The Influence of Bed Partners on Movement During Sleep

F. P. Pankhurst and J. A. Horne

Sleep Research Laboratory, Loughborough University, Leicestershire, U.K.

Summary: Two related studies are reported. Both involved the use of wrist actimetry and morning sleep logs in subjects 23-67 years of age. In the first study, 46 pairs of bed partners were monitored for 8 nights to assess the extent and concordance of their body movements, and whether the latter exhibited age and gender differences. The second study concentrated on the presence or absence of a bed partner, and included subjects who either habitually slept alone or whose usual partner was absent for at least 1 night. Men showed a significantly greater number of discrete movements during sleep than did women. Overall, 5-6% of all 30-second sleep epochs contained such movements, with about 1/2 of these movements being common (within the same epoch) to both partners. This concordance was highest in younger couples. Female bed partners reported being disturbed more often by their partner than was the case for male partners. Subjects sleeping with a partner showed a greater number of discrete movements than matched subjects who slept alone. Movements decreased during temporary absence of the usual bed partner. Couples seemed unaware of the similarity in the timing of their movements during sleep, and most reported sleeping better when their bed partner was present. Key Words: Actimetry—Sleep disturbance—Body movements—Bed partners—Gender differences.

Little research has been conducted into the effects bed partners have on sleep. The best known study, by Monroe (1), examined the effects on the sleep electroencephalogram (EEG) when the usual sleeping arrangements for 28 married (for > 12 months) good sleepers (aged 21-25 years) were changed. They slept for 3 consecutive nights in the laboratory. The first night was for adaptation, and the other two nights were randomized for sleep-with-spouse and sleep-alone. During the latter, both partners averaged 20 minutes extra stage 4 sleep, 16 minutes less stage REM sleep and fewer awakenings. All these findings were significant. Women had significantly more total sleep for all conditions. Subjective estimates of sleep quality did not differ between the conditions. Monroe concluded that sleeping alone gave better sleep.

Aaronson et al. (2) used time-lapse photography to monitor a couple (44 and 46 years of age) sleeping at home for 7 nights. Sixty percent of the man's movements were matched by the woman, and 70% of the woman's movements were matched by the man. Using similar recording methods, these authors (3) reported earlier on the effects of a pet sleeping on a bed with its owner. There was a marked amount of movement synchrony during the first part of the night.

There is a growing body of literature on the application of actimetry to sleep, which has been reviewed elsewhere (cf. reference 4). Actimeters provide an attractive method for examining the association of body movements between bed partners during sleep. We were able to do this as part of a larger study (4) that monitored 15 nights of home sleep in 400 people (20-70 years) living near U.K. airports. It appeared from objective (actimetry) and subjective (sleep log) findings that even for airports having a relatively large number of flights at night (most were not very loud) the effect of aircraft noise on sleep was minor (4), and very little of our data were affected by sleep disturbance due to aircraft noise.

Here we report the results of two studies. The first, the more substantial of the two, concerned the monitoring of sleep in 46 pairs of bed partners to assess the extent and concordance of body movements between them, and to see whether there were gender and age differences in this respect. The second study used other subjects from the main study (4) and looked both at subjects who habitually slept alone and subjects who usually slept with a partner, but whose partner was absent for at least 1 night out of the 15 nights monitored.


**METHODS**

**Subjects**

Subjects lived near one of four major U.K. airports (Heathrow, Gatwick, Stansted and Manchester) and had been living in their homes for at least 1 month. Subject selection for the main study is detailed elsewhere (4). In brief, at each of two sites per airport interviewers knocked on doors and continued interviewing until a quota of 200 was obtained. Interviewees were informed that this was a Government survey into living conditions, and one member per household was interviewed. The sample reflected the age and gender distribution of the local populations, based on the latest U.K. census data (i.e. about equal numbers of men and women, evenly distributed across the three age ranges: 20–34, 35–49 and 50–70 years). They were invited to be interviewed further about their sleep habits, and 614 agreed. Subjects on hypnotics (4.4% of our sample) or those who suffered from pain that seriously disrupted sleep were excluded. Poor sleepers not on hypnotics were included. During this interview subjects were asked to volunteer for a major study on sleep habits. Of the 447 who agreed, 400 were selected randomly. At four of the sites, subjects who always slept in the same bed as their partner were asked if the partner would take part as well. If so, the latter was also interviewed, and the same selection criteria were applied. Twelve bed partners for each of these four sites were chosen, making 46 couples in all (two couples dropped out). All subjects were paid £5 (about U.S. $8) per actimeter night. The couples were 23–67 years of age (see Table 1); each slept together in either a double (84%) or king-size (16%) bed. Eighty percent had slept together in the same bed for > 5 years, 17% for between 1 and 5 years.

