

Evidence for an objective time perception impairment and slower clock speed in mild depression.



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Time.....

- Flies when you're having fun, when you're late.....
- Drags when you're bored or miserable.....
- Depressed people often say that time seems to be passing slowly, dragging
- Why? Subjective bias or objective distortion?





Methods & previous findings

- **Subjective** - does time seem to pass slowly, rapidly, normally?
 - Consistent findings - depressed, time passes more slowly than normal
- **Objective** measures of duration
 - Verbal estimation (VE) & production estimation (PE)
 - Different durations tested - 1s to 60mins
 - Different duration content - relatively empty, filled with sorting, counting, tapping, driving, movie
 - Inconsistent findings - some studies find mood differences with some methods / durations / duration content, others don't



Two views

- Objective differences - basic processes underlying time perception function differently in depression
 - Internal clock running at a faster / slower pace than normal
- No objective differences, simply subjective distortion
 - Hawkins et al., (1988) - Ds evaluate painful quality of time passage subjectively
- But previous studies did not test same durations & same interval content using VE and PE tasks
- Exp 1: equate interval duration & content (relatively empty) across VE & PE tasks



Experiment 1 - tasks

- VE and PE estimates of 3, 5, 15, 25, 40 & 60s durations, filled with a tone

$$DV = \text{Ln} \left(\frac{\textit{estimated time}}{\textit{clock time}} \right)$$

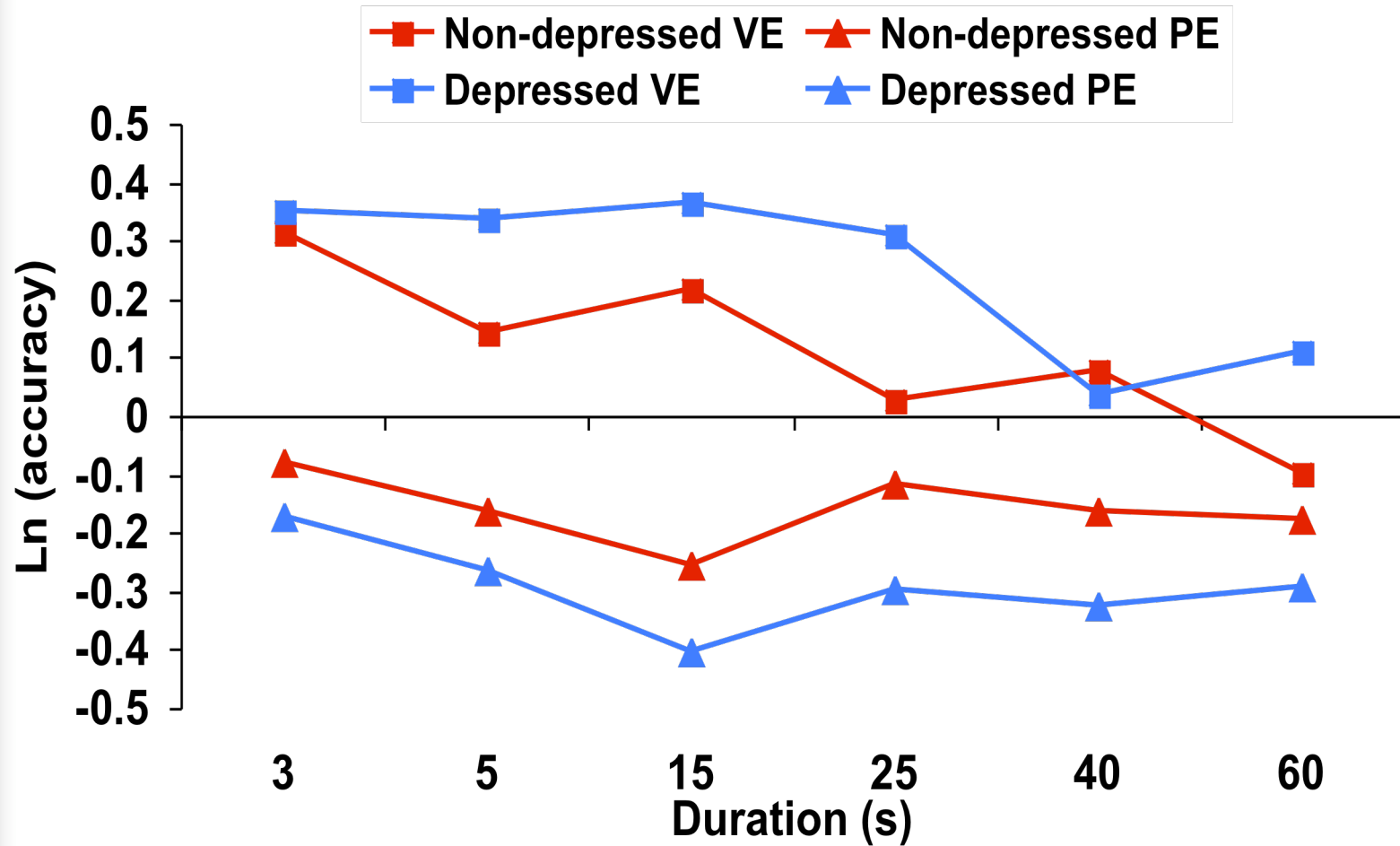
- Accurate = 0 values
- Overestimation > 0
- Underestimation < 0



