行政院國家科學委員會補助專題研究計畫成果報告

以注意力實驗檢測產品的造形表現力和內涵深度

計畫類別：個別型計畫
計畫編號：NSC97－2221－E009－049－MY2
執行期間：97 年　08 月　01 日 至　99 年　10 月　31 日

執行機構及系所：

計畫主持人：林銘煌 副教授
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成果報告類型(依經費核定清單規定繳交)：完整報告

本計畫除繳交成果報告外，另須繳交以下出國心得報告：
■出席國際學術會議心得報告

處理方式：除列管計畫及下列情形者外，得立即公開查詢
□涉及專利或其他智慧財產權，□一年□二年後可公開查詢

中　華　民　國　99　年　10　月　31 日

ABSTRACT

ERPs were examined by showing the various pairs of pictures of tables and chairs to eighteen healthy participants. The pictures were selected and divided into four chair types based on design expertise: Normal, Minimal, ReadyMade, and Deconstruction. In the sequent trials, the typical tables (normal) were matched to four styles of chairs randomly. It recorded participants' semantic matching performances and reaction time to examine the degree of conflict and observed the semantically unmatched response.

Behavioral results exhibited that the groups with both less match degree to normal table and shorter reaction time in order were Deconstruction-Unmatched, ReadyMade-Unmatched, Minimal-Unmatched, and Normal-Matched chairs. ERP result displayed that Minimal-Unmatched (combination of found objects) reached N400 maximum amplitude than others at anterior and central scale regions. Deconstruction-Unmatched (non-rectilinear shapes serve to distort, deform and dislocate elements or structure) activated the greatest late positive component (LPC) than others at anterior, left posterior and right posterior scale regions. There was no significant effect between Minimal-Unmatched (object is reduced to its necessary elements) and Normal-Matched at N400 or LPC. These findings suggest that the within-category identification task to the artifacts could obtain significant N400 when they were strongly different in style.

Keywords: artistic furniture; ERPs; N400; semantic judgments; style mapping.

CONTENTS

1. INTRODUCTION

Rapid developments in art and design have created artifacts in the same category (e.g., furniture) that have a variety of features and different design styles. Figure 1 shows various examples, including Normal, ReadyMade, Deconstruction, Minimal, etc. People might be familiar with inharmonic furniture arrangement, such as a modern floor lamp next to the classic sofa. It is of theoretical and practical importance to examine whether semantic networks represent the same-category artificial objects in different styles similarly or differently. This study answers this question using the N400 effect, which is an ERP effect for indexing whether artificial objects of different design styles produce different semantic processing.

The N400 is a widely distributed negative-going wave peaking around 400 ms after the onset of any meaningful stimuli. The N400 presents the semantic relationship between the current stimulus and the preceding context. Previous research indicates that several stimuli can elicit the N400: the final word of a sentence (Kutas and Hillyard, 1980), picture-words (Greenham et al., 2003), pairs of words (Pritchard et al., 1991; Núñez-Peña and Honrubia-Serrano, 2005 and Khateb et al., 2007), pairs of pictures (Barrett and Rugg, 1990; Bobes et al., 1996; Ellis and Nelson, 1999; Proverbio et al., 2007 and Guerra et al., 2009), and even incongruent human actions (Proverbio and Riva, 2009) when the presented objects do not fit in the previously established semantic category. Researchers have examined how classifying objects into categories evokes the N400 effect for many years. Previous studies compare the N400 effects for between-category objects (e.g., Books vs. Dogs) with those for within-category objects (e.g., Sheepdogs vs. Golden Retrievers) (Bobes et al., 1996; Proverbio et al., 2007; Guerra et al., 2009 and Hamm et al., 2002). Several studies further demonstrate that the non-prototypical categories within the same semantic category (e.g., Shar-Peis) elicit a greater negative N400 than prototypical categories (e.g., Golden Retrievers) (Pritchard et al., 1991 and Stuss et al., 1988). These results suggest that semantic category and congruency elicit N400 effects. Most of these experiments dealt with natural categories (e.g., plants, animals, fruits) rather than artificial categories (e.g., tools, furniture, bicycles) (Proverbio et al., 2007 and Paz-Caballero et al., 2006). This may be because artificial objects have more distinct features that make them easier to identify. However, the border between object categories for design or art pieces is often rather blurred, and it is occasionally too difficult to classify objects due to tremendous variations in style. For instance, the works of ReadyMade, produced with a combination of unrelated found objects, inevitably mixes the familiar with the unfamiliar. In Figure 1, the guitar chair appears bizarre as a whole, despite the fact that the box and the guitar were so common individually.

