Solving a speed discrimination task: absolute and relative strategies

Nicholas SC Price and Richard T Born

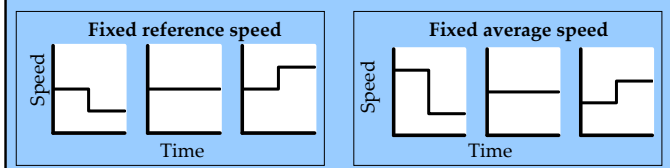
Neurobiology, Harvard Medical School, Boston, MA 02115 USA

nicholas_price@hms.harvard.edu

P5
641.9

Absolute versus Relative strategies

Sensing changes in visual stimuli is critical to assess motion in the environment. Most studies of speed change sensitivity have employed a fixed reference or average speed and could be solved by attending to a single aspect of the stimulus. Thus they may have tested absolute speed sensitivity rather than sensitivity to relative speed changes.

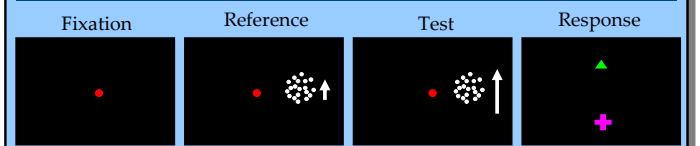


We studied speed change sensitivity, comparing discrimination performance on tasks that biased the subject toward absolute or relative strategies.

Absolute strategies should be favored on tasks with a single reference speed or when there is no reference period (forcing fast/slow judgments).

Relative strategies should be favored on tasks with multiple reference speeds and variable reference speed presentation times.

Speed change discrimination task

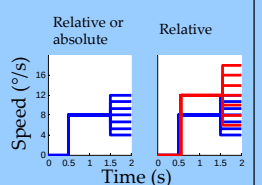


All tasks required the subject to indicate by button press or saccade if the **Test** speed was slower or faster than the **Reference** (or if the test speed was slow or fast in the absence of a reference period).

Reference speeds were 8 or 16°/s (humans) and 8 or 12°/s (macaque). Test speeds were ratios of 0.5-1.66 relative to the reference speed.

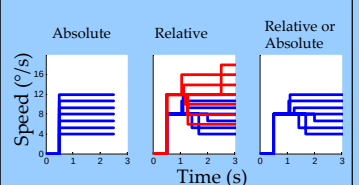
Fixed duration tasks

Respond at end of trial
No response feedback

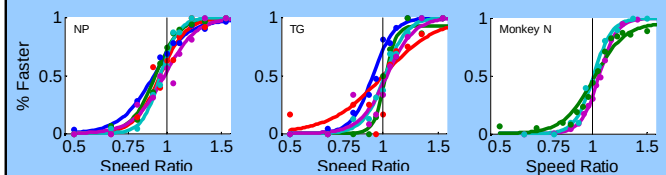


Reaction time tasks

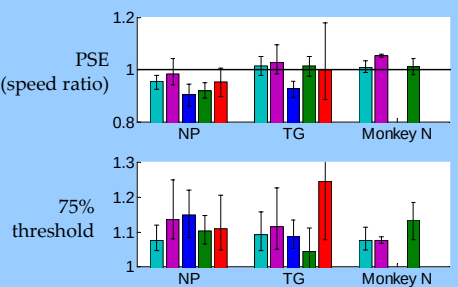
Reference: 0.5 + Exp(λ^{-1}=1) s
Test: Until response given (max 2 s)
Feedback for correct responses



Psychophysical performance



Across subjects, PSEs are close to 1 and thresholds / slopes do not systematically vary with task requirements.

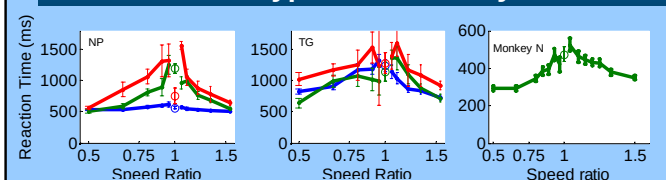


Task type

Fixed duration
Ref 8°/s
Ref 8 & 12 or 16°/s

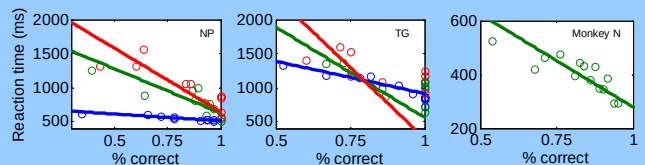
Reaction time
No reference
Ref 8°/s
Ref 8 & 12 or 16°/s

Reaction times change with task type and difficulty



Reaction times increase as speed ratio approaches 1. Reaction times are longer when the task requires a relative rather than an absolute judgment.

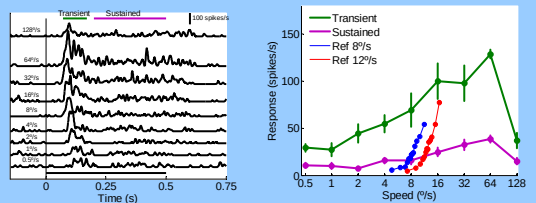
No reference
Ref 8°/s
Ref 8 & 16°/s



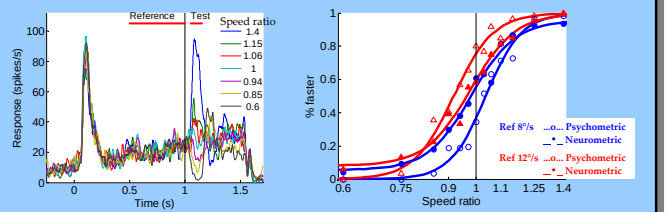
MT neurons show increased sensitivity after adaptation

Speed tuning during passive fixation was quantified using a 500 ms motion period preceded by a 500 ms period of stationary dot presentation. Transient and Sustained responses were averaged 0-100 and 150-500 ms after the cell's latent period.

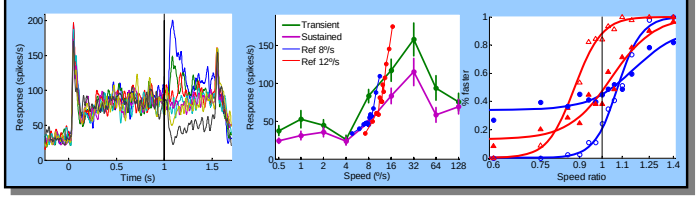
Cell 1



Speed tuning during the behavioral task was quantified in the test period, 50-150 ms after the speed change. Responses to the reference period were averaged over 500 ms prior to the speed change. Neurometric tuning was calculated using a ROC comparing responses before and after the speed change.



Cell 2



Conclusions

The strategy employed for discriminating speed changes affects reaction time but not psychophysical performance.

Speed tuning of area MT neurons is significantly changed by adaptation and shifts the neuron's peak sensitivity towards the adapting speed.

The speed sensitivity of subjects and individual MT neurons allows reliable detection and discrimination of speed changes as small as 10%, however, individual neurons are typically less sensitive than the animal as a whole.

This work was supported by an NHMRC CJ Martin Fellowship, Human Frontiers of Science Fellowship and NIH grant EY11379.