Shifting Expectations: Criterion shift association of EEG, in a recognition memory security patrol paradigm.

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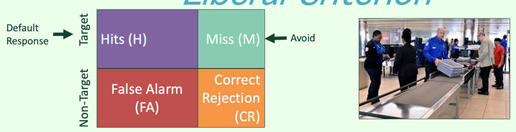
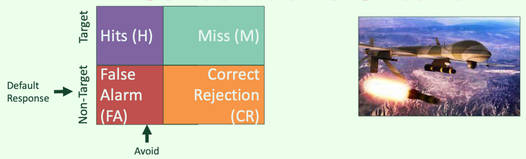
Criterion Shifting

Appropriate decision criterion placement is particularly important for suspect identification in a security setting, such as a police or military patrol. In these scenarios, false alarms can lead to innocent people getting hurt or even killed.

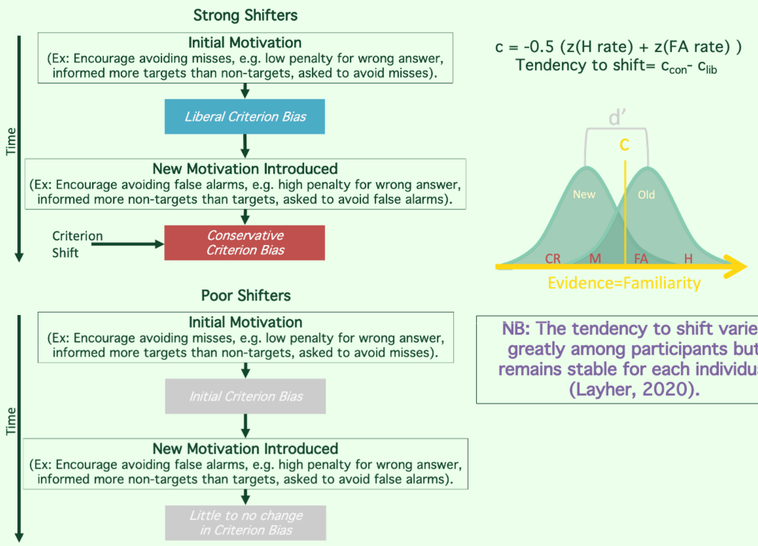
Liberal Criterion



Conservative Criterion



Tendency to shift in Individuals



c = -0.5 (z(H rate) + z(FA rate))
Tendency to shift= c_{con}- c_{lib}

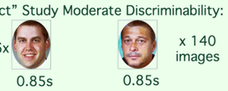
NB: The tendency to shift varies greatly among participants but remains stable for each individual (Layher, 2020).

Current Study

Study Phase

"Suspect" Study Low Discriminability:

"Suspect" Study Moderate Discriminability:



To model familiarity effects, we varied d' discriminability or memory strength by presenting participants with study images either once or six times for 0.85s.

Test Phase

Test Conservative: Identified Suspects will be "hunted down like criminals", avoid False Alarms

Test Liberal: Identified Suspects will be "mildly inconvenienced", avoid Misses

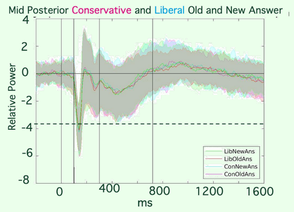
Participants were screened and only those with a criterion shift >0.4 and a moderate d prime of at least 0.75 were asked to do the EEG phase (N=59, 46 female, aged 17-29). **Test** images appear 6 times in the moderate sensitivity condition. Test blocks have 60 images (30 studied and novel images). Participants were asked to use a liberal criterion for two blocks and a conservative criterion for two blocks. Participants are told that the criterion is necessary, because of the location of the patrol ('city' or 'outskirts').

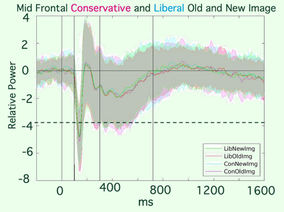
Analysis Trial Types

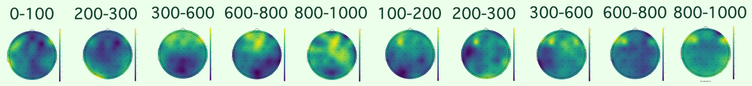
Trials (Conservative (Hit>CR) > Liberal (Hit>CR))
Images (Conservative (Studied>Unstudied)> Liberal(Studied>Unstudied))
Response (Conservative(Old(HIT, FA)>New(Miss, CR)> (Old(HIT, FA)>New(Miss, CR))

