ORIGINAL ARTICLE

Educational influence on women's colour perception: C1 event-related component analysis

Mohammed Fatin Raid[1], Tahamina Begum[2] , Mohammed Faruque Reza[3]

ABSTRACT

Objective

This study aimed to investigate colour perception in women from different educational groups using an event-related potential (ERP) analysis to examine the influence of education on colour processing among women.

Materials and methods

Twenty-four age-matched women, from high-, medium-, and low-education groups (n = 8 in each group), were recruited in this study. 128-ERP net was used for the ERP study. All women presented their like or dislike for a particular colour by pressing button '1' or '2', respectively. Nine electrodes were chosen to analyse the amplitudes and latencies of the C1 ERP component.

Results and Discussion

We found no significant differences in the amplitudes and latencies of the C1 ERP component between groups. A smaller amplitude of the C1 component indicated good perceptual learning, and no significant change indicated spatial or feature-based neutral stimuli. In this study, no significant change in the C1 amplitude was found, and we inferred that education did not influence colour processing, as colour was possibly a feature-based neutral stimulus for women.

Conclusion

Education did not influence colour perception in women.

Keywords

education; women; perception; C1 ERP component.

INTRODUCTION

Education plays an important role in improving quality of life[1,2]. Higher education can improve attention towards choosing different shapes and their arrangements[3]. The effects of higher education on the processing of different colours have been discussed in a previous paper by Hasan et al. (2016)[4], in which we proposed that an individual with higher education can more strongly attend to likes or dislikes towards any colour, which was reflected on the N200 and P300 ERP components[4]. Gender influences on colours were also examined using the same ERP components, where no significant difference was found between groups[5]. However, women can

1. Mohammed Fatin Raid, Department of Materials Science and Biomedical Engineering, University of Wisconsin-Eau Claire, Phillips Hall, Suite 177E, 105 Garfield Avenue, Eau Claire, WI 54702-4004, USA
2. Tahamina Begum, Department of Neurosciences, School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian 16150, Kota Bharu, Kelantan, Malaysia
3. Mohammed Faruque Reza,Department of Neurosciences, School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian 16150, Kota Bharu, Kelantan, Malaysia

Correspondence

Tahamina Begum, Department of Neurosciences, School of Medical Sciences, Universiti Sains Malaysia. Kubang Kerian 16150, Kota Bharu, Kelantan, Malaysia. E-mail: tahaminabegum70@hotmail.com, tahamina676@gmail.com.

Bangladesh Journal of Medical Science Vol. 23 No. 02 April'24

DOI: https://doi.org/10.3329/bjms.v23i2.72175

focus in specific ways compared to men[6], and different colours might differentially influence emotional processing[7]. Thus, educational influences on the perception of colour in women may be different than those in men, a possibility that has not yet been studied.

Perception is an important factor in evaluating colour detection[8,9]. Humans use a complex visual network for colour processing[10,11], which has been studied in various fields including medicine and neuroscience for diagnostic and therapeutic purposes. Different colours can be used to assess cognitive functions, which are important for management plans for patients[12,13]. Colour-related neuropsychology tests include the Weigl Colour-Form Sorting Test, the Wisconsin Card Sorting Test, and the Stroop Test[14-16]. The Ishihara colour chart has been used to detect colour perception deficiency[17], and another study concluded that attention deficits and brain connectivity disorders can be determined using the Ishihara colour chart[18]. However, all event-related potential (ERP) studies on colours focused on different types of ERP components. For example, the N200 and P300 ERP components have focused on attention[4,5] and brain connectivity[18], but no study has yet detected and analysed perception processing of colour. Among ERP components, the C1 ERP component can explain visual perception. Visual perception has been studied in pregnant women using a visual oddball task in C1 ERP component analysis[19,20].

We therefore aimed to examine the influence of education on colour perception in women using C1 event-related component analysis.

Materials and Methods:

Study procedure

This study was approved by the Human Ethical Committee of Universiti Sains Malaysia (USM) [USMKK/PPP/JEPeM (232.3(8)). After approval, we recruited a total of 24 age-matched women from different educational backgrounds. Power and sample size (PS) software was used to calculate sample size where true difference in the two education groups was 0.24 and standard deviation was 0.16[3]. Therefore, n = 8 in each group. We grouped them into high-education (G1), medium-education (G2), and low-education (G3) groups (n = 8 in each group) according to the Malaysian educational system[3]. High-education, medium-education and low-education groups finished their diploma (>14 years education), secondary level (14 years education) and finished/not finished primary level (≤11 years), respectively[3]. All women provided their written informed consent before starting the experiment. ERP experiment was done in MEG/ERP room at Hospital USM.

