MOOD AND TIME PERCEPTION: THUMBS UP FOR THE MILDLY DEPRESSED AND FOR ABSOLUTE SECONDS JUDGEMENT

Diana E Kornbrot[1], Rachel M Msetfi[2], Melvyn Grimwood[1]
1. University of Hertfordshire, 2. University of Limerick
d.e.kornbrot@herts.ac.uk

Abstract
Time perception and understanding the effects of mood state and attention are enduring psychophysical problems. In this study, the effect of mild depression was investigated. All participants performed four judgment tasks of time intervals ranging from 5 sec to 65 sec. The tasks could be absolute (in s) or made relative to an experienced interval. Each task had two judgment forms: estimation and production. Stevens power law exponents and relative under or over estimate bias were obtained for each individual in each condition. Mean power law exponents were close to unity and showed no effect of depression group, task or type of judgment. Relative judgment proved more difficult than absolute judgment. Intriguingly, there was a strong interaction between mood and bias. Non-depressed participants overestimated for the estimation task and underestimated for the judgment task. By contrast, the mildly depressed were accurate and showed no effect of judgment type.

It is well known that subjective time passes slowly for people who are in a depressed state. Evidence comes from general descriptions of what it feels like to be depressed, with people using phrases such as ‘time seems to drag’ although evidence from objective methods has been inconsistent and at times contradictory. More recent studies using standard psychophysical time estimation techniques have produced more consistent findings. Continuing this trend, we investigate the effect of mood state (normal, depressed) on psychophysical time estimation as a function of task type (absolute, relative) and judgment method (production, estimation). Psychophysical functions and measure of bias are obtained for individual participants from 5 durations (range 5 to 65sec), separately in each condition.

Psychophysical studies that regress ln (psychological time, τ) on ln (physical time, t) mostly find a slope (power law exponent) slightly less than 1, see (Allan, 1983; Eisler, 1976). By contrast, many (if not most) studies of the effect of non-time variables such as mood, concurrent task, meditation or drugs are usually content with raw time estimates as the main dependent variable, (Glicksohn, Ohana, Dotan, Goldstein, & Donchin, 2009; Grondin, 2010; Msetfi, Murphy, & Kornbrot, 2011 ; Msetfi, Murphy, Simpson, & Kornbrot, 2009; Wearden, 1991). Such studies often model time as an ordinal or even categorical variable and test models by looking for an interaction between physical time category and another variable, so that the metric effect of physical time is not explored. Here, we explore the metric effect of time explicitly. All analyses are conducted on both the raw untransformed *scale* of t and τ; and a natural log transformed scale of ln (t) and ln (τ). This enables us to estimate 6 parameters for each participant in each condition. Specifically, for each scale (ln, raw) we calculate the slope and intercept from regressing psychological on physical measures; and the mean bias over the 5 durations. The fit of the regressions, as measured by adjusted r^2, enable comparison of fit between scales. They also enable determination of differences in fit according to mood, task or judgment.

Systematic investigation of these 6 parameters addresses two kinds of issues with theoretical implications. The first issue is systematic bias. If people are unbiased, then mean values of slope will be unity and mean values intercept and bias will be zero. The second issue is differences among mood groups, tasks and judgments. If there are biases, then how they depend on other variables may discriminate among models. E.g. clock-based models imply a negative correlation between estimation and production bias parameters. An internal clock running fast will cause judgments to be too large for estimation and too small for production, as in scalar timing theory, refs. Because we have these 6 parameters for each participant it is possible to address all these issues at the individual as well as the group level.

Method

Participants

There were 46 participants, all psychology students fulfilling a course requirement. Mean age was 19.8 yrs., SD was 1.9 yrs., range 18 to 28 yrs.

Tasks and Design

All participants completed four conditions comprising two tasks (absolute, A, or relative, R) crossed with two judgment types (estimation, E, or production, P). In absolute tasks participants judged a single interval. For absolute production, they generated an interval specified by the experimenter in seconds; while for absolute estimation they gave a seconds estimate of an interval provided by the experimenter. For the relative task there were two intervals and participants were instructed to give the number 100 as standard to the duration of the 1st interval. For relative production, they were instructed to produce an interval with duration specified by the experimenter, assuming that the 1st interval had duration 100, (i.e. twice as long for the number 200). For estimation, they had to estimate the duration relative to 100 for the standard interval provided by the experimenter. There were 5 duration varying form 5 sec to 65 sec to be judged in each condition presented in random order (intervals varied slightly by condition to ensure no carryover between conditions and no anchor numbers such as 5, 20). In all conditions, participants were given a number at the start of each trial to be recalled at the end of the trial. This was intended to prevent using counting as a timing strategy. Participants were randomly allocated to one of four counterbalanced orders. The four time judgment tasks were programmed in Superlab 4.5 on a PC under windows XP.

