Figures and figure supplements
Interpretive monitoring in the caudate nucleus

Marianna Yanike, Vincent P Ferrera
Figure 1. Behavioral task and performance. (A) Sequence of events in each trial of the speed categorization task. (B) Percentage of trials for which the stimulus speed was categorized as ‘fast’ for slow and fast boundary positions (orange/blue, respectively). Small circles represent choices from each session and large circles represent their average. Psychometric curves (solid lines) represent fits of Naka-Rushton functions together with the corresponding error rate (orange/blue dashed lines). (C) Histograms of PSEs from the psychometric curves across sessions sorted by the boundary position. PSE (i.e., the point of subjective equality) corresponds to the stimulus speed for which the animal was equally likely to classify the stimulus as ‘fast’ or ‘slow’. Triangles represent the mean PSEs corresponding to internal estimates for each boundary position. (D) Proportion of fixation breaks of the total number of trials (open circles, mean ± SEM) for each speed sorted by the boundary position.

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Figure 2. Location of recording sites. (A) Recording chamber showing access to the associative striatum (indicated in red square) in Monkey F. (B) (top) Distribution of recording sites for post-saccade (gray) and reward (black) neurons across two animals. AP = 0 corresponds to the anterior commissure. (bottom) Location of category-related neurons with selective response to slow (orange) and fast (blue) boundaries superimposed on the location of responsive neurons (gray).

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Figure 3. Sensitivity to the boundary position in caudate neurons. (A and B) Distribution of significant p-values indicating difference in spike count between slow and fast boundary positions for neurons with activity during the post-saccade (A) and reward (B) periods of the task. Only values of less than 0.05 are shown.

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Figure 4. Representation of category signals. (A) Example neurons with activity during post-saccade (A) and reward (B) periods. (top) Spike raster plots, each row is one trial and each dot is a detected spike, and spike density functions (mean ± SEM) in response to speeds 6 (left) and 12 (right). Black lines show periods of the task. Dashed black lines indicate average reaction time to saccade. (bottom) Average neuronal activity across stimuli sorted by the boundary position. Orange/blue dashed lines, actual boundary positions. Bars, SEM. (C and D) Scatter plots of CIs for speed 6 vs speed 12 across neurons with activity during post-saccade (C, n = 31) and reward (D, n = 23) periods. Example neurons in (A and B), star and square in (C and D), respectively. (E and F) (top) Average CI across speeds for neurons with activity during post-saccade (E) and reward (F) periods. (bottom) Proportion of neurons with a significant difference between spike counts across boundaries for each speed (bootstrap test, p < 0.05). DOI: 10.7554/eLife.03727.006
Figure 4—figure supplement 1. Examples of two additional caudate neurons. On average, these neurons responded differently to the same stimulus (speed 6) on trials with slow (orange) and fast (blue) boundary positions during the post-saccade (A) and reward (B) periods of the task. Same notation as in Figure 4A,B. DOI: 10.7554/eLife.03727.007
Figure 5. Prediction accuracy for speed and category boundary. The average prediction accuracy for speed (A, C), across two boundary position, and boundary position (B, D), across all speeds, for correct only trials (black) and all trials (correct and incorrect, gray) separately for the post-saccade (A, B) and reward (C, D) neuronal populations. Corresponding chance levels are shown in dashed line. Orange/blue dashed lines, actual slow/fast boundary positions.
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Figure 5—figure supplement 1. Prediction accuracy and population size. Prediction accuracy for stimulus speed (A) and boundary position (B) as a function of neuronal population size for neurons with activity during post-saccade (black) and reward (gray) periods of the task. The decoding performance plateaued faster for the boundary position (∼5 neurons) compared to the speed (∼10–15 neurons) in each neuronal population suggesting more redundant coding for the boundary position. Chance levels are shown in dashed line.
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Figure 6. Population read out of speed and boundary position. (A and C) Proportion of correct estimates for each stimulus speed separately for slow (upper bars) and fast (lower bars) boundary positions for post-saccade (A) and reward (C) populations for correct only (gray) and incorrect (open) trials. (B and D) Average prediction accuracy for speed (black circles) and behavioral error rate (mean ± SEM, dashed and solid lines) as a function of stimulus’ position to the boundary (dashed line) for each neuronal population. The prediction accuracy for the most extreme stimuli (speeds 2, 4, 14, and 16) deviated from the behavioral error rate function, possibly due to a greater perceptual uncertainty, about the identity of the stimulus or boundary cue, compared to the intermediate stimuli. DOI: 10.7554/eLife.03727.010
Figure 7. Contextual modulation during categorization. (A and B) Prediction accuracy for two opposite directions of dots motion (up or down) for each stimulus for post-saccade (A) and reward (B) neuronal populations. (C and D) Discrimination accuracy across pairs of neighboring speeds (seven pairs, 2–4, 4–6, ..., 14–16) separately for trials with each boundary position for post-saccade (C) and reward (D) neuronal populations. The thickness of each bar corresponds to the average discrimination accuracy with ± SEM. Same notation as in above.

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Figure 7—figure supplement 1. Effect of categorical perception on discrimination of near boundary stimuli in individual neurons. Ratio Difference indexes for each neuron with activity during post-saccade (A) and reward (B) periods showing difference in neuronal activity between speed pairs (4/6 or 12/14) when categorized as same (Ratio Diff: intracategory) or different (Ratio Diff: intercategory) categories. For each neuron, a pair (4/6 or 12/14) with the maximum Ratio Diff is plotted for each period of the task. Orange/blue indicates the maximum Ratio Diff for pairs 4/6 or 12/14, respectively. DOI: 10.7554/eLife.03727.012