EMOTION REGULATION THROUGH MONASTIC DEBATE

Bachelor's Project Thesis

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Abstract: Monastic debate is a form of analytical meditation essential to the practices of Tibetan monks. The aim of these debates is to gain a deeper insight into the materials learnt as well as to have more control and regulation of their emotions. This study looked into the emotions of happiness and anger to see if there was a difference between the emotional control of beginner monks and experienced monks. The hypothesis was that both emotions would be more controlled for the experienced monks. Videos of monastic debates were watched for emotion instances which were later analysed. Electroencephalogram (EEG) was used to gain real time recordings of the brain signals during the emotions experienced in the debate, this was later analysed at the instances of emotions seen. The frequency and the duration of each of the emotions was compared between experience levels. It was found that anger increases in frequency and duration through experience in monastic debates. Happiness was found to have higher frequencies overall though of shorter duration than anger for both experience levels. No significant differences were found between frequency bands for the EEG data across different channels. Two areas of the brain were found to be significant between the emotions happiness and anger, at channels AF4 and PO4. No brain areas were found to be significant between the emotion and the experience level.

1 Introduction

Everyone has, at some point in their life, experienced emotions that in one way or another were not constructive to their environment: getting angry at stubbing your toe; laughing while in a quiet place etc.

While these emotions are important for human experience, feeling them has been proven to affect working memory (Perlstein, Elbert, and Stenger, 2002) depending on the emotion itself. As such the ability to direct your emotions could be beneficial.

Powerful emotions can represent a distraction. As Borst, Taatgen, and van Rijn (2015) have shown, distraction makes it hard to return to task. Emotional control could thus be useful in a variety of situations.

The processes and strategies of emotion regulation has been extensively researched (McRae and Gross, 2020). One such method for regulating emotions is performed by Tibetan monks who practice debating as a form of analytical meditation.

Within a monastic debate there are two sides, one person being a challenger and the other a defender. The aim of the challenger is to force the defender to contradict themselves by agreeing to something they earlier disagreed to or vice versa, disagreeing to something they had already agreed to. A defender in a debate has only certain responses that they are allowed: agree, disagree and to ask why.

As such the roles within a debate are clearly defined and further emphasised by the prescribed physical positions. A challenger in a debate is standing over the defender, walking back and forth along with making large claps to emphasise their point, this physical activity is thought to strengthen their clarity and speed of thought (van Vugt, Pollock, Johnson, Gyatso, Norbu, Lodroe, Gyaltsen, Phuntsok, Thakchoe, Khechok, et al., 2020). A defender is sat on the ground in front of the challenger without moving.

Through monastic debates, Tibetan monks are learning to deepen their understanding of a topic and control their thoughts and emotions in a situation where someone is actively trying to distract them. One of the main methods for causing distraction is through eliciting emotions. For the challenger this may be by attempting to make the defender angry, or make them laugh. Either emotion could alter the defender's train of thought which could lead them to accepting a contradiction.

By attempting to distract the defender, the challenger is trying to overwork their working memory so they admit to a contradiction by mistaking what they have already agreed or disagreed to. This implies that a larger working memory would be more beneficial for these debates as it has a proportional relationship with ability to control emotions (Schmeichel, Volokhov, and Demaree, 2008).

Learning to control their emotions is very important to the monks as this can lead to a better performance within the debate creating a potential distinction between beginner monks and experienced ones. Thus as the control of their emotions may increase with their experience, this form of debate could also help improve their working memory capacity, allowing improved recollection of what statements have been made and each response given.

Emotions cause a physical response in humans. These can be measured (Shu, Xie, Yang, Li, Li, Liao, Xu, and Yang, 2018) through a persons body temperature, their heart rate, muscle activity, respiration rate, brain activity, and sweat (Zamkah, Hui, Andrews, Dey, Shi, and Sherratt, 2020).

Electroencephalogram (EEG) is used as a method to measure in real time the response in the brain activity throughout a debate. This allows the emotions occurring within the debates to be seen as different signals in the EEG allowing comparison between them. This also allows us to see the areas of the brain where the different emotions occur.

The brain is where emotions originate and are processed and has been the area for many studies. As such when practicing monastic debate, differences between beginner and experienced monks would allow for changes in the brain to be seen.

It has been found (Popescu, 2019) that between experienced and inexperienced monks there is a difference between their experience of anger. Inexperienced monks have more occurrences of anger, with a longer duration than experienced monks who have less frequent occurrences of anger and for a shorter duration.

