Left Lateral Singular (LLS) view enhances attention at stimulus discrimination during Automobile display setting revealed by EEG/ERP and Eye Tracking Technique

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ABSTRACT

We aimed to detect the attention level and the gaze behaviour during the left lateral singular (LLS) and the right lateral singular (RLS) views of car display setting by using the Event Related Potential (ERP) and the eye tracking techniques on 15 healthy subjects. 128 sensor-net was used for the ERP study. Button '1' and '2' were pushed when subjects saw the 'RLS' and the 'LLS' view of car as quickly as possible and no response was instructed during the building picture (neutral) stimuli. One subject underwent for the eye tracking study to measure the fixation duration, the pupil size and the attention map of eye movement. The N100 and the P300 ERP components were measured at 19 electrode positions. The tendency of higher amplitude of N100 ERP component at maximum sites and maximum shorter latencies at few sites for display design of LLS view indicated that subjects had more visual selective attention and quick perception during visual presentation of LLS view as compared to RLS view. The pattern of P300 amplitude distribution at electrode sites for display design of LLS and RLS view are almost similar with maximum shorter latencies at few sites for display design of LLS view. This indicated that subjects had similar visual perception during visual presentation of LLS view and RLS view. Gaze behaviours from one case study showed equal attentiveness to the display design of LLS view and RLS view possibly due to colour interference, because the fixation duration and pupil size of the subject were larger in the black colour during the LLS view and the red during the RLS view. Both the ERP and the eye tracking results were inconsistent at stimulus discrimination task but they are constant in visual cognitive processing. This information will be useful for further evaluation of sensory marketing using simultaneous recording of ERP and Eye Tracking and for the automobile dealers during display settings to attract attention of the consumers.
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Keywords: Neuromarketing, Display Design, Event Related Potential, Eye Tracking.

1. INTRODUCTION

Last few decades, advances of neurosciences give us the opportunity to take part researches with different fields. Neuromarketing is one of the important fields among them. Neuroscience/neurology and marketing meet in together in different studies with extensive interest of knowledge which leads to neuromarketing research [1]. The main goal of neuromarketing is to take attention from consumers in different ways like new and improved product or different design as per user's aspect. To sell product well in the market depend on users emotion, meanings and positive action [2, 3] which demands user's attention. Product designs [4], brand, price, packaging of product [5] were studied to meet consumers' expectations with neuromarketing research. The way of display of different product plays an important role among consumers to buy products which is the main charming point in marketing. Therefore in this study we focused to detect consumer's attention to buy a product.

Significant improvement in neuroimaging gave us the opportunity for neuromarketing research to investigate emotions and social interactions which finally make the people for specific choice [6]. Among neuroimaging techniques, event related potential (ERP) is the most conventional method which has excellent temporal resolution to understand consumer behaviour and emotion [7, 8]. Through ERP we can obtain peoples psychological activities [9] where emotion can influence consumer's cognitive function directly [10]. Visual attention can reflect on the amplitudes and the latencies of the ERP components [8, 11] to detect and identification of the products [8, 12, 13]. Having a negative

and positive deflection in ERP components, N100 (a negative) and P300 (a positive) ERP components is playing an important role during visual attention to a product. N100 component reflects perception [14] and P300 reflects cognitive processing like attention and working memory [15]. In this neuromarketing research we measure the amplitudes and latencies of N100 and P300 ERP component to identify the level of attention by using ERP study.

Now-a-days, eye tracking technique is catching more attention in neuromarketing research field. Researchers used eye tracking technique to observe the gaze behaviour, fixation duration and pupil size of consumers which reflect users' attention to specific object [16]. Longer fixation duration or moment and more dilate pupil size can be detected during long time looking at the same place or colour when consumers give more attention to an object that usually detected by eye tracking system [17, 18] and within images [19]. Most important thing is that the eye tracking information has direct relation with cognitive function like attention [20] and gaze direction is directly proportional with the focus of attention [21].

Till now there is no study on the effect of attention regarding different car display design on users. Therefore we aimed to detect the level of attention by measuring amplitudes and latencies of the N100 and the P300 ERP components with ERP study and also by measuring fixation duration and pupil size with eye tracking technique during left and right side views of car display design.

