

Stepwise Probability Estimation Updating not Fully



Explained by Motor Cost

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Probability Updating Competing Models

- **Trial-by-trial learning (*sawtooth* changes):**
- Every new sample from a population is used immediately to update a running estimate of the probability.

$$p_{t+1} = p_t + \alpha \delta$$

- **Change-point detection (*stepwise* changes):**
- Estimates of probability are held over many samples. Updating only occurs when enough evidence accumulates that conditions have changed.

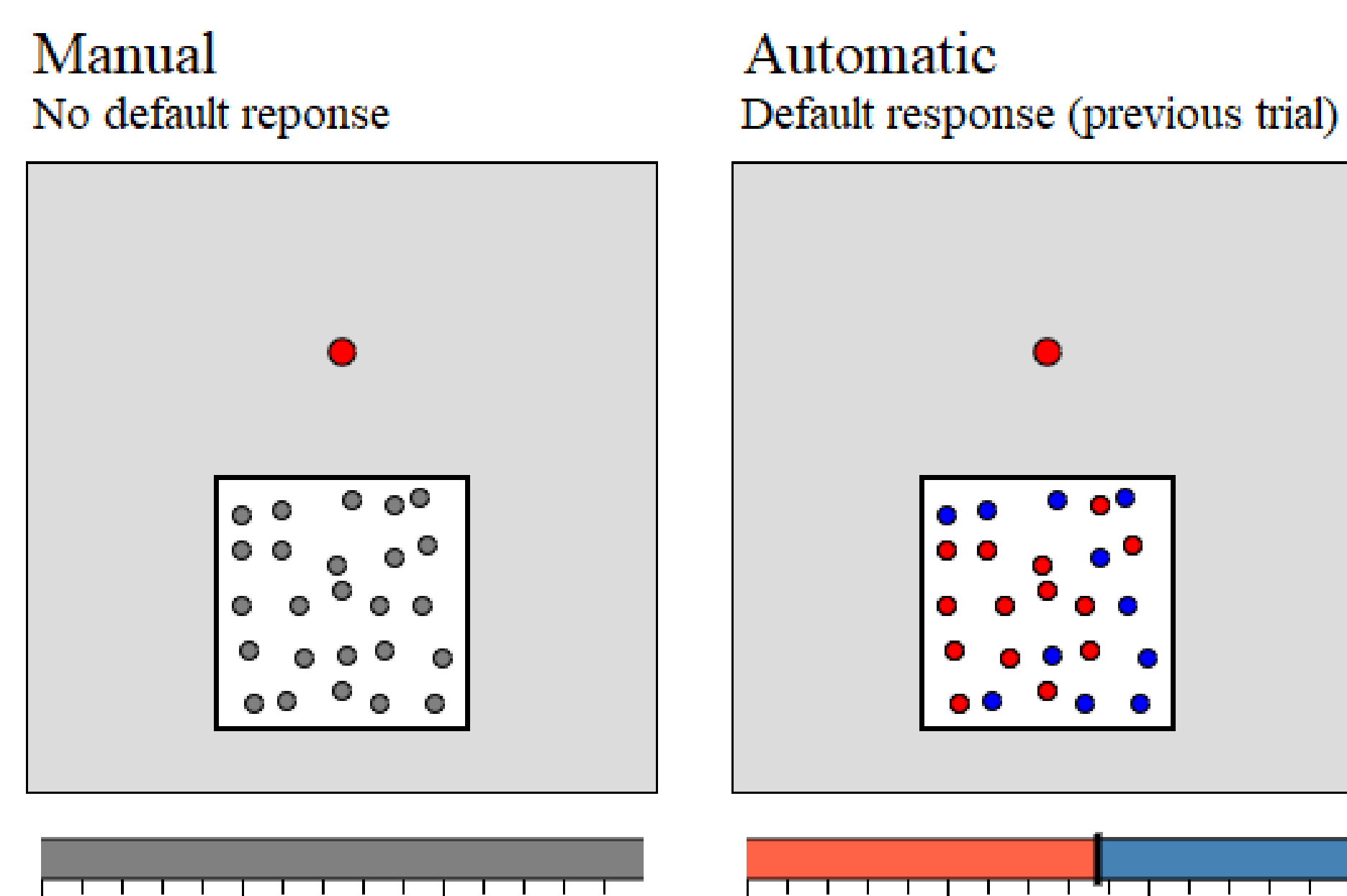
$$PostOdds = BF \times PriorOdds = \frac{MML(M_1 | D, \pi(\theta | M_1))}{MML(M_0 | D, \pi(\theta | M_0))} \times \frac{p(M_1)}{p(M_0)}$$