**Actimetry**

The “Swiss-type” actimeters (Gaehwiler Electronics, Hombrechtikon, Switzerland) were used. These react to accelerations >0.1 g and are unresponsive to normal passive movements of the bed caused by movement of a bed partner. Actimeters were set for 30-second epochs and synchronized to within ±5 seconds of each other. Actigrams (the sequential accumulations of movements per 30 seconds) were read into a com-

---

**TABLE 1. Distribution of bed partners by age and gender.**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–34 years</td>
<td>11 (23.9)</td>
<td>16 (34.8)</td>
<td>27 (29.3)</td>
</tr>
<tr>
<td>35–49 years</td>
<td>18 (39.1)</td>
<td>17 (37.0)</td>
<td>35 (38.0)</td>
</tr>
<tr>
<td>50–70 years</td>
<td>17 (37.0)</td>
<td>13 (28.3)</td>
<td>30 (32.6)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>46</td>
<td>46</td>
<td>92</td>
</tr>
</tbody>
</table>

---

**FIG. 1.** Raw actigrams for three sets of bed partners for the time window 2230–0730 hours. Diamond markers at the beginning and end of each trace indicate go-to-bed and wake-up times, respectively (taken from sleep logs). Markers outside the actigram time window are correctly placed timewise, even though the actigrams are absent.
FIG. 2. Same data as for Fig. 1, but with actigrams filtered for the onset of movements (actiblips); the vertical lines are actiblips. Diamond markers at the beginning of each trace are the estimated sleep onset based on the sleep-onset algorithm. Diamond markers at end of each trace are the wake-up times taken from the sleep logs. Note that each trace is up to 1,080 epochs wide and is much compressed laterally. What appear to be thicker actiblips are actually closely packed single actiblips.

Morning sleep logs and other questionnaires

Each morning after awakening, subjects completed a sleep log requesting the following information: times of going to bed, lights out, falling asleep, final waking and getting up; number of awakenings during the night (with details of the time of awakening, length of time awake and reason for awakening); partner present or absent; sleep quality; and level of feeling refreshed. After the study all subjects were debriefed and asked about sleep quality and quantity during the study period. They were also asked whether they slept better with or without their partners.

STUDY 1—BOTH PARTNERS MONITORED

Data analyses

Eight consecutive nights of actimetry were obtained from each couple. Of the 368 possible pairs of actimetry data nights, 355 (96.5%) were successfully recorded. Data lost were caused solely by subject non-compliance. Actigrams were actiblipped as described (see Actimetry above). Computer batch files then were calculated as 1) actiblip hit rate between the couples, determined as $\sqrt{xy}$, where $x =$ proportion of female
Bed partners and body movement in sleep

Actigraphic hit-rate for movement onset between bed-partners by epoch match.

**Fig. 3.** Actigraph hit rates (with standard error bars) between bed partners giving matches: (Ep to -1 Ep) = epoch in one partner against the previous epoch for the other partner; (Ep to Ep) = direct epoch to epoch match for both partners; (Ep to +1 Ep) = epoch in one partner against subsequent epoch for the other partner; (Ep to Ep ± 1 Ep) = epoch for one partner against previous, same and subsequent epochs for other partner.

Results

**Hit rates for discrete movements**

The mean incidence of an occurrence of an actigraph for any epoch was 0.06 (i.e. 6%). The values for men and women partners were 0.065 (SD = 0.019) and 0.054 (SD = 0.015), respectively; the difference was significant (t = 3.49; df = 45: p < 0.001). Women spent significantly more time asleep (462.8 minutes, SD = 42.5 minutes) than men (442.5 minutes, SD = 44.3 minutes). The 20-minute difference was statistically significant (t = 3.00; df = 45: p < 0.004).