2. METHODOLOGY

Human Ethical Committee of Universiti Sains Malaysia (USM) approved this study with the reference number (USMKK/PPP/JePeM 267.2[7]) before starting experiment. Participants were collected after giving advertisement in internet, e-mail and personal communication with friends. All participants signed a written inform consent form before experiment. Fifteen (15) subjects with mean (SD) age of 22.73 (± 1.71) were recruited for this research. Sample size was calculated by one statistician with PS software (Power and sample size) where statistical power was set to 0.8 and sensitivity was 0.05. All procedures were done in MEG/ERP lab of Hospital Universiti Sains Malaysia (HUSM), Kelantan, Malaysia.

A. Experimental design:

E-prime software (version 2.8, Psychology Software Tools, Inc, Sharpsburg, Pennsylvania, USA) was used for the visual stimuli of different settings of cars of six colours (Blue Lagoon, Genetic Silver, Solid White, Tranquility Black, Elegant Brown and Fire Red) with 60 pictures. Participants pressed 'button-1' when see the right lateral singular (RLS) view and 'button-2' when see the left lateral singular (LLS) view of the car as quickly and as accurately as possible. Subjects did not press any button when see the neutral stimulus (the building pictures). Stimuli were presented randomly for 1.5 sec at interstimulus intervals (ISI) of 3 sec. Figure 1 showed the experimental paradigm in this neuromarketing research.
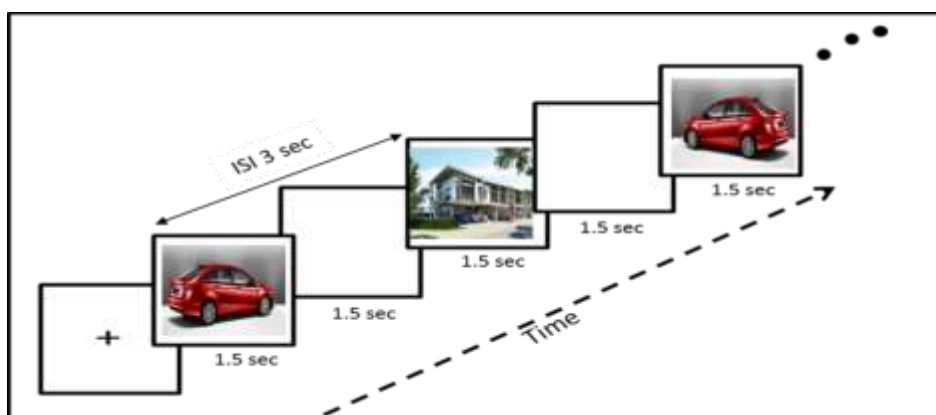

Figure 1: The experimental procedure showed the right lateral singular (RLS) view and the left lateral singular (LLS) view cars with 3 sec ISI for 1.5 sec. Different house pictures were presented as neutral stimuli.

B. 'Event Related Potential (ERP)' and 'Eye Tracking' procedure:

128-sensor net was used for the ERP study. Stimuli were presented in 22" LCD computer which was about 80 cm away from the subjects. The amplitudes and latencies of the N100 and the P300 ERP components were measured to distinguish the level of the attention during the right and the left lateral singular view of cars. Twelve (12) pictures were applied for the stimuli in eye tracking system with 60 sec duration through 'SMI experiment Center' software. The stimuli were then synchronized with the iView System. Subjects were instructed to look at the pictures in the video

presented that was 100-180 cm apart from subject. MEG 250 was used for video images which were traced by highly sensitive, high resolution infrared long-ranged camera. The image information was sent via an optical fibre to 'SMI iView' system for further processing. The 'SMI iView' software tracks the pupil for the calculation of the centre of the pupil and removes the artifact. iView software was run through the iView workstation in the computer to confine eye movement, control camera equipment and finally for the analysis of eye signals of the experiments. SMI Behavioural and Gaze Analysis Program (BeGaze) was used for the analysis of area of interest (AOI), semantic gaze mapping, focus map, heat map etc.

