6. Toward a Comparative Developmental Ecology of Human Sleep

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This exploratory comparative survey of the ecology of human sleep arises from a question posed by a pediatrician who studies mood disorders and sleep (Dahl, 1996; Dahl et al., 1996). In an attempt to gain insights into sleep regulation from ecological theory and research, he questioned what anthropologists know about sleep. The bald, if somewhat overstated, answer was: zero. Sleep, in its ubiquity, seeming nonsociality, apparent universality, and presumed biologically driven uniformity, has been overlooked as a background variable. Amazingly, it has not engaged a discipline dedicated to the study of human behavior, human diversity, and their cultural biological bases. A notable exception is the evolutionary-ethologically informed approach to the anthropological study of sleep pioneered by the work of McKenna and colleagues on sleep arrangements, infant state regulation, and risk for sudden infant death syndrome or SIDS (McKenna, 1991, 1992, 1996; Mosko, McKenna, Dickel, & Hunt, 1993). Harkness and Super have also documented cultural variation in infant sleep in relation to their studies of child care practices (Harkness & Super, 1996; Super, Harkness, van Tijen, van der Vlugt, Fintelman, & Kijksta, 1996), and scattered reports document sleep behavior (Ferreira de Souza Aguiar, Pereira da Sliva, & Margues, 1991).

Sleeping arrangements (who sleeps by whom) have been closely documented and subjected to cross-cultural analysis because of interests in incest taboo, psychoanalytic views of culture and personality, and emphases on family structure, child care practices, gender, and personality (Barry & Paxson, 1971; Whiting & Whiting, 1975; Whiting, 1981; Herdt, 1989; Morelli, Oppenheim, Rogoff, & Goldsmith, 1992; Schweder, Jenson & Goldstein, 1995; Wolf, Lozoff, Latz, & Paludetto, 1996). Sleep scarcely figures in the literature on human evolution, barring speculation about

the survival challenges for secure sleep faced by a ground-dwelling, naked large ape and the possible coevolution of these features with sociality, tool use, and fire. But the paleoanthropological record consists of material remains, and, as the ironic truism notes, behavior fossilizes poorly. Whereas much can be gleaned from floral-faunal associations, tool sources and distribution, and analysis of living sites to reconstruct ecological parameters and infer behavior patterns (Potts, 1996a,b), sleep, like gathering and child care, is low-tech and unrepresented until dwelling sites of the neolithic.

Recognition of the paucity of anthropological work on sleep is galvanizing: a significant domain of human behavior that claims a third of daily life remains largely overlooked by a discipline dedicated to the holistic study of the human condition. The question initially posed to us was clearly motivated by the possible value to existing research on sleep, state regulation, and chronobiology of comparative data concerning the evolutionary-ecological bases of sleep and the expectable range of variation in sleep behavior. Several circumstances support this expectation. First, sleep research has characterized the ontogeny and physiology of human sleep and sleep architecture, as well as extensively documented sleep-rest behavior and biology across animal taxa, especially mammals (reviewed in Allison & Van Twyver, 1970; Allison & Cicchetti, 1976; Meddis, 1983; Anderson, 1984; Campbell & Tobler, 1984; Siegel, 1995; Tobler, 1995). Nevertheless, despite recognition of the minimal sample size and limited ecological range represented in the taxonomic comparative literature (Tobler, 1995), the comparative study of sleep has not extended to population variation in humans.

Second, although sleep deprivation and chronobiological experiments have monitored acute and midrange effects of manipulated sleep ecologies (Mitler, Carskadon, Czeisler, Dement, Dinges, & Graeber, 1988; Walsh, Shweitzer, Anch, Muehlbach, Jenkins, & Dickins, 1994; Berger & Phillips, 1995; Drucker-Colín, 1995; Salzarulo & Fagioli, 1995), the developmental and lifetime ecologies of sleep normative among Western populations studied so far appear to the anthropologist as scarcely representative of the extant and expectable range of human sleep ecologies. Specifically, patterns of solitary sleep on heavily cushioned substrates, consolidated in a single daily time block, and housed in roofed and solidly walled space, contrast with the variety of sleep conditions among traditional societies. These conditions include multiple and multiage sleeping partners; frequent proximity of animals; embeddedness

of sleep in ongoing social interaction; fluid bedtimes and wake times; use of nighttime for ritual, sociality, and information exchange; and relatively exposed sleeping locations that require fire maintenance and sustained vigilance.

