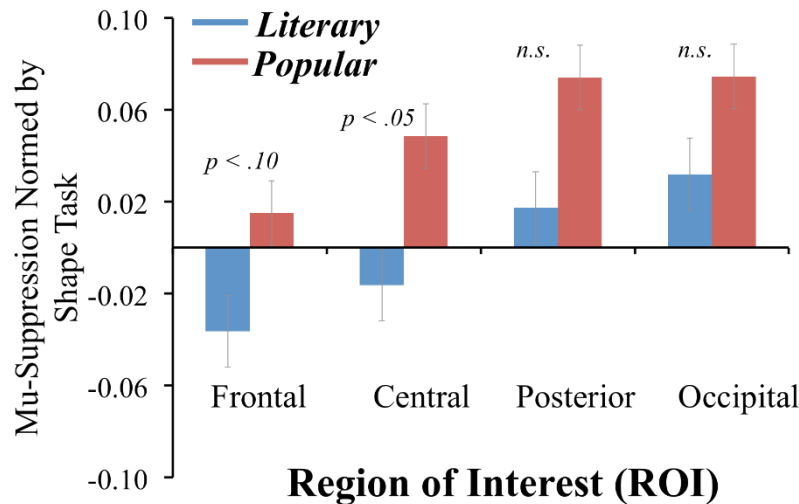


Figure 3: The results indicated that participants in the literary fiction condition had a significant increase in MNS activity in the frontal and central regions of the brain. These results suggest that the brain areas involved in ToM skills are significantly more active not only while reading literary fiction, but for some time after exposure when compared to other types of writing.

5. Conclusion

Participants who read a literary fiction short story showed significantly more Mu-wave suppression over the central area of the brain compared to those who read popular fiction. These results suggest an increase in MNS activity after reading literary fiction compared to after reading popular fiction. The data thus far support our hypothesis that reading literary fiction increases MNS activity, and that this may underlie the improved ToM performance seen in prior studies (e.g., Kidd & Castano, 2013). It’s speculated that literary fiction actively requires readers to make inferences and attributions about the characters, whereas popular fiction passively entertains readers (Bruner, 1986). The emphasis on character development in literary fiction requires increased engagement and may be responsible for improvement on ToM tasks as well as increased MNS activity. Further, Mikhail Bakhtin asserts that literary fiction is polyphonic and suggests that readers of literary fiction are required to contribute their own voice to a cacophony of possible speakers. As a result, the absence of a distinct authorial perspective causes readers to engage in creative discourse with the character, which may be a contributing factor to readers’ increased empathetic response that’s been measured via MNS activation.

The improvement in ToM tasks (Kidd & Castano, 2013) and increased MNS activity occurs after reading a single short story and appears to last at least an hour. The questions remain of could improved ToM and corresponding MNS activity after frequent reading of literary fiction have long-term effects? Further, would exposure to literary fiction benefit those with social cognitive deficits, such as individuals diagnosed with autism spectrum or social communication disorders? And could literary texts be developed for the therapeutic purposes to improve ToM? The latter question is being addressed through the continuation of this study at the University of Puget Sound, conducted by Cadwell and faculty advisors Dr. David Andresen, Dr. Siddharth Ramakrishnan and Dr. Michael Benveniste. They are investigating the composition of “literary” compared to the “popular” fiction genre in a study that focuses on digital analyses of the literary texts while integrating computer science techniques and neurolinguistic theory.

Applications of these findings support the importance of interdisciplinary collaboration that may help individuals with social deficits and suggests an emergence of new writing positions for creative fiction authors.

6. Acknowledgments

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