C. Data Analysis:

All data was normally distributed that was checked by using SPSS-22 (Statistical Package for the Social Science version 22). Value of the amplitudes and the latencies of the N100 and the P300 ERP components during all stimuli of the right and the left lateral views and the neutral stimuli were collected through Net-Station software. Band pass filter was 0.3-30 Hz and electrode impedances were below 50 KΩ. Data was segmented 100 ms before to 800 ms after the stimulation. Baseline correction was 0-100 ms before the stimulation. Bad channels (>200 µV), Eye blink (>140 µV), eye movement (>55 µV) and movement artifact were removed by 'artifact detection tool' in Net-Station software with sliding windows of 80 ms. After then these all values were analyzed through SPSS-22 software to search significance value among three stimuli. One way-ANOVA test was used in SPSS-22 software to detect significance level among groups. Independent T-test was used to find out significance level of the reaction time between the RLS view and the LLS view. The significance level was set at P<0.05.

3. RESULTS

Figure 2 showed grand average waveform of the N100 and the P300 ERP component during the LLS and the RLS views of car with the neutral stimuli at 19 electrode positions.
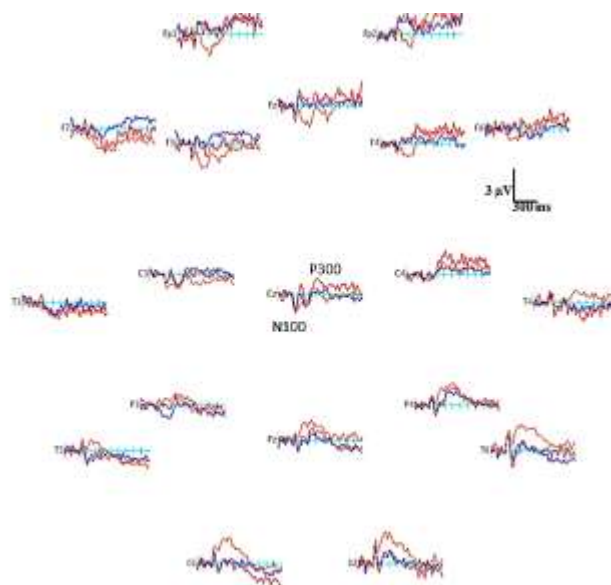

Figure 2: Grand average waveform of the amplitudes and the latencis of the N100 and the P300 ERP components were shown at 19 electrode locations during the RLS view (red trace), the LLS view (blue trace) and the neutral stimuli (orange trace) in neuromarketing research.

A. Results of N100 ERP Component

One way ANOVA analysis uncovered that the mean amplitude of the N100 component was significantly different among three stimuli (RLS, LLS and neutral) (Table 1). Post-hoc multiple comparisons using Bonferroni test indicated that the mean amplitude of the N100 for the LLS view was significantly and non-significantl higher compared to Neutral stimuli at three scalp sites, F3 [$F_{(2,42)}=4.34$, P=0.02], F4 [$F_{(2,42)}=4.71$, P=0.01], C3 [$F_{(2,42)}=3.62$, P=0.04], while the Neutral stimuli was significantly higher compared to the RLS view and the LLS view at the three sites, T6 [$F_{(2,42)}=7.57$, P=0.002], O1 [$F_{(2,42)}=4.76$, P=0.01] and O2 [$F_{(2,42)}=5.48$, P=0.008]. But the mean N100 amplitude for the RLS view was not significantly different from either the LLS or the Neutral stimuli. However, overall significant (F3, F4, C3) and non-significant (Fz, Cz, Fp1, Fp2, F7, F8, C4, P3) higher amplitudes of the N100 ERP component were observed during the LLS view compared to the RLS view. Three locations (Pz, T3, and T4) showed non-significant higher amplitudes of the N100 component during the RLS view and rest of the electrodes showed

