# Differential contributions to response preparation depending on movement type


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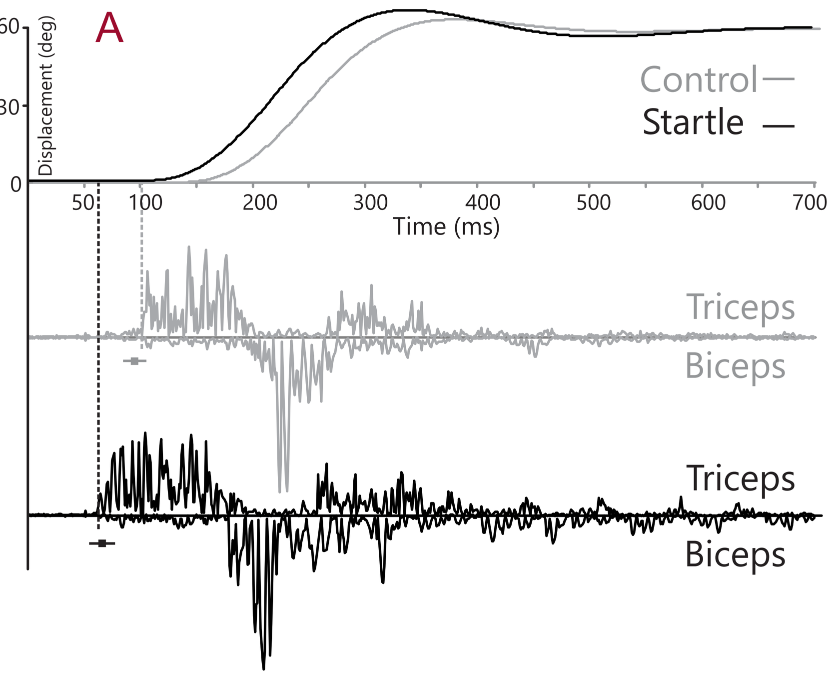
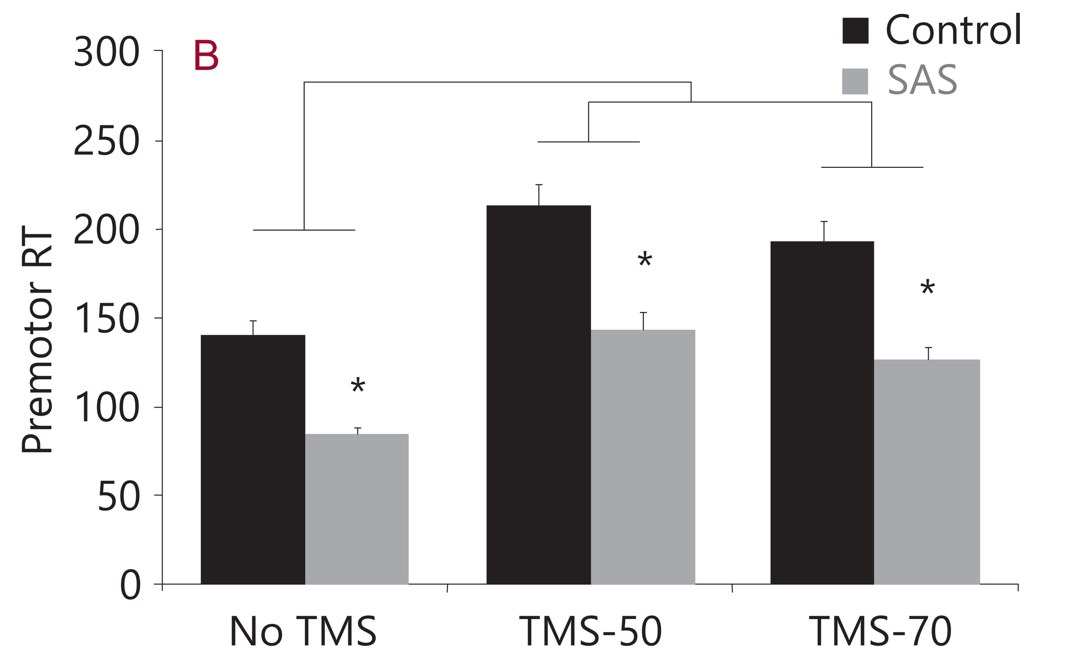
## Background and Rationale