A potential issue with studies looking at emotions in the brain is the environment when generating the emotion. Often emotions generated within the clinical atmosphere of a lab are not as strong as those found through general activities (Picard, 2016). Monastic debates allow for this problem to be adjusted as it is in a realistic setting with a task that is performed everyday for the monks.

Within a debate the main emotions that are observable from monks are happiness and anger. Due to the nature of a debate anger may arise when trying to get a point across, happiness is often seen as the monks entertain each other. These emotions can also be seen through EEG as physical differences in the brain activity.

EEG measurements show that lots of areas of the brain are active when experiencing emotions. Though we may not know all the areas, we can start with looking at the FP1, FP2, F3, F4, and T8 electrodes, in the frontal and temporal areas, which have been found to be primary areas for emotion (Perlstein et al., 2002), specifically anger (Popescu, 2019). Happiness can often be found in temporal channels (T7-T8) with higher frequency bands, such as Beta and Gamma (Jatupaiboon, Pan-ngum, and Israsena, 2013).

From this starting point I will be looking into the different brain areas EEG results for the emotions through the different channels of the EEG cap. It will also be possible to look at the results from the different frequency bands: delta (2-4Hz), theta (4-8Hz), alpha (8-13Hz), beta (14-30Hz) and gamma (30-45Hz). Delta frequencies are associated with deep sleep and theta with meditative states. Beta frequencies are associated with different types of movement and gamma with eye blinks plus focused attention (Abo-Zahhad, Ahmed, and Abbas, 2015; Thammasan, Moriyama, Fukui, and Numao, 2016). Alpha bands have also been found to have a general relation with cognitive performance (Klimesch, 1997), as well as a positive correlation with intelligence (Doppelmayr, Klimesch, Stadler, Pöllhuber, and Heine, 2002).

The practice of meditation has been shown to improve mindfulness and control attachment and is also associated with increasing awareness and non-reactivity to emotions (Pepping, O'Donovan, and Davis, 2014). If experience from meditation can have this controlling effect then surely a similar finding would be found from the analytical meditation that the monks are performing. Even though analytical meditation differs from mindfulness meditation, due to the social aspect between the monks, they both require focus and control over the actions being performed.

EEG will be used as a way to gain real time insight into the processes occurring in the brain dur-

ing the practice of debating.

This study will focus on whether there is a difference in the display of the monks emotion while they are practising monastic debating both through the EEG and from their facial expression and body language. The study will be looking at any differences between the emotions anger and happiness as well as the different experience levels of inexperienced and experienced.

Research in monastic debate as a form of analytical meditation has shown overall differences in the brain activity of the practitioner both during meditation and as a long term effect (van Vugt et al., 2020). As monastic debate is a form of analytical meditation, it is hypothesised that a long term effect should be noticeable in regards to the monks emotional control.

A sub question is whether the role of a monk (challenger/defender) affects the emotions displayed in both the EEG and from their facial expression and body language. Due to the major differences in role and physical position, a different experience of emotion may be seen. Whereas a defender only has a few select answers to chose from, the role of the challenger can potentially be seen as having more freedom of expression.

2 Method

EEG and video recordings of monastic debates from van Vugt et al. (2020) were used to research how the experience level of a monk affects the emotions happiness and anger during a debate.

The analysis will look into the relationship between the emotions that we saw and the experience level of the monk.

Further exploration into the channels of the EEG signals will help to see if there are any specific regions in the brain showing differences between these categories of emotion and experience.

2.1 Participants

Twenty-four monks participated in the study, they were between 20 and 30 years of age, all participants were male. Ten of the monks were counted as experienced with at least 15 years of debating experience (approximately 18750 hours), the other fourteen were considered inexperienced at debates with at least 3 years of debating experience (approximately 3750 hours).

2.2 Procedure

Monastic debates are performed with one challenger and one defender, each role was performed by each participant. The challenger proposes statements which the defender must answer with set responses. Within the debates there are two possible types: counting and logic. Counting involves the participants reaffirming their knowledge of texts by recalling information or definitions. Logic debates focus more on the understanding the participants have of given texts by exploring different conclusions which may arise during the debate, while avoiding contradictions. For the purpose of exploring more variety of effects, logic debates were performed, as they are considered more challenging, therefore allowing more opportunities for emotions to be seen and measured.

After choosing to focus on logic debates for the experiment the debates were then divided into easy and hard debates.

