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Sleep Positions and Position Shifts in Five Age Groups: An Ontogenetic Picture

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Summary: In an attempt to characterize the development of sleep positions and position shifts in the human, 10 subjects (5 males and 5 females) in each of the following five age groups were studied: 3–5, 8–12, 18–24, 35–45 and 65–80 years old. Subjects slept for four consecutive nights (except the 3–5 year olds who slept two nights) in the laboratory where standard polysomnography was recorded. On nights 3 and 4, sleep positions were recorded with a Super 8 Camera taking one frame every 8 seconds and were scored using four dimensions (head, trunk, legs and arms) each consisting of four categories. The results revealed a significant ontogenetic decrease in the number of position shifts with averages of 4.4, 4.7, 3.6, 2.7 and 2.1 changes per hour, respectively. There was a corresponding progressive increase in the duration of positions and in the number of periods of more than 30 minutes of postural immobility. Whereas in children, prone, supine and lateral positions were assumed to occupy an equal proportion of sleep time, trend analyses revealed a significant progressive ontogenetic disappearance of prone positions and a progressive preference, very marked in the elderly, for right-side positions. **Key Words:** Sleep positions—Position shifts—Body movements—Ontogenesis.

Human sleep has been studied extensively over the last 40 years. The focus has been, however, on its electrophysiological characteristics. The identification of sleep stages based on electroencephalographic (EEG), electrooculographic (EOG) and electromyographic (EMG) measures (1) has led to the comparison of sleep architecture in various conditions and age groups (2). Body movements during sleep have also been studied extensively (3), but, surprisingly, very little work has been carried out on sleep postures per se.

The literature on sleep positions, particularly in the first half of this century, is mostly anecdotal or based on clinical speculations (e.g. 4,5). Beginning with work by Sidis (6), however, there have been systematic attempts to determine sleep position patterns with different age groups and individual differences related to laterality and personality. However, these studies relied on direct or indirect observations of sleep behavior. For example, Boynton and Goodenough (7) studied 2–4 year olds during afternoon naps and observed that the children spent 60% of their time on the side, 27% on the stomach and 13% on the back. They also noted more movements when they slept on the left side than on the right side but even more when they slept on the back or on the stomach. Studying 1–4-year olds, also during naps, Scott (8) reported that these children spent 44% of the time on the right side, 31% on the left side, 16% on the stomach and 9% on the back. Finally, Marquis (9) observed an ontogenetic decrease in the use of supine positions from 97% of the time in the 8-week olds, to 35% in 52-week olds.

In some of these studies attention was also given to laterality (handedness). Sidis (6) tried to relate positions adopted at bedtime to laterality in children and adults. He found that right handers fell asleep on their right side, whereas left handers used their left side. Once asleep (determined visually), subjects switched to the opposite side. Sidis proposed that a limitation of voluntary muscular activity is necessary for sleep onset and thus that more control is required on the most active side at bedtime. Boynton and Goodenough (7) in the study mentioned earlier could not replicate Sidis' findings on laterality but noted that children who always adopted the same position at bedtime seemed to reach sleep more easily. They concluded that sleep onset is the result of consistency in kinesthetic feedback. Using questionnaires, Stradling and Laird (10) found that regardless of manual laterality, most subjects preferred going to sleep on the right side.

On even more speculative grounds, personality has also been related to sleep positions. Epstein (11) sug-

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gested that sleep positions in the human are constant, typical and universal. He further proposed that there is a tendency to take fetal positions, bringing the extremities toward the body. More recently, Dunkell (12) and Domino and Bohn (13), on the basis of clinical observations, postulated that sleep positions reflect personality traits and defense mechanisms. They further defined major sleep positions and their associated personality characteristics.

All of the above studies were limited in their objectivity in the measurement of sleep positions and this likely explains the lack of consistency in their results. Johnson et al. (14), using a 16-mm filming technique, were the first to obtain highly reliable information on sleep positions, although the data were limited to the normal young adult. They reported that their subjects changed positions 20–40 times per night and remained in the same position for an average of 15 minutes. They also noted a preference for side positions in a contorted configuration.