- When a startling acoustic stimulus (SAS) is presented during the delay phase of a simple reaction time (RT) task, the prepared response is elicited at short latency (i.e., StartReact effect) (A)[1]
- One hypothesis suggests that details of the planned movement are stored in brainstem structures and involuntary triggered by the SAS[2,3]
- When TMS is used to elicit a cortical silent period (SP), RT is delayed - but Startle-elicited responses were also delayed by TMS suggesting cortical involvement in the StartReact effect (B)[4,5]
- A delay due to TMS in itself does not rule out brainstem contributions to response preparation




Adapted from Stevenson et al. 2014

**Question: Is the RT delay resulting from a TMS-induced cortical silent period modulated by anatomical requirements of the task or the stimulus condition?**

## Methods

- Participants performed targeted 20 deg wrist Extension or wrist Flexion movements in the context of a simple RT task (Fig. 1)
- A SAS was unexpectedly presented on some trials 200 ms prior to the go-signal
- TMS was applied over M1 representation for the right wrist extensor (E) or Flexor (F) following the go-signal or SAS
- EMG was collected (4000 Hz) from the wrist prime movers and SCM (startle response indicator)

Experiment 1:

- TMS was set to 140% of RMT and presented at a fixed time following the go-signal or SAS (Figs. 2 & 3)

Experiment 2:

- TMS was set to intensity required to elicit a ~100 ms SP while contracting at 10% of maximal voluntary contraction and delivered 70 ms prior to individualized RT in each condition (Figs. 2 & 3)

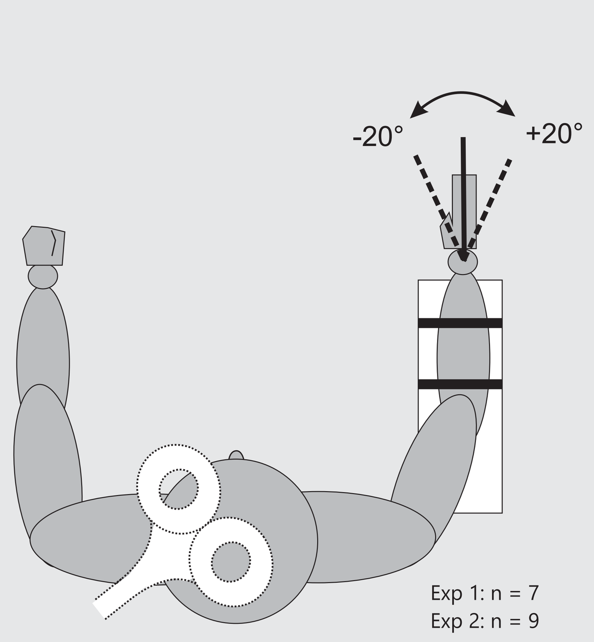



Figure 1. Participant set-up. A wrist flexion or extension RT task was performed in blocked order (counterbalanced). TMS was applied over motor hotspot on selected trials.

