Procedure

Our team investigated the effect of low visual acuity and colour sensitivity on learning performance and speed using ResNET18 and Tiny Imagenet Dataset. The model used SDG with momentum with early stopping, 10 epochs. The transformation code is taken from Ashna Chalil for color perception and acuity simulation. To observe the effect of transformations, we trained 4 identical models with identical parameters, but with different datasets:

1) **Low visual acuity model**

In this model, we transformed the training data(13 datasets in total) into pictures with blurry resolution progressing from 0 to 12 months. Then, the model was trained on each dataset, until the early stopping was triggered based on the validation value, after which the next dataset with less blur was used. To be precise, the model trained on a dataset that contained images transformed to 0 months infant's view and so on, each new dataset decreased the amount of blurring. This was expected to increase the accuracy and establish effective receptive fields.

2) **Low colour sensitivity model**

In this training, we utilised the same parameters and dataset, however, only the colour sensitivity was changing. From 0 to 12 months, we mimicked the development of colour perception as in infants. The model trained on each month's dataset, and as previously mentioned, the early stopping was implemented to skip to the next dataset, when the model accuracy was saturated.

3) **Low colour sensitivity and low acuity model**

This model is expected to combine the two features that appear in an infant's vision during its first 12 months. Therefore, every new dataset in this model contained pictures that progressively reduce the blurriness and increase the colour contrast. We expected the model to adapt to effectively use high spatial frequency cues as well as on colour cues.

4) **No transformation(default) model**

This model is a reference model to which we will be comparing the models with the transformed dataset. The early stopping was implemented also, to speed up the training and effectively compare models.

Conclusion

Observing the validation accuracies, we can see that the model that included transform performs significantly worse. We believe this might be due to the low resolution of the images (64x64 pixels). Since images are already low resolution, objects are heavily blurred. Applying blurring and low colour sensitivity only hinders learning, since high spatial frequencies are removed and colour cues are absent, which are the primary cues when objects appear blurred. The importance of color in low resolution can be seen when comparing low color sensitivity and acuity models, the accuracy for the latter one is significantly less. We hypothesize that high spatial frequency features play a more critical role in model perception than high color contrast. However, when color sensitivity is low, acuity remains unaffected, yet model performance remains significantly impaired. Both low acuity and low color sensitivity hinder training effectiveness. Nevertheless, high color sensitivity provides less performance improvement in later stages compared to high acuity. Interestingly, the model can adapt to high-acuity vision even when it begins with low acuity. In contrast, if the model starts with low color sensitivity, it struggles to improve performance later, even if color sensitivity increases.

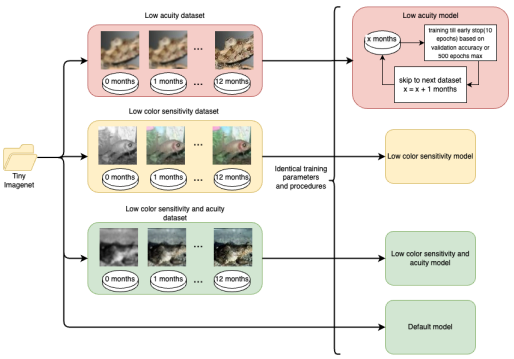
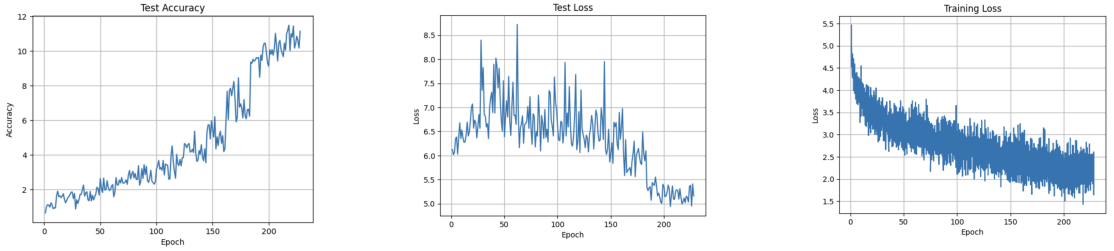
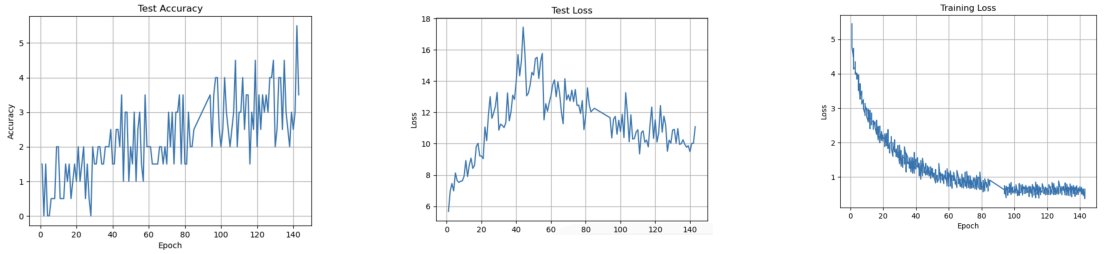


Figure 1. Dataprocessing and Training procedure.

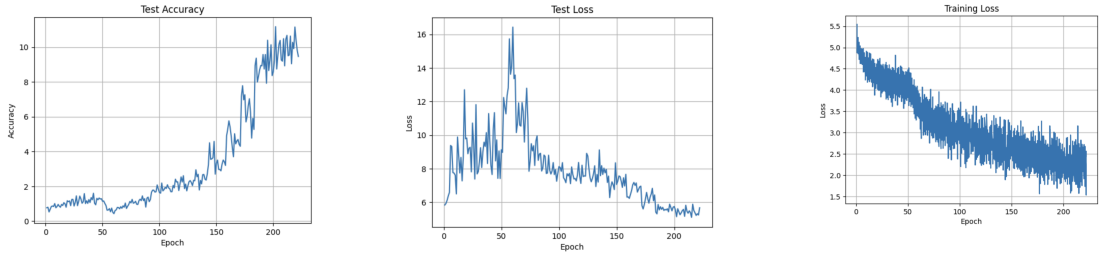
Low acuity model



Low color sensitivity model[1]



Low acuity and color sensitivity model



Default model

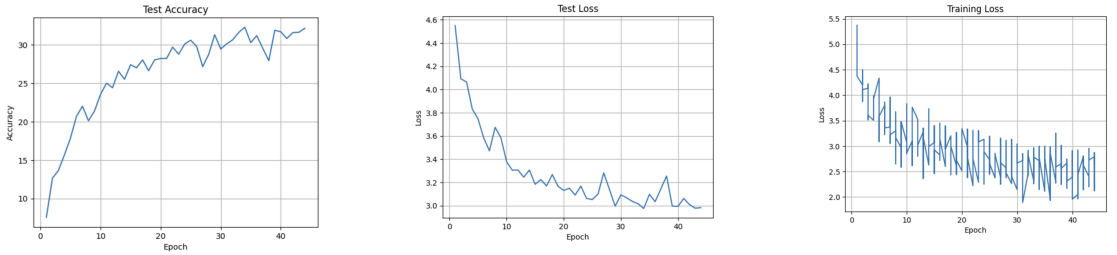


Figure 2. The validation accuracy, validation loss, training loss graphs

[1] Due to technical issues in cloud training, some of the intermediate values are missing.