The creation of abstract thoughts in the brain

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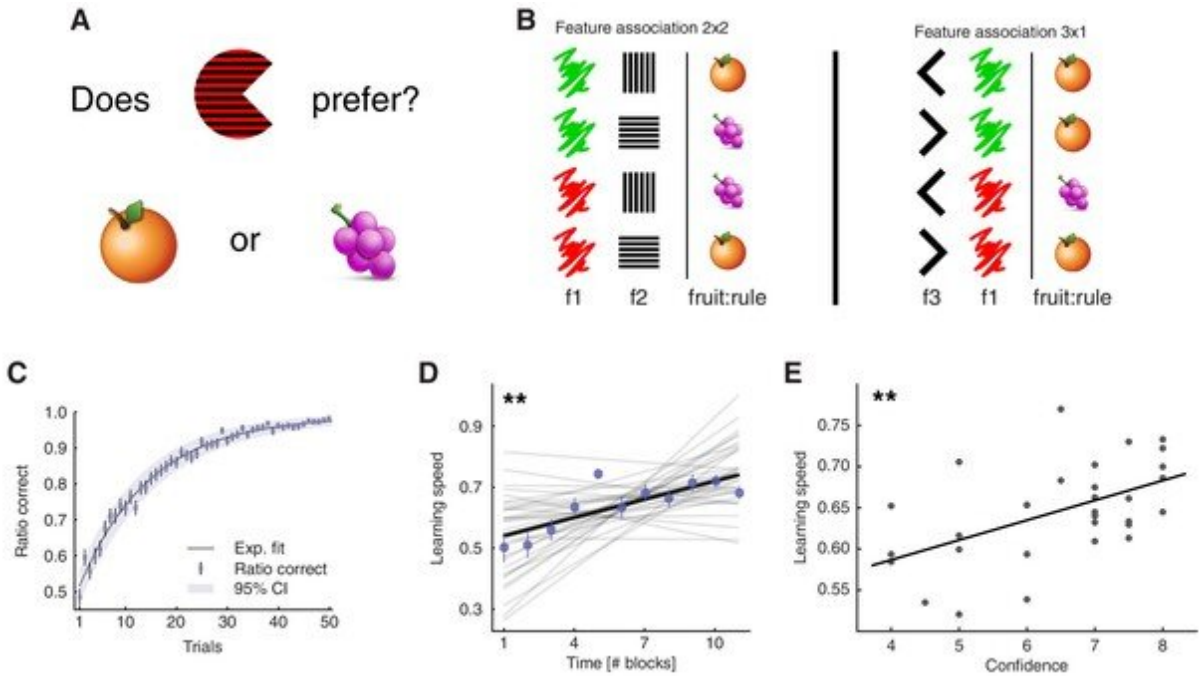

Learning task and behavioral results. (A) Task: participants learned the fruit preferences of pacman-like characters, which changed on each block. (B) Associations could form in three ways: color – stripe orientation, color – mouth direction, and stripe orientation – mouth direction. The left-out feature was irrelevant. Examples of the two types of fruit associations. The four combinations arising from two features with two levels were divided into symmetric (2x2) and asymmetric (3x1) cases. f1-3: features 1 to 3; fruit:rule refers to the fruit as being the association rule. Both block types were included to prevent participants from learning rules by simple deduction. If all blocks had symmetric association rules and participants knew this, they could simply learn one feature-fruit association (e.g. green-vertical), and from there deduce all other combinations. Both the relevant features and the association types varied on a block-by-block basis. (C), Trial-by-trial ratio-correct improved as a measure of

within-block learning. Dots represent the mean across participants, while error bars indicate the SEM, and the shaded area represents the 95% CI (N = 33). Participant-level ratio correct was computed for each trial across all completed blocks. Source data is available in file Figure 1—source data 1. (D), Learning speed was positively correlated with time, among participants. Learning speed was computed as the inverse of the max-normalized number of trials taken to complete a block. Thin gray lines represent least square fits of individual participants, while the black line represents the group-average fit. The correlation was computed with group-averaged data points (N = 11). Average data points are plotted as colored circles, the error bars are the SEM. (E), Confidence judgements were positively correlated with learning speed, among participants. Each dot represents data from one participant, and the thick line indicates the regression fit (N = 31 [2 missing data]). The experiment was conducted once (n = 33 biologically independent samples), **p