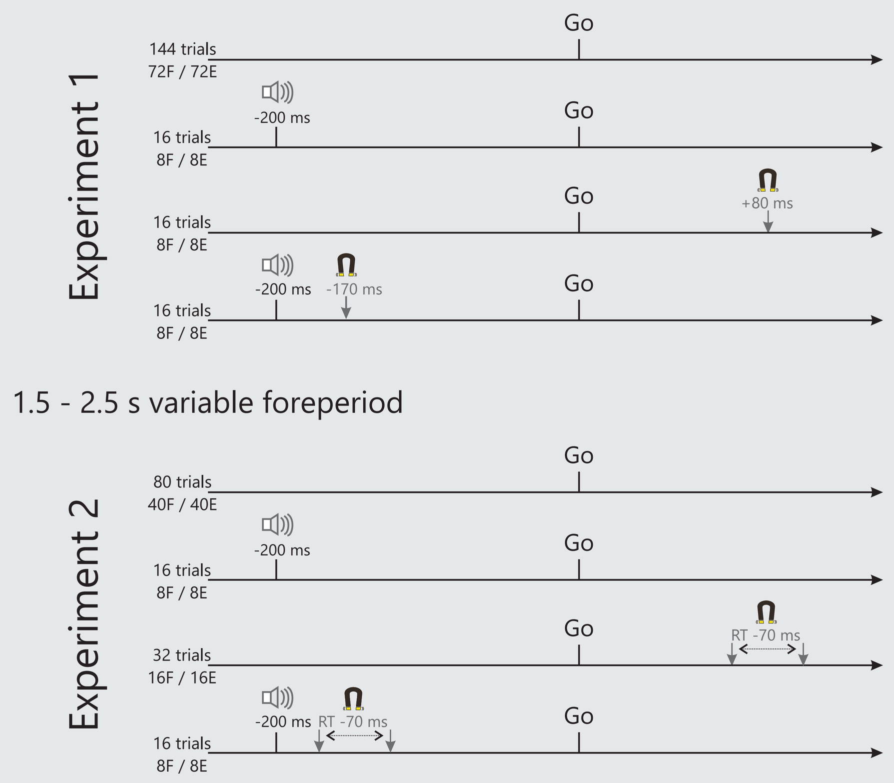



Figure 2. Trial timelines for Experiments 1 & 2. Following a variable foreperiod either a control go-signal was presented, a SAS was presented, a go-signal was presented followed later by TMS, or a SAS was presented followed by TMS.

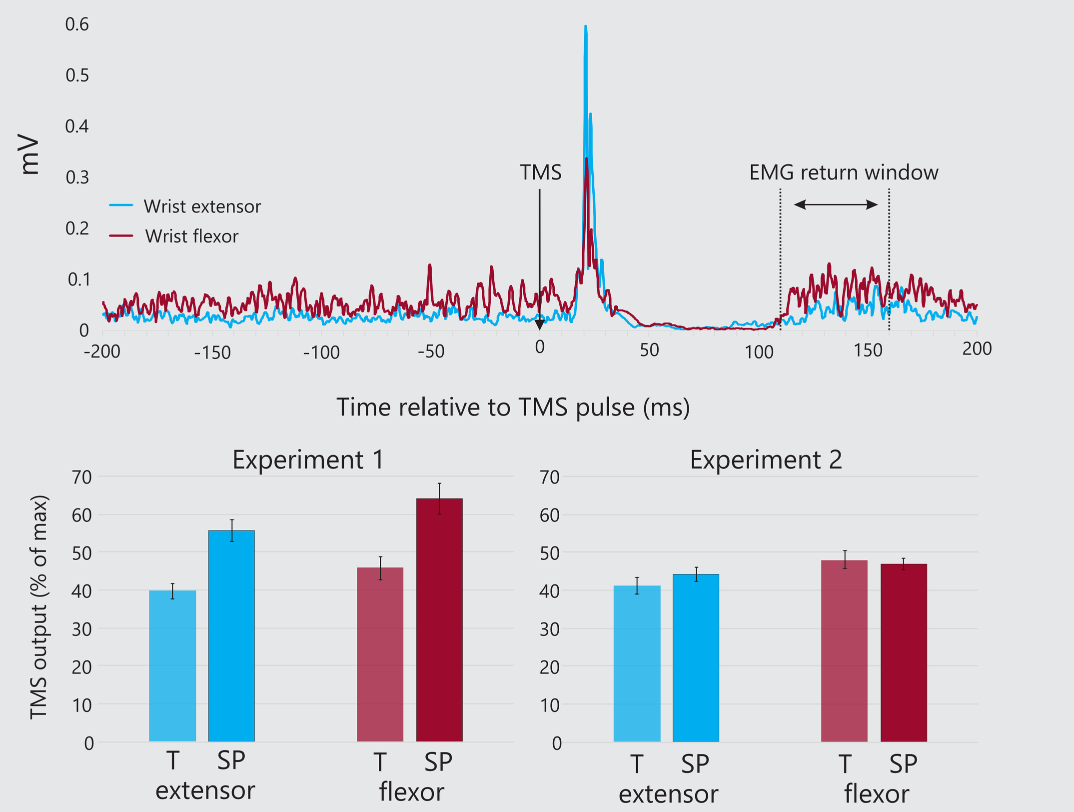



Figure 3. Top shows TMS silent period elicited in Experiment 2 for extensors and flexors (ensemble average from a representative participant). Bottom panel shows TMS output parameters for Experiments 1 and 2. Resting motor threshold (T) intensity, and intensity used to elicit a silent period (SP) are shown for extensors and flexors.