A hard debate has a more complex topic, and lasts for around 15 minutes, whereas an easy debate is less complex and lasts for approximately 10 minutes. An image of the set up of the debates can be seen in figure 2.1.

Figure 2.1: Screenshot from one of the debate videos showing the set up of the debates. To the left is the defender sitting, standing to the right is the challenger, each with an EEG cap wired up. Behind them against the wall are people involved with the setup of the experiment, as well as those rating the monks on their performance in the debate.

There were 46 video recordings made of the debates, each with an accompanying EEG recording synced with it. Half of these debates were on an easy topic and half were on a hard topic.

Each of the debates was conducted with both challenger and defender being of the same level. So beginner monks were also against beginners and experienced monks were against experienced monks.

The synchronisation of the videos to EEG was performed either via a count down on the video to the start of the EEG or by getting the challenger to blink 5 times into the camera and syncing the video with the resulting artifacts in the EEG.

The videos were recorded using a video camera with a 48kHz sampling frequency for audio, it was placed to the left of the challenger's back which gave a partial side view of the challenger and allowed a frontal view of the defender. This can also be seen in Figure 2.1

2.3 Video rating

From each of the debates we were looking for the times when happiness or anger were shown for either the defender or the challenger.

To achieve this, each video was watched 3 times by 3 different people, amongst a group of 4 people in total. The independent observations were then collated together, when 2 or more annotators agreed on an emotion, so as to get an overall agreed upon set of emotions.

Reading the emotions could be very subjective to each researcher. As the back of the challenger is seen in most videos, much of the emotion reading was determined by how loud they talked and their body language.

This caused quite a lot of controversy between the researchers, particularly the videos observed earlier in the process. Between the group of 4 annotators 3 were male and 1 was female. There was a large difference in the amount of observation seen, with the males seeing a much lower percentage of emotions than the female.

When looking for the emotions it is quite subjective as to what was deemed indicative of happiness or anger. While each annotator tried to keep along the same lines for the emotions it is hard to conclude that they all saw the same.

For happiness we looked for whether the monk was smiling and often a more in-depth look at their eyes as emotions such as happiness are often visible around the eyes.

With anger it tended to be indicated by their arm movements and largely on their tone. As we only saw the back of the challenger on the videos, listening to his voice was the main way to hear emotions. Through the sharpness of his voice and the volume of it, along with the frequency of sharp clapping (a major arm movement in a monastic debate) it was determined whether or not he was angry.

Monastic debates require that the challenger does the talking and the defender only responds to what is being said. As most of the observations for anger were from voice and arm movements, neither of which the defender does often, there was a much lower count for angry defenders.

2.4 EEG recording

Along with the videos were the EEG recordings, these were taken using an EEG cap with a Biosemi 32 channel setup and a sampling frequency of 500Hz.

Pre-processing was done using 0.5 - 45 Hz bandpass filter, removing high-frequency muscle activity. Then any artifacts were removed from the EEG using independent component analysis (ICA), before comparison to the videos. Artifacts caused by the monk's movement creates spikes in the EEG. These spikes are not due to the brain activity exclusively but to muscle movement. An additional challenge with monastic debates is that they involve a lot of movement on the part of the challenger, clapping their hands and walking back and forth, therefore these artifacts were removed.

The EEG data was separated into trials of 2 second intervals which were averaged to get a single value for each trial. The trial was labelled with an emotion (happy or angry) after being synced with the collated annotated emotions from the videos.

The EEG data was then split into each of the frequencies (alpha [8 - 13 Hz], beta [14 - 30 Hz], gamma [30 - 45 Hz], delta [2 - 4 Hz] and theta [4 - 8 Hz]) as well as the raw EEG for each of the 32 channels for every trial found to have an emotion. These trials were then used for the analyses of the EEG.

2.5 Statistics

The data analysis looked at the overlap between the amount of emotions seen by each annotator as well as the amount of those emotions seen by another annotator and collated together. A mix between MATLAB and R as well as python was used to collate the data together and analyse. The analysis of the collated data focused on the frequency of the emotion occurrences using Chi-squared tests. It also focused on the duration of the emotions, as well as the EEG analysis for each channel, these were performed through Wilcox as well as ANOVA tests.