This study investigates whether within-category semantic matching tasks elicit N400 amplitudes. The participants in this study had to decide if the presentation of a target picture matched that of a prime picture. To determine the correlation between “table” and “chair,” the normal “table” was presented as the prime image and four categories of “chairs” were presented as targets: normal, ReadyMade, deconstruction, and minimal chairs (see Figure 1). As described previously, ReadyMade works are close to a kind of art. Minimal designs are the real products, with minimal elements and a structure reduced to the bare necessities. Deconstruction works, like art pieces, usually exhibit non-rectilinear shapes with distorted, deformed, and dislocated elements or structures. The combinations of these distinguishable stimuli make it possible to observe the different degrees of within-category match and N400 effects.

2. METHOD

2.1 Participants

Eighteen undergraduate students (10 males; mean age=22y) from National Central University were paid 500 New Taiwan dollars to participate in the experiment. All participants were right-handed native Chinese speakers, with normal or corrected-to-normal vision. Written consent was obtained from all participants.

2.2 Materials

The stimuli included 8 gray-level pictures of tables and 32 gray-level pictures of chairs (see Figure 1) on a white background. All the pictures were selected from the internet. Each picture was approximately 6 cm tall and 4 cm wide. The 32 chairs were divided into 4 groups of 8 chairs. Each group corresponded to one of the following design styles: Normal, Minimal, Deconstruction, and ReadyMade. The categorization was performed by six design experts. All eight tables, however, were the normal design style. A total of 256 trials were generated by pairing each of the eight tables to each of the 32 chairs. This pairing produced four types of table-chair combinations, with 64 pairs in each combination. The semantic relationship between the table and chair was matched in Normal-Normal pairs, but not in the other three types of table-chair pairs.

Insert Figure 1 here

2.3 Procedure

Participants were fitted with an elastic electrode cap and then seated in an electrically isolated chamber at a viewing distance of 70 cm from a monitor. During the experiment, participants made style judgments on 256 table and chair pairs presented sequentially. Each trial started with showing a fixation point at the center of the screen for 1000 ms. After the fixation point disappeared, the prime image (i.e., one of the eight normal-style tables) was presented for 1000 ms, followed by a blank screen for 500 ms. The target (i.e., a chair of ReadyMade, Deconstruction, Minimal, or Normal style) then appeared and remained on the screen for 1000 ms. During this brief period, participants judged whether the chair matched the preceding table in terms of structure and appearance. The screen then went blank for 1000 ms, after which the next trial started. There was short break after 128 trials. Again, participants were instructed to judge whether the chair matched the preceding table in terms of structure and appearance. The style judgment was made by pressing the index fingers of both hands. The correspondence between left/right hands and matched/unmatched judgments was counterbalanced across participants.

2.4 ERP recording and analysis

EEG signals were continuously recorded from 64 Ag/AgCl electrodes, 62 of which were embedded in an elastic cap. The remaining two electrodes were placed on the mastoids. All channels were referenced to an electrode located between Fz and FCz, and were re-referenced off-line to the recordings of the linked mastoids. Vertical and horizontal EEG signals were recorded from bipolar electrodes placed above and below the left eye, and on the outer canthi of each eye. Data was continuously recorded and sampled at 250 Hz. All channels were amplified with a bandpass filter of 0.05-70 Hz (3dB points). Linear regression corrected the contribution of blink artifacts to the EEG signals (Semlitsch et al., 1986). ERPs were calculated for epochs of 1020 ms relative to the onset of the pictures of chairs, with a 100 ms pre-stimulus interval as baseline. Data was low-pass filtered by 30 Hz (12dB/octave). Trials containing non-blink eye movements or having a baseline drift exceeding 70 μV in any channel were rejected.

