Exploring the Mystery of Literary Reading: A Psychophysiological Perspective

Hui Wei Lin and Mei Hua Hsu

***Abstract*—To understand the neural processes involved in reading literary texts, we use a four-channel neurofeedback device to measure brain activities in subjects. Among the 22 subjects, 11 were teachers of English (expert reader group) and 11 were students (novice reader group). Following a repeated-measures design in which each subject was instructed to read silently three different texts (two non-literary and one literary) at ordinary speeds, we record the EEG measure and explore changes in brain wave patterns that may correspond to a specific phenomenology of literary experience. Some preliminary findings are presented and discussed in terms of how neuroscience helps to explain the mystery behind reading literature.**

***Index Terms*—Cognition and emotion, brain waves neurofeedback, literary reading.**

I. Introduction

Literature's power to elicit emotions, energize bodily senses, entertain and heal has been recognized for long by civilizations around the world, yet it remains a mystery. Literature is one of the language arts whose educational gains may be the least tangible to observe. Subtle internal changes (e.g. empathy, catharsis), which may happen within a fraction of second, are not easily discernible. As Burke (2011:1) puts it aptly, 'the process essential to the reading mind are not mechanical or computational, but more oceanic, that is, dynamic, fluvial, and fluctuating.' This private act of reading makes the assessment of literary responses one of the most consistently elusive issues in the field of literary studies. Over the last 20 years more insight has been gained, especially with advances in neuroscience. A significant amount is being learned about the neurology of the felt experience. For example, with the aid of brain imaging, Davis's (2006) neuro-linguistic experiments revealed interesting neurological effects in reading Shakespeare. Several empirical studies, such as those conducted by Zwaan (1991; 1993), Miall (1995; 2002) and Robbins (2008), have cast light on the process of literary reading. However, the gulf between literary scholarship and empirical studies of literary reading remains wide, and thus a meeting of minds and methods is called for to benefit of all concerned. In order to arrive at more substantive explanation of such oceanic-like mechanisms, we try to provide some possible answers from a neuro-feedback paradigm: by observing real-time multimedia representations of the electrical activity generated by the brain that reflects precisely the nature of literary reading. Starting from the question-what types of brain waves (e.g. alpha, beta, or theta, etc.) are activated during the engaged act of literary reading, the study aims to explore what (if anything) is unique to literary processing. Another aim of this study is to investigate whether there is a difference in the neural activation taking place between expert and novice readers.

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II. Materials and Methods

A. Subjects

A total of 22 subjects were included in the study: 11 subjects (EXPERT; male, 4; females, 7) aged 33–51 years and 11 subjects (NOVICE; males, 3; females, 8) aged 18–26 years participated in the experiment. The expert group consisted of teachers of English, while the novice group consisted of college students with majors in English and in Pharmacy.

B. Stimuli and Tasks of Reading

To perform this study, we presented 3 different texts of similar lengths (each of about 300 words), of which 2 were non-literary in nature. They included a brief scientific report 'Bat Signal' taken from *Newsweek* (Text1: Non-literary), an excerpt from Shakespeare's *Romeo and Juliet* (Text2: Literary), and an article from a university prospectus entitled 'Canberra--Australia's national capital' (Text3: Non-literary). The texts were printed in their original graphology and the subjects were instructed to read these texts at a natural speed. After reading the first text, they were instructed to have a short break of one minute before turning to the next page to read the subsequent text.

C. Data Acquisition

The internationally standardized 10-20 system is employed to record the spontaneous EEG in the experiment. In this system, 21 electrodes are located on the surface of the subject's scalp, as shown in Figure 1. As there were only four EEG channels of the device (NeXus-10), bipolar electrodes were used and placed on Fp1, Fp2, T3, T4 positions to measure neural activity taking place. In addition, all subjects are connected to skin electrodes to measure their galvanomic skin response (GSR).