Participants also completed a computerized version of the Beck Depression Inventory (BDI), and were categorized post hoc as *normal*, (BDI < 7, 21 participants; or *depressed*, (BDI ≥ 7), 18 participants. This criterion is consistent with mild dysphoria rather than depression.

Procedure

Participants were seated in front of a PC in a quiet experimental cubicle. They then read the general information sheet, signed the consent form, and then were given a verbal introduction explaining the 4 conditions. Each condition started with a screen presenting the relevant instructions. The participant reviewed the instructions and the experimenter checked their understanding. The participant initiated the first trial in a condition with any key. After each condition participants had a short break whilst the next condition was set up. The same procedure was performed for each of the four conditions. After the fourth condition, the experimenter initiated the computerized BDI mood survey. Finally, after completion of the BDI the participants was given a debriefing sheet that included information on counseling and other services for people who were feeling depressed.

Results

Preliminary Analyses

All inferential tests were at 95% confidence level and lower and upper 95% confidence levels follow parameters in parentheses. Ln scale psychophysical functions were obtained by regressing ln (τ) on ln (t). There were 3 depressed and 2 normal participants with an adjusted $r^2 < 0.90$ for at least one of the absolute conditions. These participants also had adjusted $r^2 < .90$ for at least one of the relative tasks. Consequently their data were excluded from all psychophysical function and bias analyses. There were a further 12 participants with had $r^2 < .90$ for at least one of the relative judgment tasks only, leaving only 26 participants who were clearly capable of magnitude estimation and production for all tasks. Hence, it was decided to perform psychophysical function and bias analyses only for the absolute tasks.

Task Difficulty

Much to our surprise the absolute seconds task, requiring long-term memory, appeared easier than the relative judgment task that required no such memory. 12 participants were successful in the absolute seconds task, but failed the relative task; while there were no participants who passed the relative but failed the absolute task. McNemar χ^2 (1) = 15.8, p = .00007 for the difference.

Timing Parameters

At the individual level, ANCOVAs were conducted for both the ln and raw scale for each participant for the psychophysical regression functions to determine if there were significant differences between production and estimation for either the slope or intercept. Similarly, independent t-tests were conducted on both ln and raw scales to determine whether the mean bias over the 5 durations differed between production and estimation. Hence for each individual we could determine for both the ln and raw scale: (a) direction, whether a parameter's deviation from the predicted value was positive or negative; and (b) significance, whether that difference from zero was significant at the 95% confidence level. For slope the predicted value for veridical time perception is 1 and for intercept and bias it is zero. We also estimated for each parameter and participant whether the estimated value was higher than the production value (direction), and whether that difference was significant. Figure 1 shows summary of means and proportions.

Effect of Mood and Judgment

In order to investigate group effects on means (left panel Fig 1), ANOVAs were conducted for all 6 parameters, with mood as a between factor and judgment as a repeated measure. As illustrated in Fig 1, there were no significant main effects. There were also no significant interactions for either ln or raw slopes. However, the interactions apparent in Fig 1.were significant for ln bias, F (1, 37) = 5.85 p = .021, $\eta^2 = .14$; for raw intercept, F (1, 37) = 54.26 p = .046, $\eta^2 = .10$; and for raw bias, F (1, 37) = 5.14 p = .029, $\eta^2 = .12$. The interaction fell just short of significance for ln intercept, F (1, 37) = 3.55, p = .067, $\eta^2 = .09$. (Note that the 95% confidence level bars are for between group comparisons and hence do not reflect the interaction which has a within group comparison for judgment). The results for the proportions in the different direction & significance categories were broadly similar, (right panel Fig 1). There were no effects of mood for any parameter, using Fisher's exact χ^2.

What might be termed a depressive realism effect is most dramatic for raw bias. Normals overestimate in estimation by 3.3 sec, range (-7.6, 27.4), and underestimate by 3.7 sec, range (-12.8, 8.6). By contrast, the depressed, estimation has mean -1.1 sec, range (-7.6, 13.4); production has mean 1.8 sec, range (-9.0, 38.6). (Fig 1. Left, bottom). Translating the values for ln bias back into % over or under estimates gives: normals estimation mean 10% over, range (35% under, 206% over), production mean 15% under, range (50% under, 159% over); depressed estimation mean 6% under, range (52% under, 32% over), production mean 3% over, range (27% under, 229% over). (Fig 1. Left 3rd panel down).

Comparison with Theoretical Predictions: Power Law Exponent

Across all participants and all judgments mean slope for the classic psychophysical function of ln (t) on ln (t) was .982 (.958, .994). This is significantly lower than 1, $p = .009$ and similar to values. Values of mean slope were less than 1 for each mood group separately and each judgment group. The mean slope for estimation across groups = .978 with a p-value of 0.09. For estimation, there were 28/39 participants with slopes less than 1, Fisher's exact $p = .009$. However there was no difference for production with 20/39 participants having slopes < 1.