Experimental procedure and data analysis

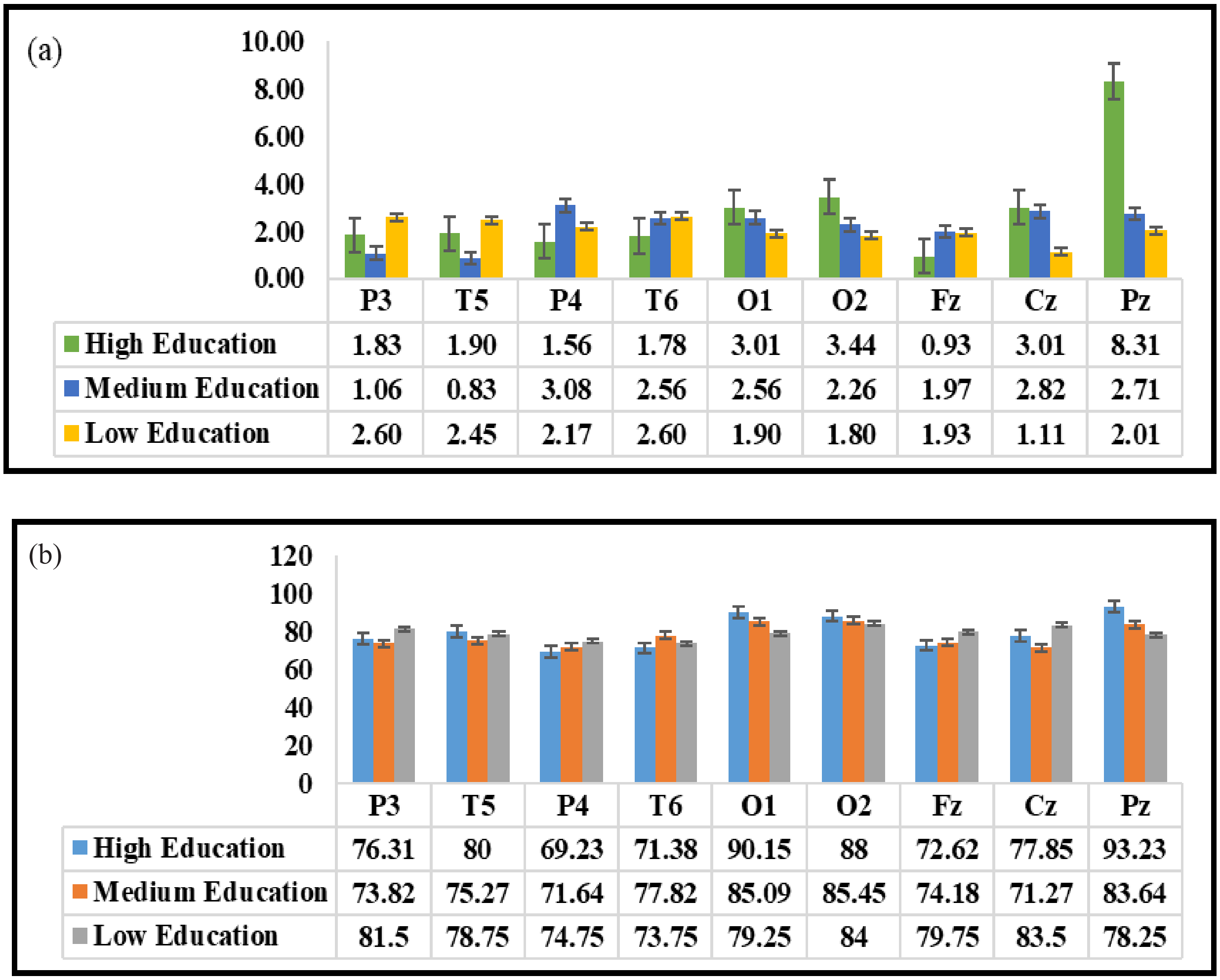
The experimental procedure has been explained in detail in previous studies[4,5]. Different colours were chosen by participants, and they were instructed to press button '1' if they liked a particular colour and button '2' if they disliked it. Data were collected using Net Station software. All data collected from Net Station software were subjected to data analysis steps of Net Station software. Filtering (0.3-30 Hz), stimuli rate (250 Hz), segmentation (-100 to 500 ms), artefact detection (eye blink, eye movement, body movement), and baseline correction (-100 ms) were performed. Amplitudes and latencies of the C1 ERP component were analysed in nine electrode locations: P3, P4, T5, T6, O1, O2, Fz, Cz, and Pz.

To determine the significance of the results among groups, we used analysis of variance (ANOVA) in Social Package for Social Sciences version 24.0 (SPSS v24.0) software. Statistical significance was set as $p \leq 0.05$.

RESULTS

Twenty-four age-matched women were selected for this study in three groups: G1 (high education), G2 (medium education), and G3 (low education). Mean ages (±SD) were 28.65 (±2.63) years for G1, 28.23 (±8.67) years for G2, and 34.39 (±8.28) years for G3. Mean years of education were 16.38 (±1.41), 13.58 (±0.49), and 9.43 (±2.70) years, respectively.