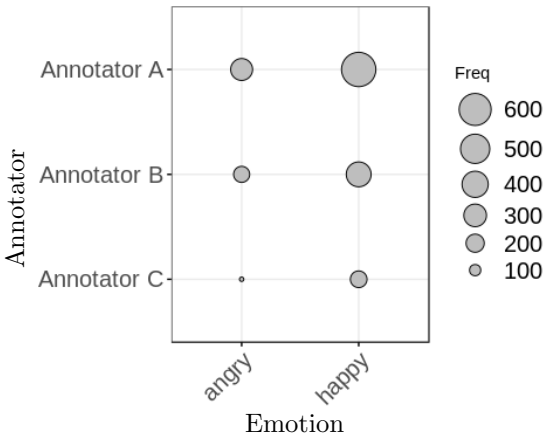

Figure 3.1: Frequency of emotions seen before collation for each annotator beween the emotions angry and happy

3 Analysis

First I examined whether the annotators saw a significantly different amount of emotions from each other. A Chi-squared test, $\chi^2(2) = 471.93$, $p < .05$, showed a significant difference in the amount of emotions seen between annotators, this difference can be seen in Figure 3.1.

From this I checked whether each annotator showed bias towards a particular emotion. A Chi-squared test $\chi^2(2) = 1.03$, $p = .60$, showed no significant difference between annotator and emotion. Looking at the different proportion of emotions between happy and angry for each annotator, showed approximately 30% of emotions seen were angry and the remaining 70% were happiness.

The data from each annotator was then collated into times when 2 or more annotators agreed. This gave more credence to each emotion occurrence due to the agreement by another annotator.

Figure 3.2 and Figure 3.3 show the split between the amount of seconds for each emotion (happy and angry) that were observed by 1 annotator and the percentage seen by 2 or more annotators. Out of the 5882 original seconds observed for anger, only 16% of those were agreed upon by another annotator, and thus only 924 seconds were used for later analysis. For happy there was an agreement between annotators of 19%, therefore out of the 8878 seconds originally observed only 1649 seconds were used for later analysis. The seconds agreed upon by at least 2 annotators were then used as the emotion instances in the EEG. Less than 5% of seconds observed for each emotion were agreed upon by all 3 annotators. Therefore over 80% of the observed data in both categories of emotion was not used.

3.1 Frequency

After collation I wished to see if there was a bias between the frequency of the different emotions (happy and angry) and the experience level of the monks.

First I examined whether one emotion occurred more often in the monks' debates, by testing the difference in frequency of emotions between happy and angry. A chi test showed a significant difference between the frequency of happy and angry emotions with more occurrences of happiness being seen in the monks than anger, $\chi^2(1) = 274.5$, $p < .05$. For each debate that was recorded there is an average frequency of 3 angry emotions and 13 happy ones.

Then I checked for a difference in frequency of emotional occurrences between the experience level of a monk. There was no significant difference in frequency found between the experience levels, $\chi^2(1) = 0.23$, $p = .633$.

Finally to determine if there is an effect of a monks experience in the frequency of either emotion happiness or anger, a chi test was performed across the categories, this showed a significant interaction, $\chi^2(1) = 95.39$, $p < .05$. A higher frequency of anger occurrences was found for experi-

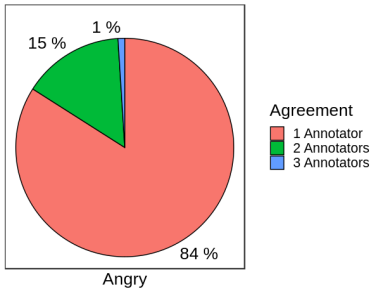

Figure 3.2: Percentage of seconds agreed upon between number of annotators for the emotion of anger

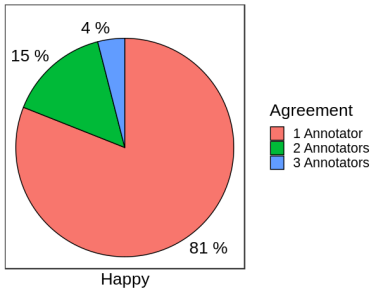

Figure 3.3: Percentage of seconds agreed upon between number of annotators for the emotion of happy

enced monks, this can be seen in Figure 3.4 and with the proportions in Table 3.1.

Figure 3.4 also shows that the emotions have a more balanced frequency for experienced monks, whereas inexperienced monks display larger amounts of happy emotions compared to angry emotions.

	Angry	Happy
Inexperienced	0.02	0.47
Experienced	0.17	0.34

Table 3.1: Proportion of emotions (angry/happy) and experience level from the collated debates

A sub-question for the research looked into any effect that the role a monk is performing may have on the amount of emotion that is seen, due to the different task that is being performed. Testing what effect the role of a monk had on the frequency of emotions seen showed a significance, $\chi^2(1) = 31.59$,

Figure 3.4: Frequency of emotions seen between the different emotions (happy and angry) and the different experience levels of the monks (experienced and inexperienced)

$p < .05$. Figure 3.5 shows more emotions were seen from the monk as a defender rather than when they are a challenger.