Thus this study, consistent with other *recent* work. (Glicksohn, et al., 2009) shows an exponent (very) slightly below 1. It is noteworthy that up to a third of people have an exponent > 1. Comprehensive studies in the 80s give a mean exponent considerably lower, under .8 (Allan, 1983). The classic much cited study (Stevens & Galanter, 1957) gives an exponent of 1.1, but this was not based on individual functions. (This dubious value of 1.1 is in Wikipaedia and in any text that covers Steven's law, - hard to find these days). The results for duration can be contrasted with other modalities, e.g. utility or loudness, where although there is a wide range of individual exponents, it is very rare to find exponents greater than 1.

Comparison with Theoretical Predictions: Bias and Consistency

Thus normals tend to overestimate in estimation and underestimate on production, although mean deviations from zero are not significant. Depressed means are near zero. The distribution of individual results shows a particularly interesting pattern. There is no statistically reliable effect of asymmetry, i.e. the number of people overestimating is not significantly different from 0.5 for any mood or judgment group, using Fisher's exact test. So one might expect very few individual bias parameters significantly different from zero at the 95% confidence level, i.e. mean expected frequency of significant results is 1 overestimate and 1 underestimate for the 39 participants. For ln bias, normals have 11/21(3 under, 8 over) significant results for estimation and 13/21 for production (11 under, 2 over); while depressed have 8/18 for estimation (5 under, 3 over) and 8/18 (4 under, 4 over) for production. The point probability for all these results is under .000005. Results for raw bias show a similar pattern: normals have 10/21(2 under, 8 over) significant results for estimation and 1/21 for production (under); while depressed have 4/18 for estimation (2 under, 2 over) and also have 1/18 (under) for production. The differences for chance are highly significant for estimation with all $p < .009$, but do not approach significance for production.

The important conclusion is that many individuals are highly consistent in their judgements, hence the high number of significant individual results. However, the groupmean and frequency asymmetry is not significant because there are similar numbers who have significant differences in opposite directions.