significant (T6, O1, O2) and non-significant (Fz, T5, P4) higher amplitudes of the N100 component during neutral stimuli (Table 1). Significant (Fz, Fp1, F3, F4) and non-significant (Cz, Fp2, F7, F8, C3, T3, T5) shorter latencies of the N100 component were detected during the LLS view compared to the RLS view (Table 1). Most of the sites evoked significant group effects at Fz [F(2,42)=4.30, P=0.02], Fp1 [F(2,42)=6.93, P=0.003], F3 [F(2,42)=4.73, P=0.01] and F4 [F(2,42)=3.56, P=0.04] areas during the LLS view. Four locations (C4, T4, P3, O2) showed non-significant shorter latencies of the N100 component during the RLS view and the rest of the electrodes (Pz, T5, T6, P4, O1) evoked shorter latencies of the N100 component during the neutral stimuli (Table 1).

Table 1: Values of the amplitudes and latencies of the N100 ERP component (mean± SD) were shown in Table 1.

Sites	RLS view (mean ± SD)	LLS view (mean ± SD)	Neutral (mean ± SD)	F (df)	P	Significance
N100 ERP Component Amplitudes (in µV) (mean±SD)						
Fz	0.58±0.56	0.95±0.86	0.96±0.87	1.14(2,42)	0.33	NS
Cz	0.99±1.38	1±0.77	0.47±0.44	1.51(2,42)	0.23	NS
Pz	1.4±1.13	0.75±1.03	1.37±1.5	1.33(2,42)	0.28	NS
Fp1	0.87±0.54	1.17±1.43	1.03±0.88	0.32(2,42)	0.73	NS
Fp2	0.87±1.19	2.06±1.95	1.3±0.76	2.80(2,42)	0.07	NS
F3	**0.53±0.43**	**2.21±2.92**	**0.67±0.51**	**4.34(2,42)**	*0.02*	**S**
F4	**0.68±0.79**	**1.62±1.29**	**0.76±0.54**	**4.71(2,42)**	*0.01*	**S**
F7	0.84±0.67	1.15±1.3	0.87±0.59	0.54(2,42)	0.59	NS
F8	1.36±1.8	1.74±2.2	0.92±0.7	0.89(2,42)	0.42	NS
C3	**0.56±0.36**	**1.14±1.22**	**0.43±0.31**	**3.62(2,42)**	**0.04**	**S**
C4	1.04±1.24	1.3±1.01	0.64±0.47	1.78(2,42)	0.18	NS
T3	1.33±0.78	1.14±1.05	1.18±0.75	0.19(2,42)	0.83	NS
T4	2.14±1.62	1.54±2.41	1.87±1.28	0.40(2,42)	0.68	NS
T5	2.19±0.98	1.14±1.49	2.21±1.45	3.12(2,42)	0.06	NS
T6	**2.95±1.64**	**1.06±1.88**	**3.53±1.89**	**7.57(2,42)**	*0.002*	**S**
P3	1.13±0.98	1.19±1.14	0.93±0.64	0.29(2,42)	0.75	NS
P4	1.8±1.58	1.21±1.53	2.24±1.48	1.70(2,42)	0.2	NS
O1	**2.5±1.44**	**1.2±1.37**	**3.07±2.17**	**4.76(2,42)**	*0.01*	**S**
O2	**2.63±1.75**	**1.09±1.26**	**2.86±1.71**	**5.48(2,42)**	*0.008*	**S**
N100 ERP Component Latencies (in ms) (mean±SD)						
Fz	**123.7±18.48**	**112±24.09**	**132.2±12.69**	**4.30(2,42)**	*0.02*	**S**
Cz	124.8±12.75	120.5±22.87	126.9±15.15	0.52(2,42)	0.6	NS
Pz	114.1±25.02	114.6±31.95	106.6±25.68	0.39(2,42)	0.68	NS
Fp1	**122.6±17.67**	**105±20.81**	**128.5±14.95**	**6.93(2,42)**	*0.003*	**S**
Fp2	121.3±24.26	109.8±21.1	121.8±18.81	1.49(2,42)	0.24	NS
F3	**134.1±18.99**	**114.1±23.36**	**130.9±13.81**	**4.73(2,42)**	*0.01*	**S**
F4	**120.2±15.67**	**110.4±23.79**	**129±17**	**3.56(2,42)**	*0.04*	**S**
F7	127.4±17.75	116.8±25.93	126.4±23.06	1.02(2,42)	0.37	NS
F8	116.2±27.35	105±26.46	121±24.02	1.50(2,42)	0.24	NS
C3	125±17.98	122.4±24.64	126.6±15.76	0.18(2,42)	0.84	NS
C4	108.8±22.43	119.2±25.17	124.5±23.41	1.71(2,42)	0.19	NS
T3	120.5±21.32	109.8±29.07	115.7±25.09	0.67(2,42)	0.52	NS
T4	91.47±20.66	101.3±24.45	104.8±25.03	1.30(2,42)	0.28	NS
T5	104.5±29.11	102.1±29.54	97.87±24.46	0.22(2,42)	0.8	NS
T6	95.47±24.46	98.93±28.18	90.13±13.76	0.56(2,42)	0.58	NS
P3	109.3±23.06	111.7±31.47	112.5±26.26	0.06(2,42)	0.95	NS
P4	96.53±24.32	100±26.83	95.47±16.06	0.16(2,42)	0.85	NS
O1	104±29.04	107.7±31.69	97.33±22.3	0.53(2,42)	0.59	NS
O2	87.2±9.93	95.47±24.41	95.47±19.64	0.95(2,42)	0.4	NS