Experiment 1

- Participants - students classified on basis of Beck Depression Inventory Scores (≤ 8 - non-depressed; ≥ 9 - depressed)
 - Depressed ($n=24$) and non-depressed ($n=28$)
 - BDI score

Depressed BDI = 15.58	} $p < .001$
Non-depressed BDI = 4.42	
 - Matched age, years of education, pre-morbid IQ (NART), digit span, not gender, most participants female



*Estimation method, $p=.028$; *Estimation method x Mood, $p=.05$

Non-depressed: Estimation method, *ns*.

Depressed: *Estimation method, $p=.015$

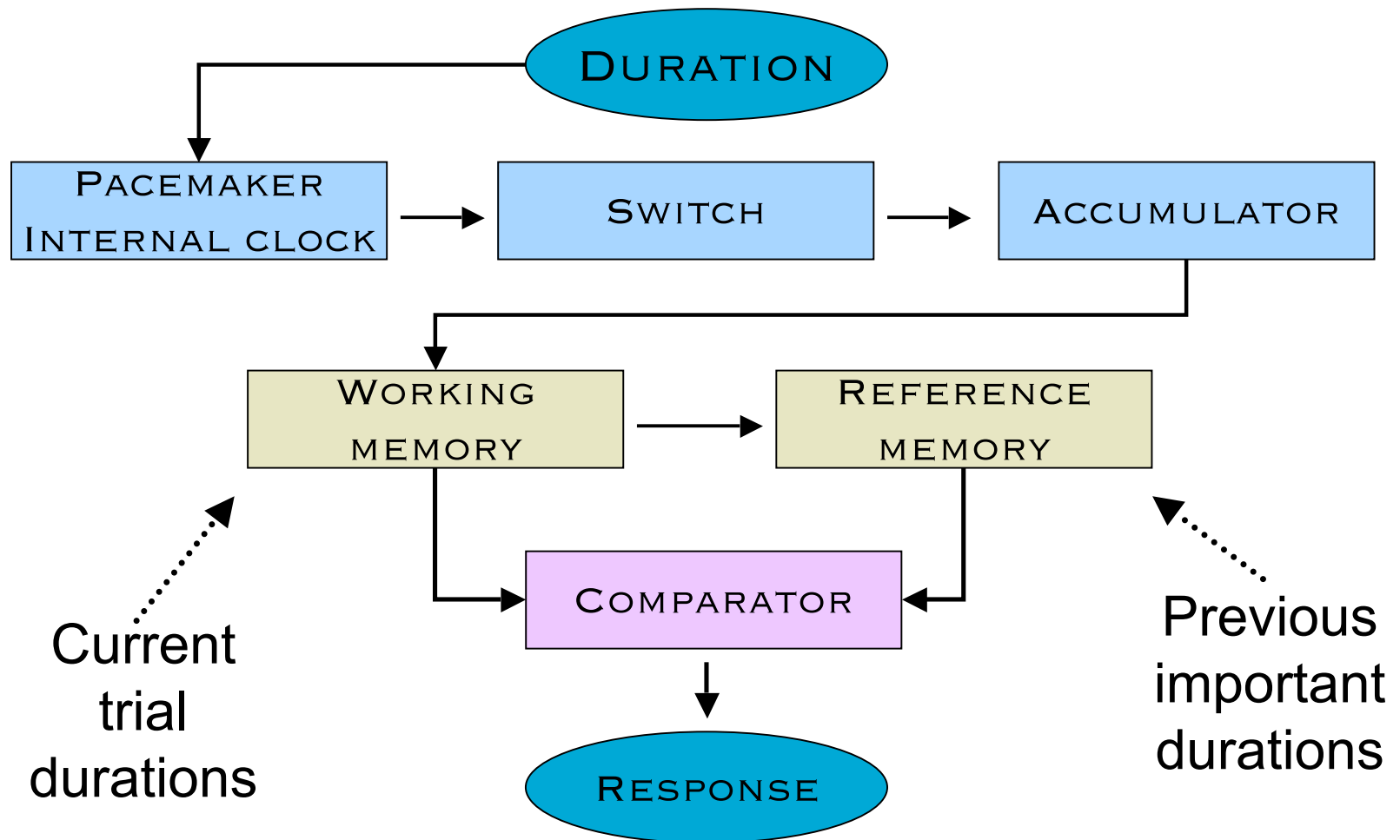
Comparing to zero: VE >0, $p=.008$; PE $**<0$, $p=.003$**