Since the establishment of polygraphic standards for determining sleep, there have been very few studies of sleep positions in controlled laboratory settings. The availability of modern video techniques and time-lapse photography have served mostly to study patterns of movements and of immobility in sleep (3,15). In 1978, we proposed a simple technique using super-8 film to record sleep positions in the laboratory in conjunction with standard polysomnographic recording (16). A scoring system for positional dimensions was developed and applied in a first study of young adult poor and good sleepers (17) as defined by Monroe (18). The results on good sleepers corroborated those of Johnson et al. (14) obtained with normal subjects. They changed positions between 20 to 30 times per night and maintained each position for an average of 20 minutes. Furthermore, lateral positions occupied 60% of sleep time and thus were preferred over prone and supine positions.

Our poor sleepers, however, not only woke up more frequently during the night, but also changed position more often (an average of 35 times per night). Finally, poor sleepers spent significantly more time in supine positions than good sleepers (41% versus 23% of the night). This relationship is consistent with the results obtained by Douthitt and Brackbill (19) with 20 newborns who slept on a stabilimeter. They noted that babies placed on their stomachs spent more time in rapid eye movement (REM) and nonREM (NREM) sleep and had more regular respiration and electrocardiograms (EKG), whereas those placed on their backs had more awakenings with twice as much motor activity.

This association between supine positions and poor sleep quality is interesting as it has long been observed that these positions facilitate snoring. Furthermore, it has been clearly demonstrated recently that supine positions facilitate sleep apneas in the adult (e.g. 20) and the newborn (21). There is also some suggestion that the sudden infant death syndrome (SIDS) may be linked in part to the positions in which children are placed into the crib (22–24).

Although there is evidence that sleep positions are linked with sleep quality and some sleep disorders, there is no basic information on the normal distribution of sleep positions across age groups. The present study was a first step in this direction using a cross-sectional approach with five age groups. The present report focuses on sleep positions across the night independent of sleep stages. A subsequent report will deal with sleep positions and electrographically defined sleep patterns.

Although there is no extensive data base on which to formulate predictions regarding the distribution of sleep positions at different ages, data obtained on body movements suggest that children move much more frequently than adults during sleep (25) and therefore are likely to change sleep position more often.

METHODS

Subjects

Five females and five males in each of five age groups were selected: 3–5 (mean = 3.9), 8–12 (9.8), 18–24 (22.5), 35–45 (39.5) and 65–75 (72.1) years old. The inclusion criteria were: self-declared right-handedness, normal weight, no medication and no sleep disorder. Each subject signed a consent form and received a compensation of $10.00 for each night spent in the laboratory.

Design

The design called for subjects to sleep in the laboratory for four consecutive nights: the first two nights for adaptation to the laboratory situation and the last two nights for data collection. However, a pilot study with 3–5-year olds revealed minimal adaptation effects to the laboratory situation. Furthermore, they did not want to sleep beyond two nights. For this age group, the first two nights were therefore used for data collection. Subjects slept in a standard single bed (185 × 100 cm) and were covered with a single bed sheet. Room temperature was kept constant at 22°C.

Electrophysiological measures

The EEG, EOG and EMG were monitored following the guidelines of Rechtschaffen and Kales (1). Sleep stage scoring followed the standard criteria. The reli-

FIG. 1. Photographic enlargement of a super-8 frame showing a lateral position that is scored as A2–B4–C2–D2. The clock's "seconds" hand is not well seen on the print, but its position is more readily detectable with an analyzing projector. Although video recordings are more easily obtained, super-8 still permits faster scoring with sharper images and contrast.

ability of scoring was obtained by calculating the percentage of agreement between two independent judges on half of the records. For all sleep stages, the percentage of agreement was above 90%.

Sleep position recording and scoring

Sleep positions were recorded through a viewing window by a Nizo super-8 camera placed outside the room. The camera was set to take one frame every 8 seconds with an 8-second exposure thus providing 3,600 frames over 8 hours. For children, the interval was 9 seconds allowing for 9 hours of recording on a super-8 cassette. With Ektachrome 160 film, 7 W continuous illumination (night light) was sufficient to obtain clear frames (see Fig. 1). A large clock beside the head of the bed synchronized with the polygraph permitted precise recording of the time of night on each frame so that the time of each position could be identified and scored in conjunction with the electrophysiological recordings.