Motor Cost Confound? (Forsgren et al 2020)

Providing participants a default probability estimate (previous response) has predisposed them to update infrequently (i.e. *stepwise updating*)

Modified Experimental Task

How likely will the next dot be blue?

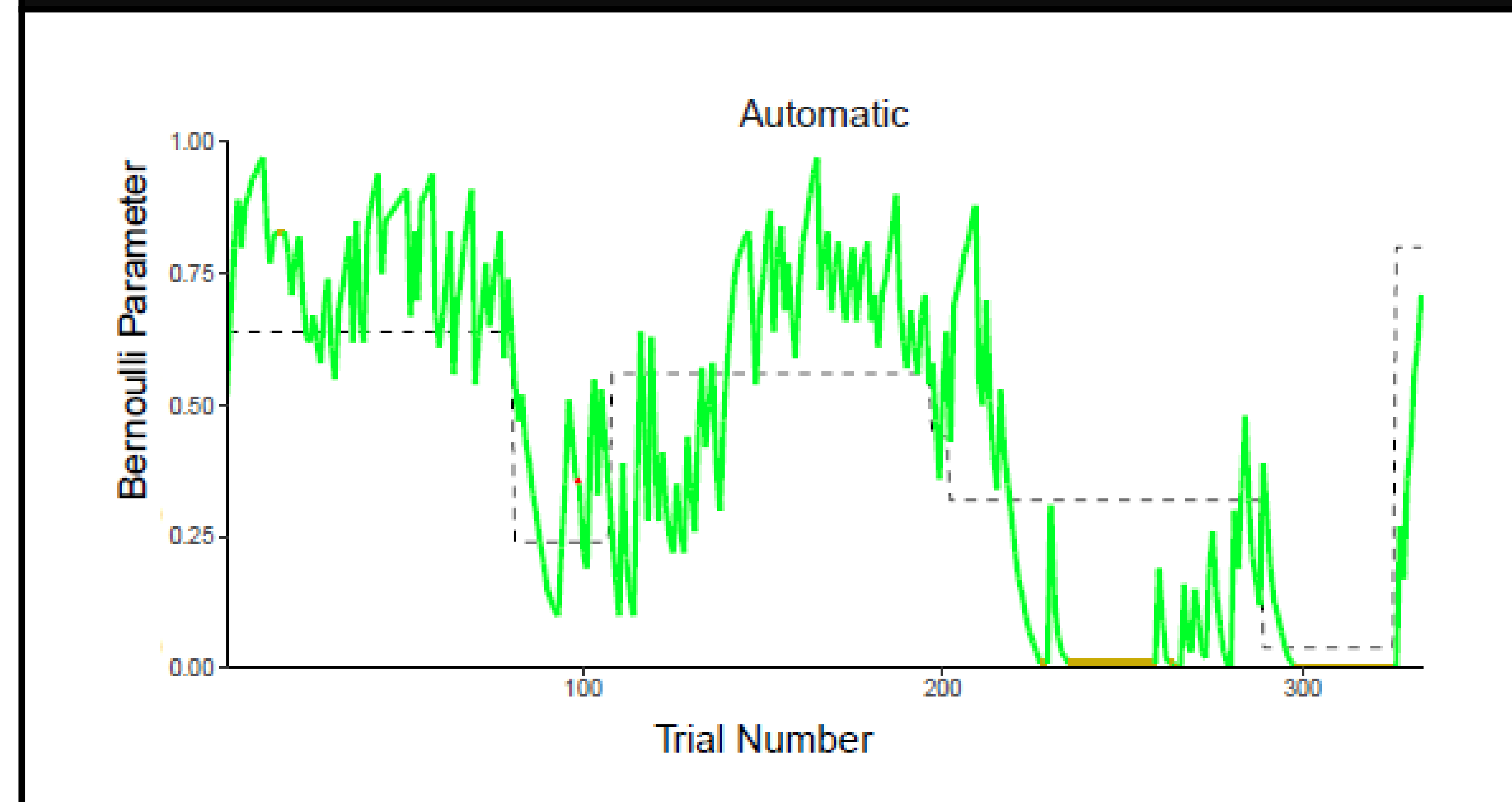


References