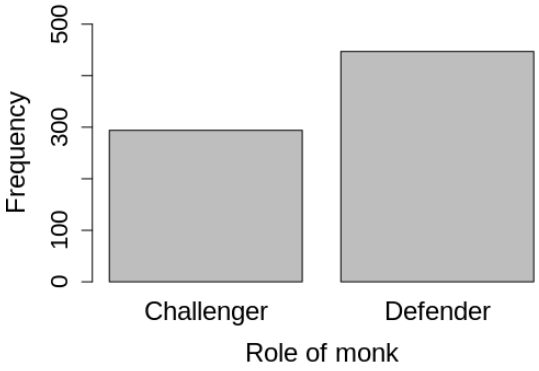

Figure 3.5: Frequency of emotions seen between the different roles performed during a debate

3.2 Duration

After checking for any bias in the amount of emotions experienced, I was then interested in how this would correlate to bias' within the duration of an emotion occurrence.

First I examined for any bias in the duration of a monk's emotion based on which emotion is being seen. A Wilcox test showed a significant difference in the mean duration of emotions ($z = 7.35$, $p < .05$), with angry emotions having a longer duration than happy emotions.

I then looked into the effect of a monk's experience level on the duration of the emotions. Using a Wilcox test between the different experience levels of the monks showed no significant difference in mean duration ($z = 0.52$, $p = .6$).

Lastly I checked for any effect on duration by the interaction of a monk's experience level and the emotion that they experienced. An ANOVA test on the interaction of duration by experience level and emotion showed there is a significance in duration between experience levels and emotion ($F(1, 737) = 6.57$, $p = .011$), with anger being experienced longer than happiness, and experienced anger being longer than inexperienced, this can also be seen in Figure 3.6

The sub-question of the research looked into any bias between the duration of emotion and the role of the monk, challenger or defender. Testing for this bias in the mean duration with a Wilcox test found that there was a significant difference in the mean ($z = 2.30$, $p < .05$). There is a longer duration time for challenger than defender, as shown in Table 3.2 and Figure 3.7.

		M (s)	SD
Emotion	angry	6.38	9.29
	happy	2.77	3.34
Experience level	experienced	3.79	6.35
	inexperienced	3.14	3.83
Role	challenger	4.26	7.33
	defender	2.96	3.18

Table 3.2: Mean and Standard deviation for the duration (s) of emotion occurrences for categories of emotion (angry/happy), experience level of the monk's (inexperienced/experienced) and role of monk in the debate (challenger/defender)

3.3 EEG

The raw EEG was averaged over each 2 second trial for each emotion occurrence after collation, this average was then used for the analysis.

To see if there was any areas of the brain significantly different between the emotions angry and happy, I analysed each of the channels on the EEG cap through Wilcox tests between the emotions.

Testing the raw EEG data between the emotions through a Wilcox test showed channels P04 and AF4 were significant after false discovery rate was taken into account, these areas can be seen in Figure 3.8.

I then tested for any brain areas that were affected through the experience level of the monks in the monastic debates. Wilcox tests on the raw EEG data for each different channel between experience levels of the monks showed no significant results for any channels after false discovery rate was taken into account. However, channels PO4, FC2 and AF4 were significant before false discovery rate was looked at, this can be seen in Figure 3.9.

This paper is mainly interested in any affect that could occur in the brain between monks of different experience levels between happy and angry emotions. However, ANOVA tests on the raw EEG for interaction between emotion and experience showed no significant channels, therefore no claims can be made on how experience in debating effects these emotions in the brain.

A sub-question of the research focused on how emotions would differ in the brain between the different role of the monks. Testing between the monks role (challenger/defender) for all channels with Wilcox tests showed that before false discovery rate was taken into account channel AF4 was significant along with channel C4, this can be seen in Figure 3.10. From this I also tested if there was any effect in the brain due to the role of the monk and the emotion was being experienced. This showed no significant channels however for interaction between role of the monk and the emotion.

For tests within the frequency bands (alpha [8 - 13 Hz], beta [14 - 30 Hz], gamma [30 - 45 Hz], delta [2 - 4 Hz], theta [4 - 8 Hz]) in regards to emotion, experience and role, the same channels were found to be significant as with the raw EEG.

