出國報告(出國類別:參加國際研討會)

LED 平板燈照度與色溫對視覺疲勞之影響

服務機關：國防大學
姓名職稱：石裕川教授
派赴國家：溫哥華，加拿大
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摘要

LED 平板燈近來越來越受歡迎，可能會替代傳統的照明系統。本研究探討在閱讀任務後，LED 面板照明的三種色溫（3000,4200 和 6000K）和兩種照度（300 和 750lux）的組合對視覺疲勞的影響。實驗招募 8 位 18-25 歲的受試者參與，其中男性 4 名，女性 4 人。在給定的實驗條件下，用色度計（KONICA MINOLTA CL-200A）控制房間內的照度和色溫。受試者先在休息 5 分鐘後測量第一個視覺臨界融合頻率（CFFpre），並在連續的 30 分鐘閱讀任務後再次測量第二次（CFFpost）。因變項是 CFF 的變化，命名為△CFF（= CFFpost-CFFpre）。 t 檢定結果顯示，30 分鐘的閱讀任務確實引起眼睛疲勞，即△CFF 顯著小於零，但變異數分析(ANOVA)結果顯示，性別，照明，色溫，或它們的交互作用並不顯著影響△CFF。這顯示與 LED 面板照明相關的六個組合對 CFF 的變化具有相同的效果。未來繼續投入關於 LED 平板燈對不同視覺任務的研究仍然是必要的。

關鍵字：LED 平板燈，視覺臨界融合頻率，色溫，照度，閱讀任務

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一、 目的

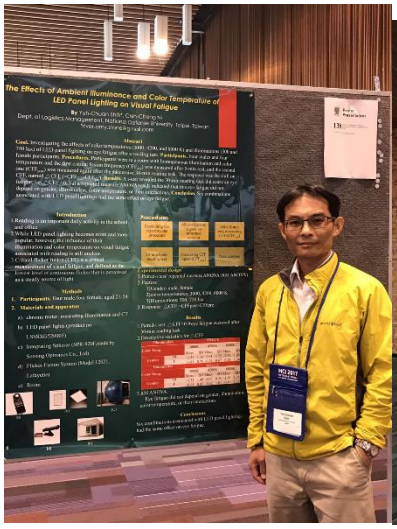
參加國際性研討會，促進學術交流以及提升自我研究能力。

二、 過程

(1). 07/10 早上抵溫哥華

(2). 07/11 至會場報到並參加開幕式、聽開幕式講演 (The New ABCs of Research: Grand Challenges for HCI, by: Ben Shneiderman)。

(3). 07/12-14, 參加研討會並進行研究分享



三、 心得

1. HCI 歷年來都是從事人機互動、介面設計，與使用者經驗領域學者的學術盛宴。這次台灣亦有多位學者參與，主要還是以從事人因工程、介面設計，與互動教學學者居多。該相關領域中國學者也愈來愈多人參與。
2. HCI 歷來結合很多不同子議題之研討會一併舉辦，故參加人數不少。
3. Keynote Speech 由 Ben Shneiderman 進行演講，主題為”The New ABCs of Research: Grand Challenges for HCI”，其旨概為”Solving the immense problems of the 21st century will require ambitious research teams that are skilled at producing practical solutions and foundational theories simultaneously – that is the ABC Principle: Applied & Basic Combined. Then these research teams can deliver high-impact outcomes by applying the SED Principle: Blend Science, Engineering and Design Thinking, which encourages use of the methods from all three disciplines.

These guiding principles (ABC & SED) could drive HCI research to become the key transformational discipline for the 21st century by accelerating discovery and innovation."

四、 建議事項:

1. 民國104年3月23日行政院科技會報辦公室邀集經濟部、科技部、教育部、農委會、衛福部、勞動部等，跨產業(製造業、商業服務業、農業)共同召開「2015 年行政院生產力4.0科技發展策略會議」，凝聚產官學研的意見與結論共識，進而研擬「行政院生產力 4.0 發展方案(英文名稱：Taiwan Productivity 4.0 Initiative)」，以作為推動生產力4.0科技發展計畫之依據(行政院，104 年)。之所以選擇進行生產力 4.0 的科技發展策略規劃，主要是觀察到全球競逐智慧製造科技發展，有兩個重要的趨勢：一是全球競逐智慧科技發展趨勢的拉力；一是就業人口遞減現實的推力。該方案以行政院所推動的「智慧型自動化產業發展方案」為基礎，整合商業自動化、農業科技化發展進程，提出生產力4.0發展規劃，期能開發智慧機械、物聯網、巨量資料、雲端運算等技術來引領製造業、商業服務業、農業產品與服務附加價值提升，同時，發展人機協同工作的智慧工作環境，以因應高齡化社會工作人口遞減的勞動需求。
2. 近年來，因應台灣雲端科技趨勢發展與相關智能科技之普及，使用者經驗(user experience, UX)愈亦受到重視。UX 與人因工程息息相關；人因工程的基本精神就是「以人為本」，基於此，產品設計必須以使用者為中心(Human-Centered Design)。UX 的核心價值應是「將人視為系統的一份子，且系統依人性而設計，進而建構以人為尊的系統及其使用環境」(INSIDE, 2016)。依人性而設計即依人類生理、心理特性與限制，了解人與系統間之介面問題而設計。人類訊息通路包括眼、耳、鼻、舌、膚等感覺系統，任何產品都需依其範圍與特性而設計，否則就無法被感覺到或不符人類需求。察覺不同訊息後，才能進行判讀與認知，進而會產生互動式的使用經驗。初步體驗或後續之互動經驗，皆深受人體生、心理條件及限制的影響，當然也受到區域文化、習慣、價值的左右。故產品要全球化，則須兼顧文化、習慣、認知，與人員生理特性(如體力、身型)。若系統設計不符人因，可能產生不良互動經驗，甚至無互動而產生不了經驗；所以，依人因而設計是 UX 的基本根基。
3. 台北市電腦公會於 2016 年 10 月在 TAF 空總創新基地舉辦的 XSION 跨界創新國際論壇邀請了 beBit、三星、聯想，與 IBM 等專家進行講演，同時也邀請 EST 一起參與規劃，以及呈展一些學研成果。EST 也趁機邀請澳大利亞人機界面技術研究中心主任