ANOVA revealed no significant differences in amplitudes and latencies of the C1 ERP component between groups. Group effects (F(df), *p*) of C1 amplitudes were as follows: P3: 1.126(2,21), *0.335*; P4: 0.693(2,21), *0.506*; T5: 1.058(2,21), *0.358*; T6: 0.151(2,21), *0.861*; O1: 0.380(2,21), *0.686*; O2: 0.845(2,21), *0.438*; Fz: 0.637(2,21), *0.535*; Cz: 1.440(2,21), *0.250*; Pz: 1.963(2,21), *0.155* (Fig. 1).



(a)

	P3	T5	P4	T6	O1	O2	Fz	Cz	Pz
High Education	1.83	1.90	1.56	1.78	3.01	3.44	0.93	3.01	8.31
Medium Education	1.06	0.83	3.08	2.56	2.56	2.26	1.97	2.82	2.71
Low Education	2.60	2.45	2.17	2.60	1.90	1.80	1.93	1.11	2.01

(b)

	P3	T5	P4	T6	O1	O2	Fz	Cz	Pz
High Education	76.31	80	69.23	71.38	90.15	88	72.62	77.85	93.23
Medium Education	73.82	75.27	71.64	77.82	85.09	85.45	74.18	71.27	83.64
Low Education	81.5	78.75	74.75	73.75	79.25	84	79.75	83.5	78.25

Figure 1: Bar chart showing mean amplitudes (a) and latencies (b) of the C1 ERP component in high, medium, and low education in women. Error bars indicate standard errors.

Group effects (F(df), *p*) of C1 latencies were as follows: P3: 0.704(2,21), *0.501*; P4: 0.410(2,21), *0.667*; T5: 0.279(2,21), *0.758*; T6: 0.555(2,21), *0.579*; O1: 1.604(2,21), *0.215*; O2: 0.274(2,21), *0.762*; Fz: 0.600(2,21), *0.554*; Cz: 1.461(2,21), *0.245*; Pz: 2.787(2,21), *0.075* (Fig. 1).

DISCUSSION

We investigated the effects of education on colour perception in the high-, medium-, and low-education groups by analysing the amplitude and latencies of the C1 ERP component. There were no significant differences in the amplitudes and latencies of the C1 component between the groups at any channels.

The C1 ERP component reflects visual perception[21,22]. A smaller amplitude of C1 indicated good perceptual learning[23], with no significant differences, meaning that the colour stimuli are spatial or feature-based neutral stimuli[24,25]. Ananth et al. (2021) found that C1 amplitude and latency were intact in pregnant women and that for pregnant women, the visual oddball task evaluated feature-based neutral stimuli[19]. In this study, we investigated preferences to different colours. We assumed that women from different educational backgrounds exhibit similar perceptual processing for colour and that the colour stimuli were spatial or feature-based neutral stimuli for women[22,25].

CONCLUSION

We conclude that the early sensory component of colour perception was not affected by education level in women. Further studies using other ERP components with larger sample sizes are needed in the future.

Acknowledgement

This work was supported by the Short Term Grant of Universiti Sains Malaysia (USM) (304/PPSP/61311092) for T.B.

Conflict of interest: None.

Author Contributions

Data collection and conception of the study: Raid F, Begum T, Reza F.

Study design: Reza F, Begum T.

Data collection, writing, and submission of manuscript: Begum T, Reza F.

Editing and approval of the final draft: Raid F, Begum T, Reza F.