3. RESULTS

Repeated measures ANOVA were used to analyze both the behavioral and ERP data. The

Greenhouse-Geisser correction for non-sphericity was applied as necessary, and F ratios are reported with Greenhouse-Geisser epsilon values (ε) and adjusted p-levels.

3.1 Behavioral data

Table 1 displays the proportions of "match" responses and reaction times for the style judgments of all four types of chairs. A repeated measure ANOVA on the proportion of match responses reveals a significant main effect of chair type ($F[3, 51]=19.76$, $p<.001$, $\varepsilon=0.48$). Post-hoc comparisons with Bonferroni corrections shows that the proportions of match responses were statistically equivalent for Normal chairs and Minimal chairs, and were both higher than the proportions for ReadyMade chairs (both $p<.001$) and Deconstruction chairs ($p<.005$, and $p<.001$, respectively). There were no differences between the proportion of match responses for ReadyMade chairs and Deconstruction chairs. A two-way repeated measure ANOVA on the reaction time data reveals that both the main effects of chair type and response type (matched vs. unmatched) were insignificant, along with their interaction.

Insert Table 1 here

3.2 ERP data

This study computes ERPs time-locked to the onset of the chairs based on the responses of each participant, including "match" responses for normal chairs and "unmatch" responses to Minimal, Deconstruction, and ReadyMade chairs. The discussion below uses the following nomenclature to label these four ERP categories: Normal-Matched, Minimal-Unmatched, Deconstruction-Unmatched, and ReadyMade-Unmatched. The mean trial numbers for these four types were 27 (16-60), 28 (17-43), 41 (16-63), and 41 (23-60), respectively.

Figure 2 shows the grand averages of the ERPs associated with these four response types. The waveforms diverged approximately 200 ms after stimulus onset, with the ReadyMade-Unmatched and Deconstruction-Unmatched waveforms being more negative than the Normal-Matched and Minimal-Unmatched waveforms 300-500 ms after stimulus onset. The N400 analysis in this study is based on the mean amplitudes of this 300-500 ms time window. An ANOVA was first conducted for each time period using data acquired from 27 electrode sites located over 9 scalp regions: left anterior (F7, F5, F3), medial anterior (F1, Fz, F2), right anterior (F4, F6, F8), left central (T7, C5, C3), medial-central (C1, Cz, C2), right central (C4, C6, T8), left posterior (P7, P5, P3), medial-posterior (P1, Pz, P2), and right posterior (P4, P7, P8). Factors in this analysis included chair response type, left-right scalp region (left, medial, right), and anterior-posterior caudality (anterior, central, and posterior). Subsidiary ANOVAs for pairwise comparison were conducted for any significant effects involving the chair type factor.

Insert Figure 2 here

3.3 N400

The global ANOVA showed that the main effect of chair type was significant ($F[3,51]=2.88$, $p=.05$, $\varepsilon=0.87$). The interaction between chair-response type and caudality was also significant ($F[6,102]=14.49$,

p<.001, ε=0.35). Subsidiary analyses of Normal-Matched vs. ReadyMade-Unmatched categories showed that the main effect of chair-response type and its interaction with caudality were significant (F[1,17]=6.14, p<.05 and F[2,34]= 10.26, p<.01, ε=0.65, respectively). These findings revealed a greater negativity in ReadyMade-Unmatched than Normal-Matched, and this N400 effect was most pronounced at the anterior and center sites (F[1,17]=9.68, p<.01; F[1,17]=6.70, p<.05). A comparison between Deconstruction-Unmatched and Normal-Matched reveals significant interaction between chair-response type and causality (F[2,34]=16.26, p<.001, ε=0.62). Follow-up analyses revealed a greater N400 effect for the Deconstruction-Unmatched category than Normal-Matched category at the anterior sites (F[1,17]=9.69, p<.01), but a positivity over the posterior sites (F[1,17]=5.33, p<.05). A comparison between the Minimal-Unmatched and Normal-Matched categories reveals no significant effects involving the chair-response factor.