杜本麟教授、北京清華大學饒培倫教授，與東海大學李永輝教授共同舉辦「人因與智慧科技大師座談會」，並由台科大林久翔教授擔任主持人。主要議題乃談論未來科技趨勢演變下,「以人為中心的設計」是關鍵核心，對人的認知心理與行為面的知識進行了解、洞察、與應用；也探討「人因」如何影響新科技與前所未見的各種創新產品、服務與商業模式。當工業生產以及生活環境變得愈來愈智慧化時，「人因」的考量如何讓這些即將改變人類生活與工作的科技也愈來愈懂得我們。XSION 從商業應用、創新科技和使用者體驗三大方向來進行使用者經驗的分享與討論，期提供整合性思維概念，融合 Business(商業策略) ,Technology(創新科技應用) ,User(使用者體驗)三大要素作，為發展基底的成功商業模式及其他潛力應用。由此足見人因工程於雲端科技趨勢發展與相關智能科技應用之重要性。

4. 然 Prof. Ben Shneiderman 所謂之 ABC 或許可以 problem-oriented 與 demand-derived 方面視之，透過解決問題或創造需求藉以結合理論與應用，並將科學、工程，以及設計的思維融合在一起，才是 HCI 的未來趨勢。

附件：論文

The Effects of Ambient Illuminance and Color Temperature of LED Panel Lighting on Visual Fatigue

Yuh-Chuan Shih*, Chih-Cheng Ni

Department of Logistics Management, National Defense University, Taipei, Taiwan
River.amy@msa.hinet.net

Abstract. LED panel lighting recently becomes more and more popular and will be possibly instead of the traditional lighting systems. Present study investigated the effects of six combinations of color temperatures (3000, 4200, and 6000 K) and illuminations (300 and 750 lux) of LED panel lighting on eye fatigue after a reading task. Eight young participants aging 18-25 years old and including four males and four female took part in this experiment. They were asked sat in a 5.1m*4.0m*2.2m (L*W*H) room with homogeneous illumination and color temperature under given experimental conditions, which was measured and by a chroma meter (KONICA MINOLTA CL-200A). The first critical fusion frequency (CFF_{pre}) was measured after 5-min rest, and the second one (CFF_{post}) was measured again after the successive 30-min reading task. The response was the shift on CFF, named △CFF (=CFF_{post}-CFF_{pre}). A t-test revealed the 30-min reading task did cause an eye fatigue, i.e. △CFF was less than zero significantly, but a repeated measure ANOVA result indicated that this eye fatigue did not depend on gender, illumination, color temperature, or their interaction. It demonstrated that the six combinations associated with LED panel lightings had the same effect on the shift on CFF. In the future, more related studies about their influence on different visual tasks are still necessary.

Keywords: LED panel lighting, critical fusion frequency, reading task, eye fatigue

1 Introduction

Reading is a daily activity, especially in the school and office. Even different electronic displays are popularly used, the traditional paper reading is still unavoidable. Appropriate ambient illumination is necessary for visual task. While LED panel lighting recently becomes more and more popular and will be possibly instead of the traditional lighting systems, however, the influence of their illumination and color temperature on visual fatigue associated with reading is still unclear.
Prolonged visual activities easily cause visual discomfort/fatigue. Besides a subjective questionnaire, critical flicker fusion (CFF) is measure of visual fatigue (Chi & Lin, 1998; Murata et al., 1996), it is the lowest level of continuous flicker that is perceived as a steady source of light.
While performing an experimental visual task on a CRT display screen under different work speeds and amounts. The colour (red, green and yellow) CFF values of the subjects were measured every 15 min during the task. Results indicated that the green and yellow CFF deteriorated significantly at 30 min after the start of the task. The red CFF values decreased significantly at 15 min after the start of the task (Iwasaki, Kurimoto, & Noro, 1989). Authors evaluated the effects of light source, ambient illuminance, character size, and interline spacing on visual performance and visual fatigue in using commercial electronic paper displays. Regarding visual fatigue, results showed that light source and ambient illumination had non-significant effects on change of critical flicker fusion (CFF) and subjective visual fatigue (Lee, Ko, Shen, & Chao, 2011). Shieh and Lin (2000) investigated the effects of screen type, ambient illumination, and target/background color combination on visual identification performance and subjective preference for visual display terminal (VDT) screen

characteristics. They found visual performance was better under lighter ambient illumination, 450 lux versus 200 lux. Along with the popularity of application of LED panel lighting systems, knowledge about their illumination and color temperature on visual fatigue associated with paper-reading is urgent.

