Should it Matter When We Record? Time of Year and Time of Day as Factors Influencing Frontal EEG Asymmetry

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Abstract

Resting frontal encephalographic (EEG) asymmetry is a relatively stable individual difference that identifies trait aspects of risk for psychopathology such as major depression. Superimposed on stable trait variance are occasion-specific fluctuations that, to date, have been relatively poorly characterized. A recent study (Peterson & Harmon-Jones, 2008) found that time of year and time of day interacted to predict differences in resting frontal asymmetry, with participants assessed on fall mornings having more relative right frontal activity versus those assessed on spring mornings. In a sample of 163 non-depressed individuals, a time-of -year by time-of-day interaction was just shy of significance, although the direction differs from that of Peterson & Harmon-Jones, with participants assessed on fall mornings having more relative left frontal activity than those assessed on spring mornings. To determine if the effects were due to seasonal variations such as photoperiod or possibly driven by seasonal psychosocial stressors inherent in a student sample, season was replaced by a dimensional scale of length of the photoperiod; significant findings were largely consistent with those based on fall/spring coding. Morning sessions run in periods of less light show more relative left frontal activity than other session times. Time awake appears to be an important moderating variable for the interaction of photoperiod and session time. Results of this study highlight the need to monitor or control seemingly extraneous factors that influence metrics assumed to be trait indices of motivational/affective propensities.

Introduction

- Frontal EEG asymmetry has been investigated as a marker of risk for depression and emotion-related psychopathology in many studies over the past several decades. Although largely supportive of the proposition that frontal EEG asymmetry may index a risk factor for depression, results have been somewhat inconsistent. This may partially due to the influences of state variance inherent in every sample such as time of day and time of year.
- In general, on a trait level, relatively less left than right resting frontal activity is thought to reflect a propensity towards lower approach and greater withdrawal motivation (e.g.Coan & Allen, 2003) and may function as a trait marker of depression (e.g. Allen, Urry, Hitt, & Coan, 2004).
- The change in the number of hours of daylight is thought to relate to the winter lowering of mood. One study to date suggests that there may be seasonal effects on frontal EEG asymmetry (Peterson & Harmon-Jones, 2008)
- Sources of state variance may be problematic for researchers looking for stable trait markers of depression, but they may also reveal interesting information about normal variation in mood.

Hypotheses

Hypothesis 1:
Participants run on fall mornings will show more relative right frontal activity than participants run in the spring and other session times.

Hypothesis 2:
A dimensional scale reflecting hours of light in a day (photo period) might be a better metric to capture the underlying construct than the categorical variable of season

Hypothesis 3
Time awake before recording will interact with session time and photo period, with those who only recently awoke expected to show more right frontal activity.

Methods

Subjects:

- 163 (107 women) participants were enrolled following structured clinical interviews and at the time of the study were free of any current Axis I psychopathology. Of the 163 people included in the original data set, 106 (65 women) had information regarding time awake and were used in testing hypothesis 3.

Data Collection & Processing:

- Data were collected on 4 separate days within a 2 week window. Each session had 2 eight minute resting baselines recorded using a 64 channel EEG cap.
- Data sampled at 1000 hz with a 0-200hz bandpass filter. An online reference was immediately posterior to CZ, and the data were later re-referenced to Linked Mastoids and an averaged reference.
- Data were visually inspected for artifacts and the cleaned data run through a blink rejection algorithm that rejects any segments where ocular activity breached the +/-75 microvolt threshold in the vertical ocular channel.
- The data were epoched in 117 2.048 second blocks that overlapped by 1.5 seconds. A Fast Fourier Transform (FFT) was run on the epoched data to extract the power spectrum for the alpha band.
- Alpha asymmetry scores were calculated for each resting session by subtracting the natural log transformed alpha scores (Ln[Right]-Ln[Left]) between homologous sites for each session. The scores were then aggregated across the two resting baselines within each day.

Statistical Analysis:

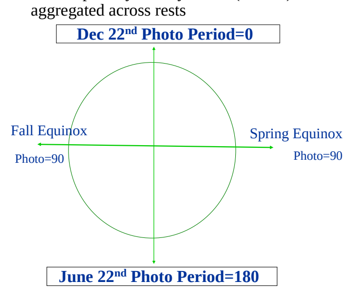
Full factorial mixed linear model (SAS 9.2) was run with

Model 1 (Hypothesis 1)

- Between Subject Variables:
  Time of Year
- Within Subjects Variables:
  Time of Day
  Day
  Reference (AVG, LM,)
  Channel Pair (F2_F1, F4_F3, F6_F5, F8_F7)
- Dependent Variable:
  Total alpha asymmetry score (8-13hz)
  aggregated across rests

Model 2 (Hypothesis 2)