3.4 Topographic Analysis

Because the ReadyMade-Unmatched and Deconstruction-Unmatched categories produced a greater N400 effect than the Normal-Matched category, this section examines whether the N400 effect for these two types of chairs exhibited different scalp distributions. Two different waves were generated by subtracting the Normal-Matched waveforms from the ReadyMade-Unmatched and Deconstruction-Unmatched waveforms. The waves from the 62 scalp electrode sites were range-normalized using the max-min method to avoid any confounding effects in the magnitudes of the two effects and the differences in scalp distribution (McCarthy & Wood, 1985). The range-normalized data was then entered as a factor with 62 levels (all the scalp electrodes) in topographical analysis (Figure 3). Results show that a significant interaction between chair-response type and recording site (F[61,1037]=2.77, p<0.001, ε=0.08), suggesting that the N400 effect had different topographic distributions for ReadyMade and Deconstruction chairs.

Insert Figure 3 here

4. DISCUSSION

This study shows that a stronger variation in style elicits stronger N400 effects within the same category. These results imply that people can easily recognize conspicuous styling as non-prototype. In addition, the N400 effects of the Deconstruction and ReadyMade styles had different topographic distributions, indicating that these two styles might reveal unique characteristics.

When examining stimuli individually, unrelated parts in ReadyMade objects have an important influence on the impression of the whole, and produced similar trials for between-category tasks. For instance, the participants might initially confuse the guitar chair for a musical instrument (Figure 1). Similar to Deconstruction objects, even maintaining a vague impression of chairs, they include peoples within the puzzle (Figure 1) because their fragmentary and distortional features are distant from the ideal type of chair. Even though Minimal chair designs have fewer elements than normal chairs, they possess the essential frame of a chair, which is not much different from that found in a typical chair. As the result, the comparison of four “within-category” styles in this study is similar to “non-prototypical categories and prototypical categories” (Pritchard et al., 1991 and Stuss et al., 1988). This shows that for natural objects (Proverbio et al., 2007 and Paz-Caballero et al., 2006) and artificial objects, non-prototypical categories elicited a greater negative N400 effect than prototypical categories.

The sensitivity of semantic recognition may depend on expertise. For example, because the participants in this study were not familiar with styling, experts might have been better able to detect the tiny different

feature in the within-category identification task. Thus, professional designers would likely elicit a greater N400 than the general public, even when comparing Minimal-Unmatched with Normal-Matched chairs. Future research should adopt a hierarchical structure of the spectrum of artistic styles.

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TABLE & FIGURE CAPTIONS

Table 1. Behavioral results for four chair types in the semantic matched/unmatched judgment tasks (standard deviation of means in parentheses)

	Matched response (%)	Reaction time (ms)	
Normal table vs. Normal chair	54 (22)	matched	920 (290)
		unmatched	925 (459)
Normal table vs. Minimal chair	44 (13)	matched	959 (477)
		unmatched	923 (284)
Normal table vs. Deconstruction chair	20 (15)	matched	895 (649)
		unmatched	874 (404)
Normal table vs. ReadyMade chair	21 (11)	matched	993 (538)
		unmatched	869 (315)

Figure 1. Stimuli included 4 types of table-chair pairs (Normal-Normal, Normal-Minimal, Normal-Deconstruction, and Normal-ReadyMade).