Note: ns: nonsignificant, n: significant, p<=.05

B. Results of P300 ERP Component:

The results revealed that although most of the electrode areas evoked higher amplitude of the P300 ERP component during neutral stimuli, our target display were the LLS view and the RLS view. We discovered that the mean amplitudes of the P300 component were significantly different during the three stimuli (RLS, LLS and Neutral) (Table 2). Post-hoc analysis revealed that the mean P300 amplitude was significantly higher at F4 $[F(2,42)=4.26, P=0.02]$ during the RLS view, while significantly higher at T6 $[F(2,42)=56.44, P=0.004]$ during the neutral stimuli. However, non-significantly higher amplitudes of the P300 ERP component were evoked at 11 electrode positions (Fz, Pz, Fp1, F3, F7, C3, T3, T5, P3, O1 and O2) during the LLS view compared to the RLS view. The RLS view evoked higher amplitudes at other eight (8) electrode positions compared to the LLS view (Table 2). But in case of the P300 ERP latency, most areas evoked non-significantly shorter latencies of The P300 component at the majority sites (Fz, Cz Pz, Fp1, Fp2, F3, F4, F8, C3, T4, T6, P4, O1 and O2) during the LLS view compared to the RLS views. Other five locations (F7, C4, T3, T5, P3) demonstrated shorter latencies during the RLS view compared to the LLS view. There were no significant group effects among three stimuli across all electrode sites in case of the P300 latency (Table 2).

Table 2: Table 2 showed the amplitudes and latencies of the P300 ERP component (mean±SD).

