Running head: BILATERAL EYE-MOVEMENTS

The Impact of Bilateral Eye Movements on Frontal-Midline Theta

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Abstract

The bilateral eye-movement manipulation facilitates cognition on a range of cognitive tasks, including executive functions task

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Executing rapid bilateral eye-movements is a manipulation that has gained increasing attention in recent years due to its effects on cognition. Research on bilateral eye-movements (BEMs) has demonstrated its effects on cognition in areas such as memory, attention, and creativity, among others (e.g., Christman, Garvey, Propper, & Phaneuf, 2003; Lyle & Martin, 2010; Shobe, Ross, & Fleck, 2009). However, research exploring the impact of BEMs on cognition is mixed, with results varying depending on consistency of handedness (e.g., consistent versus inconsistent handed; Brunye, Mahoney, Augustyn, & Taylor, 2009; Lyle, Hanaver-Torrez, Hacklander, & Edlin, 2012; Lyle, Logan, & Roediger, 2008; Parker & Dagnall; 2010), as well as whether eye movements were horizontal or vertical (Christman et al., 2003; Lyle et al., 2008). More importantly, there is a shortage of neuroimaging research clarifying the impact of BEMs on brain activity (c.f., Propper, Pierce, Geisler, Christman & Bellardo, 2007; Samara, Elzinga, Slagter, & Nieuwenhuis, 2011).

of executive attention and working memory (Gevins et al., 1998; Gevins, Smith, McEvoy, & Yu, 1997), and will allow a direct test of the SICE theory.

The BEM manipulation is typically implemented using 30 s of rapid eye movements performed by participants tracking a dot visually that alternates in location between the left and right sides of a computer screen every 500 ms (Christman et al., 2003; see also Lyle & Edlin, 2015; Shobe, Ross, & Fleck, 2009). BEMs have been used in clinical settings such as during therapy for PTSD. According to the **Adaptive Information Processing Model** (AIP; Shapiro & Solomon, 1995), BEMs facilitate the processing and alleviation of distressing memories (Shapiro, 1989). Shapiro's model postulates that internal and external triggers can elicit the original perceptions of a distressing memory thereby inducing psychosomatic symptoms (e.g., high anxiety, nightmares, intrusive thoughts; Solomon & Shapiro, 2008). According to the AIP model (Solomon & Shapiro, 2008), the bilateral stimulation in EMDR therapies allows the individual to access previously stored dysfunctional information and to link the distressing memory with information from other memory networks thereby enabling new associations. The reduction in distressing memory symptoms of PTSD following BEMs has been supported in various studies (e.g., Lee & Drummond, 2008; L callosum. The assumption is that BEMs equalize activation levels of the hemispheres allowing six days. One week after submitting their journal entries, participants were assigned to participate in one of two conditions before recall; a 30 s BEM condition or a 30 s central-control condition. Participants in the BEM condition recalled significantly more journal entries and produced fewer false recalls than the central-control condition. The results of Experiment 2 suggest that BEMs increased episodic memory retrieval for real-life events in addition to the lab-based word lists used in Experiment 1. However, because hemispheric activation or interaction was not measured for either experiment the observed memory enhancement, it is unknown if performance following BEMs correlated with a change in IHI.

In subsequent research exploring the neural correlates of BEMs, Propper and colleagues (Propper et al., 2007) used EEG to measure potential changes in coordination between the hemispheres after participants were exposed to BEMs. Propper et al. (2007) examined gamma activity (35-54 Hz) due to their association with the processing of episodic memories (Babiloni et al., 2010). Examination of homologous frontal sites FP1 and FP2 were also chosen because of their associations with episodic memory. Their findings indicate that engaging in BEMs led to a decrease in the correlation of gamma power between the two frontal electrode sites compared to a central-control condition. The researchers acknowledged the discrepancy between their findings and the IHI hypothesis and stated that changes in brain activity do not always translate into changes in cognitive function (Propper et al., 2007). According to Propper et al. (2007), interhemispheric coherence indicates that the two hemispheres are doing similar things, and interhemispheric interaction indicates that two hemispheres are performing coordinated, but not necessarily similar things. The authors assert that a decrease in interhemispheric coherence does not necessarily indicate a reduction in IHI (Propper et al., 2007), as was seen in prior research using bimanual motor tasks in which participants showed significant increase in coordination of their left and right hands (IHI), but decrease of gamma-band interhemispheric coherence between the hemispheres (Gerloff & Andres, 2002).