- Gallistel, C. R., Krishan, M., Liu, Y., Miller, R., & Latham, P. E. (2014). The perception of probability. *Psychological Review*, 121(1), 96.
- Forsgren, M., Juslin, P., & van den Berg, R. (2020). Further perceptions of probability: in defence of trial-by-trial updating models. *BioRxiv*, 2020-01.

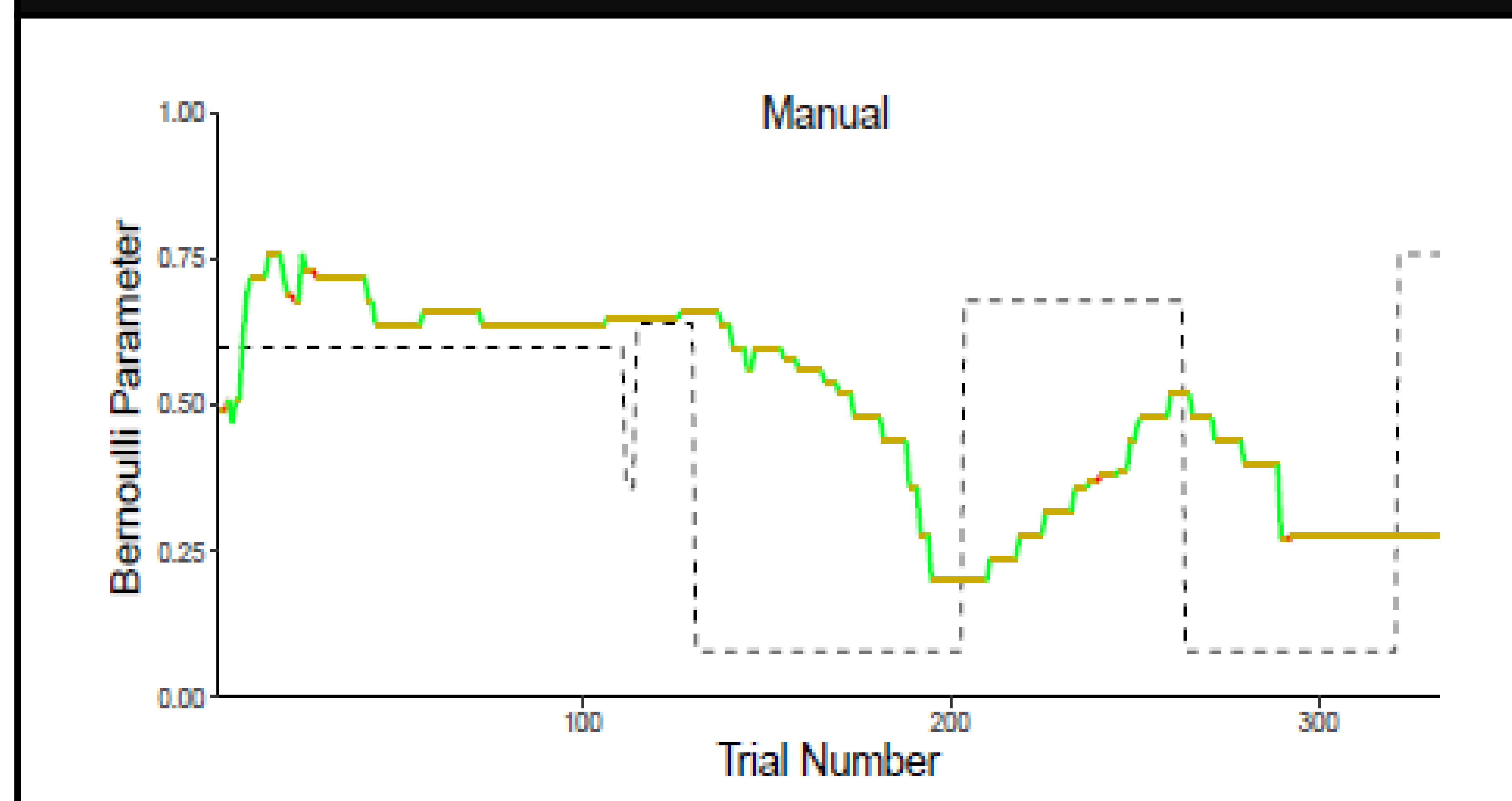
Intentional *Sawtooth* Probability Estimation