Experiment 1 findings

- Non-depressed people relatively accurate
- Evidence for an objective time perception distortion in depression
- Depressed people tend to:
 - **Overestimate** when asked to provide numeric labels for duration
 - **Underestimate** when asked to produce duration
 - Generally consistent with previous studies which have concluded mood effects

Theory of interval timing





Speeded clock in depression

Real time 10s

1	2	3	4	5	6	7	8	9	10
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Pulses of rapid clock during VE task

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
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*A speeded clock emits more than 10s worth of pulses during the 10s interval E.g., 10s judged as 17s - **VE overestimate***

Pulses of rapid clock during PE task

1	2	3	4	5	6	7	8	9	10
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*During production of 10s interval, speeded clock emits 10s worth of pulses in shorter period E.g., 10s produced in 6s - **PE underestimate***

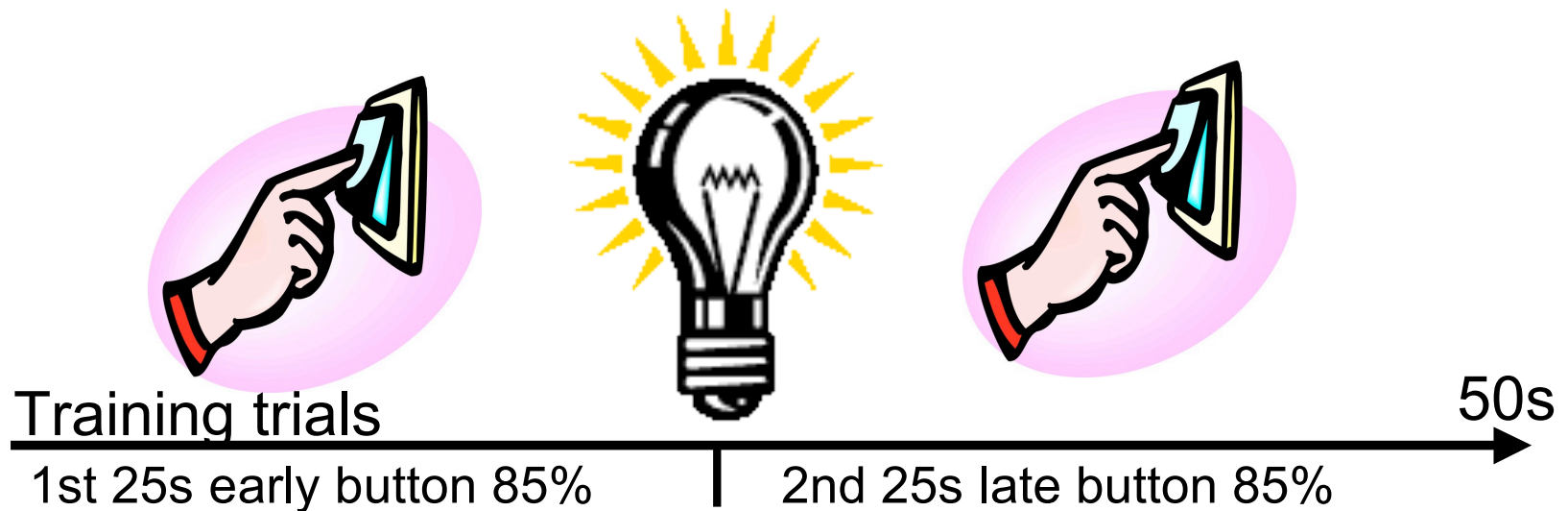


Problems

- Depressed VE & PE estimates consistent with rapid clock accounts
- BUT: do VE & PE estimates really reflect clock speed?
 - Numeric labelling of durations: bias, quantisation
 - Distortion of reference memory: memory for durations acquired outside experimental setting
- 2 further experiments designed to examine clock speed specifically

Behavioural measure of duration

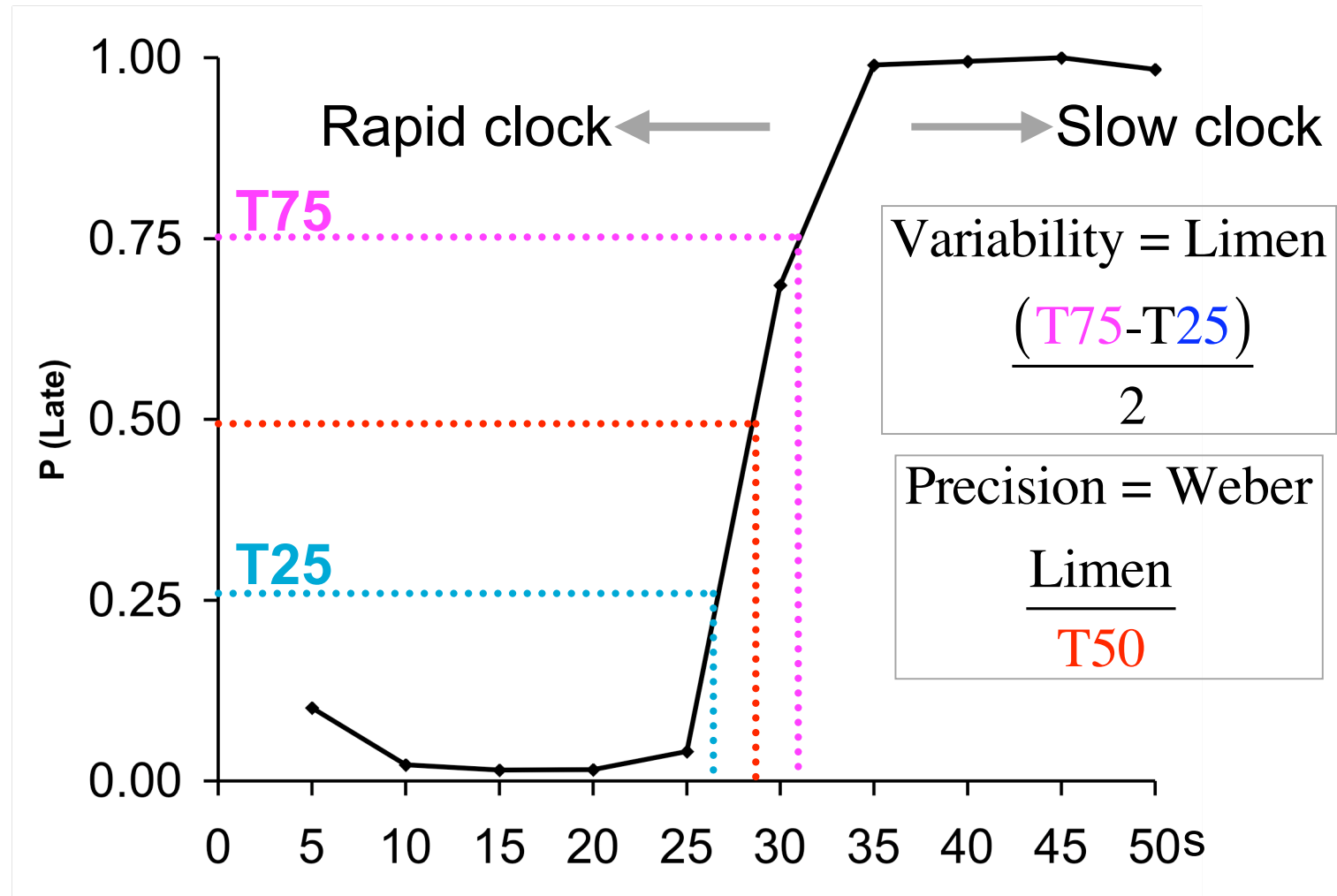
Free-operant psychophysical procedure - adapted for humans