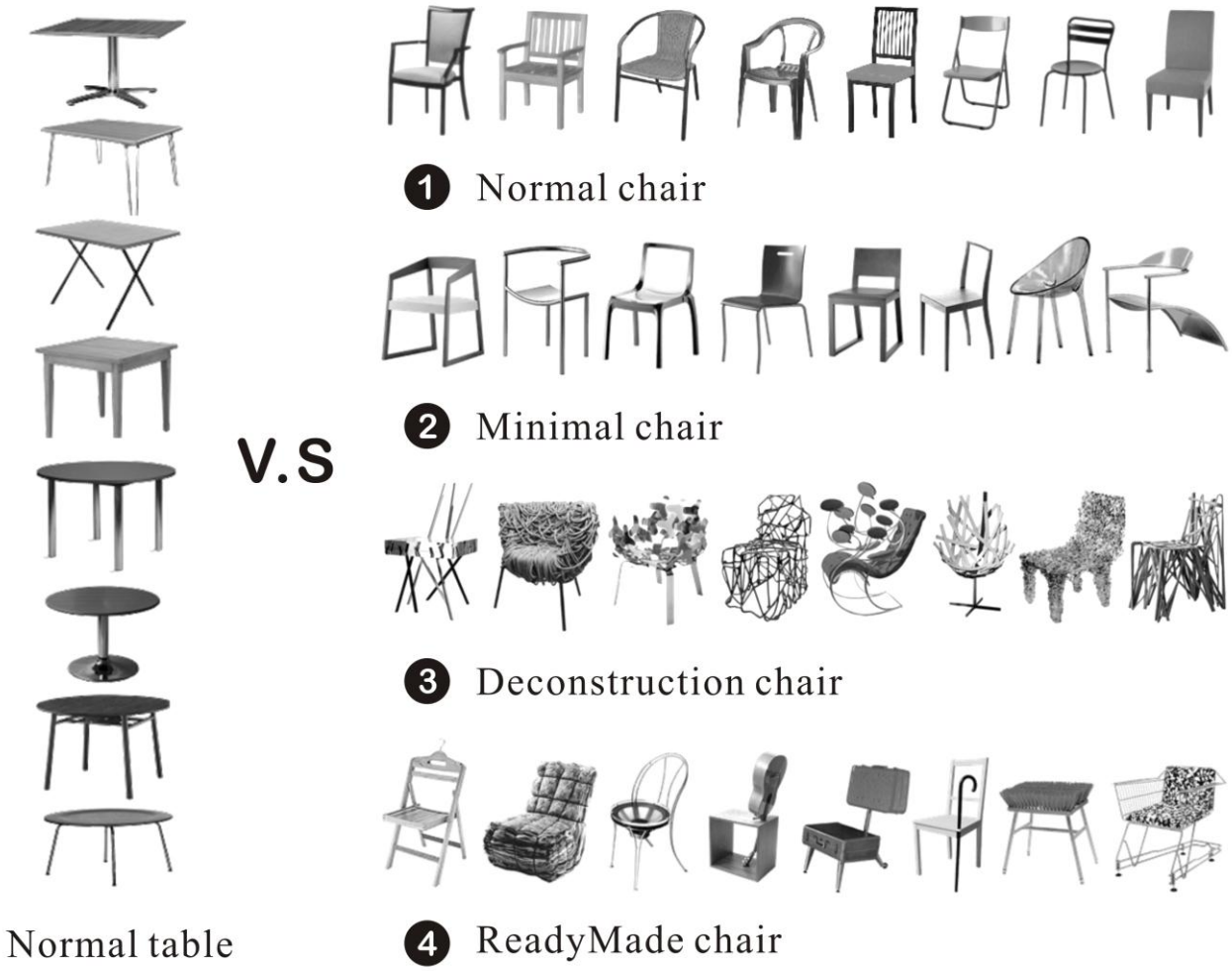


Figure 2. Grand average ERP waveforms showing the N400 effects in ReadyMade-Unmatched, Deconstruction-Unmatched, and Minimal-Unmatched conditions (N400: 300-500 ms).