Sleep positions were analyzed with the De Koninck et al. (17) scoring system, which uses four dimensions: the position of the head, trunk, legs and arms. The various categories used within each dimension are presented in Table 3. In the arm and leg dimensions, "folded" was scored when the limb flexion was judged to be of 45° or more. In order to be scored, a body position had to be maintained (no change in any of the categories of any position dimension) for at least 1 minute. A position change was thus scored when there was a change in any category and/or position dimension. Data were also obtained on the duration of each position, the time of the night and the stage during which it occurred. To discriminate long periods of postural immobility (LLPI, 15), the criterion of 30 minutes was used. For the analysis, the data from nights 3 and 4 (1 and 2 for the 3–5-year olds) were combined. It should be noted that analyses of variance confirmed the absence of significant differences between nights 3 and 4 on any of the electrophysiological and sleep position variables. The reliability of the photographic scoring was established by having two judges score half of the photographic records. Their percentage of agreement was above 80% for all of the 16 position dimensions, as well as position shifts and position duration.

RESULTS

The average time spent in bed per night, along with the average sleep duration and the percentage of time awake for each age group, are presented in Table 1. Analyses of variance revealed significant differences between groups on all three variables (time in bed: $F = 22.9$; df = 4,49; $p < 0.001$; total sleep time: $F = 25.30$; df = 4,45; $p < 0.001$; percent wake time: $F = 5.79$, $p < 0.001$). Trend analyses showed significant linear and quadratic trends corresponding to an overall decrease with age but with a small increase in the elderly in time in bed ($F = 57.22$ and 28.63; df = 4,45; $p < 0.001$ and 0.01). Sleep time also exhibited significant linear and quadratic trends ($F = 92.36$ and 6.59; $p < 0.001$ and 0.05). Finally, the percentage of wake time ($F = 18.15$, $p < 0.001$) exhibited linear and quadratic trends, this time corresponding to an overall increase with age but which is clearly manifested only in the adults and the elderly. Detailed results on the other sleep parameters (sleep stages and sleep cycle) and their relationship with the variables presented below are the subject of a separate report.

The results on position shifts per night and position shifts per hour in bed and LPPI are presented in Table 2. Analyses of variance revealed significant differences between groups on all dimensions. Trend analyses showed significant linear trends corresponding to decreases in the number of position shifts per night ($F = 73.25$, $p < 0.001$), position shifts per hour ($F = 38.06$, $p < 0.001$) and increases in the number of LPPI ($F = 42.87$, $p < 0.001$). The trend distributions across the age groups are illustrated in Fig. 2. There were no significant quadratic or higher-order trends. On the latter dimension, it is interesting to note that the elderly were the only ones to experience periods of immobility lasting more than 200 minutes.

The main interest of this study was the distribution of postural dimensions and their categories across the five age groups. The percentages of time spent in each position dimension and categories are shown in Table 3. A multivariate analysis of variance carried out on the 16 position categories revealed that there were significant differences between groups ($F = 2.42$, $p < 0.001$). Of interest was the presence of developmental

TABLE 1. *Mean scores of nights 3 and 4 combined on the electrophysiological measures of sleep (SD) for each of the five age groups*

	Groups				
	I 3–5 years	II 8–12 years	III 18–24 years	IV 35–45 years	V 65–80 years
Time in bed in minutes	590.3 (45.2)	525.6 (44.1)	441.2 (39.8)	443.9 (28.4)	470.2 (53.6)
Sleep duration in minutes	561.3 (45.2)	505.5 (39.9)	418.9 (50.7)	402.4 (23.2)	383.9 (67.5)
Time awake in %	4.9 (2.3)	3.8 (3.1)	5.4 (5.0)	9.2 (5.4)	14.5 (9.7)

TABLE 2. *Mean scores of nights 3 and 4 combined on the photographic measures (SD) for each of the five age groups*

	Groups				
	I 3–5 years	II 8–12 years	III 18–24 years	IV 35–45 years	V 65–80 years
Number of position shifts	42.3 (8.8)	44.5 (11.3)	27.1 (8.9)	19.6 (5.6)	16.4 (7.1)
Number of position shifts per hour	4.4 (0.9)	4.7 (1.1)	3.6 (1.0)	2.7 (0.7)	2.1 (0.9)
% of LPPI	7.7 (2.5)	14.1 (4.1)	16.3 (6.3)	25.9 (8.9)	26.0 (4.6)

LPPI: long period of postural immobility.