As a direct follow up, Samara et al. (2011) tested the IHI hypothesis and highlighted of frontal electrodes (FT7 and FT8) showed a decrease in alpha band (8-13 Hz) coherence after BEMs. Samara et al. (2011) presume that since alpha coherence has previously been shown to be reduced during a cognitive task versus a resting state (Nunez, 2000), perhaps less coherence in the alpha frequency band at frontal electrode reflects brain states related to decreased arousal or cognitive processing. Interestingly, behavioral data indicated a significant increase in recall of emotional words for the BEM condition compared to the central-control condition. This set of findings suggests that IHI may not be the critical change in brain activity associated with retrieval enhancement and that this cognitive enhancement may be the result of other underlying mechanisms.

To further test the IHI theory, Lyle and Martin (2010) utilized a letter matching task to differentiate the impact of BEMs on intrahemispheric processing versus interhemispheric processing. In this task, participants were asked to fixate on a cross in the middle of the computer screen and indicate when the bottom letter matched the top letter that appeared by pressing the letter “h”. The authors reasoned that if the target and a matching letter probe are presented in the aric trials), then the two letters are processed within the same hemisphere and IHI is not necessary to probe are presented in different visual fields (interhemispheric trials), they are processed in different hemispheres and IHI is necessary for match detection. Participants completed two experimental blocks after the central-control manipulation and two experimental blocks after the BEM manipulation. The two manipulations were counterbalanced and separated by a 15-minute interval that consisted of unrelated questionnaires. Lyle and Martin predicted that if engaging in BEMs facilitates IHI, enhanced performance response time and accuracy in interhemispheric trials should occur following BEMs. In contrast to predictions of IHI, accuracy on

incongruent flankers were significantly faster following BEMs than a central-control condition, and no differences were found in RTs between groups for trials containing congruent flankers. Therefore, BEMs reduced RTs whenever there was incongruent input that required greater attentional control to overcome the mismatch, an indication that BEMs specifically enhanced the subsequent operation of the executive function network (Edlin & Lyle, 2013).

The purpose of the present research was to measure the electrophysiological effects of BEMs on the frontal-midline region of the brain. Frontal-midline theta (FMT) is defined as rhythmic waves at a frequency of 4-8 Hz measured at electrode Fz reflecting activity of dense projections from Brodmann's Areas 8, 9, 24, 32, and 33 to the frontal-midline region (Gevins et al., 1997; Ishii et al., 2014; Pizzagalli, Oakes, & Davidson, 2003). Interestingly and relevant to the current study, voluntary eye movements and visual attention are linked to the same Brodmann's areas (Allman, Hakeem, Erwin, Nimchinsky, & Hof, 2001; Purves et al., 2001; Squire et al., 2012). Moreover, increases in FMT have been associated with increased attention (Asada, Fukuda, Tsunoda, Yamaguchi, & Tonoike, 1999), task difficulty (Gevins, Smith, McEvoy, & Yu, 1997; Smith, Gevins, Brown, Karnik, & Du, 2001), and memory load (Tesche & Karhu, 2000) which are components of the cognitive tasks that have been affected by BEMs in prior research (Lyle & Edlin, 2015; Martin & Lyle, 2010).

Additionally, increases in FMT during episodic memory retrieval tasks (Addante, Watrous, Yonelinas, Ekstrom, & Ranganath, 2011; Gruber, Tsivilis, Giabbiconi, & Muller, 2008) and in working memory tasks have been reported (Gevins et al., 1997; Gevins et al., 1998; Hsieh, Ekstrom, & Ranganath; 2011; Roberts, Hsieh, & Ranganath, 2013). In one study that explored the relation between FMT and task difficulty, Gevins and colleagues (Gevins et al., 1998) examined the sensitivity of EEG measures to variations in working memory load as

sustained attentional control may be associated with the enhanced cognition that occurs following BEMs.

In addition to studies that have shown the appearance of FMT to be more pronounced during the performance of attention demanding tasks (Gevins et al., 1997; Mizuki, Tanaka, Isozaki, Nishijima, & Inanaga, 1980; Kubota et al., 2000), other investigations have shown a strong link between FMT activity and lower trait anxiety (Inanaga, 1998) and lower state anxiety (Suetsugi, 2000). To explore if any link exists between the appearance of FMT and a significant change in self-report anxiety measures, behavioral measures of personality and affect were administered to use as possible covariates in the analyses.

