Reinforcement of variability in saccadic amplitude

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INTRODUCTION

Current theories of motor control view sensorimotor variability as the outcome of noisy process occurring during visual processing, response selection or motor processing. Because variability has a cost it must be minimized, presumably using post-movement errors. However several studies showed that variability of response choice might be controlled by operant learning [1;2].

Here, we argue that sensorimotor variability is an operant dimension, that is, a response feature controlled by environmental contingencies. To test for this possibility we experimentally reinforced various levels of saccade amplitude variability in the absence of a retinal error.

METHODS

Non naïve subjects (n=3) - No reinforcement during baseline

1 and 2: baseline

1st baseline: 800 regular saccades

2nd baseline: 800 stabilized saccade trials

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

3 learning variability:

Reinforcement of the saccade if the 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)

RESULTS

Saccadic gain distributions vary according to the reinforcement contingencies

The reinforcement contingencies increase standard deviations while keeping medians constant

CONCLUSIONS

Our results show that saccadic amplitude variability can be manipulated by reinforcement contingencies. They extend the results obtained by Madelain et al. (2007) [3] 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 [4]: we view sensorimotor variability as the basis for adaptation processes.

We have shown elsewhere that saccadic adaptation depends on reinforcement as well [5]. That environmental contingencies control amplitude variability might therefore be critical to maintain saccadic accuracy during the lifespan.

References:

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