INTRODUCTION

Current theories of motor control view sensorimotor variability as the outcome of internal neural noise occurring in sensing, information processing or movement execution [1]. Because variability has a cost, its effects must be minimized [2], presumably using post-movement errors as feedbacks.

However several studies, mostly about response sequences, showed that variability might result from operant learning [3].

Here, we argue that part of sensorimotor variability can be experimentally controlled by reinforcement contingencies. We show that the spread of saccadic amplitude distributions may be manipulated.

METHODS

Experiment 1: extent of control by reinforcement contingencies (n=3)

INTRODUCTION

Here, we argue that part of sensorimotor variability can be experimentally controlled by reinforcement contingencies. We show that the spread of saccadic amplitude distributions may be manipulated.

METHODS

Experiment 1: extent of control by reinforcement contingencies (n=3)

1 and 2: baseline

1st baseline: 600 regular saccades

2nd baseline: 800 stabilized saccade trials

Target is displayed at post saccadic eye position → median = goal median amplitude for the 3rd and 4th stages

3 and 4: auditory reinforcement provided on a trial-to-trial basis depending on the saccade amplitude

3 learning variability:

Auditory stimulus if the saccade amplitude falls within the 5 least frequent bins (computed over the previous 50 trials) (30 sessions of 200 saccades on average)

4 recovery:

Reinforcement criteria determined by the 30% of the previous 50 saccades closest to the goal amplitude (12 sessions of 200 saccades on average)

Experiment 2: is contingency necessary to control variability (n=8)? Yoke control

1st baseline: 800 regular saccades

2nd baseline: 800 stabilized saccade trials

Reinforcement criteria determined by the 30% of the previous 50 saccades closest to the goal amplitude

reinforcement (17 sessions of 200 saccades on average)

- contingent on variability (n=4)

- non-contingent on variability (n=4)

RESULTS

Saccadic gain distributions vary according to the reinforcement contingencies

The reinforcement contingencies increase standard deviations while keeping medians constant

Variability is the only parameter consistently modified by the reinforcement procedure

CONCLUSIONS

Our data show that saccadic amplitude variability can be manipulated by reinforcement contingencies. They extend the results obtained by Madelain et al. (2007) [4] who modified saccade latency variability while maintaining the median unchanged.

According to the operant conditioning theory, variability is a central factor for adaptation, in that the ability to select and shape a particular class of responses is constrained by the range of variations [5].

We have shown elsewhere that saccadic adaptation depends on reinforcement [6]. Sensorimotor variability may be necessary to provide the substrate from which saccades leading to clear vision could be selected. This might be critical to maintain saccadic accuracy during the lifespan.