References

1. Blakemore SJ, Silvia AB. At the nexus of neuroscience and education. *Dev Cogn Neurosci* 2012;**2**S:S1-S5. doi: 10.1016/j.dcn.2012.01.001
2. Urh M, Eva J. Learning habits in higher education. *Procedia Soc Behav Sci* 2014;**116**:350-355. https://doi.org/10.1016/j.sbspro.2014.01.220
3. Begum T, Reza F, Ahmed I, Abdullah JM. Influence of education level on design induced N170 and P300 components of event related potentials in the human brain. *J Integr Neurosci* 2014;**13** (1):71-88. doi: 10.1142/S0219635214500058.
4. Hasan RA, Reza F, Begum T. Education level is associated with specific N200 and P300 profiles reflecting higher cognitive functioning. *J Adv Med Pharm Sci* 2016;**10** (4):1-12. DOI: 10.9734/JAMPS/2016/29783
5. Hasan RA, Reza F, Begum T. Gender influences on colour processing: an event related potential (ERP) study. *Bangladesh J Med Sci* 2018;**17** (04): 612-618. https://dx.doi.org/10.3329/bjms.v17i4.38324
6. Kimchi R, Rama A, Anat SK. Gender differences in global local perception? Evidence from orientation and shape judgments. *Acta Psychol* 2009;**130** (1):64-71. DOI: 10.1016/j.actpsy.2008.10.002
7. Rozenkrants B, Polich J. Affective ERP processing in a visual oddball task: Arousal, valence, and gender. *Clin Neurophysiol* 2008;**119** (10):2260-2265. doi: 10.1016/j.clinph.2008.07.213
8. Ahmad I. Three-dimensional shade analysis: Perspectives of color—Part I. *Pract Periodontics Aesthet Dent* 1999;**11** (7):789-796. doi: 10.1016/j.clinph.2008.07.213
9. Chu SJ, Devigus A, Mieleszko A. Fundamentals of color: shade matching and communication in esthetic dentistry. *Quintessence, Chicago*, 2004. ISBN: 978-0-86715-497-9; 9780867154979.
10. Romero MC, Vicente AF, Bermudez MA, Gonzalez F. Color-Sensitive Neurons in the Visual Cortex: An Interactive View of the Visual System. In Skusevich D, Matikas P, eds. Color Perception: Physiology, Processes and Analysis, Nova Science Publishers, Inc., 2010:161-183.
11. Sasaki H. Cortical and Sub-cortical Processing of Color: A Dual Processing Mode of Visual Inputs. In Skusevich D, Matikas P, eds. Color Perception: Physiology, Processes and Analysis. Nova Science Publishers, Inc., 2010.
12. Stroop JR. Studies of interference in serial verbal reactions. *J Exp Psychol* 1935;**18** (6):643-662. https://doi.org/10.1037/h0054651
13. Hiscock M. Behavioural Experimental Techniques. In Hugdahl K, ed. Experimental Methods in Neuropsychology. Vol. 21 of Neuropsychology and Cognition, Springer US. 2003;**21**:1-27.
14. Chiu WZ, Papma JM, de Koning I, Donker Kaat L, Seelaar H, Reijs AE, et al. Midcingulate involvement in progressive supranuclear palsy and tau positive frontotemporal dementia. *J Neurol Neurosurg Psychiatry* 2012;**112**:3086-3094. doi: 10.1136/jnnp-2011-302035.
15. Beglinger LJ, Unverzagt FW, Beristain X, Kareken D. An updated version of the Weigl discriminates adults with dementia from those with mild impairment and healthy controls. *Arch Clin Neuropsych* 2008;**23** (2):149-156. DOI: 10.1016/j.acn.2007.11.002
16. Tanaka K, Quadros AC Jr, Santos RF, Stella F, Gobbi LT,

Gobbi S. Benefits of physical exercise on executive functions in older people with Parkinson's disease. *Brain Cogn* 2009;**69** (2):435-441. doi: 10.1016/j.bandc.2008.09.008.

17. Bohnen N, Roger A, Robert K, Kirk F, Martijn M. Impaired color perception is associated with more severe nigrostriatal denervation in Parkinson disease. *J Nucl Med* 2013;**54**:1787.
18. Al-Marri F, Reza F, Begum T, Hitam WHW, Jin GK, J Xiang. Neural activation patterns and connectivity in visual attention during number and non-number processing: An ERP study using Ishihara pseudoisochromatic plates. *J Integr Neurosci* 2017;**17** (3):257-270. https://doi.org/10.31083/JIN-170058
19. Ananth D, Begum T, Reza F. Modulation of the visual C1 event-related component in pregnancy. *Bangladesh J Med Sci* 2021 (accepted).
20. Begum T, Reza F. Source localization of the visual C1 ERP component in pregnancy. *Bangladesh J Med Sci* 2021 (accepted).
21. Rauss K, Schwartz S, Pourtois G. Top-down effects on early visual processing in humans: a predictive coding framework. *Neurosci Biobehav Rev* 2011;**35** (5):1237-1253. https://doi.org/10.1016/j.neubiorev.2010.12.011
22. Di Russo F, Martinez A, Hillyard SA. Source analysis of event-related cortical activity during visuo-spatial attention. *Cereb Cortex* 2003;**13** (5):486-499. https://doi.org/10.1093/cercor/13.5.486
23. Ahmadi M, McDevitt EA, Silver MA, Mednick SC. Perceptual learning induces changes in early and late visual evoked potentials. *Vision Res* 2018;**152**:101-109. https://doi.org/10.1016/j.visres.2017.08.008
24. Kropotov JD. Event-Related Potentials. In Functional Neuromarkers for Psychiatry 2016;59-78. https://doi.org/10.1016/B978-0-12-410513-3.00006-1

Fu S, Greenwood PM, Parasuraman R. Brain mechanisms of involuntary visuospatial attention: an event-related potential study. *Hum Brain Mapp* 2005;**25** (4):378-390. https://doi.org/10.1002/hbm.20108