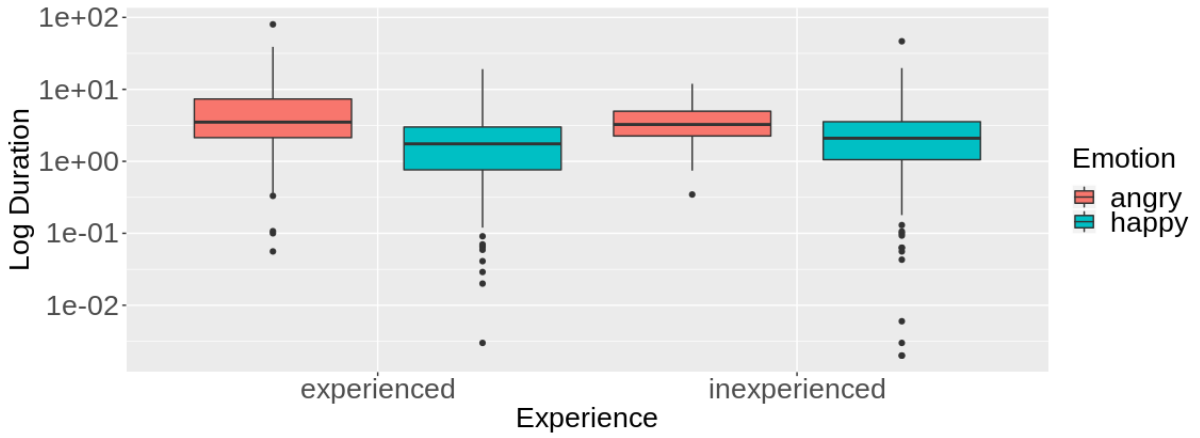

Figure 3.6: Duration at $\log_{10}$ between the experience levels (inexperienced and experienced) and the emotions (happy and angry)

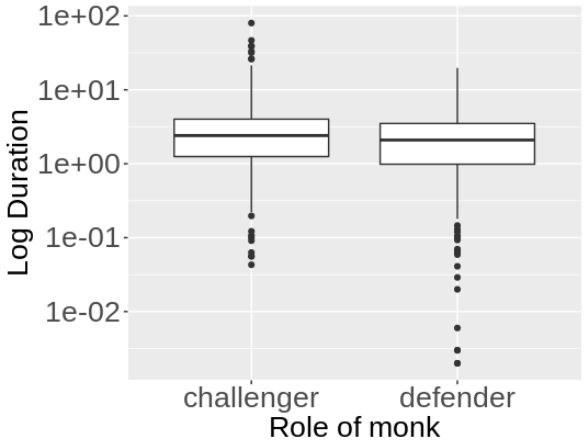

Figure 3.7: Duration at $\log_{10}$ for the different roles of the monks (challenger and defender)

4 Discussion

The objective of this study was to look for any emotion differences from the EEG recordings of Tibetan monks during monastic debating. The study focused on the emotion categories of happiness and anger, the experience level of the monks, and the role they were in during the debate, challenger or defender.

From the collated emotions seen for each emotion and experience level, it was seen that inexperienced monks had more instances of happiness than anger, whereas experienced monks had approximately the same amount between the emotions. Additionally the duration of the emotions per debate was found to be much longer for angry experienced monks than any other category. This does not agree with previous studies into this topic (Popescu, 2019), indicating further study may be necessary for definitive conclusions. While no firm conclusions can be drawn, it can be suggested that the difference is due to the more experienced monks taking the debate more seriously and potentially having more control over which of their emotions they show.

A longer duration of emotion was also found for the challenger rather than the defender, a potential reason for this could be that as it was not possible to see the face of the monk, establishing the endpoint for the emotion was less precise than for the defender.

The means for almost all potential categories within the raw EEG were equal. Though when the different channels were examined, certain areas of the brain were more significant than others. Specifically the PO4 and AF4 points which were found to be significantly different between the emotions.

Research into the frequency bands showed similar areas of the brain displaying significant results within the different categories of emotion and of experience.