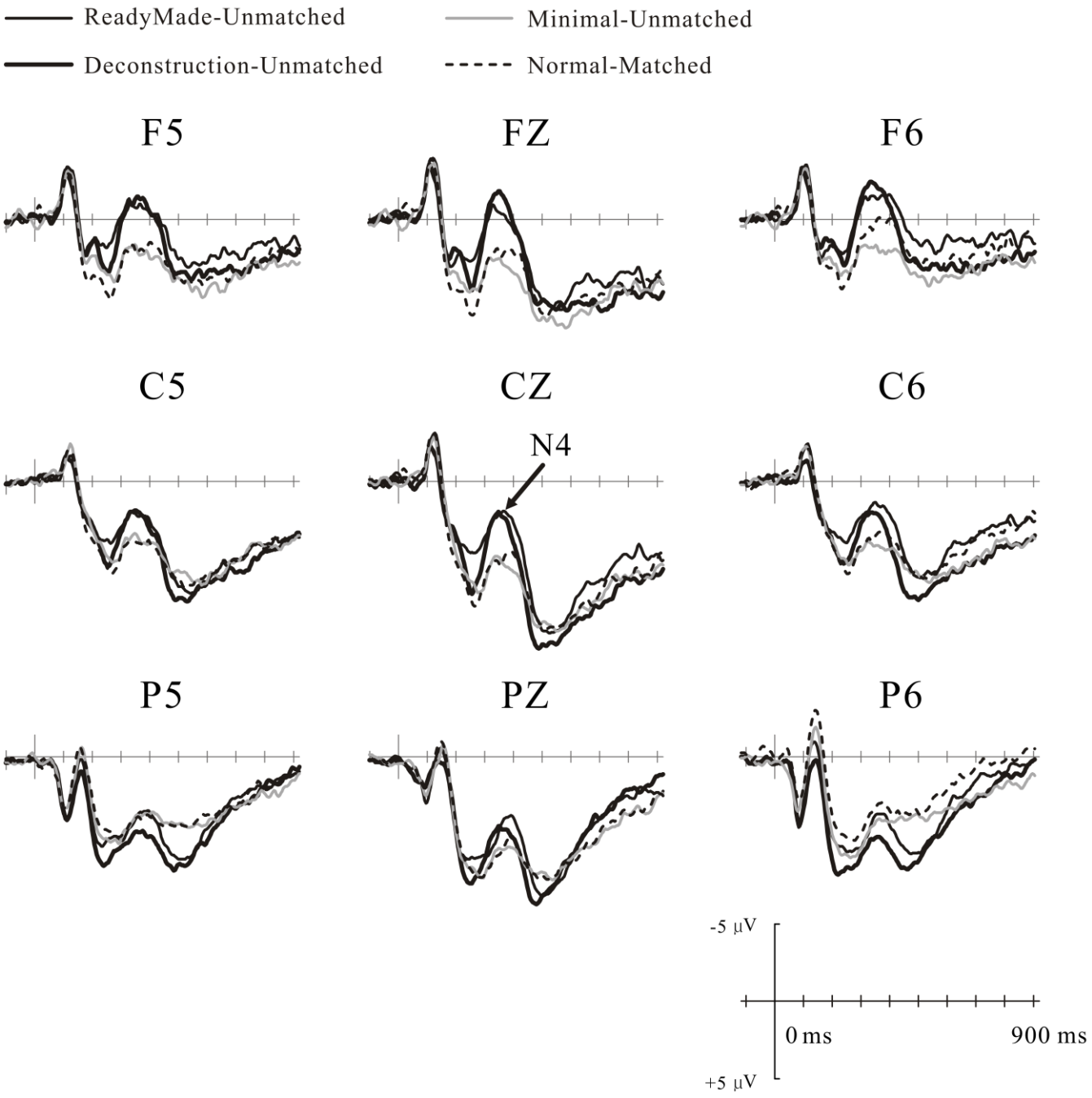
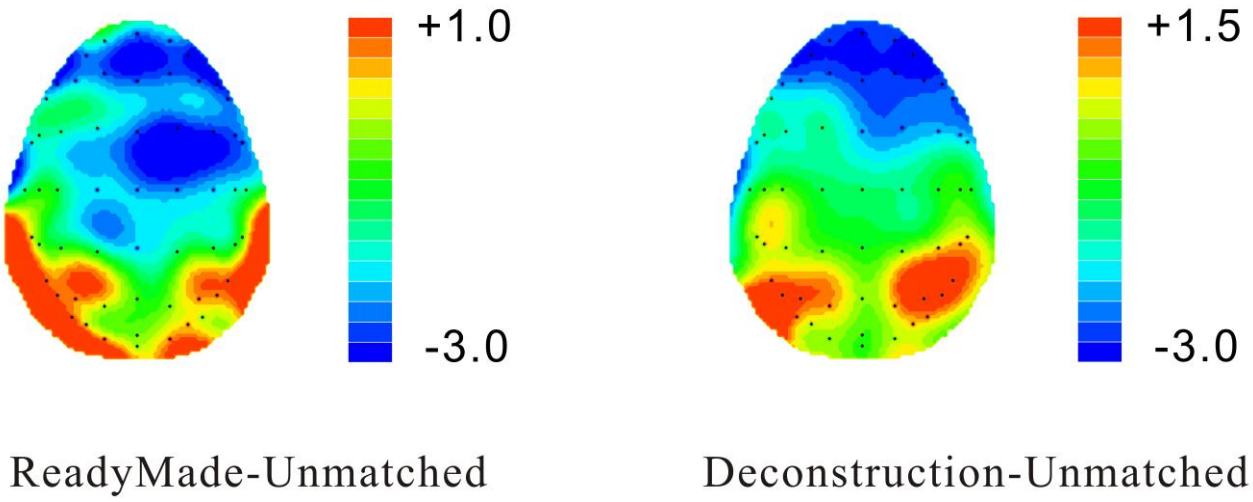


