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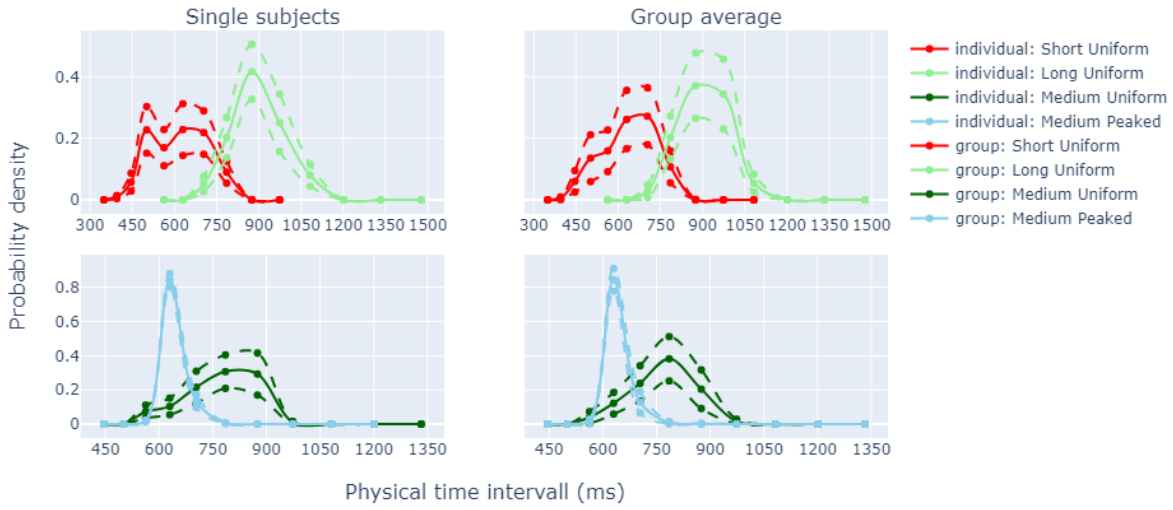
Final Project Part 2: Essay

1. **Create a figure similar to Acerbi's Figure 7, based on your model's DM.**



The retrieval probabilities of the integer pulses stored in memory at the beginning of each trial for each subject within the test sessions were used as priors. The training sessions were not included, since these lead to the creation of the respective prior for each condition. All trials from the test sessions were used and not only e.g. the last one, because the probabilities still strongly depend on the last perceived interval or pulse. Thus, a robust estimate of the prior could be obtained in the mean (points on the solid line) with estimates on standard deviations (+-1 sd.: points on the dashed line). Since the prior for integer pulses is discrete, the points are the actual prior and the lines themselves are only for better illustration, but do not themselves represent a continuous density function. For a better comparison with the plot of Acerbi, the pulses were again converted to milliseconds, but without the usually used noise, because additional uncertainty in this pure rescaling wouldn't make sense.

2. **(a) Are there qualitative differences between the two figures? If so, what may be the cause of these differences?**

In the plot shown here, the observable probabilities are scaled much higher than in Acerbi's plot, but this is only due to the fact that in my plot, as already mentioned, a discrete density function is estimated which is only nonparametrically approximated by the lines, and in Acerbi's plot a continuous density is estimated, which leads to a different scale on the y-axis. In principle, a maximum of the density around the respective mean value (but mode value for "Medium Peaked") of the condition and a roughly symmetric behaviour can be recognized in both graphs. The maximum is more pronounced in the graph of my cognitive model, i.e. first it is steeper with a lower variance. This is probably due to the fact that higher activations of more frequently perceived pulses are weighted too strongly in the model in comparison to less frequently perceived pulses when calculating the probabilities. The extremely high probability of a pulse with about 80% for "Medium Peaked" with a maximum probability of the true interval of 7/12 underlines this assumption. In Acerbi's case, there are also some modes at the tails, but as mentioned in the paper, these are probably due to outliers, which consequently cannot occur in my cognitive model. The principal

multimodality in Acerbi's priors with the given standard deviations also probably speaks for slight overfitting due to too low regularization parameters in the non-parametric estimation and are therefore also not found in my modeled prior.

2. **(b) At a more theoretical level, how does your model's DM compare to the priors that Acerbi derived from participants' responses?**

A difference already mentioned is that the DM of the model assigns probabilities to integer pulses stored in memory and thus generates an interpretable but discrete prior. In the paper, a continuous distribution is estimated for this prior, taking into account other assumptions such as a loss function or the likelihood based on data points. Thus, this prior for the subjects also provides an estimate of the assumed probabilities of the intervals per block, but does not provide an interpretable model for the cognitive processes in the subjects' memory. Moreover, as described above, such non-parametric estimates are less robust and more prone to errors due to e.g. the choice of hyperparameters like the regularization parameter or due to outliers. In the paper it is also considered plausible that for the specification of the prior of the subjects, skewness is also important in addition to expected value and variance, which is also taken into account by the non-parametric estimation. However, by using discrete probabilities for the individual pulses, this effect can also be easily approximated in the prior in the DM, which would be evident, for example, in more experiments with non-uniform probabilities and can also slightly be seen at the more skewed prior of the "Medium Peaked".