行政院國家科學委員會專題研究計畫 成果報告

理性與感性：文學閱讀歷程之心電感應
研究成果報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 100-2410-H-041-006-
執 行 期 間 ：100 年 08 月 01 日至 101 年 07 月 31 日
執 行 單 位 ：嘉南藥理科技大學應用外語系

計 畫 主 持 人 ：林揮偉

計畫參與人員： 大專生-兼任助理人員：徐于雯

公 開 資 訊 ：本計畫涉及專利或其他智慧財產權，2 年後可公開查詢

中 華 民 國 101 年 10 月 08 日

中 文 摘 要 ： 用科學的實證角度，探究文學閱讀歷程中腦波變動的機制和意義。從神經學的研究切入，我們可以更深入了解，閱讀文學作品時，讀者腦波是否會有變化以及是否有啟用特殊機制。假如教育的目的是促使學生有效學習，那麼我們應該可以透過腦科學研究，啟動學生的最佳生理狀態以增進學習成效。本研究認為，透過生理回饋（biofeedback）所蒐集之腦波及生理資料，我們不但可以看見閱讀文學作品時所產生的內在現象，甚可進一步訓練讀者演化出積極回應文學作品的思維方式、改變內在神經的閱讀機制，以使得閱讀文學的迴路更為活化，如此一來，文學作品將可以帶給讀者更多「理性的」以及「感性的」心電感應。

中文關鍵詞： 文學閱讀歷程，腦波變化，生理回饋，文學感受力

英 文 摘 要 ： To understand the neural processes involved in reading literary texts, this study uses 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, the experiemnt recorded the EEG measure and explored 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.

英文關鍵詞： neurofeedback, literary reading, literary awareness, cognition and emotion, brain waves

Sense and Sensibility: a Neurofeedback Approach to Literary Responses

Hui Wei Lin

Abstract. To understand the neural processes involved in reading literary texts, this project used 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, the experiment recorded the EEG measure and explored 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 the act of reading literature.

Keywords: neurofeedback, literary reading, cognition and emotion, brain waves.

1. 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 (2007) 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.

2. Materials and methods

2.1 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.

2.2 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.

2.3 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).

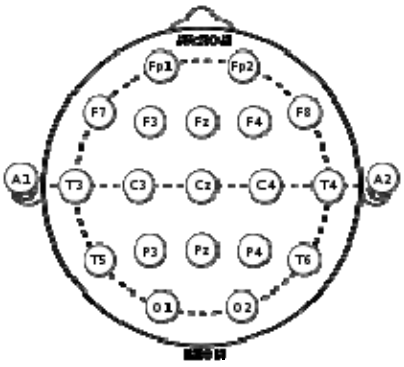

Fig. 1: The location of scalp electrodes on top of the head

2.4 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.

3. 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?

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 Table1). 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.

Table 1 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

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 2) 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 2 *t*-test of brain waves of experts' and novices

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

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 3): 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).

Table 3 *t*-test of brain waves shown by expert and novice readers in reading Text 2

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

Note: $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

4. 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.

5. **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.

6. References

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國科會補助計畫衍生研發成果推廣資料表

日期:2012/09/20

國科會補助計畫	計畫名稱: 理性與感性：文學閱讀歷程之心電感應
	計畫主持人: 林揮偉
	計畫編號: 100-2410-H-041-006- 學門領域: 英語能力研究

無研發成果推廣資料

100 年度專題研究計畫研究成果彙整表

計畫主持人：林揮偉	計畫編號：100-2410-H-041-006-
計畫名稱：理性與感性：文學閱讀歷程之心電感應	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	本計畫已將部分之研究發現整理並投稿至 2012 2nd International Conference on Languages, Literature and Linguistics-ICLLL 2012。文章名為 Exploring the Mystery of Literary Reading: A Psychophysiological Perspective 已獲得大會接受發表 。 另，目前已匯整本計畫所獲得之更詳盡研究發現，並撰寫一文投搞至 Researching the Reading Conference, June 11-12, 2013 in Oslo, Norway.

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)

在人類文明發展過程中，文學作品一直蘊含觸動情感、激發人心、療癒心靈以及改變人類思維的魔力。然而，在語言學習的範疇中，文學教育所賦予的學習成效，卻難以捉摸。在閱讀文學作品歷程中，讀者的「神入」(empathy）或是讀者感受到的「洗滌淨化」(catharsis)，皆不易觀察，更不用說是去量化這些心理層面之感應。所幸腦科學知識的普及與電腦科儀之快速發展，我們得以窺探大腦中神經元集體（neurons）種種活動。這項突破使我們更清楚地了解到大腦的秘密。本計畫從科學的實證角度，探究了文學閱讀歷程中腦波變動的機制和意義。從神經學的研究切入，我們可以更深入了解，閱讀文學作品時，讀者腦波的變化以及特別發達的波段與顯著的生理變化。教育的目的之一是促使有效學習，本研究結合人文與腦科學研究，探究閱讀文學讀本時的生理狀態並從此發現中，找出腦波變化的深層意義，期能了解背後機制運作，以應用於提升學習與閱讀成效。本研究指出，透過生理回饋（biofeedback）所蒐集之腦波及生理資料，我們不但可以看見閱讀文學作品時所產生的內在現象，甚可進一步訓練讀者演化出積極回應文學作品的思維方式、改變內在神經的閱讀機制，以使得閱讀文學的迴路更為活化，如此一來，我們將可以解釋，文學作品到底是如何帶給讀者「理性的」以及「感性的」心電感應。這樣的研究成果將幫助相關研究領域(如 cognitive stylistics, empirical study of literature)做進一步的躍進。