Figure 3. Voltage spline maps showing the topographies of the N400 (300-500 ms) effects elicited in ReadyMade-Unmatched and Deconstruction-Unmatched categories.



Appendix A

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）

本研究透過 ERP 腦波科學技術，觀看產品設計的視覺刺激所產生的腦波變化，對心理反應與設計風格的辨識及剖析，具體地描繪出在腦中的觀念思想，已釐清哲學思辯－設計思潮－產品風格呈現－使用者心理反應的一連串脈絡。在學術成就上，過去兩年期間積極參加研討會，尤其在今年出席一場與研究有關的腦波研討會，此會議是歐洲神經學會重要之國際會議之一，在台灣是認知神經及復健等相關醫學院時常參與的國際會議。而會議其中一個的主題是”神經學與藝術(neurology and arts)”，正好符合本研究結合設計與認知心理學跨領域的研究，增進研究交流。在未來，本研究成果已於今年十月投稿至 International Journal of Psychophysiology SCI 期刊，期刊目前審核中，而設計與認知神經科學等跨領域研究的期刊相當得少，此篇若通過相信能提高這些腦波期刊對設計議題的接受率及影響力。

Appendix B

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：98 年 06 月 15 日

計畫編號	NSC 97-2221-E-009-094-MY2		
計畫名稱	以注意力實驗檢測產品的造形表現力和內涵深度		
出國人員姓名	林銘煌	服務機構及職稱	交通大學應藝所
會議時間	98 年 5 月 27 日至 98 年 5 月 29 日	會議地點	Charlmers University of Technology, 倫敦, 英國
會議名稱	Cumulus Conference, London 2009		
發表論文題目	New Member's Fair & General Assembly		

一、參加會議經過

Cumulus是一個大學及學院中藝術、設計和多媒體領域的國際協會。它是為合作、轉化知識和實務的一個論壇。全球超過140所學院和大學加入此協會，大家在年度的國際會議和活動中聚會。今午Cumulus Conference, London 2009在5月27~30日舉行，為期四天，以專題演講為主。

今年會議主題以視覺傳達為主，探討在科技的進步下，身為有「經驗的」設計教育者應如何與電腦同步成長的新世代相處，即使是五年前，今天設計和傳達的景象仍是難以想像的。創造性產業的彈性和敏捷性是卓越的，但相對的，技術創新快速的腳步令人產生眩暈的反應。在創造性的產業內，設計比其他領域進展更快、更根本。本次會議面對挑戰與變動提出問題：在2012年或2015以前將發生什麼？我們在教育和產業上是否有技能來處理和促進的內部變化？

會議過程十分緊奏，活動範圍以倫敦千禧巨蛋內的演講廳舉行，因場地絕佳，相對的，餐飲服務都得自費。主講人包括：Ken Robinson, Dr Angela Dumas, Chris Powell, Shane Walter, Matthew Bagwell, Professor Robin Baker等。活動中還包括會員會議、新會員授證儀式、新會員展覽會，開幕茶會、.歡送會、參訪RCA畢業展、倫敦參訪等。

二、與會心得

本次為第一次參與此一國際研討會，主要因為交大應藝所加入Cumulus 組織，得參加新會員展覽會、新會員授證儀式，故代表交大應藝所參加新會員授證儀式。本次新加入的會員中在亞洲區的設計院校有日本的千葉大學、神戶工藝大學、中國的清華大學、湖南大學、汕頭大學等，可見此組織雖由

