REPLY: Regression coefficient values

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The raw data collected in the studies from the cited papers (published in 2000, 2004, 2005, and 2010) are unfortunately no longer available. However, I am able to respond to the specific question relating to the comment on the high linear regression coefficients (R). In the graphs that show individual markers, the markers represent individual data points, and the regression coefficients were computed using them as single measurements. In the graphs that include standard deviations, the regression coefficients were computed by using only the mean value of the ordinate for each (independent) value of the abscissa. This is the reason for the rather high values the computed regression coefficients.

I have checked the reported values of the linear regression coefficients by manually digitizing the data points in the published figures, and using two different methods to compute the coefficients and the linear regression equations. The results (shown in detail in the Appendix below) are in very good agreement with the published values. To the best of my knowledge, there are no errors in the calculation of the regression coefficients. However, my calculation checks suggest that the R values reported in Tautz et al. (2004) are actually R^2 values, as detailed in the Appendix. Apologies for this probable typographical error.

There are, of course, some inevitable minor discrepancies arising from errors in the manual digitization process. In the case of Fig. 2 in Srinivasan et al. (2000) and Fig. 1b in Zhang et.al. (2005) manual digitization was not necessary as the data are supplied in Table 1 (Srinivasan et al. (2000)) and in the inset of Fig. 2b (Zhang et.al. (2005), respectively.

I do not know if the editors of JEB have been able to contact the other authors on these papers (some of whom were primarily responsible for the statistical analysis of the data in some of the papers). The email addresses that I have for them are now obsolete.

APPENDIX

For all the papers, the published values of the coefficients of linear regression, R, and the linear regression equations were checked by repeating the calculations after manually digitizing the points in the graphs of a few sample figures.

In each case, R was computed using two methods:

(a) From the Pearson's correlation coefficient, using the coordinates of the n points on the graph (x_i, y_i) $(i = 1,2, \dots n)$:

$$R = \frac{I_{XY}}{I_{XX} I_{YY}} \qquad (1)$$

where $I_{XY} = \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$, $I_{XX} = \sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}$, $I_{YY} = \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}$,

$\bar{x} = \left(\frac{1}{n}\right)\sum_{i=1}^{n} x_i$, and $\bar{y} = \left(\frac{1}{n}\right)\sum_{i=1}^{n} y_i$.

(b) From Matlab's linear regression fitting model routine 'fitlm'.

The linear regression equation was computed using

(c) Matlab's polynomial fitting function 'polyfit' for a first-order fit; and
(d) Matlab's linear regression fitting model routine 'fitlm'.

Evangelista et al. 2010

Evangelista, C., Kraft, P., Dacke, M., Reinhard, J. and Srinivasan, M.V., 2010. The moment before touchdown: landing manoeuvres of the honeybee Apis mellifera. *Journal of Experimental Biology*, *213*(2), pp.262-270.

Fig. 5

Body-platform angle versus platform tilt (filled circles, 17 manually digitized points):

Published results:
R^2= 0.99; → R= 0.995. Regression equation: Body-platform angle = 0.82*tilt -11.49

Check of calculations:

From equn (1): R=0.996.

From Matlab polynomial fit model (for first-order fit):
Regression equation: Body-platform angle = 0.82*tilt -11.93

From Matlab linear regression model (ML):
R^2= 0.985; → R= 0.992.
Regression equation: Body-platform angle= 0.82*tilt -11.93

Body-horizontal angle versus platform tilt (open circles, 18 manually digitized points):

Published results:
R^2= 0.92; → R= 0.96. Regression equation: Body-horizontal angle = 0.16*tilt -13.74

Check of calculations:

From equn (1): R=0.96.

From Matlab polynomial fit model (for first-order fit):
Regression equation: Body-horizontal angle= 0.16*tilt -13.34

From Matlab linear regression model (LM):
R^2= 0.92; → R= 0.96.
Regression equation: Body-horizontal angle= 0.16*tilt -13.34

Srinivasan et al. 2000a

Srinivasan, M.V., Zhang, S., Altwein, M. and Tautz, J., 2000a. Honeybee navigation: nature and calibration of the" odometer". *Science*, 287(5454), pp.851-853.

Fig. 2 (8 points, tabulated in Table 1):

Published results:
R=0.998. Regression equation: Tau=95.91 + 1.88*d

Check of calculations:

From equation (1): R= 0.998.

From Matlab polynomial fit model (for first-order fit):
Regression equation: Tau=95.96 + 1.88*d

From Matlab linear regression model (LM):
R^2= 0.997; → R= 0.998.
Regression equation: Tau= 95.96+1.88*d

Srinivasan et al. 2000b

Srinivasan, M.V., Zhang, S.W., Chahl, J.S., Barth, E. and Venkatesh, S., 2000b. How honeybees make grazing landings on flat surfaces. *Biological Cybernetics*, 83, pp.171-183.

Fig. 6a (land01): 14 manually digitized points

Published results:
R=0.14. Regression equation: Vd=0.82*h +14.80

Check of calculations:

From equation (1): R= 0.14.

From Matlab polynomial fit model (for first-order fit):
Regression equation: Vd=0.81*h + 14.81

From Matlab linear regression model (LM):
R^2= 0.0198; → R= 0.14.
Regression equation: Vd=0.81*h + 14.81

Fig. 6d (land17): 11 manually digitised points

Published results:
R=0.94. Regression equation: Vd=5.61*h -9.42

Check of calculations:

From equation (1): R= 0.94.
From Matlab polynomial fit model (for first-order fit):
Regression equation: Vd=5.59*h -9.12

From Matlab linear regression model (LM):
R^2= 0.887; → R= 0.94.
Regression equation: Vd=5.59*h - 9.12

Zhang et al. 2005

Zhang, S., Bock, F., Si, A., Tautz, J. and Srinivasan, M.V., 2005. Visual working memory in decision making by honey bees. *Proceedings of the National Academy of Sciences*, 102(14), pp.5250-5255

Fig. 1b (8 points, tabulated in figure inset)

Published results:
R^2= 0.985; → R= 0.99. Regression equation: t=0.018*X_d + 0.421

Check of calculations:

From equation (1): R= 0.99.

From Matlab polynomial fit model (for first-order fit):
Regression equation: t=0.018*X_d + 0.420

From Matlab linear regression model (LM):
R^2= 0.985; → R= 0.99.
Regression equation: t=0.018*X_d + 0.420

Tautz et al. 2004

Tautz, J., Zhang, S., Spaethe, J., Brockmann, A., Si, A. and Srinivasan, M., 2004. Honeybee odometry: performance in varying natural terrain. *PLoS Biology*, *2*(7), p.e211.

Fig. 2a: 16 manually digitized points

Published results:
R=0.9613. Regression equation: Y=1.303*X +202.4

Check of calculations:

From equation (1): R= 0.9804 → R^2= 0.9612.

From Matlab polynomial fit model (for first-order fit):
Regression equation: Y=1.296*X +219.0

From Matlab linear regression model (LM):
R^2= 0.961; → R= 0.9803.
Regression equation: Y=1.296*X +219.0

Fig. 3a: 16 manually digitized points

Published results:
R=0.9770. Regression equation: Y=1.431*X +168.6

Check of calculations:

From equation (1): R= 0.9888 → R^2= 0.978.

From Matlab polynomial fit model (for first-order fit):
Regression equation: Y=1.446*X +174.1

From Matlab linear regression model (LM):
R^2= 0.978; → R= 0.989
Regression equation: Y=1.446*X +174.1

In this paper, it appears that the values reported as ‘R’ are actually the values of R^2.
Apologies for this typographical error.