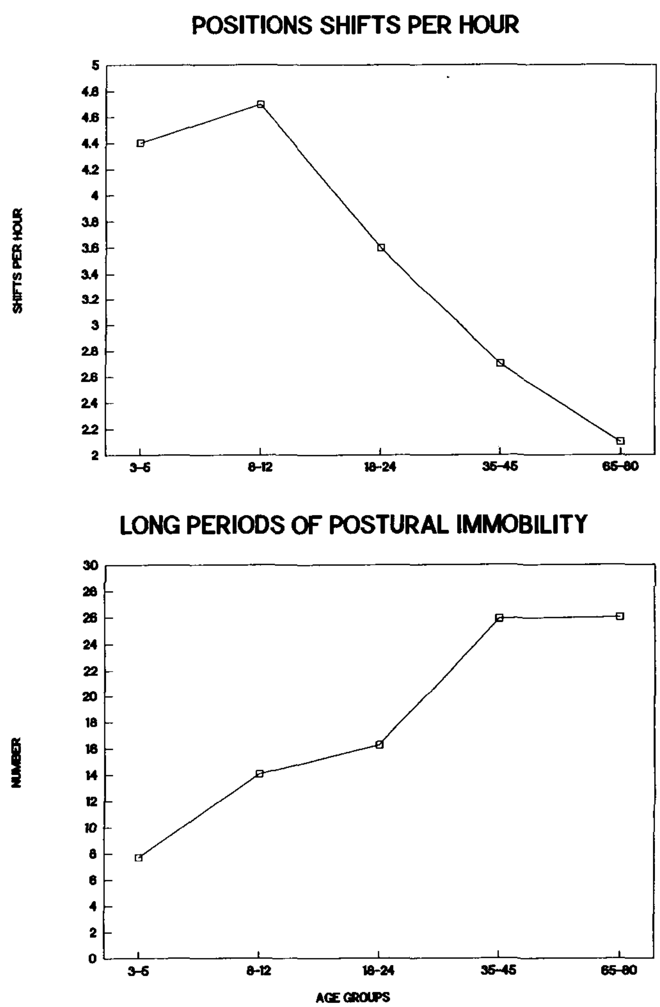

FIG. 2. Developmental trends on photographic measures of position shifts per hour and long periods of postural immobility for nights 3 and 4 combined, across the five age groups.

trends. Significant linear trends were observed for the following dimensions: increases in right-side positions for both the head ($F = 9.62$, $p < 0.005$) and the trunk ($F = 22.08$, $p < 0.001$) and decreases in left side for the head ($F = 16.78$, $p < 0.001$) and prone trunk position ($F = 7.31$, $p < 0.01$). There was also a significant quadratic trend ($F = 6.71$, $p < 0.02$) in the right side of the trunk accounting for the fact that the increase manifests itself in the adult and the elderly (see Fig. 3).

The next step was to examine postural configurations. Each posture is a combination of one category from each of the four dimensions (A = head, B = trunk, C = legs, D = arms). For example, a semifetal position is defined by Dunkell (12) as trunk and head on the side, arms and legs bent and assumed on the right side. It would be classified as A3–B3–C2–D2 using the system illustrated in Table 3. Examining the various combinations, we have determined that 116 postural configurations are possible (for example, it is not possible to have the head upward in a prone position). As a first step, the incidences of these configurations for each group have been calculated. The five most frequent positions for each group along with the percentage of time of their use are listed in Table 4. The positions held for the longest periods (corresponding to long periods of postural immobility—more than 30 minutes) are identified with an asterisk. It can be seen that for all groups, side positions with both arms and legs bent were preferred. Figure 1 is a print taken from a super-8 frame, which illustrates the configuration A2–B4–C2–D2.