## Results

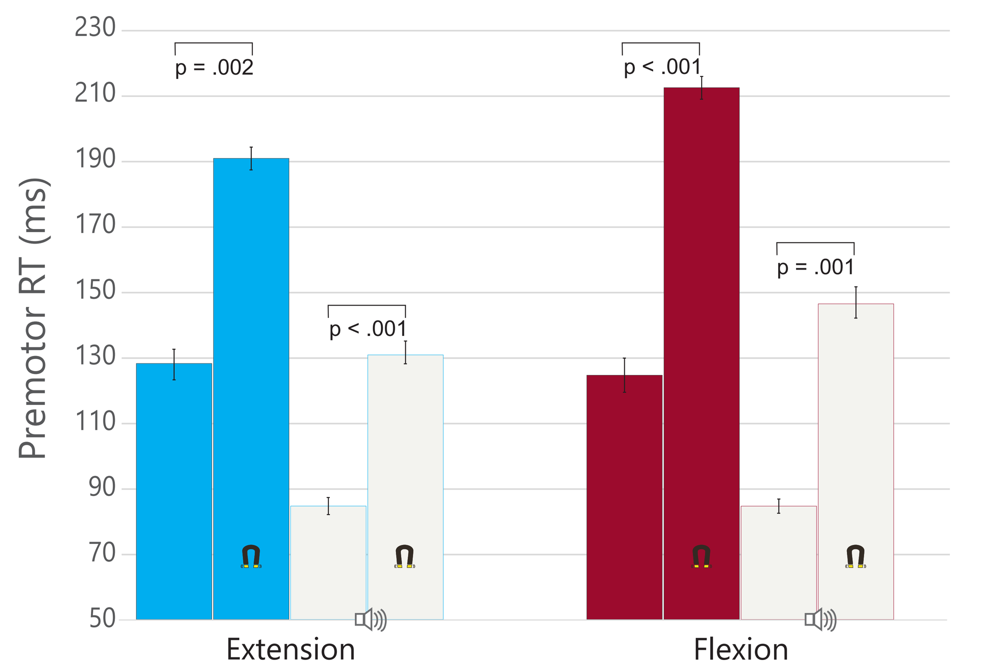



Figure 4. Mean premotor RT (SE) in Experiment 1 as a function of movement type, acoustic stimulus condition, and TMS condition. Blue bars represent extension movements, Red bars are flexion; Filled bars are control tone, Grey are SAS; Magnet icon indicates TMS conditions. Although SAS resulted in significantly faster RTs, TMS led to large RT delays.

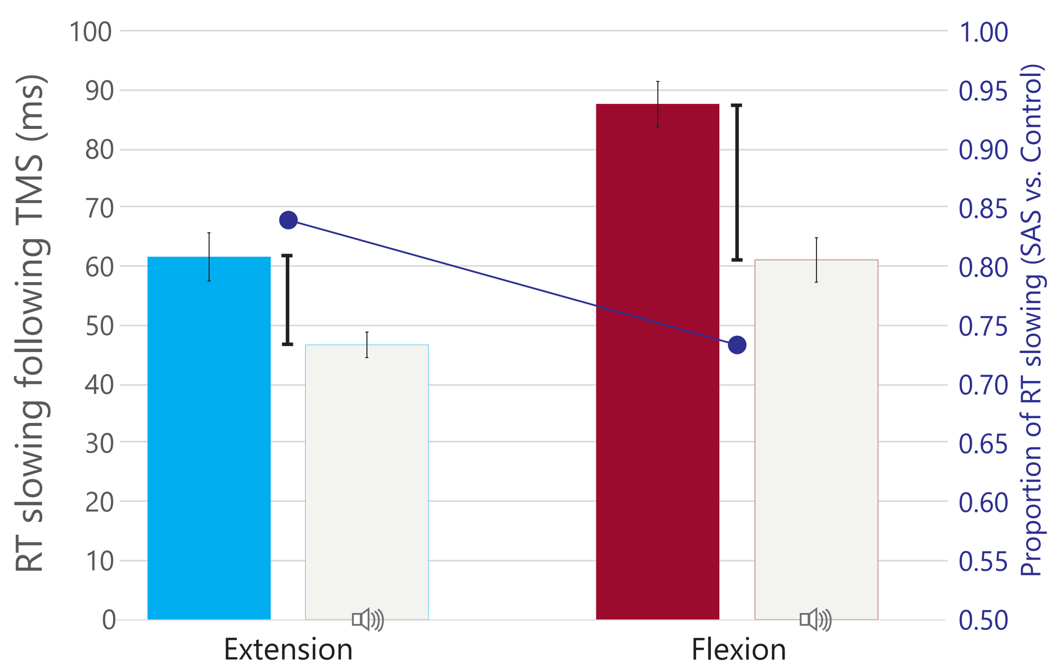



Figure 5. Experiment 1 Mean RT delay (SE) induced by TMS in Extension and Flexion movements for both the control and SAS stimuli. A SAS x TMS interaction (p=.005) suggests that TMS had a smaller effect following the SAS (54 ms) compared to control (75 ms). A task x TMS interaction (p = .027) suggests TMS had a larger effect on flexion movements; however, a significantly higher TMS intensity was used (see Fig. 3). A proportionally smaller TMS delay (SAS delay / Control delay; dark Blue) in flexion hints at a smaller effect of TMS in flexion.

