Appendix A

Table 1: List of all 43 concepts and 7 classes in (Dehaene et al. 2006)

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Appendix B

We also evaluated the CNN models against data collected from the 2-AFC version of the odd-one-out task developed by Marupudi and Varma (2023). In this version, participants are shown a target image and two alternative images, only one which embodies the same GT concept as the target image. Participants must judge which of the two alternative images is most "similar" to the target image.

We used a similar, though simpler procedure for the 2-AFC task. For a given model and a given layer, we presented the three images of the stimulus – the standard image and the correct alternative, both of which embody the GT concept, and the incorrect alternative, which does not – and recorded the three activation vectors. We then computed the cosine similarity between every pair and ranked them in decreasing order of average similarity. Correct performance was signaled when the vector corresponding to the incorrect alternative was ranked least similar (rank = 3). We again quantified performance in two ways: by the average rank of the incorrect alternative image and, more coarsely, by whether this image was correctly identified (i.e., had rank = 3) or not. Thus, the 2-AFC task can be viewed as a 3-panel version of the 6-panel odd-one-out task (Dehaene et al. 2006).

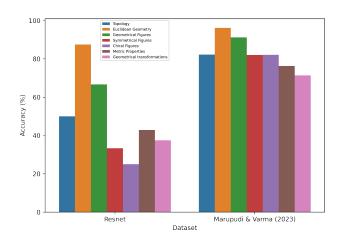


Figure 1: Absolute accuracies across the 7 classes for ResNet and the Marupudi and Varma (2023) participants on the 2-AFC task. The Pearson correlation is 0.79.

Table 2 summarizes the performance of the CNN models, again as measured on the finally, fully-connected layer and aggregated to the level of the 7 classes of GT concepts. ResNet is still the best performing model (accuracy = 53.49%). Recall that chance in the 2-AFC task is a much higher bar for participants to exceed to demonstrate sensitivity than in the odd-one-out task (50% vs. 16.67%). Interestingly, GoogLeNet (avg. rank = 2.26) now achieves better performance than ResNest (avg. rank = 2.2) on the finergrain average rank measure, assigning the higher average rank to the incorrect alternative image.

Figure 1 presents the profile analysis for ResNet and for the American adults who completed the 2-AFC task of Marupudi and Varma (2023). The two profiles are highly correlated (r=.79), indicating that the model finds the same classes of GT concepts to be relatively easy and relatively difficult as humans.

Table 2: Overall performance of the CNN models on the 2-AFC task. Note that all the entries that differ significantly from the chance level of 16.67% (i.e., where p; 0.05 on a binomial test) have been marked with an "*". The results of the overall best performing model, Resnet, are shown in bold.

Model	Topology	Euclidean Geometry	Geometrical Figures	Symmetrical Figures	Chiral Figures	Metric Properties	Geometrical Transformations	Overall Accuracy	Avg. Rank
VGG-19	50.0	87.5*	44.44	0.0	25.0	57.14	25.0	46.51*	2.13
AlexNet	75.0	75.0*	44.44	33.33	25.0	14.29	50.0	46.51*	2.12
ResNet	50.0	87.5*	66.67*	33.33	25.0	42.86	37.5	53.49*	2.2
DenseNet	50.0	62.5	55.56	33.33	25.0	57.14	37.5	48.84*	2.15
GoogLeNet	50.0	75.0*	55.56	0.0	50.0	57.14	25.0	48.84*	2.26

References

Dehaene, S.; Izard, V.; Pica, P.; and Spelke, E. S. 2006. Core Knowledge of Geometry in an Amazonian Indigene Group. Marupudi, V.; and Varma, S. 2023. Graded Human Sensitivity to Geometric and Topological Concepts. *Cognition*, 232: 105331.