ERP Group Results

Left: ERPs for Conservative and Liberal Old and New responses and Topographic maps of Conservative(Old Response>New Response)>Liberal (Old Response>New Response) ERP contrast power averaged for all participants and over 5 100 to 300 ms time intervals (corresponding with N1, P2, P3, and late positive potential ranges). Right: ERPs for Conservative and Liberal Old and New images and Topographic maps of Conservative(Old Response>New Response)>Liberal (Old Response>New Response) ERP contrast power averaged for all participants and over 5 100 to 300 ms time intervals (corresponding with N1, P2, P3, and late positive potential ranges). Shaded area indicates participant standard deviation.

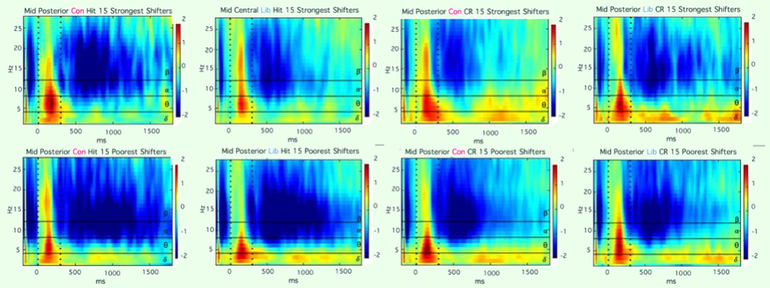




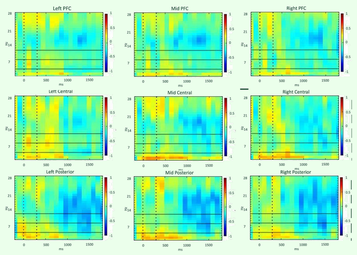


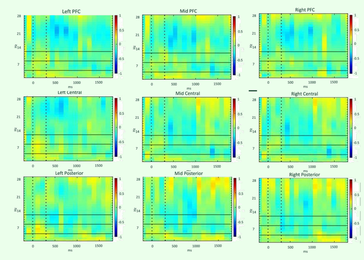
ERSP Individual Differences

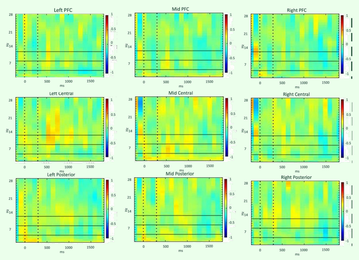
Averaged conservative > liberal event-related spectral power (ERSP) for δ <4 Hz, θ 4-8 Hz, α 9-12 Hz, β 12-30 Hz averaged across the 15 participants with the greatest difference between liberal and conservative criterion placement and the 15 participants with the smallest difference between liberal and conservative criterion placement. Horizontal lines at 4, 8, and 12 Hz from 0-2.5 ms post-stimulus.



Pearson's correlations between averaged ERSP power and individual tendency to shift from -200ms to 1800ms post-stimulus, averages across 9 200 ms blocks and over frequencies 1 to 28. Participant conservative criterion vs liberal criterion placement ranged from -0.067 (no tendency to shift) to 2.96 (strong tendency to shift). Top Right: Conservative(Hits>CR)>Liberal (Hits>CR), Bottom Left: Conservative(Studied Image>Unstudied Image)>Liberal (Studied Image>Unstudied Image), Bottom Right: Conservative(Old Response>New Response)>Liberal (Old Response>New Response). Red to orange cells indicate a positive correlation between individual tendency to shift and ERSP power and blue cells indicate a negative correlation. Yellow and green cells indicate no or very low correlations. We propose that clusters of moderate to strong correlations in the same direction over multiple time bins, such as those seen in the beta region (mean r for each 200 ms block from 900-1000 ms in the mid posterior region from 14 to 26 Hz: -0.32, range -0.04 to -0.47) and delta region (mean r for each 200 ms block from 0-90 ms in the mid posterior region from 1 to 4 Hz: 0.35 range 0.39 to 0.30) of the top right image indicate potentially meaningful relationships between ERSP frequency band power and individual tendency to shift.