The present research explored differences in FMT in resting-state EEG activity recorded before and after participants completed 30 s of BEMs or 30 s of a central-control manipulation. Comparable to the method applied by Samara et al. (2011), a 4-min baseline recording, alternating in 1-min intervals between eyes open and eyes closed was recorded before exposure to either the BEM or central-control manipulation followed by a 4-min post recording using the same recording sequence. The change in FMT was compared between the BEM group and central-control group to test the hypothesis that participants in the BEM condition would show a greater increase in FMT after the manipulation than participants in the central-control condition.

Method

Participants

Ninety-one undergraduate psychology students from Stockton University participated in the research for course credit. Exclusion criteria included a history of traumatic brain injury or neurological disorder, epilepsy, a history of mental health disorder and/or current use of medications for the treatment of mental health disorders, and substance use/addiction in the past year.. Sixteen participants did not have usable EEG data and were also excluded from the analysis. Lastly, only participants who scored a 70 or higher on the Edinburgh Handedness Inventory (EHI; Oldfield, 1971) were classified as strongly right-handed and were included in the analysis. Those who scored below 70 on the EHI were classified as weak-handed and were excluded from analysis ($n = 15$), leaving 60 participants (6 females, 54 males) for data analysis. Demographics and data from self-report measures of personality and affect for the remaining participants are provided by condition in Table 1.

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[illegible]

[illegible] The PANAS is comprised of 20 emotional descriptors, 10 which assess negative affect (NA; e.g., hostile or nervous) and 10 which assess positive affect (PA; e.g., enthusiastic or attentive). Respondents indicate to what extent they have felt this way during the past week using a 5-point Likert scale. Watson et al. (1988) have provided evidence demonstrating that the PA and NA scales are valid assessments of positive and negative affect. For the PA Scale, the Cronbach’s alpha coefficient ranged from .86 to .90 and for the NA Scale was between .84 and .87. In addition, over an 8-week time period test-retest reliabilities (.68 for PA and .71 for NA) indicate that the PANAS is a reliable measure of trait affect and possesses strong concurrent validity for measures that include general distress and dysfunction, depression, and state anxiety (Watson et al., 1988).

[illegible] The SPQ-B is a 22 item self-report measure of schizotypal personality characteristics based on the original SPQ (Raine, 1991), a self-report [illegible] modeled on the DSM-III-R criteria for schizotypal personality disorder. The SPQ-B contains three factors modeled after the three scissors, using a knife without a fork, and striking a match) by choosing from the following responses (with the corresponding scoring): Always Left (-10), Usually Left (-5), No Preference (0), Usually Right (5), or Always Right (+10). Handedness scores for participants range from -100 (dominantly left-handed) to 100 (dominantly right-handed).

EEG

High-density EEG data were recorded using a 129-channel HydroCel Geodesic Sensor Net, with Cz reference (Electrical Geodesics, Inc.). Sensor impedance levels were below 50 K

The procedure for the present research was approved by Stockton University’s Institutional Review Board. Participants began by giving written informed consent for their participation in the project. The consent form was followed by the demographics form. Participants were then asked to complete the PANAS (Watson et al., 1988), TIPI (Gosling et al., 2003), and the SPQ-B (Raine & Benishay, 1995) prior to the EEG portion of the experiment; the order of the questionnaires was counterbalanced across participants. After the questionnaires were completed, the EEG net was applied. A mild solution of distilled water and potassium chloride was used as a conductance medium.

During the EEG recording, participants began by having their resting brain activity recorded for 4 minutes, alternating back and forth between 1 minute eyes-closed and 1 minute eyes-open recordings. During these recordings participants were asked to sit in a relaxed position and not to think about anything in particular. After recording resting brain activity, half of the participants engaged in a BEM manipulation lasting for 30 seconds (experimental condition). In the BEM condition, participants were asked to track a moving circle as it shifted back and forth between the left and right sides of the computer screen, switching in location every .5 seconds (see Christman et al., 2003). The other half of the participants engaged in a central-control manipulation. In this task, participants were asked to view a circle in the center of the computer screen that randomly changed color two times per second. This control task offered visual stimulation but did not involve eye movements. Random assignment was used to assign each participant to either the experimental or control condition. After the 30-second manipulation (experimental or control), participants’ brain activity was recorded again for 4 minutes using the same sequence as in the pre-manipulation recording. Immediately after the post-manipulation recording, participants completed the P

In order to explore differences in the distribution of absolute power in the theta frequency band in the midline region in more depth, a 2 x 2 x 3 mixed model analysis of variance was performed with visual manipulation (BEM versus central-control) as a between-subjects variable and time (pre and post) and anterior-posterior (A-P) electrode location (electrodes Fz, Cz, and Pz) as within-subjects variables to analyze (see Figure 1 for the electrode layout used in the