2 Methods

2.1 Participants

Four male and four female participants aged 21-24 years old took part in this experiment. They were either under- or graduate students.

2.2 Materials and apparatus

A 5.1m*4.0m*2.2m (L*W*H) room was used and controlled to be homogeneous illumination and color temperature for the requirement of experimental conditions, which was measured and by a chroma meter (KONICA MINOLTA CL-200A).
LED panel lights (product no. LSSSXG520005) were manufactured by Eneragyled Corporation, which is a professional LED lighting company in Taiwan by using the LED lighting characteristics to create the additional values of finished products demanded by customers.

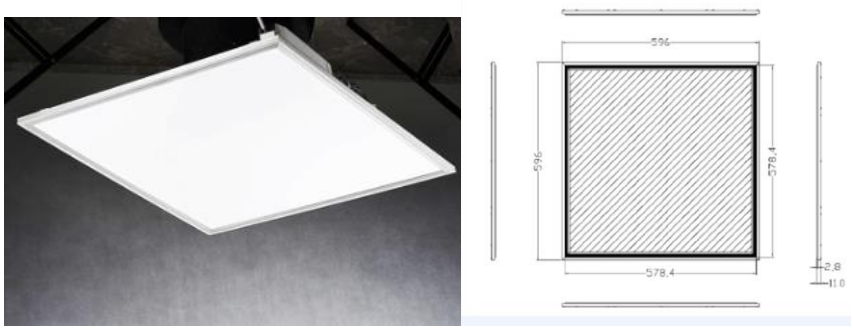


Fig. 1. The LED panel lights used in this study (product no. LSSSXG520005)

1. Integrating Spheres (SPR-920F,made by Sensing Optronics Co., Ltd): to measure the total light radiated in all directions from a lamp. An integrating sphere can be used to measure the diffuse reflectance of surfaces, providing an average over all angles of illumination and observation
2. Goniophotometer (GO-2000, made by Jet-Power Technology Co., Ltd): for measurement of the angular dependence of optical quantities. It is applicable to acquire the luminous intensity distribution, luminous flux, spatial color distribution, and luminance distribution of lamps and luminaires. The latter two are proposed in recent years as the development of light & lighting.
3. Illuminometer (CL-200A, KONICA MINOLTA): for measuring brightness in lux.
4. Flicker Fusion System (Model 12021, Lafayette) was used to measure the flicker fusion threshold (or flicker fusion rate), the frequency at which an intermittent light stimulus appears to be completely steady to the average human observer.

2.3 Procedures

First, the experimental procedure was explained, and all participants signed an informed consent. After 5-min rest, the first critical fusion frequency (CFF_{pre}) was measured. The second one (CFF_{post}) was measured following a 30-min book-reading task immediately.

2.4 Experimental design

A repeated measure ANOVA was employed, in which the studied factors were gender, color temperatures and illuminations of LED panel lighting, and each had two levels (male and female), three levels (3000, 4200, and 6000 K) and two levels (300 and 750 lux), respectively. The response variable was the shift on CFF, named $\triangle CFF = CFF_{post} - CFF_{pre}$.

3 Results

Firstly, a paired t-test was conducted to ensure whether eye fatigue occurred, i.e. $\triangle$CFF was less zero. The result revealed that the 30-min reading task did cause an eye fatigue significantly ($\triangle$ CFF<0). Furthermore, a repeated measure ANOVA result indicated that this eye fatigue did not depend on gender, illumination, color temperature, or their interaction. It demonstrated that the six combinations associated with LED panel lightings had the same effect on the shift on CFF.

Table 1. The descriptive statistics

Illumination		750LUX					
Color Temp.		3000K		4200K		6000K	
		Mean	SD	Mean	SD	Mean	SD
Gender	M	-1.51	1.33	0.01	1.72	-2.35	1.85
	F	-1.61	0.75	-0.24	0.67	0.18	1.34
Illumination		300LUX					
Color Temp.		3000K		4200K		6000K	
		Mean	SD	Mean	SD	Mean	SD
Gender	M	-1.71	1.49	-0.97	0.55	-1.88	1.35
	F	-0.61	0.81	-0.42	1.01	-0.40	1.22

4 Conclusions

Visual fatigue defined the shift of CFF among the six combinations of illuminations (300 and 750 lux) and color temperature (3000, 4200, and 6000 K) is not significantly different. This result implies that customers can select these six conditions as they wish due to the equal influence on the shift of CFF.

5 References

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