Overall, the results did not correspond with previous research on which channels were significant for the different emotion categories. There were also many contributing factors that have to be taken

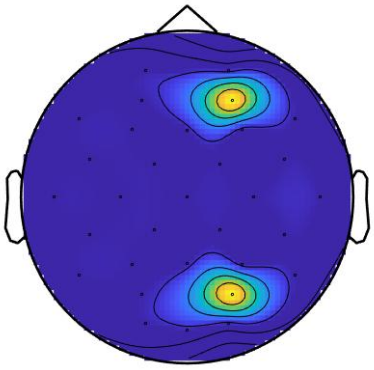

Figure 3.8: Significant channels PO4 and AF4 after FDR for the effect of emotion on raw EEG data

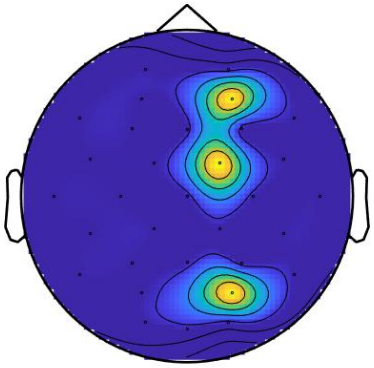

Figure 3.9: Significant channels PO4, FC2 and AF4 before FDR for the effect of the experience level on raw EEG data

into account when discussing the results such as, the subjectivity in emotion detection, the gender bias in the annotators along with other details of the experimental set up.

The main aspect of the study was research into the different emotions that the monks were experiencing. However, detecting the emotions was an extremely subjective process, as none of the annotators understood the language and the more subtle emotion shown on the face of the Tibetan monks. Studies have shown that emotion recognition is not

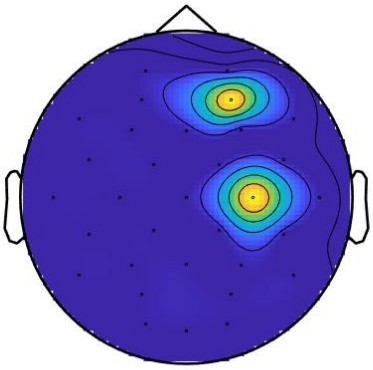

Figure 3.10: Significant channels AF4 and C4 before FDR for the role of the monk on raw EEG data

universal and it is more difficult to recognise emotion in other cultures (Gendron, Roberson, van der Vyver, and Barrett, 2014). Future research into this topic could have Tibetan speakers annotating the emotions seen, to provide comparison between observations by those who do not understand the language.

The annotator group consisted of one female and three males, and there was a large variation in frequency of emotions seen within these gender categories. I saw a lot more emotions in total than any of the male annotators. Studies into recognising emotions between genders show that women are better at seeing the subtle emotions (Hoffmann, Kessler, Eppel, Rukavina, and Traue, 2010), which may explain the increase in emotions seen. It has also been shown that men may have a tendency to see more of the angry emotion (Knyazev, Slobodskoj-Plusnin, and Bocharov, 2010), though as all annotators saw approximately 30% anger each this cannot be claimed for this project. These differences are important to the research due to the potential emotions that were not seen, as well as those potential emotions seen but not agreed upon. As seen in Figure 3.2 and Figure 3.3 approximately 80% of the seconds for both emotions happy and angry were discarded. The annotators agreed approximately 20% of the time, less than 5% with all the annotators in agreement. In future research it

could be noted if the amount of agreement between annotators changes if factors such as the gender and racial diversity of the annotating group were different.

Another issue for emotion recognition was the camera location in recording the debate, as it blocked the face of the challenger throughout the debate. Future research into this topic could have another camera facing the challenger as well. This could be an explanation for the longer duration of emotions for challengers. Due to the lack of sight on the monk's face, other body language attributes had to be used to distinguish an emotion, thus identifying when an emotion had ended was performed differently for challengers than for defenders.

Syncing the camera data to the EEG could also be made more reliable by getting both challenger and defender to blink at their own camera, so the syncing could be performed through the artifacts in both sets of EEG data. This method could help by removing a potential issue for future research. In the current study some of the videos were only synced through count down, this was less accurate as there was a time delay between the EEG recording being started and the end of the countdown.

The research question for this study was whether or not we can see the difference in prevalence of emotions (happiness and anger) between debating monks, and if that differs between neural manifestation of emotions for experienced monks and the beginner monks. It can be said to hold true, as while no difference was found for the mean EEG between emotion and experience level of the monks there were significant differences identified in the duration and frequency of the emotions between monks' experience levels.

Contrary to expectations the frequency of anger instances increases to the level of happiness through experience rather than decreasing.

Inexperienced monks seem to have a lot less anger when performing debates, there are a few potential reasons for this: perhaps they take it less seriously, or have to focus on the material itself more than experienced monks. Further research into this topic could look into monks with even more experience to see how this control progresses with 20 years of experience or more.