FMT from pre to post manipulation and the central-control group showed a decrease in FMT from pre to post manipulation (see Table 3 for electrode power means by condition). Two supplemental analyses were conducted using pre and post PANAS scores to determine if BEMs had a significant impact on positive and negative mood compared to a control group. The results of a 2 (Time: pre versus post) x 2 (Condition: BEM versus central-control) mixed-model ANOVA examining changes in negative mood revealed a significant Time x Condition interaction ($F(1,58) = 4.698$, $p = .034$, $\eta_p^2 = .075$) (see Table 4 & Figure 5); differences between groups for positive mood were not significant, but displayed a general increase from pre to post for the BEM group and a decrease for the central-control group (see Table 5 & Figure 6).

Subsequently, a mixed model analysis of variance of the midline region revealed no

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interaction for frontal electrode pair F3-F4 $F(1,58) = 8.095$, $p = .006$, $\eta_p^2 = .122$) and parietal electrode pair P3-P4 $F(1,58) = 10.911$, $p = .002$, η_p^2

change in mean FMT power from pre to post in both conditions. Additionally, the BEM group showed a general increase in positive mood and a statistically significant decrease in negative mood, and the central-control group again showed the opposite affect; namely a decrease in positive mood and a statistically significant increase in negative mood.

Exploratory analyses did not reveal significant differences at the midline region (Fz, Cz, Pz) between the BEM group and the central-control group in any of the recording conditions: eyes-closed, eyes-open, or combined. However, a significant effect was found at frontal and parietal lateral electrode locat

Edlin and Lyle (2013) proposed that executing the 30 s BEM manipulation produces an increase in attentional control and prepares participants for executive control tasks that follow. This hypothesis was supported by their findings that the execution of BEMs leads to shorter RTs during incongruent trials of the ANT-R task compared to a central-control group and, as the authors concluded, that BEMs enhanced the executive function network due to the top-down attentional control required to execute BEMs (Edlin & Lyle, 2013; Edlin & Lyle 2014). The current study revealed a general increase in FMT occurring after the execution of BEMs compared to the central-control condition, and adds support that executing BEMs facilitates attention and may prime cognition for performance on subsequent memory, attention, and creativity tasks (e.g., Christman, Garvey, Propper & Phaneuf, 2003; Lyle & Martin, 2010; Shobe, Ross, & Fleck, 2009). However, while variations in attentional-control between the two conditions reflected general changes in the distribution of FMT power, the current study suggests that the FMT effects may be more apparent during more challenging task-related demands of the executive function network that require greater working memory load and sustained mental effort (Gevins et al., 1997; Gevins et. al, 1998; Gundel & Wilson, 1992; Smith, Gevins, Brown, Karnik, & Du, 2001; Yamamoto & Matsuoka, 1990).

One of the aims of the current study was to contribute to the shortage of resting state EEG research exploring the neural mechanisms following BEMs. To date, no other study has specifically explored the effects of BEMs on FMT, an established EEG marker of executive attention. Previous EEG research has attempted to explain BEMs by testing the IHI hypothesis which states that BEMs equalize activation levels of the hemispheres thus allowing for superior episodic memory retrieval (Christman et al., 2003). Propper et. al (2008) explored gamma activity at electrode sites FP1 and FP2 due to their association with the processing of episodic memories (Babiloni et al., 2010). Contrary to the IHI theory, Propper et al. (2008) found that BEMs led to a decrease in gamma coherence between frontal pole electrode pair FP1 and FP2. No other homologous electrode sites were examined. Moreover, a follow up investigation of BEMs to address the limitations of examining a single electrode pair in the aforementioned study was performed by Samara et al. (2011) a parietal locations that occurred concurrently with the increase in frontal theta power coincides with fMRI studies that showed that decreases in activity in the temporoparietal junction (TPJ) during voluntary control of attention along with increases in activity in the intraparietal sulcus (IP) and the FEF during a visual motion detection task occurred concurrently (Shulman et al., 2003). Recent studies have suggested that dorsal frontoparietal regions are involved in directing attention based on goals or expectations, whereas regions in the TPJ are activated by subsequent target detection, particularly if the target is unexpected and requires attention to be reoriented (Corbetta et al. 2000; Linden et al. 1999; Macaluso, Frith, & Driver, 2002; Marois, Leung, & Gore, 2000). The nature of the BEM task aligns closely with these studies in that it is a visual manipulation consisting of expected shifts of visual attention alternating from left to right every 500 ms for 30 s without any reorientation of attention. The present results open up the possibility that the attentional control necessary to perform 30 s of BEMs, preparing participants for executive control tasks that follow, is reflected by theta power changes in resting-state brain activity in frontal and parietal regions, thereby supporting the [illegible] (Edlin & Lyle, 2013).