Actigraphs showed a substantial degree of concordance between the 46 couples, which is illustrated by the sleep actigrams of three pairs of bed partners as shown in Figs. 1 and 2. For all couples, hit rates were calculated for each night of simultaneous recording of sleep. Figure 3 gives four forms of hit rate (i.e. \( \sqrt{xy} \)) averaged over all partners and nights. “Epoch to -1 epoch” compares an actigraph in one partner with only the previous epoch in the other partner. “Epoch to epoch” compares the same epoch for both partners. “Epoch to +1 epoch” compares an actigraph in one partner with the subsequent epoch in the other partner. “Epoch to ±1 epoch” compares the same epoch for both partners. “Epoch to ±1 epoch” is an amalgamation of all three forms of hit rate.

It can be seen (Fig. 3) that 0.32 of discrete movements are common to the same 30-second epoch in both partners. If this was an entirely random process, then the chance hit rate would be 0.06. Extension of the match to epoch ± 1 epoch increases concordance to 0.46, but about 0.18 of this (i.e. 3 × 0.06) is by chance. Although this less stringent match allows for time lags in one partner responding to the other (i.e. +1 epoch) and the possibility (-1 epoch and +1 epoch) of a small desynchrony in the timing of the two actimeters registering near-synchronous movements, the resulting improvement of the hit rate (0.14) is at chance level (about 0.12). Hence, any association between the movements of bed partners lies predominately in the same epoch.

Concerning the issue of whether men or women respond more often to the other, it was not possible to undertake further analyses because 1) almost all of the movements common to both partners were confined...
Actigraphic hit-rate for movement onset between bed-partners by bed-partner type,

![Figure 4](image-url)

**FIG. 4.** Actiblip hit rates (epoch to epoch ± 1 epoch) between bed partners for: 1) true bed partners and 2) matched pseudo-bed partners when female bed partner is replaced (Pseudo-1) and male bed partner is replaced (Pseudo-2).

... to one single 30-second epoch, which could not be reduced further, and 2) most of the hits from an epoch in one partner to the successive epoch in the other partner were at chance level.

Figure 4 gives the epoch to epoch ± 1 epoch hit rates for the true bed partner versus the male or female pseudo-bed partner over all nights. Actiblip hit rates between the true bed partners (0.46, SD = 0.1) were significantly greater than those for the two sets (0.15, SD = 0.1 and 0.12, SD = 0.1) of pseudo-bed partners ($F = 320.6; df = 2,135; p < 0.0001$). A post hoc Tukey test showed no significant difference between the hit rates for the two sets of pseudo-bed partners. In fact, the hit rates for the two latter groups were insignificantly below chance levels (~0.18).

With regard to possible age effects, 45 of the 46 bed-partner couples could be assigned in equal proportions to one of three age groups (20–35, 36–49 and 50–70 years), according to the average of their ages (i.e. 15 per group). Hit rates between bed partners for the epoch to epoch ± 1 epoch match for each age group are shown in Fig. 5. The association is higher for the youn-

![Figure 5](image-url)

**FIG. 5.** Actiblip hit rate (epoch to epoch ± 1 epoch) between partners by mean age of partners.

*Sleep, Vol. 17, No. 4, 1994*
**Subjective data from the sleep logs**

Men tended to report later going-to-bed and lights-out times than did their partners. They also took less time falling asleep and woke up and got up earlier. Whereas only one of these findings was significant (lights out: men = 2330 hours, women = 2322 hours; t = 2.25; df = 45; p < 0.03), the combination resulted in significantly shorter subjective hours spent in bed for the men (t = 2.62; df = 45; p < 0.01).

Women reported significantly more awakenings (n = 445) than did men (n = 306) (t = 2.42; df = 45; p < 0.19), but there was no significant difference in the mean duration of these awakenings. Figure 6 shows by gender the proportional distributions of awakenings by cause, as reported by bed partners (all causes, men and women summed = 100%). Women reported higher proportions of awakenings caused by "toilet", "children", "partners" and "don't know".

The reasons for all awakenings were reduced to the seven most commonly reported causes (toilet, don't know, children, partner, aircraft noise, noise from outside and other causes). For each bed partner and category a yes/no score was given to indicate whether or not an awakening of that type had been reported at least once during the 8 nights. Only one cause, bed partner, showed a statistically significant difference between the sexes ($\chi^2 = 4.5; df = 1; p < 0.03$), with more women (n = 22) reporting this than men (n = 10).

Ninety-five of all the awakenings reported by the women and men could be matched to within 30 minutes or each other, 75 to within 15 minutes, and 35 had exactly the same reported awakening time (subjects tended to round these to the nearest 5 minutes clock-time). Applying the same equation to these matches as that used for the actiblip hit rate, the respective hit rates were 0.26, 0.21 and 0.1. Examination of the 35 awakenings common to the same time showed that 15 (44%) were caused by children, followed by toilet (20%) and "other" factors (10%); 69% were attributed to the same reasons.

There was no significant gender difference for self-
reported sleep quality as given in the sleep logs. About half (44%) of the bed partners reported sleeping better with their partner present, and 22% reported sleeping better when the partner was away; the remainder reported no difference. There was no difference between the sexes for these responses. Twice as many women reported sleeping better with their partner “due to feeling secure”, and more men than women reported sleeping better with their partner due to “habit”.

STUDY 2—PARTNER VS. NO PARTNER

Two data sets were compiled from the 400 subjects used in the main investigation. One set was based on those who habitually slept alone, and the other on the temporary absence of a habitual bed partner. Thirty-nine subjects from the main study slept alone. Eight recording nights from these lone sleepers were compared to those of a bed-partner subject of the same gender from Study 1. Ninety percent of the subjects who slept alone could be matched with a pseudo-partner to within 10 years of age; the remainder were matched to within 17 years.

In the second data set there were 56 subjects from the main study whose partner was absent temporarily for at least 1 night. These nights were compared (within subjects) with nights from the same day of the week when the partner was present. If the partner was away for successive nights, then only the 1st night was analyzed. It should be noted that, as far as we know from the sleep logs, these nights of absence were due to benign factors such as “away on business” or “visiting relatives”, and not to discord between the partners or to family urgency.

Results

Actimetry

Actiblip incidences (movement onsets per hour asleep) were calculated for: always sleep with a bed partner versus always sleep alone, and the bed partner present versus absent. Figure 7 shows these comparisons and, for reference, the corresponding findings for the men and women bed partners from Study 1 (who are significantly different from each other). For the other two sets of pairs, the only significant finding was for the temporary absence of the bed partner (t = 2.26; df = 55; p < 0.03), with absence leading to fewer movements.

The duration of sleep (SO until self-reported wake up) was significantly shorter (t = 3.46; df = 38: p < 0.001) for those who always slept alone (396.6 minutes, SD = 67.5 minutes) than for those with a bed partner (444.6 minutes, SD = 41.3 minutes); the difference was 48 minutes. The other comparison, involving those subjects who usually slept with a bed partner but whose partner was temporarily absent, was not significant.

Subjective data from sleep logs

Of all the variables obtained from the sleep logs, only going-to-bed and lights-out times gave any significant results when examined under conditions of “habitually sleep alone vs. with a partner”. Only sleep onset latency was significantly different under conditions of “partner temporarily absent vs. present”. Subjects who usually slept alone reported getting into bed (2342 hours, SD = 47 minutes) and switching out the light (2356 hours, SD = 50 minutes) significantly later than subjects who usually slept with a bed partner (2313 hours, SD = 43 minutes (t = 2.67; df = 38: p < 0.01) and 2324 hours, SD = 42 minutes (t = 2.75; df = 38: p < 0.01)), respectively. For subjects usually sleeping with a bed partner, the only significant finding was a reportedly shorter sleep onset latency when the partner was present [12.8 minutes, SD = 17 vs. 18.7 minutes, SD = 23.2 minutes (t = 3.03; df = 51: p < 0.004)]. There were no significant differences for self-reported awakenings for either paired comparison.

The reported reasons for awakenings during the nights in question were consolidated into the same seven categories reported in the analysis for Study 1. Awakenings due to partners were excluded from both comparisons. Some of the category values were too small to test for significance. In the majority of cases the values were very similar, and none produced a significant difference.

DISCUSSION AND CONCLUSIONS

For couples sharing beds, there was a strong relationship between bed partners for body movements during sleep, with most of the concordance being within the same 30-second epoch. For all the subject groups examined in Studies 1 and 2, the average numbers of discrete movements are within the normal range given by Kleitman (5) and Johnson et al. (6) (around 20–60 movements during sleep). The significant effect of age that we found for actiblip concordance between bed partners indicated that well-established, older couples shared fewer movements than did young couples. There are two obvious explanations: couples become used to their partner’s movements during sleep (SO until self-reported wake up) was significantly shorter (t = 3.46; df = 38: p < 0.001) for those who always slept alone (396.6 minutes, SD = 67.5 minutes) than for those with a bed partner (444.6 minutes, SD = 41.3 minutes); the difference was 48 minutes. The other comparison, involving those subjects who usually slept with a bed partner but whose partner was temporarily absent, was not significant.

Downloaded from https://academic.oup.com/sleep/article-abstract/17/4/308/2753131 by guest on 08 March 2019
and shorter epochs may have clarified this issue further. Examination of hits between successive epochs indicated only chance levels, and we were unable to determine whether both bed partners were responding to common stimuli or one partner stimulated the other. However, our subjective findings were that women reported significantly more awakenings because of their partner than did men. We must stress that this was the only cause of awakening for which there was a gender difference. Interestingly, male subjects had a significantly higher incidence of discrete movements than female.

There were few self-reported awakenings that could be matched between the partners for time of night, and the relatively small hit rate between partners indicated that few awakenings were thought to be shared. There was no major effect of indirect disturbances (e.g., one bed partner reporting an awakening caused by noise followed by the other bed partner reporting an awakening caused by their already disturbed partner). In fact, the majority of common awakenings that were reported at the same time, as well as about 1/3 of the awakenings reported to be within 15 minutes of each other, were due to the same cause, particularly children, toilet, partner and “other”. This again emphasizes the point that sleep disturbance in our subjects was hardly affected by aircraft noise (4).

Similar to the reports by Monroe (1), we found a general preference among our subjects for sleeping with their partner rather than without, despite the objective evidence that showed that sleep was “poorer” when they did so. The reported reasons given for this preference seemed to depend on the gender of the bed partner, and for the most part had a psychological rather than physical nature. On the other hand, the reasons given for sleeping better without the partner were the converse. Significantly more women than men reported sleeping better with their partner because they felt secure, whereas for men the reason was more through habit. Our findings concerning those who had a partner but preferred to sleep alone were that the partner was restless, took up too much space or snored.

The second study, on the presence or absence of a bed partner, revealed two separate patterns, depending on the subject’s habitual sleeping arrangement. Comparisons of subjects who usually slept alone with those who usually slept with a bed partner revealed a non-significant trend for a higher incidence of discrete movements in the latter, who also slept for a significantly longer period of time. Subjective reports showed that the sleep-with-a-partner group had significantly earlier go-to-bed and lights-out times. The reduction in actiblips during the sleep of subjects whose partner was present was due to the bed partner, as it seems that much of the disturbance or movement would happen anyway. Hence, the proposal (2) that bed partners trigger each other’s movements is more plausible.

There was a tendency for subjects to go to bed earlier when their partner was away, which might be related to the significantly longer reported time it took to fall asleep. Although this could also have been due to anxiety induced by the separation [as noted by Monroe (1)], we found no significant differences in the causes of reported awakenings or in subjective quality of sleep when the partner was away. If anything, the absence of the usual bed partner, at least for the 1st night, appeared to allow the subject to enjoy a longer and more peaceful night’s sleep. It should be noted that the reported reasons for the temporary absence of a bed partner were benign.

In conclusion we found that 1) there was a substantial degree of movement concordance between bed partners as recorded by actimetry. This effect was strongest in younger couples. 2) Men showed more discrete movements than women. 3) Subjective evidence suggests that men are more likely to affect their partners’ sleep than are women. 4) The effects of changes in sleeping arrangements on sleep differed according to the habitual form of this arrangement. 5) Subjects who habitually slept with a bed partner had longer sleep than those who habitually slept alone. The former displayed fewer discrete movements for at least the 1st night when the partner was absent. 6) The majority of our subjects reported that they slept better with their partner than without and appeared to be unaware of any decrements in their sleep quality that seemed to be the result of sleeping with a partner.

Acknowledgements: This project was funded in part by the U.K. Department of Transport. We thank Ceryl Jones, John Ollerhead, Louise Reyner and Alan Woodley for their help.

REFERENCES