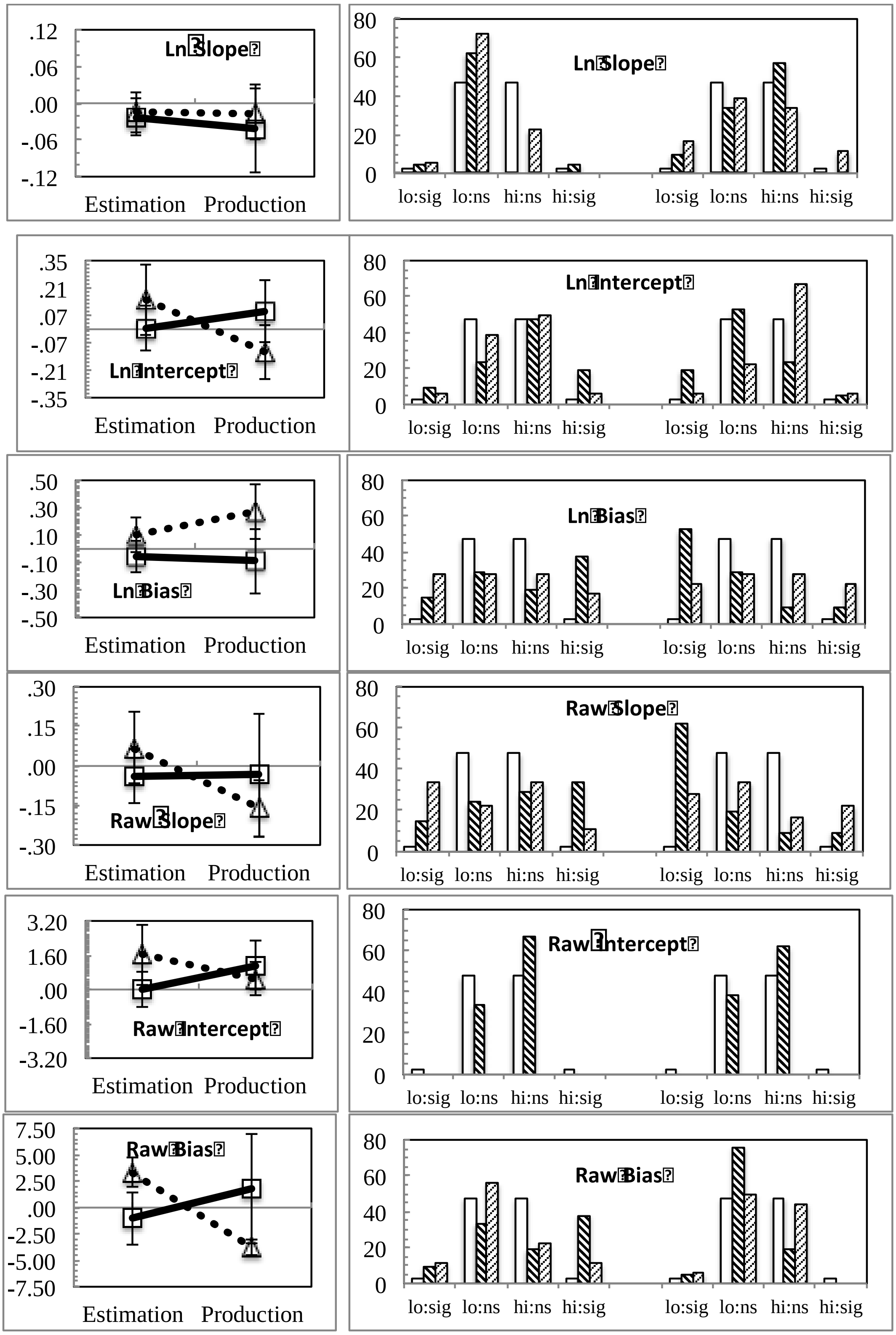

Figure 1. Group summary by mood & judgment. Left means: dashed normal, solid depressed. Right %: left estimation, right production: no fill theory, dark fill normal, light fill depressed.

Clock models, e.g. (Allan, 1998; Wearden, 1991) predict a negative correlation between estimation and production. Consistent with these models, we found a significant *negative* correlation between estimation and production values for all parameters.

Correlations were as follows (all $p < .001$ except for raw intercept): ln slope -.51, ln intercept -.64, ln bias -.79; raw slope -.65, raw intercept -.06, raw bias -.68. As with other studies, there was a negative correlation between slope and intercept: estimation -.62, production -.64. (Correlations and frequencies were similar for both mood groups and hence combined here). These results were supported by the frequency analyses, where the proportion with estimation and production in *opposite* directions was consistently greater than 0.5. Frequencies of opposite estimation and production parameters and associated Fisher's exact χ^2 probabilities were: ln slope 25/39, p = .108; ln intercept 27/39, p = .024; ln bias 29/39 p = .002; raw slope 30/39 p = .001; raw intercept 18/39, p = .631; raw bias 30/39, p = .001.

Summary and Highlights

- Absolute judgement in seconds is *easier* than judgement relative to an immediately preceding interval. No other dimension we know of has this feature.
- Depressive realism is a feature of time estimation as well as other cognitive tasks.
- Mean power law exponent for time is *just* under 1, but 1/ 3 people have exponents > 1.
- Individual behaviour is highly consistent. Lack of group effects is due to there being roughly equal numbers with consistent parameters in opposite directions. It is not due to all participants having individual parameter values near zero.
- Clock models are supported to the extent that parameters in estimation conditions are negatively correlated with those in production conditions.

References

Allan, L. (1983). Magnitude estimation of temporal intervals. *Attention, Perception, & Psychophysics, 33*(1), 29-42. doi: 10.3758/bf03205863

Allan, L. (1998). The influence of the scalar timing model on human timing research. *Behavioural Processes, 44*(2), 101-117.

Eisler, H. (1976). Experiments on subjective duration 1868-1975: A collection of power function exponents. . *Psychological Bulletin, 83*(6), 1154-1171.

Glicksohn, J., Ohana, A. B., Dotan, T. B., Goldstein, A., & Donchin, O. (2009). Time production and EEG alpha revisited. *NeuroQuantology, 7*(1), 138-151.

Grondin, S. (2010). Timing and time perception: A review of recent behavioral and neuroscience findings and theoretical directions. *Attention, Perception, & Psychophysics, 72*(3), 561-582. doi: 10.3758/APP.72.3.561

Msetfi, R. M., Murphy, R. A., & Kornbrot, D. E. (2011). The Effect of Mild Depression on Time Discrimination. [Article]. *The Quarterly Journal of Experimental Psychology, in press*, 653-662.

Msetfi, R. M., Murphy, R. A., Simpson, J., & Kornbrot, D. E. (2009). Impaired context maintenance in mild to moderately depressed students. [Article]. *The Quarterly Journal of Experimental Psychology, 62*(4), 653-662. doi: http://dx.doi.org/10.1080/17470210802486092

Stevens, S. S., & Galanter, E. H. (1957). Ratio scales and category scales for a dozen perceptual continua. *Journal of Experimental Psychology, 54*, 377-411.

Wearden, J. H. (1991). Do humans possess an internal clock with scalar timing properties. *Learning and Motivation, 22*(1-2), 59-83. doi: 10.1016/0023-9690(91)90017-3