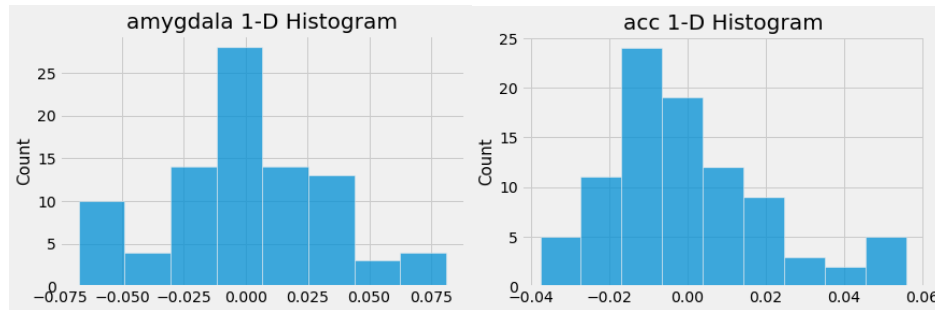# Density estimation: Psychological experiments

1-dimensional histograms for **amygdala** and **acc** can be seen below. To decide on a suitable number of bins for each plot, the Freedman-Diaconis rule was passed as a parameter when creating the plots.


Additionally, 1-dimensional KDE plots for **amygdala** and **acc** can be seen below. To set an appropriate kernel bandwidth, Silverman's Rule of Thumb was passed as a parameter when creating the plots.
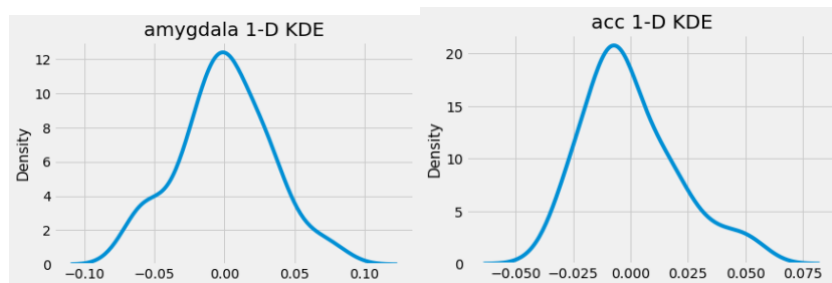
The 2-dimensional histogram for the pair of variables (**amygdala**,**acc**) can be seen below. The number of bins used was 15, as it provided the clearest shape of the distribution of the options tested.
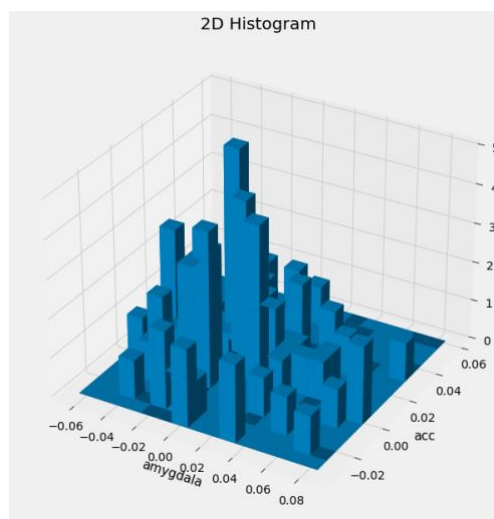
The 2-dimensional density function of (amygdala, acc) can be seen below. To set an appropriate kernel bandwidth, Silverman's Rule of Thumb was passed as a parameter when creating the plot.
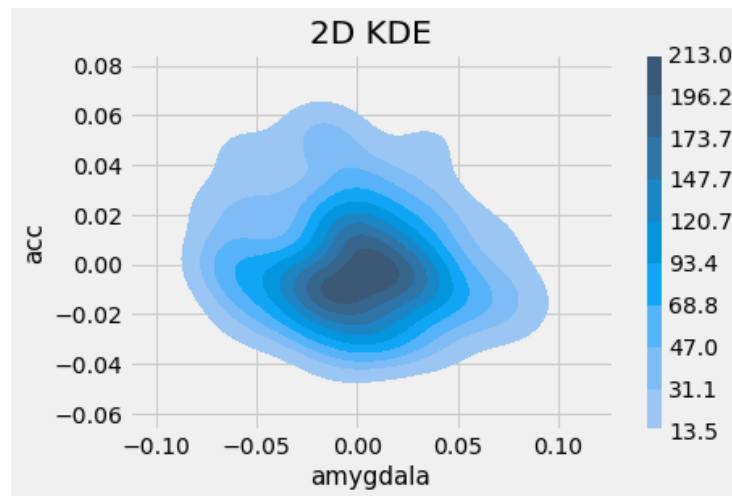

When considering all the previous plots of **amygdala** and **acc**, it appears that the distribution is unimodal. This can be seen clearly in all the plots provided, as the 1-dimensional and 2-dimensional distributions all show unimodal distributions in the histograms and KDE plots. Additionally, there do not appear to be any significant outliers. The 1-dimensional KDE plot for **amygdala** appears to show unevenness in the tails of the distribution and the plot for **acc** seems to show a right-skewed distribution. When viewing these in conjunction with the 2-dimensional plots this unevenness can be seen, however, it still does not appear that there are any significant outliers.