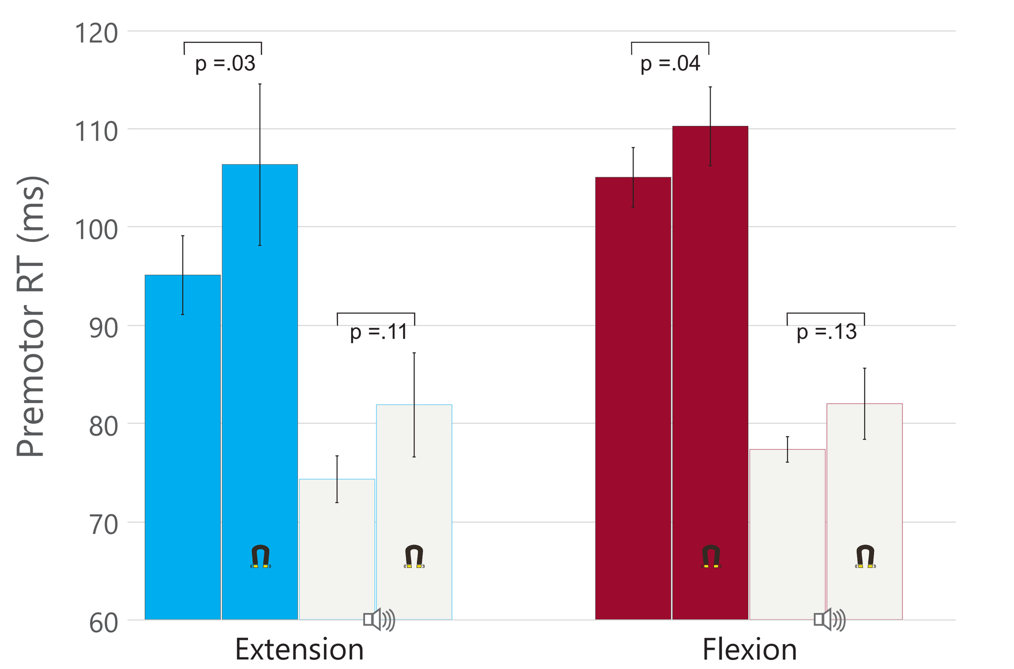



Figure 6. Mean premotor RT (SE) in Experiment 2 as a function of movement type, acoustic stimulus condition, and TMS condition. Blue bars represent extension movements, Red bars are flexion; Filled bars are control tone, Grey are SAS; SAS resulted in significantly faster RTs, but TMS only led to significant RT delays for control go-stimulus.