Participant with default response meticulously updates every trial



Intentional *Stepwise* Probability Estimation

Participant with no default response meticulously maintains estimates

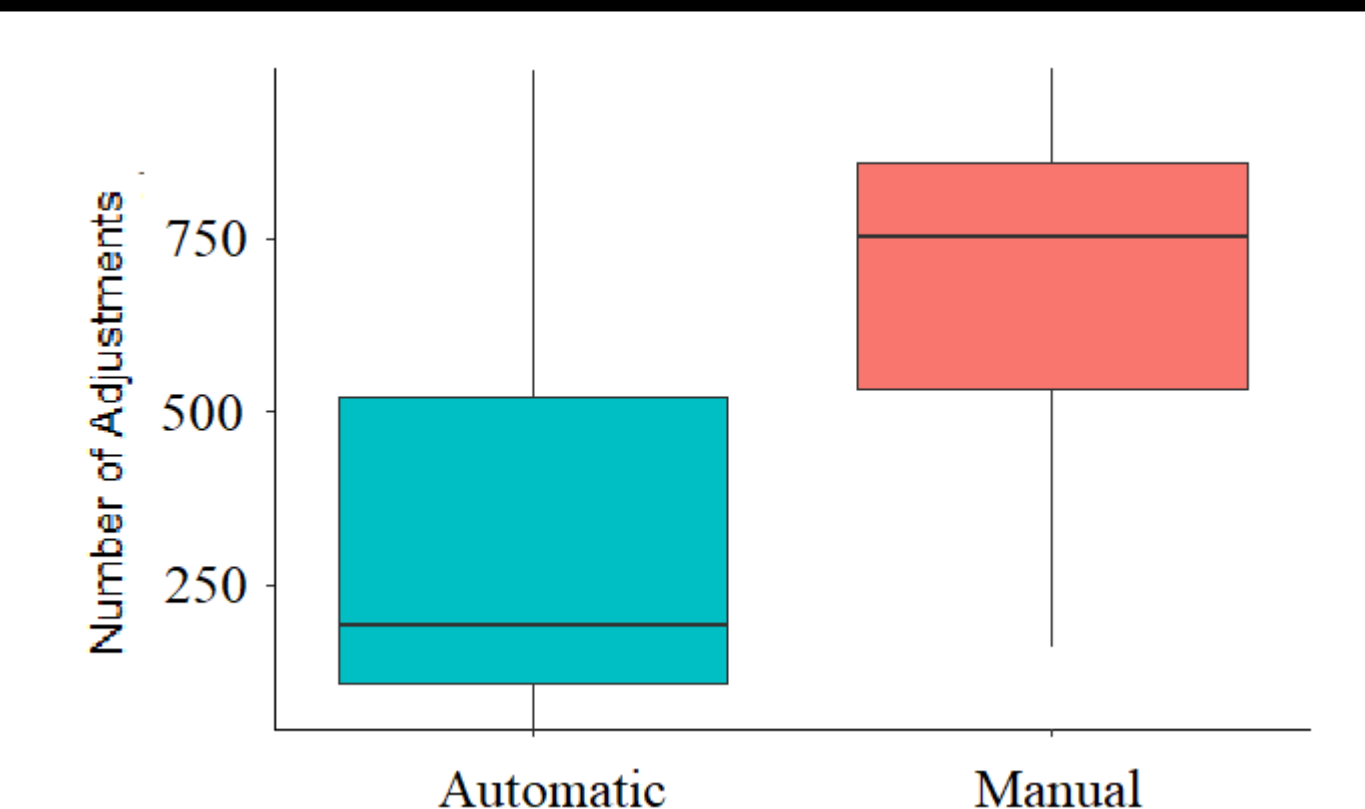