We also examined six possible interrelations of sleep positions during the night: the position at bedtime with that at sleep onset, at morning awakening, and the preferred position through the night; the position at sleep onset with that at awakening and the preferred night position; and the morning awakening position with the preferred night position. Using χ^2 analyses, only the combination of the bedtime position and the sleep onset position was found to be related to the age groups ($\chi^2 = 14.06$, df = 4, $p < 0.01$). Specifically, preadolescents, adults and the elderly more frequently adopted the same postural configuration at bedtime and at sleep onset than the children and the young adults. However, this constancy does not appear to be related to a shorter sleep latency because all subjects tended to fall asleep rapidly regardless of whether or not they adopted the same position at these two moments.

TABLE 3. *Mean percentage of time, of nights 3 and 4 combined, spent in each category of sleep position (SD) for each of the five age groups*

	Groups				
	I 3–5 years	II 8–12 years	III 18–24 years	IV 35–45 years	V 65–80 years
Head (A)					
1) Upward	5.4 (6.4)	18.8 (18.6)	13.0 (10.2)	8.5 (7.9)	21.2 (12.1)
2) Left side	51.9 (16.2)	41.3 (14.0)	40.6 (15.1)	44.8 (14.3)	18.9 (16.3)
3) Right side	41.4 (14.3)	38.0 (14.7)	43.9 (11.8)	46.6 (11.5)	59.9 (19.5)
4) Downward	1.3 (2.5)	1.9 (3.1)	1.9 (1.1)	0.0 (0.0)	0.0 (0.0)
Trunk (B)					
1) Stomach	16.9 (7.3)	20.2 (14.0)	13.4 (12.2)	16.9 (19.7)	1.3 (4.1)
2) Back	27.6 (7.6)	27.2 (19.7)	26.7 (13.8)	13.4 (11.7)	26.0 (14.4)
3) Right side	27.8 (10.0)	23.2 (15.1)	30.0 (9.0)	37.5 (15.4)	55.0 (20.5)
4) Left side	27.7 (8.7)	29.5 (12.0)	29.2 (14.1)	32.1 (7.7)	17.6 (17.3)
Legs (C)					
1) Both straight	26.6 (15.5)	18.8 (11.3)	26.5 (9.2)	26.6 (19.4)	32.6 (18.1)
2) Both folded	58.5 (13.2)	52.3 (9.2)	40.8 (11.7)	55.4 (20.5)	61.6 (17.5)
3) Right folded	6.8 (6.8)	15.8 (8.2)	16.1 (10.4)	9.5 (13.1)	2.3 (3.2)
4) Left folded	8.1 (3.7)	13.1 (7.0)	16.6 (9.5)	8.4 (10.1)	3.4 (6.5)
Arms (D)					
1) Both straight	11.5 (8.6)	2.0 (2.7)	10.4 (7.2)	2.5 (3.5)	2.0 (4.6)
2) Both folded	73.3 (14.0)	80.2 (15.5)	77.2 (6.5)	92.6 (7.3)	90.6 (9.4)
3) Right folded	9.1 (6.4)	12.7 (13.7)	4.2 (4.7)	1.2 (1.6)	4.3 (5.5)
4) Left folded	6.1 (6.7)	5.1 (5.8)	8.2 (7.9)	3.6 (4.8)	3.5 (5.1)

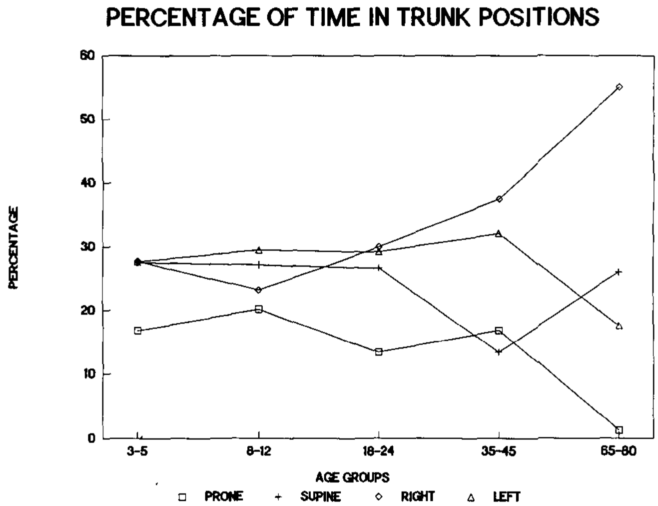

FIG. 3. Developmental trends in the percentage of time spent in trunk sleep position dimensions on nights 3 and 4 combined, across the five age groups.