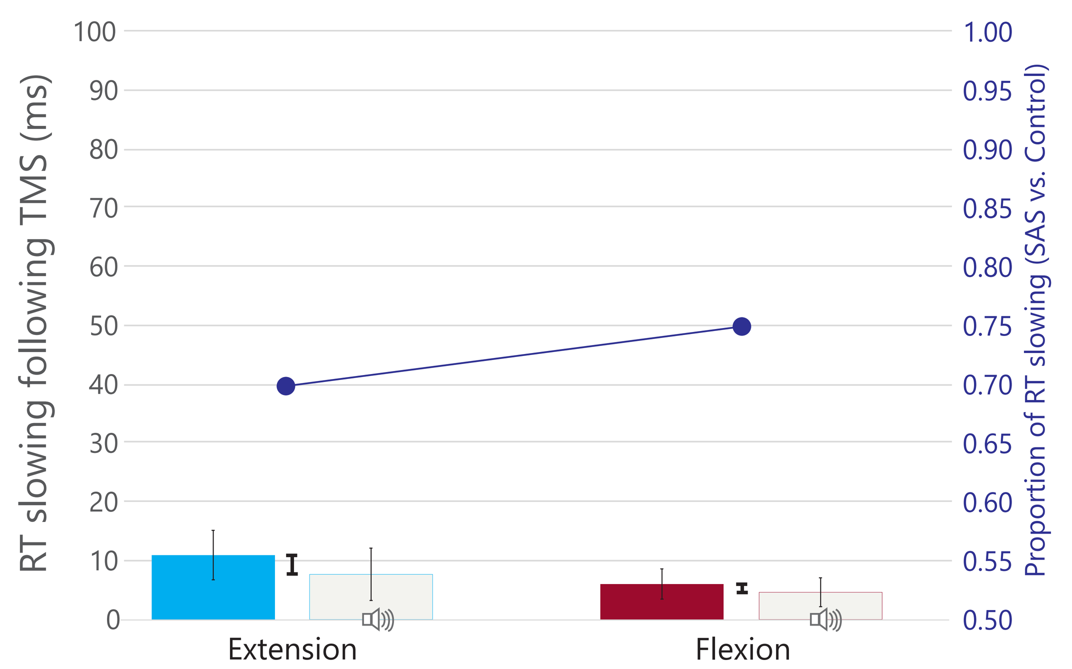



Figure7. Experiment 2 Mean RT delay (SE) induced by TMS in Extension and Flexion movements for both the control and SAS stimuli. Although the TMS RT delay was only half the magnitude in flexion as compared to extension this difference was not significant. Additionally the SAS x TMS interaction was not significant (p=.098) however, data in Fig. 6 suggests TMS had a smaller effect following the SAS compared to control. Proportional TMS delay (SAS delay / Control delay) is shown in dark Blue.

## Conclusions

- A SAS resulted in significant RT shortening; TMS resulted in RT delays for both Control and SAS trials (Figs. 4 & 6).
- RT delays following SAS were significantly smaller (Figs. 5 & 7) suggesting a larger subcortical (reticular) contribution in these movements.
- Data hint that RT delays may be smaller for Flexion compared to Extension movements suggesting possible differential cortical / reticular contributions to preparation/initiation between different functional classes of movements (e.g. Fig. 8).
- Follow-up studies with strict controls will be conducted to confirm these preliminary results.

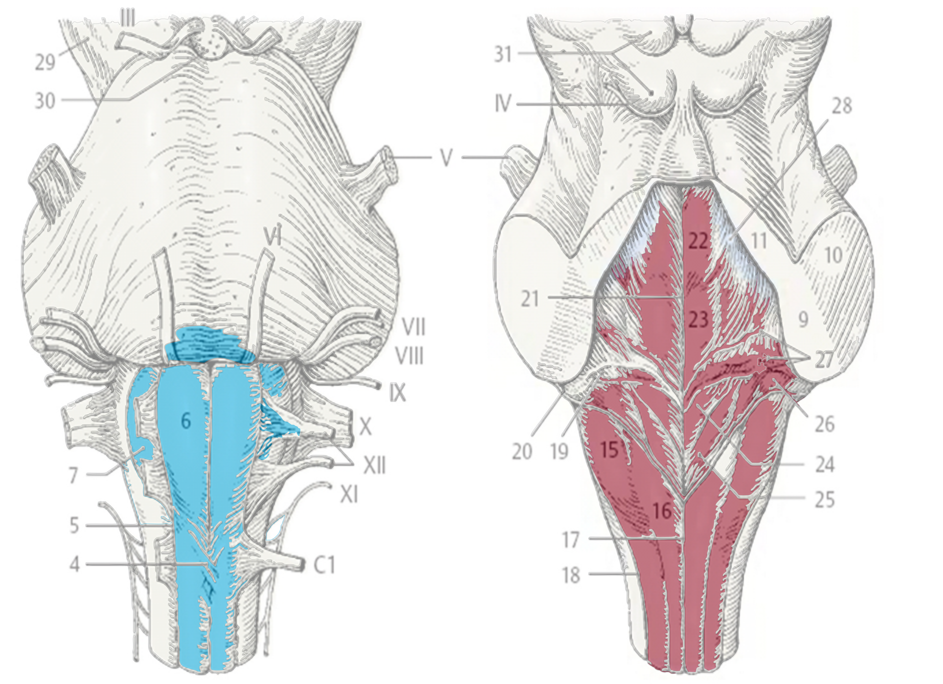


Figure 8. Schematic diagram of brainstem representing different levels of brainstem contribution to Extension and Flexion movements.

### References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