Summary of Results

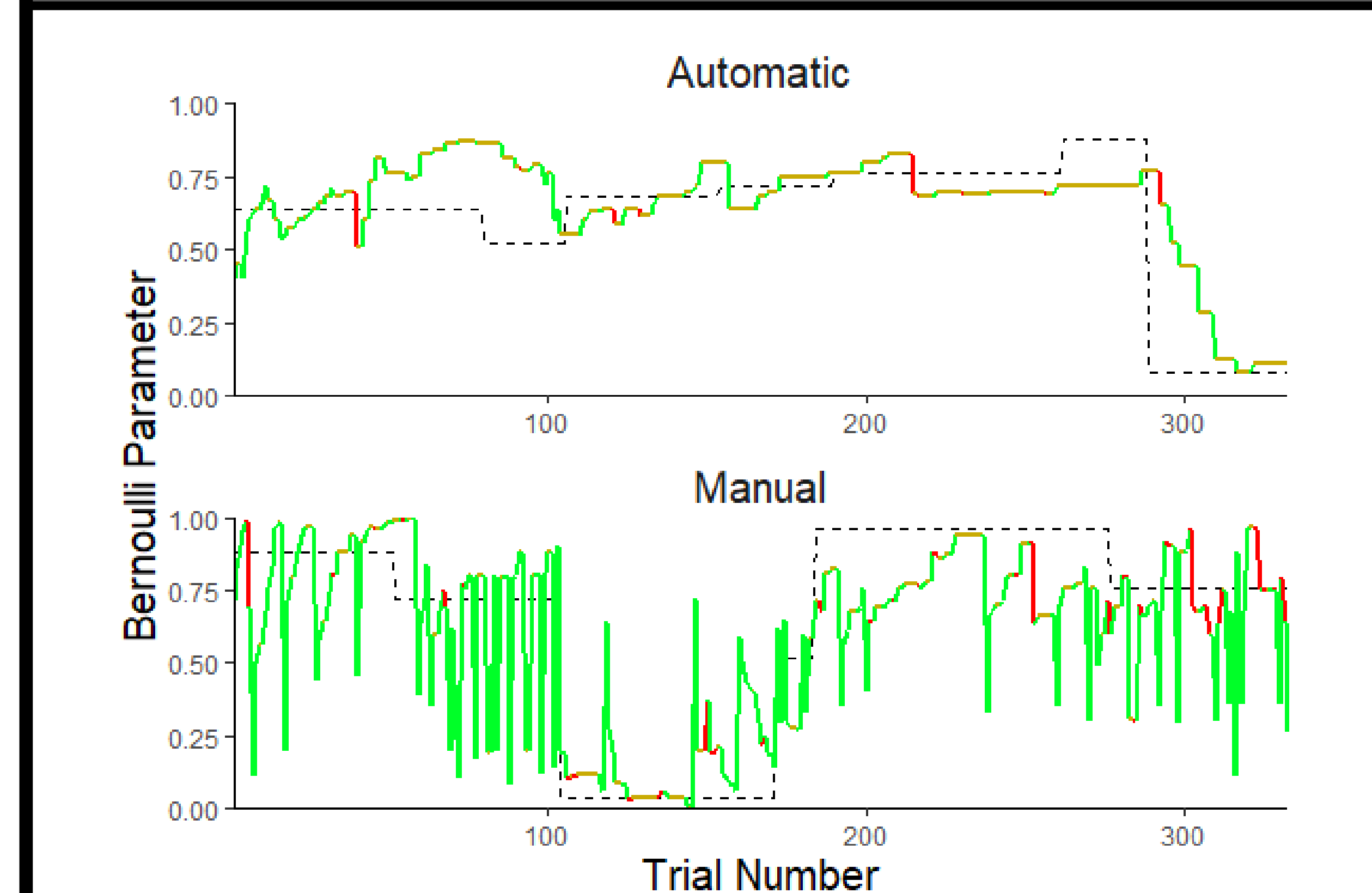
- Vast individual differences in updating frequencies
- Removing the motor-cost confound did not completely abolish stepwise behavior