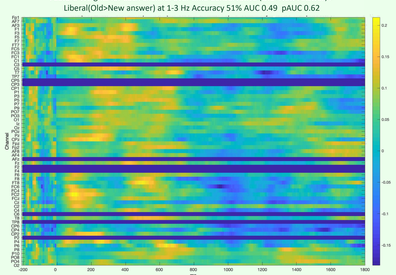




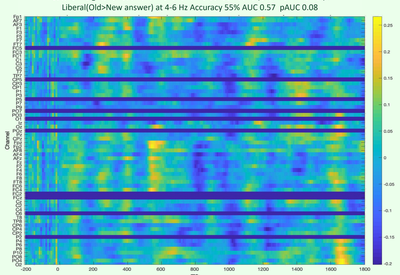


ERSP Decoding

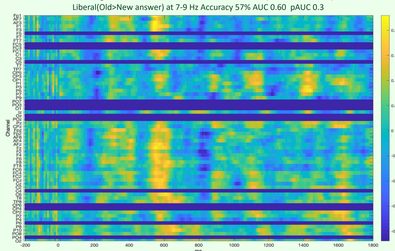
Feature Weights for each channel over time Conservative (Old>New Answer) > Liberal(Old>New answer) at 1-3 Hz Accuracy 51% AUC 0.49 pAUC 0.62



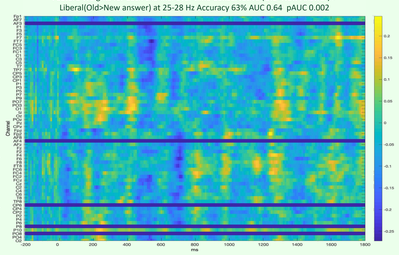
Feature Weights for each channel over time Conservative (Old>New Answer) > Liberal(Old>New answer) at 4-6 Hz Accuracy 55% AUC 0.57 pAUC 0.08



Feature Weights for each channel over time Conservative (Old>New Answer) > Liberal(Old>New answer) at 7-9 Hz Accuracy 57% AUC 0.60 pAUC 0.3



Feature Weights for each channel over time Conservative (Old>New Answer) > Liberal(Old>New answer) at 25-28 Hz Accuracy 63% AUC 0.64 pAUC 0.002



Binary classification using sparse Bayesian multiple kernel learning which shows how well the temporal patterns can distinguish between averaged conservative old>new answers vs liberal old>new answer contrasted ERSPs. Cross-validated prediction accuracy was tested against null distributions using non-parametric permutation testing. Weights graphed according to channel (y-axis) and time (x-axis). Top right: 1-3 Hz, Top left: 4-6 Hz, Bottom left:7-9 Hz, Bottom right: 25-28 Hz. AUC is the area under the receiver operating characteristic curve, which shows the classification performance over time and pAUC is the performance of the classifier over 1000 permutations. The best classifier performance was in the high beta (25-28 Hz) range with a pAUC of 0.002.

Conclusion & Future Directions

The decoding analysis revealed that high beta band (25-28 Hz) power may be able to have distinct temporal patterns between conservative and liberal criterion placement. When we compare ERSP power for strong and poor shifters, the reduction in poor shifters show an increased reduction in beta power in for both liberal and conservative Hits and Correct rejections, while strong shifters show a more modest in conservative Correct rejections and Liberal hits. The Pierson correlation analysis also shows beta power is negatively correlated with individual tendency to shift criterion for Conservative and Liberal Hits and Correct Rejections contrasts. However, the correlations were very modest. This indicates the potential relationship between beta power and individual tendency to shift may be complex than what our Pierson model is able to show. We are currently designing a decoding analysis to see if temporal patterns can distinguish between strong and poor shifters in the hopes of developing a more robust model.

References

Layher, E. Dixit, A., & Miller, M. B. (2020). Who gives a criterion shift? A uniquely individualistic cognitive trait. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *46*(11): 2075–2105.

Acknowledgements

Barry Giesbrecht and the UCSB Attention lab, especially Tom Bullock and Diya Das. Analysis advice from: Michael Spezio and Tyler Santander. Research assistants: Amanda Atanasolo, Matejas Mackin, Hana Simon, Luke Hamilton, Saleem Omary, Thien Truong, Tanya Bhatia, Mark Wang, Omeed Soltanalipour, and Nohemi Reyes Meraz.

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This research was sponsored by the Army Research Laboratory and was accomplished under the Cooperative Agreement Number W911NF-19-2-0026. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Army Research Laboratory or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein.