Baseball teams beaten by jet lag

SIR — Rapid travel across multiple time zones can lead to a constellation of symptoms known as 'jet lag'[1,2]. The severity of jet lag and the number of days required for full recovery depend on the number of time zones crossed and the direction of flight, with faster readjustment after westward than eastward flights. Although jet lag has been investigated in laboratory and field studies of individuals, its economic and social consequences in natural society have been difficult to analyse. Competitive athletics may provide a unique experiment for this purpose. An eastward flight across six time zones diminishes strength and endurance[3], and there are a few anecdotal reports that ascribe poor performance in athletic competitions to jet lag[4,5]. It has not, however, been possible to separate the deleterious effects of jet lag from those due to the stress and fatigue of the flight itself or to the necessity of competing in an unfamiliar environment. Games lost by a travelling team tend to be attributed to the opponent's 'home field' advantage.

To control for these variables and to gauge the possible effects of jet lag in professional athletics, we have studied the last three complete season records (1991–93) of the 19 North American major league baseball teams based in cities of the Eastern and Pacific time zones. We chose baseball because of the necessity for repeated road trips of about two weeks in length requiring air travel over three time zones, and the fact that only one or two days (at most) separate pre- and post-travel games. In baseball, the large number of games per season, somewhat repetitive activities in each game, and meticulous record-keeping all tend to make long-term effects more easily discernible. As these 19 teams won more of their 1991–93 games when playing at home than away (54% against 46%; $P<0.0001$; χ^2), we investigated whether this home-field advantage was further influenced by transcontinental travel.

Schedules and box scores were obtained for the 1991–93 seasons from the American and National League Box Scores and Official Averages. For the target teams, statistical data were collected for the two games immediately before and after each transcontinental trip. The first two post-travel games were used because of the conventional rule of thumb that resynchronization of jet lag requires about one day for each time zone passed. Transcontinental trips interrupted by play in cities of the Central time zone were not included. For the three-year span, the overall winning percentages of the eastern and western teams were no different (50% and 49%, respectively). The home team won 56% of the games we studied, but the probability of winning depended on whether the visiting team had just travelled eastward (Table 1). Further analysis of the influence of various factors on game outcome (Table 2) showed that the home team could expect to score 1.24 more runs than usual when the visitor had just completed eastward travel ($P = 0.006$). Home teams also scored 0.62 more runs during the day than the night ($P = 0.03$). No other factors were significant.

TABLE 1 Home team winning percentage depends on the direction of visitor's transcontinental travel

Visitor's direction of travel	No. of games	Games won	Winning %
No travel	712	385	54.1
East→west	194	109	56.2
West→east	175	110	62.9
Totals	1,081	604	55.9

TABLE 2 Linear regression analysis of runs scored

Variable	Parameter estimate	Standard error	*P* value
Intercept	1.31	0.80	0.10
National or American League	0.03	0.25	0.90
Month	*	*	0.35
Night game	−0.62	0.28	0.03
Coast:			
Home team	−0.13	0.34	0.71
Visitor	−0.15	0.23	0.51
Home team's travel:			
East→west	0.07	0.40	0.87
West→east	0.17	0.40	0.68
Visiting team's travel:			
East→west	0.66	0.40	0.10
West→east	1.24	0.45	0.006
End of visitor's road trip	0.03	0.95	0.47

Game outcome was defined as the difference between the runs scored by the home team and the runs scored by the visiting team. This was modelled by linear regression using the predictors shown. The parameter estimates in the linear regression have a direct interpretation as the number of runs scored. A logistic regression analysis using the binary outcome "win or lose" confirmed the results assigning significance at $P<0.05$. Exploratory analyses of interactions among these factors showed no additional significant predictors of runs scored.

*Month of play (April to September) has 6 categories and becomes 5 binary variables in the regression model. Hence, this factor does not have a single regression coefficient.

Many factors undoubtedly contribute to winning baseball games, but our data indicate that one critical, previously unrecognized component of the 'home field' advantage of east and west coast baseball teams involves previous transcontinental travel by the visiting team within the preceding two days, but only if the direction of travel is eastward. This effect cannot be attributed to the stress and fatigue of either high-altitude flight or prolonged stays away from home, because home-field advantage is not enhanced after westward travel or at the end of road trips. The dramatic directional dependence is consistent with previous studies of jet lag, in which greater eastbound effects seem to be independent of relative flight orientation (homeward/outgoing) or time of flight departure (day/night)[6]. Whether due to jet lag or some other aetiology, our findings are of practical importance for the west coast teams, because only they face the double handicap of playing their away games after eastward trips. The result is that these teams are giving up more than one additional run in every game played after such travel.

While the performance decrements described here might seem small in magnitude, their consequences for competitive athletics are substantial. For west coast baseball teams, the games we studied represent less than 5% of their entire season; yet, in 1991 and 1993 the National League Western division races were lost by west coast teams to their eastern rivals by only one game.

Lawrence D. Recht*
Robert A. Lew†
William J. Schwartz*
**Department of Neurology, University of Massachusetts Medical School, Worcester, Massachusetts 01655, USA*
†Multipurpose Arthritis & Musculoskeletal Diseases Center, Department of Rheumatology and Immunology, Brigham and Women's Hospital, Boston, Massachusetts 02115, USA

1. Winget, C. M., DeRoshia, C. W., Markley, C. L. & Holley, D. C. *Aviat. Space envir. Med.* **55**, 1085–1096 (1984).
2. Comperatore, C. A. & Krueger, G. P. *Occupational Medicine: State of the Art Review* Vol. 5, 323–341 (1990).
3. Wright, J. E. *et al. Aviat. Space envir. Med.* **54**, 132–137 (1983).
4. Sasaki, T. in *Chronobiology: Principles and Applications to Shifts in Schedules* (eds Scheving, L. E. & Halberg, F.) 417–431 (Sijthoff & Noordhoff, Alphen aan den Rijn, Netherlands, 1980).
5. Antal, L. C. *Br. J. Sports Med.* **9**, 9–12 (1975).
6. Klein, K. E., Wegmann, H. M. & Hunt, B. I. *Aerospace Med.* **43**, 119–132 (1972).

Scientific Correspondence

Scientific Correspondence is intended to provide a forum in which readers may raise points of a scientific character. Priority will be given to letters of fewer than 500 words and five references.