Probe / test trials: light covered, but make light flash as many times as possible.

Subs must learn to switch from pressing early to late at 25s. The switching point (T50) is behavioural estimate of 25s interval.

Typical data



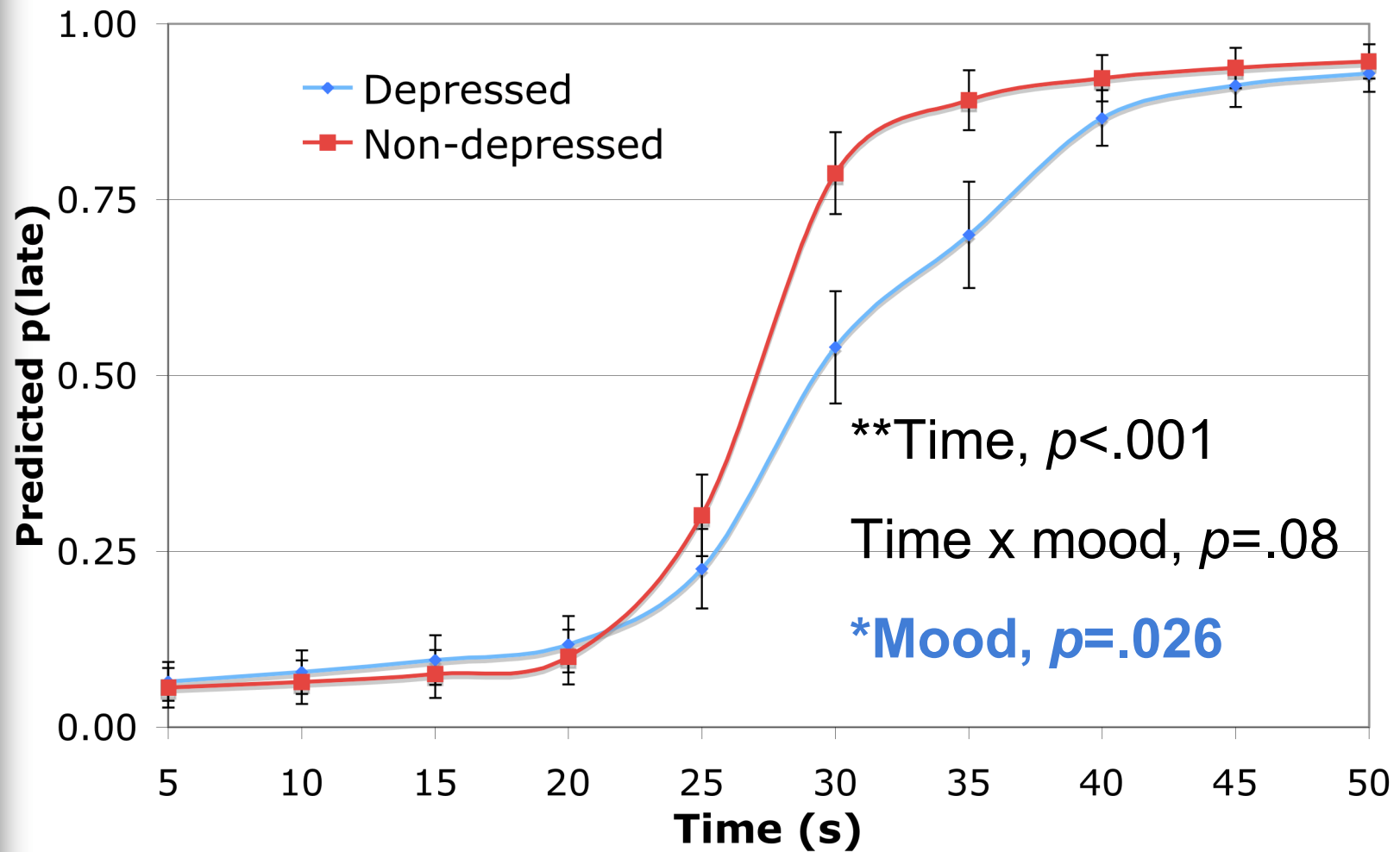
T50 - 25s behavioral est

**Parameters estimated using logistic function*



Experiment 2

- Initial sample: D = 24 and ND = 24 students (basis of BDI scores)
- 7 participants excluded (flatlines, always pressed early or always late) leaving: D = 20; ND = 21
- BDI scores - $p < .001$
 - Depressed = 14.6
 - Non-depressed = 4.38
- Matched education, pre-morbid IQ (NART), digit span, gender
- DV = probability of pressing late button at each time point or predicted probability (calculated using logistic regression) - no difference to overall results



Mean parameter estimates

	T25	T50*	T75	Limen	Weber	Slope
Depressed	21.771	29.656	37.545	7.887	0.721	1.140
Non-depressed	20.311	26.550	32.792	6.240	0.507	1.183

$p = .03$



Interpretation

- In the depressed group - shift to the right in the psychophysical function. Ds behavioural estimates of 25secs real time = 29.66secs. NDs = 26.55secs.
- Usually interpreted like PE task, producing 25sec interval - **over-estimate = slower clock**
- In task where numeric labelling is excluded, results suggest **slower** rather than faster clock in Ds
- But although numeric labelling is excluded in this task, reference memory stage is still present. So findings could be due to distorted reference duration representation



Time discrimination

- Two durations presented on same trial, both held in working memory. Which duration is the longer?