歐洲發起，與會者大多來自歐洲的學者，但目前已壙展至全球一百五十幾所大學設計院校。

本次會議與參訪和十年前在倫敦求學相比，覺得倫敦進步很大，像千禧巨蛋、千禧橋、倫敦眼等等新建築，加上市容和地鐵的更新，令人看見老城市成長的一面，或許臺北也有所成長，只是自身感受不大罷了。自RCA 畢業十年了，今舊地重遊，感觸良多，走過熟悉的街道，住日求學情景，一一浮現，再想想十年來的教學、研究等努力和成果，似乎還有再加強和期盼的空間。

Appendix C

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期：99 年 10 月 05 日

計畫編號	NSC 97-2221-E-009-094-MY2		
計畫名稱	以注意力實驗檢測產品的造形表現力和內涵深度		
出國人員姓名	林銘煌	服務機構及職稱	交通大學應藝所
會議時間	99 年 9 月 25 日至 99 年 9 月 28 日	會議地點	Palexpo, 日內瓦, 瑞士
會議名稱	2010 The European Federation of Neurological Societies		
發表論文題目	Electrophysiological evidence for semantic within-category task across different styles		

一、參加會議經過

2010年第十四屆歐洲神經學會聯盟會議 (2010 The European Federation of Neurological Societies)，從9月25日至9月28日止，為期四天，在瑞士日內瓦舉辦。全球將近有兩千篇的稿件，絕大部分來自於歐洲國家，其中，台灣共有十四篇稿件，大多屬與醫學相關之研究。會議宗旨是促進歐洲國家在神經科學、臨床實驗學、認知行為研究、病理學等相關的醫療研究之交流。此會議是歐洲神經學會重要之國際會議之一，在台灣是認知神經及復健等相關醫學院時常參與的國際會議。會議其中一個的主題是「神經學與藝術(neurology and arts)」，正好符合我們結合設計與認知心理學跨領域研究的目標，故遠道而來，首次參與如此盛大，對本人是跨領域的會議。參與此會議的目的，希望能向神經科學這方面專業的研究者表達設計結合科學技術跨領域的努力：透過ERP腦波科學技術，觀看產品設計的視覺刺激所產生的腦波變化，對心理反應與設計風格的辨識及剖析，具體地描繪出在腦中的觀念思想，以釐清哲學思辯－設計思潮－產品風格呈現－使用者心理反應的一連串脈絡。另外，學習來自其他地方的研究成果、了解並交換彼此最好的心得。

大會的地點鄰近日內瓦機場的Palexpo，如照片2，是攝影於第二天9月26日在會場的入口處。在四天的會議期間的活動中還包括開幕茶會、主題講座、歡送會等。我們選擇兩門與設計相關的專家主題講座，共10講者，分別是「New frontiers in behavioural neurology」和「Cognitive neurology」，帶著學習的心態前來聽課。第三天，9月27日的下午14:30~16:00為期一小時半的海報發表時間中，有一群專家前來詢問我們的研究，由於這些專家是屬醫學方面的領域，對我們設計結合腦波科技的研究感到好奇，在發表後適時地給予良好建議及引介先進的研究技術，說明我們目前執行的還只是研究的起步。同場次並碰到台北醫學大學暨署立雙和醫院蔡行瀚副院長，與其求來教。預計今年將研究成果投稿至「Applied Cognitive Psychology」SCI期刊，此期刊有應用腦波技術及設計相關的研究，非常適合我們這種應用型的跨領域研究。

二、與會心得

本次會議在歐洲國家舉辦，是敝人第一次參加神經科學的會議，感覺相當龐大，且以poster為主，和設計領域有許多不同的地方。我們也基於所學，前往起家於蘇黎士的國際設計品牌Freitag包包的販賣總店參觀，其展示方式展現獨特思考資源回收的創意。

而日內瓦當地知名的景點眾多，像是的噴泉、聖母峰、蘇黎士的萊因瀑布、聖彼得教堂、拜耳鐘錶博物館、聖母教堂等等還不錯。整個瑞士市區，幾乎都浸在藝術的細胞與氣息中，吸引不少外來的觀光客。瑞士的交通系統便捷，有陸上的Tram電車和地下火車，串流在整個市中心，讓我們能四通八達，再加上古老的建築藝術、繁華的市容、街道的美化，看見不同文化的一面。

照片1，台灣有十四篇稿件

照片2 攝影於大會正門口