From the results of this study it can be seen that analytical meditation has an influence on a person's emotions. Future research could be carried out to see if this is the case with other forms of meditation also. Meditation has been seen to improve mindfulness and control of attachment (Pepping et al., 2014) and from this paper to have an effect on emotions through analytical meditation. Further research could look into more methods of meditation and other influences it may have between our interactions in everyday life and the corresponding potential changes in our brains.

References

M Abo-Zahhad, Sabah M Ahmed, and Sherif N Abbas. A new eeg acquisition protocol for biometric identification using eye blinking signals. *International Journal of Intelligent Systems and Applications*, 7(6):48, 2015.

Jelmer P Borst, Niels A Taatgen, and Hedderik van Rijn. What makes interruptions disruptive? a process-model account of the effects of the problem state bottleneck on task interruption and resumption. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems*, pages 2971–2980, 2015.

Michael Doppelmayr, Wolfgang Klimesch, Waltraud Stadler, Doris Pöllhuber, and Cornelia Heine. Eeg alpha power and intelligence. *Intelligence*, 30(3):289–302, 2002.

Maria Gendron, Debi Roberson, Jacoba Marietta van der Vyver, and Lisa Feldman Barrett. Perceptions of emotion from facial expressions are not culturally universal: evidence from a remote culture. *Emotion*, 14(2):251, 2014.

Holger Hoffmann, Henrik Kessler, Tobias Eppel, Stefanie Rukavina, and Harald C Traue. Expression intensity, gender and facial emotion recognition: Women recognize only subtle facial emotions better than men. *Acta psychologica*, 135(3): 278–283, 2010.

Noppadon Jatupaiboon, Setha Pan-ngum, and Pasin Israsena. Real-time eeg-based happiness detection system. *The Scientific World Journal*, 2013, 2013.

Wolfgang Klimesch. Eeg-alpha rhythms and memory processes. *International Journal of psychophysiology*, 26(1-3):319–340, 1997.

Gennady G Knyazev, Jaroslav Y Slobodskoj-Plusnin, and Andrey V Bocharov. Gender differences in implicit and explicit processing of emotional facial expressions as revealed by event-related theta synchronization. *Emotion*, 10(5): 678, 2010.

Kateri McRae and James J Gross. Emotion regulation. *Emotion*, 20(1):1, 2020.

Christopher A Pepping, Analise O'Donovan, and Penelope J Davis. The differential relationship between mindfulness and attachment in experienced and inexperienced meditators. *Mindfulness*, 5(4):392–399, 2014.

William M Perlstein, Thomas Elbert, and V Andrew Stenger. Dissociation in human prefrontal cortex of affective influences on working memory-related activity. *Proceedings of the National Academy of Sciences*, 99(3):1736–1741, 2002.

Rosalind W Picard. Automating the recognition of stress and emotion: From lab to real-world impact. *IEEE MultiMedia*, 23(3):3–7, 2016.

Mihai Popescu. Distinguishing anger in the brain using machine learning on eeg data, 2019.

Brandon J Schmeichel, Rachael N Volokhov, and Heath A Demaree. Working memory capacity and the self-regulation of emotional expression and experience. *Journal of personality and social psychology*, 95(6):1526, 2008.

Lin Shu, Jinyan Xie, Mingyue Yang, Ziyi Li, Zhenqi Li, Dan Liao, Xiangmin Xu, and Xinyi Yang. A review of emotion recognition using physiological signals. *Sensors*, 18(7):2074, 2018.

Nattapong Thammasan, Koichi Moriyama, Ken-ichi Fukui, and Masayuki Numao. Continuous music-emotion recognition based on electroencephalogram. *IEICE TRANSACTIONS on Information and Systems*, 99(4):1234–1241, 2016.

Marieke K van Vugt, Joshua Pollock, Bryce Johnson, Kalden Gyatso, Ngawang Norbu, Thabkhe Lodroe, Thupten Gyaltsen, Lobsang Phuntsok, Jampa Thakchoe, Jampa Khechok, et al. Interbrain synchronization in the practice of tibetan monastic debate. *Mindfulness*, pages 1–15, 2020.

Abdulaziz Zamkah, Terence Hui, Simon Andrews, Nilanjan Dey, Fuqian Shi, and R Simon Sherratt. Identification of suitable biomarkers for stress and emotion detection for future personal affective wearable sensors. *Biosensors*, 10(4):40, 2020.