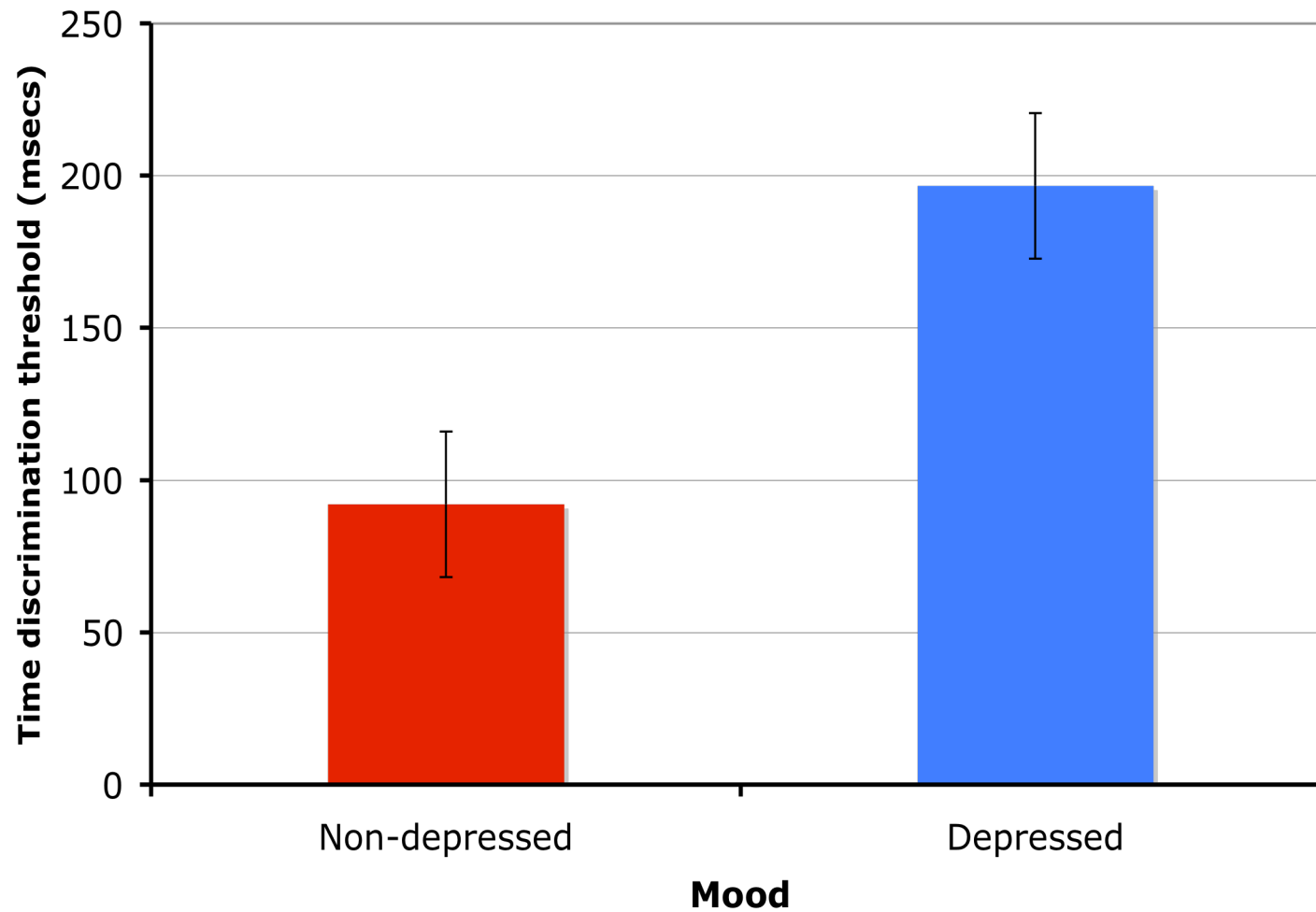


- 32 trials: Correct - difference reduced; Incorrect - difference increased. Calculate difference threshold.
- Faster clock = better discrimination performance, more finely tuned
- Slower clock = poorer discrimination performance



Experiment 3

- Participants: 12 non-depressed & 12 depressed students
- BDI scores: D = 17.92, ND = 4.08, $p < .001$
- Matched pre-morbid IQ (NART), digit, education, gender, Ds older $p = .006$



Threshold 104.5msecs higher in depressed group
****Mood, $p=.013$, $\text{Eta} = .27$**