TABLE 4. *Mean percentage of time, of nights 3 and 4 combined, spent in the five most frequent postural configurations for each of the five age groups*

Postural configurations	Groups				
	I 3–5 years	II 8–12 years	III 18–24 years	IV 35–45 years	V 65–80 years
1	A2–B4–C2–D2*	A2–B4–C2–D2*	A3–B3–C2–D2*	A3–B3–C2–D2*	A3–B3–C2–D2*
%	17.0	12.2	9.6	19.2	27.0
2	A3–B3–C2–D2	A3–B3–C2–D2	A2–B4–C2–D2	A1–B2–C1–D2	A1–B2–C1–D2
%	13.2	11.9	7.2	15.7	19.5
3	A3–B2–C1–D2	A3–B1–C1–D2	A3–B3–C4–D2	A3–B1–C1–D2	A2–B4–C2–D2
%	3.1	4.9	4.2	7.1	8.8
4	A2–B4–C1–D2	A1–B2–C4–D2	A1–B2–C1–D2	A1–B2–C1–D2	A3–B3–C1–D2
%	3.0	4.6	4.2	5.8	8.5
5	A2–B4–C3–D2	A2–B4–C2–D3	A3–B2–C1–D2	A2–B4–C1–D2	A1–B2–C3–D2
%	3.0	4.0	3.7	5.1	3.3

* Represents the configurations that were held for the longest periods (more than 30 minutes, corresponding to long periods of postural immobility).

DISCUSSION

The macro sleep characteristics of our age groups are well in agreement with previous ontogenetic data (2) reporting a progressive decrease in time in bed and increase in the percentage of wake time. Similarly, the decrease in body movements during sleep with age is consistent with the literature. Garvey (25), for example, reported that children moved twice as much as adults during their sleep. Accordingly, the decrease in the number of position shifts per hour of sleep is not surprising. It could be a reflection of the amount of body activity during the day although there do not appear to be studies that have addressed that question. However, as the significant quadratic trends confirmed, the fact that the children had fewer position shifts than the preadolescents appears contradictory upon initial consideration with the developmental trend. In fact, Renshaw et al. (26) also observed that a group of 11–13-year olds moved more frequently than a group of 5–7-year olds. In our sample, we did observe that our preadolescents were more agitated before going to bed than our children. Finally, the developmental trend is clearly seen in the proportion of long periods of postural immobility (Fig. 2).

An examination of the sleep position dimensions across the age groups revealed interesting developmental trends. Our attention was drawn to the evolution of trunk position preferences, which are clearly revealed by Fig. 3. In children, lateral and supine positions are equally represented with prone positions occupying a somewhat lower percentage of time. With the young adult, preference for side positions emerges and is marked in the 35–45-year-old group. In the elderly, however, a clear preference for the right side is present and there is a near complete disappearance of prone positions. The abandonment of prone positions is most likely attributable to the lack of flexibility of the spinal cord and/or the extra effort required for breathing from the respiratory cage. The right-side preference in the elderly is more difficult to explain. All our subjects were self-declared right handed, but a laterality factor would more likely have appeared in the younger groups as well. Could it be related to cardiovascular functions? Further investigations will be required to test this interpretation.

The overall preference for the semifetal configuration confirms earlier observations, notably those of Johnson et al. (14) who reported that it was associated with the longest held positions. It is also interesting to note that the most frequent postural configurations adopted for each group also corresponded to those of the longest periods of immobility.

This study provides a first picture of the pattern of body positions across normal age groups. Larger samples would be required to explore potential sex differences. Furthermore, the recordings were carried out in the laboratory. It is possible, particularly for the children and the elderly, that sleeping in their home environment would lead to different positional preferences. It would also be interesting to explore the impact of various potential factors such as body temperature, room temperature, presleep motor activity, laterality and bed surface on sleep positions. In a separate report we will explore the relationship between sleep positions and electrophysiologically defined sleep stages.

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