Sites	RLS view (mean ± SD)	LLS view (mean ± SD)	Neutral (mean ± SD)	F (df)	P	Significance
P300 ERP Component Amplitudes (in µV) (mean±SD)						
Fz	2.33±1.49	2.36±2.06	2.01±1.38	0.21(2,42)	0.81	NS
Cz	3.28±1.8	3.06±2.74	2.19±1.37	1.17(2,42)	0.32	NS
Pz	2.97±1.8	3.53±2.19	4.17±3.55	0.78(2,42)	0.47	NS
Fp1	3.13±1.66	4.12±3.51	3.67±2.28	0.55(2,42)	0.58	NS
Fp2	5.72±4.36	4.58±4.04	4.55±2.55	0.48(2,42)	0.62	NS
F3	1.4±0.79	2.63±2.88	2.42±1.76	1.61(2,42)	0.21	NS
F4	**4.02±2.6**	**2.69±2.46**	**1.72±1.1**	**4.26(2,42)**	**0.02**	**S**
F7	0.98±0.82	1.95±1.57	1.71±1.32	2.34(2,42)	0.11	NS
F8	4.04±3.31	2.39±1.93	2.25±1.76	2.50(2,42)	0.1	NS
C3	1.25±0.99	2.13±1.87	1.76±1.05	1.58(2,42)	0.22	NS
C4	3.61±1.43	2.69±1.97	2.23±1	3.20(2,42)	0.05	NS
T3	1.34±1.78	1.92±2.6	2.07±1.97	0.49(2,42)	0.62	NS
T4	2.71±2.71	1.83±1.51	2.81±1.45	1.12(2,42)	0.34	NS
T5	2.07±1.48	2.08±1.32	2.68±1.35	0.95(2,42)	0.4	NS
T6	**2.13±1.36**	**1.91±1.29**	**3.92±2.23**	**6.44(2,42)**	**0.004**	**S**
P3	1.98±1.37	2.75±2.24	2.76±1.32	1.03(2,42)	0.37	NS
P4	3.37±1.96	2.76±1.77	3.74±1.69	1.13(2,42)	0.33	NS
O1	2.7±2.91	3.13±2.2	3.71±1.95	0.68(2,42)	0.51	NS
O2	2.79±1.83	2.89±2.12	3.52±2.63	0.47(2,42)	0.63	NS
P300 ERP Component Latencies (in ms) (mean±SD)						
Fz	538.9±143.6	481.8±163.2	574.1±118	1.60(2,42)	0.23	NS
Cz	472.8±113	461±118.1	469.3±103.6	0.04(2,42)	0.96	NS
Pz	415.2±110.5	388.8±99.93	433±99.38	0.70(2,42)	0.5	NS
Fp1	574.1±129.7	488.8±167.4	594.1±115.1	2.42(2,42)	0.1	NS
Fp2	589±108	509.8±170.3	612.5±99.85	2.57(2,42)	0.09	NS
F3	477±150.5	474.6±160	518.4±124	0.43(2,42)	0.66	NS
F4	566.4±105.8	490.1±144	557.6±116.1	1.72(2,42)	0.19	NS
F7	430.1±161.3	478.9±164.2	560.8±130.5	2.80(2,42)	0.07	NS
F8	557.6±118.4	536.2±157	572.2±116.5	0.28(2,42)	0.76	NS
C3	454.4±118.7	452.5±124.9	491.4±131.3	0.46(2,42)	0.63	NS
C4	475.4±106.5	492.8±148.7	518.4±107.3	0.47(2,42)	0.63	NS
T3	455.4±138	514.1±162.3	508.8±139.7	0.73(2,42)	0.49	NS
T4	510.4±142	481.6±158.9	473.3±125.8	0.28(2,42)	0.76	NS
T5	413.6±133.8	442.1±130.3	390.9±104.7	0.65(2,42)	0.53	NS
T6	463.4±134.3	373.6±112.4	384.2±82.46	2.89(2,42)	0.07	NS
P3	418.6±92.44	439.4±123.7	415.2±116.6	0.21(2,42)	0.81	NS
P4	446.1±116	417.3±102	384±52.11	1.64(2,42)	0.21	NS

O1	449.6±135.7	375.7±108.5	375.2±76.27	2.29(2,42)	0.11	NS
O2	440.5±141.5	419.7±143.2	376.2±72.22	1.06(2,42)	0.36	NS

Note: ns: nonsignificant, n: significant, $p <= .05$

C. Reaction Time

The mean reaction time (mean±SD) was longer during the LLS view (577.0±192.5) compared to the RLS view (561.8±173.3) which was not statistically significant (P=0.21) (Figure 3, Table 3). No significant association was found between view and feedback status using Pearson Chi-square test (P=0.92). Non-significant higher correct and lower incorrect responses were found during the RLS view compared to the LLS view. The bar chart showed equal 'no response' feedback during both the RLS and the LLS views (Figure 4, Table 3).
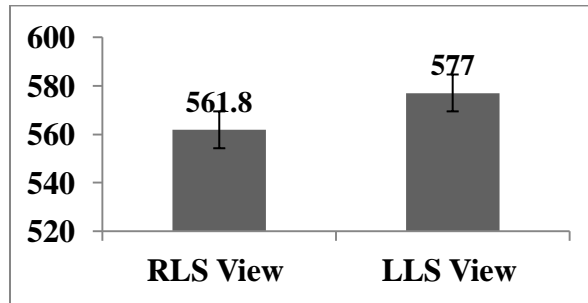