Suggests that clock is **running slower** in depressed states

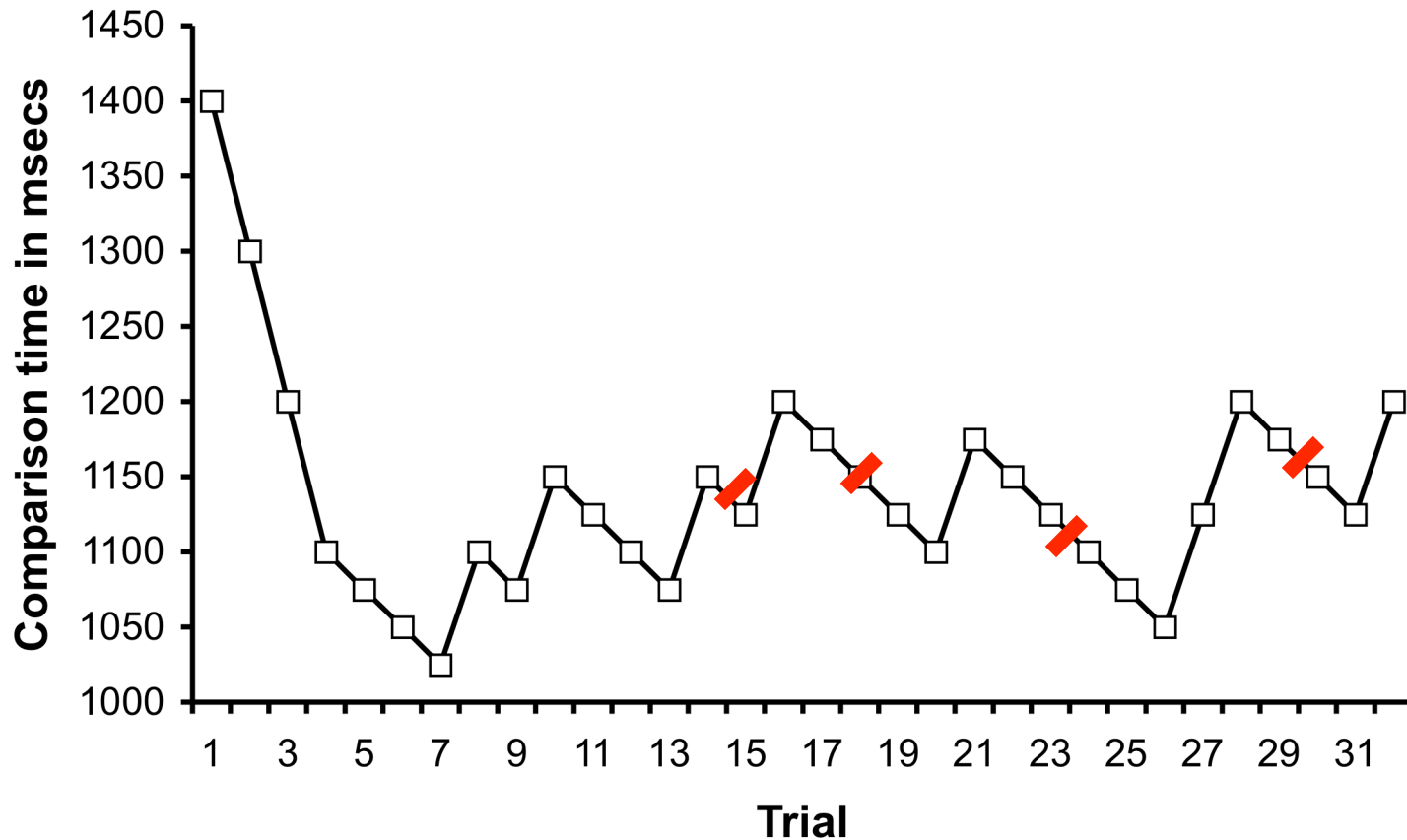


Summary

- On all tasks - evidence of objective mood related distortion of chronometric time
 - Ex1 - pattern of Ds verbal overestimation, production underestimation. **Consistent with rapid clock.** But problem of verbal labelling & role of reference memory
 - Ex2 - behavioural task, Ds production overestimation. **Consistent with slow clock.** No problem of labelling, but role of reference memory
 - Ex3 - discrimination task, Ds poorer discrimination performance. **Consistent with slow clock.**
- **Subjective slowness** in mildly depressed participants related to **slower** clock speed
 - Rethink use of VE & PE estimates as measure of clock speed

*Time doesn't fly when you're not
having fun....*





Trial 1 to 3 - incorrect +300, correct -100ms

Trials 4 to 32 - incorrect +75, correct -25ms

Produces 'runs' of correct & incorrect responses. Take mid-point of every 2nd run, last 20 trials.

DV = discrimination threshold (average of midpoints, 75% correct.)