INTRODUCTION

Cognitive and perceptual processes involve complex operations that are executed by the mammalian brain at time scales ranging from tens to a few hundred milliseconds. The speed of these processes puts strong constraints on the underlying neuronal mechanisms. In the present study, we investigate reaction times in a monkey performing both spatial and conditional working memory tasks (White & Wise, 1999) and compare the results to data obtained from the same animal performing a figure-ground-segmentation task.

METHODS

Animal

A male Rhesus monkey (Macaca mulatta) was sequentially trained to perform two visually guided tasks: a Go/NoGo delayed-match-to-sample task and a figure-ground-segmentation task. In both tasks, conditional responses were used to signal the target stimulus. Eye position was monitored using a head-mounted video camera.

Tasks

1. Delayed Match-to-Sample

The monkey was trained to perform an on-off Go/NoGo delayed-match-to-sample task in which one of two rules determined the correct stimulus (location-encoding, identity-matching). A sample stimulus consisting of a simple complex object was presented at one of three possible locations at an eccentricity of 7.5 degrees. The sample was followed by a 1-second delay interval during which the monkey redirect its gaze to three targets: correct, incorrect, or a neutral target. After the delay interval, a new stimulus was presented in the same location as the sample stimulus, and the monkey was required to indicate whether the target stimulus was the same or not by making a saccade to the target or not. The correct stimulus was indicated by a target located on the left side of the monitor, and the incorrect stimulus was indicated by a target located on the right side of the monitor. The neutral stimulus was located in the center of the monitor and did not require a saccade to be made. The sample stimulus was a rectangle with a black outline and a black center. The correct stimulus was a rectangle with a black outline and a red center. The incorrect stimulus was a rectangle with a black outline and a green center.

RESULTS

The monkey performed the two tasks sequentially over a period of roughly one year and the data presented are from periods when the performance was stable (100% correct responses). In addition, only trials with a 1-second response and with a stimulus-to-go time greater than 0 ms to 100 ms were included. A failure stimulus was done based on a 254 ms trial, which only held about 80% correct responses even analyzed. This was done to maintain changes in attention. The data from the delayed-match-to-sample task come from times when the monkey was required to make two separate judgments: location-matching and identity-matching. To ensure a delay was given in the monkey to indicate that the trials had been changed.

Data analysis

Eye position signals were digitized at 1 kHz. The onset of successive responses (a reaction time) was identified when the eyes velocity crossed a threshold of 0.018 deg/s.

CONCLUSIONS

1. In the delayed-match-to-sample task, when the response is based on object location the difference in mean times between Go and NoGo responses is -10 ms. Three conditions differ by the fact that the GoNoGo block is terminated when NoGo trials are included in the session. The collected collection of the fixation point with the correct stimuli after the correct stimulus has been removed has been increased in reaction times (see Fuld & Wallach, 1993) and this may explain the 2–10 ms difference.

2. Identity, when the fixation point is shaded to indicate the identity the correct stimulus reaction time is (-10 ms) and increases up to 20 ms in GoNoGo sessions. However, the difference between these conditions (-10 ms) is much larger than (-10 ms) expected above and that cannot be explained by the Fuld & Wallach estimation effect.

3. Furthermore, the identity-based responses differ drastically from the location-based responses by an estratification process and lack of prior knowledge about the stimuli. So that the identity can solve the identity task relatively, at least an additional -30 ms identity-location-based matching times with NoGo trials included in the sessions. This suggests that the difference between object-discrimination followed by the decision to encode an identity (and not decision to encode a preencoded location) can account for the difference.

4. The same model used for the delayed-match-to-sample task, and that the difference between identity- and location-based responses is only due to a lack of prior knowledge of the target location, i.e. that the difference between reaction times is no longer significant. Thus, the difference in reaction times when behavior is guided by the location of the target or the identity in a gamma-gated, that is, discrimination process and negatively related to reaction time conditions is no longer valid.

5. It has been shown that monkey's with better scores (70% correct), as observed in the conditional discrimination, are more accurate in the delayed-match-to-sample task than monkeys with better scores (30% correct). This is because the delayed-match-to-sample task is less sensitive to the number of discrimination conditions. When comparing the reaction times between discrimination and recognition of a stimulus from background noise, we observe a difference of 0.01 s. Which suggests that the neuronal mechanisms underlying central segregation require a time of at least 0.01 s to complete.

SUMMARY

1. Baseline

2. 100% Go

3. 70% NoGo/No/No

4. 50% Cont

5. Location or without background

6. 70% Go, 30% NoGo

Table 1: Summary of mean reaction times across all experimental conditions. * significant difference (p< .05, t-test) from the control group.

REFERENCES


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