Given that the data is unimodal and there does not appear to be a trend, we can infer that the two variables **(amygdala, acc)** are not correlated and therefore are likely to be independent. This is because the joint distribution (the 2-dimensional KDE plot) appears to equal the product of the two marginal distributions (the 1-dimensional KDE plots) for all x and y.
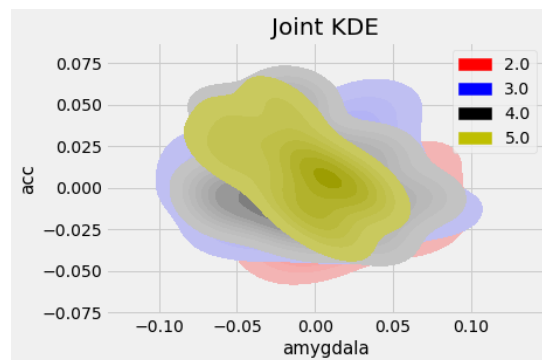
The conditional distribution of **amygdala** and **acc** conditioning on **political orientation** can be seen below. The 1-dimensional density function for the orientation's within each variable are plotted with a corresponding legend, and the kernel bandwidth was set using Silverman's Rule of Thumb.
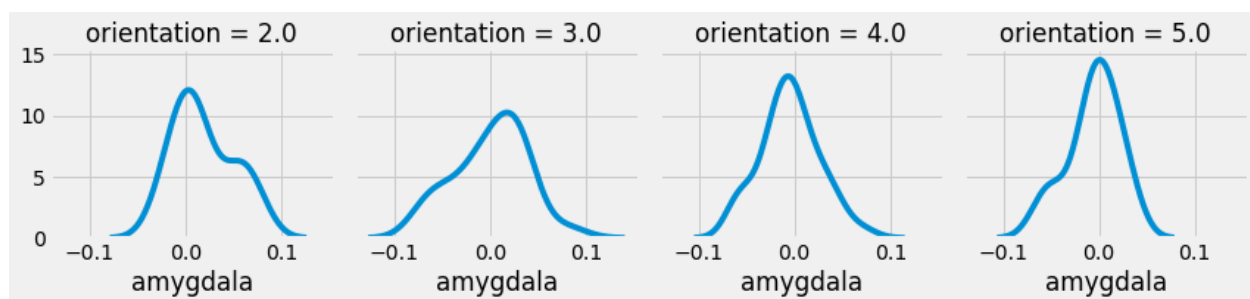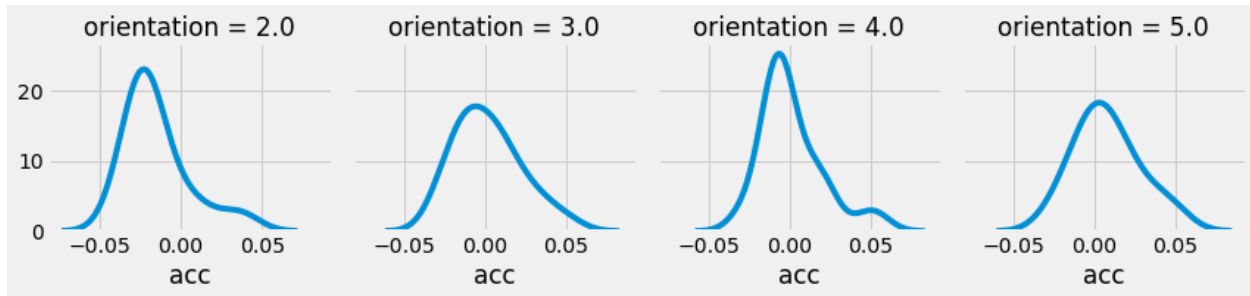
From the previous conditional distribution plots, it appears that amygdala gets larger as political orientation moves from 2 to 5. In the context of the problem, this appears to show that the more liberal a person is the lager the amygdala region of the brain is. Furthermore, it appears that acc region of the brain is larger for political orientations 2 and 4, compared to 3 and 5. This doesn't appear to show a general trend in the size of the acc region of the brain based on political orientation, as both slightly liberal and slightly conservative subjects showed larger acc regions.

The 2-dimensional KDE plot for **amygdala** and **acc** conditional on a function of **political orientation** can be seen below. The kernel bandwidth was set using Silverman's Rule of Thumb, and political orientation colors were chosen to provide contrast.

Given the results from this plot, it does appear that the conditional distribution of the variables **(amygdala, acc)** are different from some values, $c = 2, \ldots, 5$. Notably, when c=5, there is a clear negative trend showing that as **amygdala** increases, **acc** decreases. Similarly, when c=2 there is a clear positive trend showing that as **amygdala** increases, **acc** also increase, which is a distinctly different relationship than when c=5. This appears to show a notable difference in brain structure for the two most polarized subject groups in this study, as slightly conservative and very liberal subjects show opposite relationships between the variables **amygdala** and **acc**. Political orientations where c=3 and c=4 show less clear differences and appear to be more of a combination of c=2 and c=5. The slightly liberal orientation appears to show a slight downward trend like the strongly liberal orientation and the neutral orientation appears to show a slight positive trend like the slightly conservative orientation, but both are notably not as strong as the more polarized orientations. This would make since as these political orientations are less polarized, and while they may lean one direction or the other they may also exhibit characteristics of both sides.