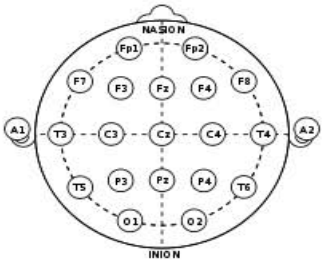

Fig. 1. The location of scalp electrodes on top of the head

D. Data Analysis

SPSS 11.0 software was used to analyze the EEG data. For answering the questions that interest the present study, *t*-test was used to see if significant differences were present in the brain wave patterns between experts and novices. One-way ANOVA was also conducted to compare differences in the subjects' brain waves while processing the three separate textual sources.

III. Results

Q 1: What types of brain waves (e.g. alpha, beta, or theta, etc.) are activated during the engaged act of literary reading? Are certain wave patterns systematically observable during the process of reading literature?

TABLE I: Descriptive Analysis of Brain Waves in the 3 Texts

	Text 1	Text 2	Text 3	Mean
Right hemisphere				
theta	5.6505	5.7768	5.6268	5.6874
alpha	4.6364	4.7414	4.7200	4.6992
SMR	4.0114	4.3155	4.3855	4.2374
beta	8.1055	8.9932	8.9786	**8.6924**
Left hemisphere				
theta	5.8282	6.0450	5.9809	5.9514
alpha	4.4900	4.7623	4.7859	4.6794
SMR	3.4777	3.6036	3.5836	3.5550
beta	6.4955	6.8718	6.5727	**6.6467**
Central				
C-theta	6.5486	**10.4741**	6.3336	7.7855
C-alpha	3.9386	**5.9286**	3.9723	4.6132
C-SMR	2.7982	**4.2177**	2.9791	3.3317
C-beta	2.8218	**4.0941**	3.0782	3.3314
Mean	4.9002	**5.8187**	5.0831	
GSR	3.3677	3.5773	3.7445	3.5632

For answering this question, one-way ANOVA was performed to observe the mean differences of brain waves while reading the 3 articles. The analysis revealed no significant differences in the types of brain wave, nor did we find any significant difference in GSR. However, from the descriptive analysis of the dependent variables, some interesting findings are worth mentioning (see Table I). First, it was found that when subjects were reading these texts, the beta wave band in both hemispheres of the subjects' brains seemed to be more activated than with other brain waves. Second, as can be seen from the mean score for processing each text, more neural activation was observed when subjects were reading Text 2 (Romeo and Juliet). Additionally, the frontal lobe was more active than the left and right brain when subjects were engaged in reading Text 2.

Q2: What may be observed regarding the literary experience of the expert readers, in contrast to the novice readers?

Independent *t*-test was employed to compare the means of brain waves observed in the expert and novice readers. Comparison showed that (see Table II) there were some significantly different performances. Among these, experts showed more theta wave activity of their right brain than novices in all reading (t=2.783, p<.01); novice readers used significantly less theta and alpha wave of their left hemisphere than experts (t_{theta}=-2.114; t_{alpha}=-2.388, p<.05). Moreover, experts as a whole exhibited stronger Sensory Motor Rhythm (SMR) and beta wave activity in their left brain than novices did (t_{SMR}=2.951; t_{beta}=2.769, p<.01). Finally, it was detected that the skin conductance response in expert readers was markedly lower than novices during the course of reading (*t*=-2.306, p<.01). However, the activity in the frontal lobe showed no significant difference between experts and novices.