Former EEG investigations of resting-state brain activity, a state of wakeful rest without cognitive task demands, have suggested marked differences in EEG between eyes-closed versus eyes-open resting states (Chen, Feng, Zhao, Yin, & Wang, 2007; Kounios et al., 2007). EEG data in the current study underscored differences in eyes-closed versus eyes-open resting state brain activity and showed significant differences between the BEM condition and the central-control condition at frontal and parietal lateral electrode locations for eyes-closed recording conditions but not in eyes-open recordings. The differences in theta power at frontal regions during eyes-closed recordings is consistent with the findings in Chen et al. (2007) that revealed a significant reduction in theta power from eyes-closed to eyes-open states at the fronto-central area. With an increase in FMT and overall theta activity at the frontal region after execution of BEMs, the results of this study demonstrate pronounced differences in eyes-closed resting-state recordings between the BEM group and the central-control condition, not evident in the eyes-open recording condition.

The BEM condition showed increased frontal theta activity concurrently with a significant reduction in negative mood thereby supporting research that reports individuals exhibiting greater theta activity tend to have lower state and trait anxiety scores (Inanaga, 1998).

research may consider administering the post-manipulation self-report measure of mood immediately after the experimental or control task, potentially revealing a stronger effect of BEMs on mood. A final limitation of the current study was that the investigation was limited to the theta frequency band. Previous studies have shown that the alpha frequency band is associated with visual attention (Kounios et al., 2007), and thus future investigations exploring absolute power across all frequency bands would provide a meaningful contribution to the literature examining the neural mechanisms of BEMs. Due to the low task demands of resting-state EEG, research containing challenging attentional demands of the executive function network following BEMs will potentially reveal more prominent FMT effects and shed light on the relationship between BEMs and the cognitive enhancement that follows.

In conclusion, the current study suggests that various degrees of attentional-control are reflected by changes in FMT, and the heightened attentional-control that follows from BEMs appear to increase theta power at frontal brain regions and reduce negative mood. Resting-state EEG data from this study make a meaningful contribution to our understanding of the differences between eyes-closed versus eyes-open brain activity following a visual attention task. In order to better test the cognitive enhancement that occurs after BEMs, future EEG studies should implemgnit]TJ,t.000rol are appt(d ligh liTJ 22. -.48(na .0005 Tcemnitive self-rif)3.bilen br)-6.1(55ngful)]

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[illegible] Age and self-report measures of personality and affect.

Condition	Control (*n* = 28)		Eye Movement (*n* = 32)	
	M	SD	M	SD
Age	20.21	3.47	19.61	1.93
SPQ Total	7.68	4.88	6.97	4.12
PANAS Positive	32.81	4.84	34.23	5.47
PANAS Negative	18.71	5.18	19.48	6.70
Extraversion	4.32	1.41	4.65	1.56
Agreeableness	4.88	.86	5.13	1.02
Conscientiousness	5.79	.98	6.16	.81
Emotional Stability	4.88	1.33	4.73	1.20
Openness	5.50	1.16	5.53	1.20
P-Brief Positive	12.04	4.65	14.06	4.69
P-Brief Negative	6.21	1.66	5.52	1.38
Handedness	90.71	9.10	90.00	10.33

[illegible] .

ANOVA Exploring differences in Theta Power for Time (Overall Pre versus Overall Post) by Electrode Location (Midline Electrode: Fz) by Condition (Eye-Movement Versus Control) Comparisons

[illegible]	[illegible]	SS	df

[illegible]

ANOVA’s Exploring differences in Positive and Negative Mood for Time (Pre versus Post) by Condition (Eye-Movement Versus Control) Comparisons

[illegible]	[illegible]	SS	df	MS	F	p	ES
[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Time x Condition	.306	1	.306	.589	.446	.010

[illegible] [illegible]

[illegible]	[illegible]		[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

ANOVA Exploring differences in Theta Power for Time (Overall Pre versus Overall Post) by Electrode Location (Midline Electrode: Fz, Cz, and Pz) by Condition (Eye-Movement Versus Control) Comparisons