- Between Subject Variables:
  Photo Period
- Within Subjects Variables
  Time of Day
  Day
  Reference (AVG, LM,)
  Channel Pair (F2_F1, F4_F3, F6_F5, F8_F7)
- Dependent Variable:
  Total alpha asymmetry score (8-13hz)
  aggregated across rests



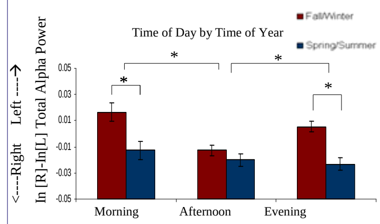
Model 3 (Hypothesis 3)

Between Subjects Variables:
Hours Awake
Photo Period

- Within Subjects Variables:
  Time of Day
  Day
  Reference (AVG, LM,)
  Channel Pair (F2_F1, F4_F3, F6_F5, F8_F7)
- Dependent Variable:
  Total alpha asymmetry score (8-13hz)
  aggregated across rests

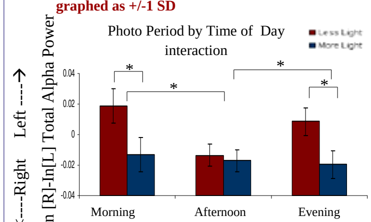
Results

For all hypotheses the interactions of interest are not qualified by a reference interaction.

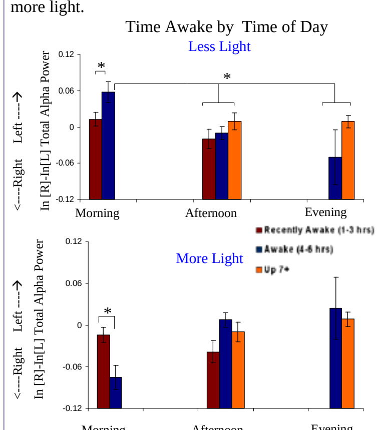


Hypothesis 1: A Season*Time of Day interaction was just shy of significance (p=.0509). The pattern of results is contradictory to the previous findings reported by Peterson & Harmon-Jones (2008). Fall morning sessions show significantly more left frontal activity than morning sessions in the spring. There is a main effect of season such that fall sessions show more relative left frontal activity than spring sessions. Peterson & Harmon-Jones (2008) did not have an evening session category, but did not report any significant differences between session times within spring sessions. An afternoon lull is also seen (main effect of Time of Day).

Figures with photo period variable are graphed as +/-1 SD



Hypothesis 2: A significant photoperiod by time of day interaction was found such that participants run during the morning in periods of less light show significantly more relative left frontal activity than those run during periods of more light (p<.01). Within periods of less light, there is an afternoon lull with participants showing more relative right frontal activity compared to morning and evening sessions (p<.05). In the evening, participants run during periods of less light show more relative left frontal activity than those run during periods of more light.



Hypothesis 3: When time awake is factored into the model, people run in periods of less light who awoke within 3 hours of their session show more relative right frontal activity then those who had been awake 4-6 hours before their session. There are no significant differences between people who recently awoke before their sessions when run in periods of less light or more light. Those who had been awake 4-6 hours showed more relative left frontal activity when run in periods of less light.

Discussion

- In a sample designed to replicate the time of year by time of day interaction of Peterson and Harmon-Jones (2008), the relationship was found to be in the opposite direction, with fall morning sessions characterized by the greatest relative left frontal activity. Peterson and Harmon-Jones concatenated evening and afternoon sessions into a single category, which may partially explain why results for the present study vary from those previously reported as the magnitude of the difference between evening sessions and morning sessions in the fall is not considerable.
- To determine if the time of year effect could be the result of seasonal variations in daylight hours as opposed to seasonally varying psychosocial stressors in a college-student populations, a photoperiod metric was calculated, with results showing that those run in periods of less light show more relative left frontal activity in both morning and evening sessions compared to those run in periods of more light. Within afternoon sessions in periods of less light, there is more relative right frontal activity compared to morning and evening sessions, suggesting a possible lull in mood. In periods of more light there are no significant differences as a function of session time.
- Participants' time awake before a session moderates the photo period by time of day interaction, and may help further explain the contradictory results of the present study and that of Peterson and Harmon-Jones. In periods of less light, those who woke up closest to their session time in the morning showed more relative right frontal activity then those who had been awake for longer lengths of time. For the present sample most sessions started after 10am, a relatively late start time, possibly allowing participants more time to wake up before their sessions.
- Future studies seeking to use EEG alpha asymmetry to isolate trait markers for psychopathology should take into account sources of state variance inherent in all samples such as time of day, photo period and time awake. This may help strengthen their results as well as clear up inconsistencies in the literature.

References

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