TABLE II: *T*-Test Analysis of Brain Waves of Experts' and Novices

	N	M	SD	t
R-theta				
Experts	11	6.0488	1.3098	2.783**
Novices	11	5.3206	.7349	
L-theta				
Experts	11	6.2888	1.4798	2.114*
Novices	11	5.6139	1.0839	
L-alpha				
Experts	11	4.9897	1.1682	2.388*
Novices	11	4.3691	.9294	
L-SMR				
Experts	11	3.9976	1.5483	2.951**
Novices	11	3.1124	.7559	
L-beta				
Experts	11	7.7979	4.4883	2.769**
Novices	11	5.4955	1.6363	
GSR				
Experts	11	2.8624	2.0714	-2.306**
Novices	11	4.2639	2.8110	

Note: * p < .05; * * p < .01; * * * p < .001

TABLE III: T-Test Analysis of Brain Waves Shown by Expert and Novice Readers in Reading Text 2

	N	M	SD	t
L-alpha				
Experts	11	5.2055	1.1304	**2.042**
Novices	11	4.3191	.8910	
L-SMR				
Experts	11	4.1764	1.5716	2.266*
Novices	11	3.0309	.5828	
L-beta				
Experts	11	8.4300	4.9297	**2.014**
Novices	11	5.3136	1.4257	

Note: * p < .05; * * p < .01; * * * p < .001

Independent *t*-test was also used to examine differences of distinctive brain waves between experts and novices while reading the first, second and third texts. Analysis shows no significant expert-novice difference between the first and third articles. However, it differed significantly from the processes manifested by reading the second text (see Table III): experts produced stronger SMR on the left brain than

novices (t=2.266, p<.05). Moreover, the usage of alpha and beta waves of left brain was almost significantly different between expert and novice readers (t_{alpha}=2.042; t_{beta}=2.014, p<.06).

IV. Discussion

When we speak of *experiencing* feelings, we usually speak of how we become *aware* of these feelings and not of what feelings initially are: that is, the neural activity taking place in the brain. It is evident from the present experiment that certain brain waves capture empirically what is distinctive to literary processing, given that a specific literary text may call for a mode of response unique to that text. It might be theorized that once a literary work has been recognized, the neurons in the readers' brain activate a distinctive form of processing. As proposed similarly by Zwaan (1993: 31), there is a "literary control system" governing and regulating the processes. Seen in this light, it might be hypothesized that the higher beta and theta amplitudes found in expert readers may be representative of such a subtle activation of schemata. Theta waves, in particular, are associated with creativity and spontaneity (Demos, 2005). Thus, we proposed that when expert readers began to read Text2, they might be initiating an inferencing process in response to the occurrence of textual complexity and foregrounding features. As Miall (2006) has also noted in his experimental study on the experience of literary reading, the presence of foregrounding correlates with readers' rating of feeling. Potentially, the signals from the brain speak directly to and about the relevant information about the mind's processes. Notwithstanding, it is how to decipher and find meaning in the patterns of brain activity and then relate them to literary experience that remains a largely uncharted area. The present findings seem to point us towards a route worth taking: the application of a psycho-physiological method to the interpretation of literary experience commonly discussed in cognitive poetics so that it will, perhaps, assist us in verifying numerous theoretical claims.

V. A Preliminary Conclusion

If we claim that reading literature performs some function for us that no other experience can provide then it is desirable to obtain objective data from empirical observations and measures to explain the unique aspect of this phenomenon. The neuro-physiological findings show how it is possible to bring measurement and objectivity to the study of the engaged literary mind, which renders the conscious experience of literature to be one that seems intangible, incomplete, beyond our grasp, yet imbued somehow with personal meaning. In this respect the application of EEG in empirically literary studies has a valuable role to play—enriching the old hermeneutic mode of textual interpretation. From a practical point of view, it is essential to examine whether we can take advantage of these technological advances in order to improve teaching, a concept echoed by Dehaene (2009). It is important therefore to note that investigating the phenomenon for its own sake to understand its processes is but one step from truly valuing literary reading processes. This step also leads to an examination of the conditions under which literary reading takes place in education with a view to improving them. How we capitalize on these scientific insights takes on a new significance, as they may drive change in the brain and maximize the reading performance of ordinary readers. Our hope is that, in due course, research on the scholarship of teaching, literary discourse, and neuroscience will merge into one unified science of reading. Only then may we be able to argue forcefully about the ways literature instruction triggers catharsis and create change in humanity through ethos, pathos, and logos.

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