[illegible]	SS	df	MS	F	p

[illegible]

ANOVA Exploring differences in Theta Power fo

[illegible]

ANOVA Exploring Differences in Theta Power between Conditions (Eye-movement versus Control) for Time (Overall Pre versus Overall Post) by Electrode Location (Anterior-Posterior), by Hemisphere

[illegible]	SS	df	MS	F	p	ES
Condition	.163	1	.163	.265	.608	.005
Time	.005	1	.005	.336	.564	.006
Time x Condition	.010	1	.010	.689	.410	.012
AP	441.579	2.794	158.037	111.546	.000	.658
AP x Condition	3.196	2.794	1.144	.807	.484	.014
Hemi	10.435	1	10.435	21.809	.000	.273
Hemi X Condition	.045	1	.045	.094	.760	.002
Time x AP	.054	2.701	.020	.676	.553	.012
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Time x Hemi	.012	1	.012	.589	.446	.010
Time x Hemi x Condition	.019	1	.019	.922	.341	.016
AP x Hemi	2.711	3.365	.806	2.300	.071	.038
AP x Hemi x Condition	.211	3.365	.063	.179	.928	.003
Time x AP x Hemi	.066	2.984	.022	1.812	.147	.030
Time X AP x Hemi X Condition	.049	2.984	.016	1.331	.266	.022

[illegible]

ANOVAs Exploring Group Differences in Theta Power between Conditions (Eye-movement versus Control) for Time (Overall Pre versus Overall Post) by Electrode Location (Anterior-Posterior)

[illegible]		SS	df	MS	F	p	ES
FP1-FP2	Condition	.226	1	.226	.217	.643	.004
	Time x Condition	.015	1	.015	.549	.462	.009
[illegible]	Condition	.003	1	.003	.007	.934	.000
[illegible]		[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
C3-C4	Condition	1.455	1	1.455	1.471	.230	.025
	Time x Condition	.059	1	.059	6.036	.017	.094
[illegible]	Condition	.234	1	.243	.320	.574	.005
[illegible]		[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
O1-O2	Condition	1.432	1	1.432	1.068	.306	.018
	Time x Condition	0.00	1	0.00	.006	.938	.000

[illegible]

ANOVA Exploring Differences in Theta Power between Conditions (Eye-movement versus Control) for Time (Pre-Closed Versus Post-Closed) by Electrode Location (Anterior-Posterior), by Hemisphere

[illegible]	SS	df	MS	F	p	ES
Condition	.158	1	.158	.258	.614	.004
Time x Condition	.004	1	.004	.205	.653	.004
AP x Condition	3.283	2.732	1.202	.757	.508	.013
Hemi x Condition	.100	1	.100	.212	.647	.004
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Time x Hemi x Condition	.009	1	.009	.234	.630	.004
AP x Hemi x Condition	.102	3.330	.030	.085	.976	.001
Time x AP x Hemi x Condition	.122	3.101	.040	2.006	.113	.033

[illegible]

[illegible]

ANOVA Exploring Differences in Theta Power between Conditions (Eye-movement versus Control) for Time (Pre-Open versus Post-Open) by Electrode Location (Anterior-Posterior), by Hemisphere

[illegible]	SS	df	MS	F	p	ES
Condition	.215	1	.215	.336	.565	.006
Time x Condition	.015	1	.015	.1.036	.313	.018
AP x Condition	3.335	2.773	1.203	.888	.442	.015
Hemi x Condition	.046	1	.046	.102	.751	.002

[illegible] Raw PANAS and P-Brief scores were standardized. This figure illustrates a significant decrease in negative mood for the BEM condition and a significant increase for the central-control condition.

[illegible] Raw PANAS and P-Brief scores were standardized. This figure illustrates a general increase in positive mood for the BEM condition and a general decrease for the central-control condition.

[illegible] Raw theta power scores were log transformed and standardized. This figure illustrates a significant increase for the BEM condition and a significant decrease for the central-control condition in overall theta power from pre to post at frontal electrode pair F3-F4.

[illegible] Raw theta power scores were log transformed and standardized. This figure illustrates a significant decrease for the BEM condition and a significant increase for the central-control condition in overall theta power from pre to post at parietal electrode pair P3-P4.

Raw theta power scores were log transformed and standardized. This figure illustrates a signiteral Eye8ustraten ey.32closef sl6(d)-250lofrom pJ -to-5.st atofronttelecdwode paird an2(F3-F4.9 TD 08