Group Level Analysis

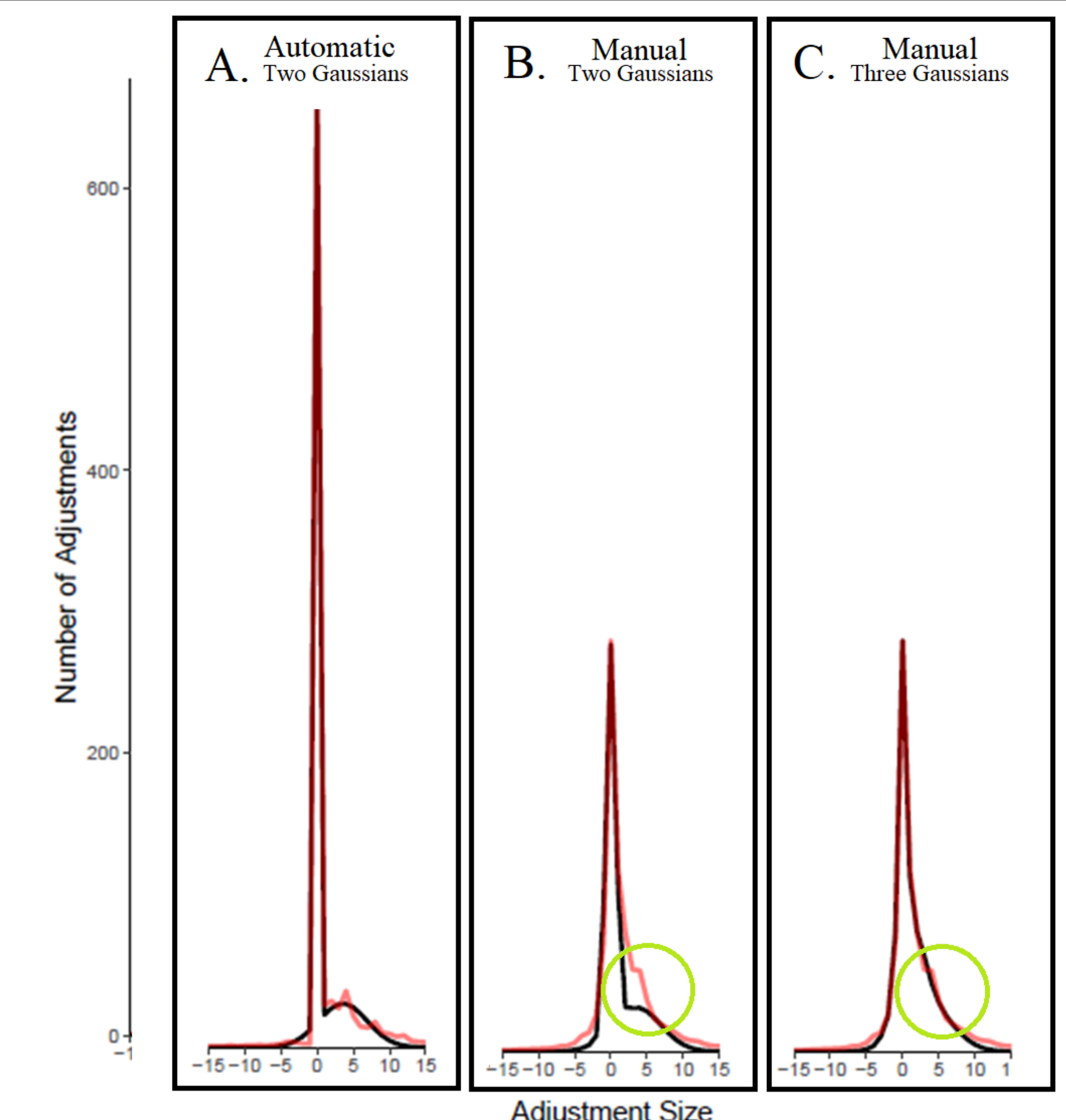
Manual participants changed their responses more



Group representatives: participants making median number adjustments per their group



Mixture Modeling shows that manual adjustments reflect both more noise and more new updating events (see circled regions)



A. Automatic data modeled with two distributions representing (1) response maintenance (2) updating events
B. Refitting Automatic model to Manual data with variable parameters representing added noise
C. Refitting above model and adding a new third distribution representing new small updating events