Figure 3: Bar chart showed mean reaction time during the RLS view and the LLS view. I- sign indicates error bars with of standard error.
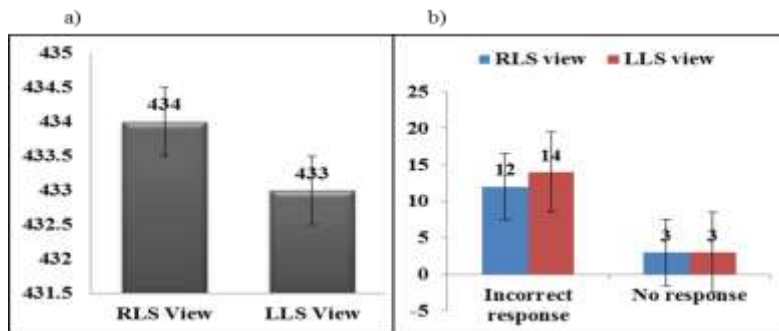

Figure 4: Correct (a), incorrect and no responses (b) of the feedback status were shown during the RLS view and the LLS view. I- sign indicates error bars with of standard error.

Table 3: Feedback status during the RLS view and the LLS view:

Variables	Feedback			Total
	Correct	Incorrect	No Response	
RLS view	435	12	3	450
	E = 434	E = 13	E = 3	
LLS view	433	14	3	450
	E = 434	E = 13	E = 3	
Total	868	26	6	900

D. Results of eye tracking:

Fixation duration and pupil size: One subject participated during eye tracking technique. The fixation time for black AOI (1014.8±685.1) (ms) was longer compared to other AOI during the LLG view. Pupil Size (50.50±0.778) (mm) was larger during LLG view for black AOI compared to other AOI (Table 4). During the RLG view, longer fixation time (708.3±436.9) and larger pupil size (52.04±0.778) were detected for red AOI compared to other AOI (Table 4).

Table 4: Value of fixation duration (in ms) and pupil size (in mm) were shown in the eye tracking system during the LLS and RLS views:

Stimulus	AOI	Fixation Duration (ms) (mean SD)		Pupil Size (mm) (mean SD)	
LLS	**Black**	**1014.8**	**685.1**	**50.50**	**0.778**

view	Blue	0.00	0.00	0.00	0.00
	Gold	0.00	0.00	0.00	0.00
	Red	959.0	0.00	49.20	0.00
	Silver	0.00	0.00	0.00	0.00
	White	0.00	0.00	0.00	0.00
	White Space	0.00	0.00	0.00	0.00
	Black	159.0	56.56	51.70	0.989
	Blue	0.00	0.00	0.00	0.00
RLS view	Gold	0.00	0.00	0.00	0.00
	Red	**708.3**	**436.9**	**52.04**	**1.599**
	Silver	0.00	0.00	0.00	0.00
	White	279.5	168.9	50.70	0.424
	White Space	254.0	30.00	52.35	0.680

Attention map (focus map and heat map): During display design of the LLS and the RLS views, gaze received was more at the middle and at the rear side of the car, respectively. Figure 5 showed attention maps (heat map and focus map) during display design of the LLS view and the RLS view

Figure 5: Attention maps (Heat and Focus) during display design of the LLS (left panel) and the RLS (right panel) views.

4. DISCUSSION

In order to investigate the cognitive function by means of attention during different display settings of the car, we used left lateral singular (LLS) view and right lateral singular (RLS) view of the cars with images of different houses as neutral pictures with using ERP and eye tracking procedures. The higher amplitudes and the shorter latencies of the N100 and the P300 components at most locations were found during the LLS view compared to the RLS view. Non-significant longer reaction time was revealed during the LLS view compared to the RLS view. Eye tracking result revealed that fixation duration was longer and pupil size was larger during the LLS view compared to the RLS view. Subject showed interest on black and red colour during the LLS and the RLS views, respectively. According to heat map and focus map, amount of gaze behaviour during both views were equal, but the locations of the car were different. And it was middle part during the LLS view and back side during the RLS view.

User's attention is the key factor in marketing to sell product successfully. ERP study explores the neural activities of consumer's attention. Various display settings of different products evoked the N100 and the P300 ERP component and explore the answer about level of perception and attention to the products. Early ERP component, the N100 is the indicator of visual perception and the P300 is the higher cognitive function component that means attention [22].

Amplitudes of the N100 increased when attention was more [23]. Smaller amplitudes and shorter latencies reflect increased processing of the stimuli during multimodal presentation [24, 25] which need more attention towards those stimuli [26]. Subjects need special attention to choose a specific object where perceptual information is processed further. On that case the higher amplitude of the N100 component reflects special attention for selection mechanism with influencing further perceptual processing [27].

Combining all the points of Martinez's (2006) [27] and McDonald's (2005) [23] research findings about the visual N100 component we can explain that consumers gave a special attention during the left lateral singular (LLS) view display setting in our study compared to the right lateral singular (RLS) view where perceptual processing was influenced. Taking the points from Van Wassenhove (2005) and Stekelenburg and Vroomen (2007) the results of our study consistent with them in case of the LLS view of the car display setting. We found smaller amplitudes and shorter latencies at few sites which is similar finding to their studies (Table 1). Though not all sites reflect the same results but we can take the consistency from those studies as some reflection we get. If so, then we can say that during the RLS car view, participants had a lack of attention which needs more perceptual processing. And the results of the LLS view display setting proved the opposite of the RLS view setting where subjects gave more attention compared to the RLS view in our study.

P300 ERP component is a cognitive assessment marker [28, 29] with the measurement of the amplitudes and the latencies of the P300 component. Higher amplitude is related with more attention [30] where lower amplitudes reflect reduced motivation with less attention [31]. Longer latency of the P300 indicated less attention [32]. The P300 component also considered as an indicator of visual consciousness with the higher amplitudes of the P300 component which reflects higher consciousness [33, 34]. With consistent result of all these studies about the P300 component we assume that in our study participants had more attention and consciousness during the LLS car view compared to the RLS view as the higher amplitudes and the shorter latencies of the P300 component at the most sites during the LLS view compared with the RLS view (Table 2). When people are more attentive to one object then they will have voluntary attention which need lass time (reaction time) to select the object. This voluntary attention indicated as genuine attention [35]. Similar of this point in our study we have faster reaction time during the RLS view compared to the LLS view but as this reaction time difference is very little and not significant therefore we can still say that subject paid genuine attention during the LLS view rather than the RLS view.

Longer fixation duration and larger pupil size is related with the higher attention and emotion [17, 18]. Even by eye tracking system we can monitor the fixed location within images [19]. By supporting these research results of the eye tracking system, our gaze behaviour data supported that participants gave more attention during the LLS view compared to the RLS view with their high emotion during the LLS view as longer fixation duration and larger pupil size were found during LLS view (Table 4) and the results of heat map and focus map proved that subjects paid attention at the middle and at the back side during the LLS and RLS views, respectively (Figure 5). By this research we expose information that participants liked black colour during LLS view and red colour during RLS view.

CONCLUSION

In this neuromarketing research we studied the left lateral singular (LLS) and the right lateral singular (RLS) car views to investigate the consumers behavior by means of attention using the ERP and the eye tracking techniques. Visual selective attention was pronounced at LLS view compared to RLS view exposed by the trend of higher amplitude of N100 ERP component at maximum electrode sites. Visual cognitive processing was almost similar at both views revealed through P300 amplitude distribution at electrode sites for display design of LLS and RLS view. Gaze behaviours from one case study showed equal attentiveness to the display design of LLS view and RLS view possibly due to colour interference, because the fixation duration and pupil size of the subject were larger in the black colour during the LLS view and the red during the RLS view. Both the ERP and the Eye Tracking results were inconsistent at stimulus discrimination task but they are constant in visual cognitive processing. This information will be helpful for further evaluation of sensory marketing using simultaneous recording of ERP and Eye Tracking and for the automobile dealers during display settings to attract attention of the consumers.

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