The present analysis represents a preliminary attempt to address these issues substantively, by considering the micro, macro, developmental, and evolutionary ecology of human sleep. To this end, we draw upon the thin extant cross-cultural anthropological literature that pertains to the ecology of human sleep, heavily augmented by data from in-depth interviews of contemporary ethnographers concerning sleep conditions and patterns across a worldwide range of traditional forager, pastoralist, horticulturist, and agriculturalist communities. Although scarcely definitive, this survey provides sufficient evidence to suggest that the sleep pattern, architecture, and ontogeny of Western postindustrial populations may be grounded in a distinctive sleep ecology, from infancy on, and that a comparative, cross-cultural investigation is required for a more complete understanding of sleep, its developmental and regulatory neurobiological substrates, and its chronobiological correlates. Consonant with the focus of this volume on adolescents, the distribution of sleep deprivation for ritual or agonistic purposes, including for adolescent rites of passage, is also noted.

Components of Human Sleep Ecology

Sleep behavior and architecture clearly have strong biological determinants. Yet consider Henri Rousseau's famous picture, *Sleeping Gypsy*, in which a rigidly prostrate, colorfully clad dusky figure, clutching a stick, lies asleep on bare earth amid a barren landscape beneath a blank full moon, under the alert gaze of an adjacent lion. The impact of the painting relies largely on what is missing, namely the usual social and material contexts of sleep, and the sense of danger aroused when these contexts are absent. A solitary, unprotected, and unequipped sleeper is an aberration; for humans, sleep is embedded in behaviorally, socially, and culturally constituted environments enabling safe sleep. Safety concerns not only macropredators such as lions or human enemies, but also buffering elements, protection from micropredators such as mosquitoes, and general reduction of external disturbance and predation risk. Safety also inheres in membership in a well-functioning social group that frames and

populates the context for sleep. Shelter for and accoutrements of sleep define its physical microenvironment. Moreover, the diurnal patterning of sleep is influenced by a set of structural and cultural features operating variably across the life course, including labor demands, schedules of social and ritual activity, status and role differentiation, and beliefs about the nature and functions of sleep.

The following sections outline the constituent factors defining sleep ecology, proximal to distal, and illustrate them with examples from published and new ethnographic material. The new material is drawn from interviews on sleep of ethnographers with intimate knowledge of one or more societies. The societies, locations, and sources, arranged by subsistence type, are as follows:

1. Foragers: Ache (Paraguay, Magdalena Hurtado) (Hill & Hurtado, 1996), Efe (Zaire, Robert Bailey) (Bailey & DeVore, 1989), !Kung (northwest Botswana, Melvin Konner) (Lee & DeVore, 1976; Marshall 1976; Lee, 1984), Hiwi (southern Venezuela, Magdalena Hurtado) (Hurtado & Hill, 1987, 1990).
2. Pastoralists: Gabra (northern Kenya, John Wood) (Prussin, 1995; Wood, n.d.); mixed agriculturalist Swat Pathan (Pakistan, Frederik Barth) (Barth, 1965, 1981, 1985).
3. Horticulturalists: Baktaman (highland Papua New Guinea, Frederik Barth) (Barth, 1975); Gebusi (highland Papua New Guinea, Bruce Knauft) (Knauft 1985a,b); Lese (Zaire, Robert Bailey) (Bailey & DeVore, 1989).
4. Agriculturalists: Balinese (Singaraja, Buleleng Province, northern Bali, Frederik Barth) (Wikan, 1990; Barth, 1993).

Ours is a sample of convenience, selected on the basis of accessibility and knowledge of the ethnographer, roughly drawn across continents, climates, and subsistence types. The aim was to apply an analytic framework concerning determinants of sleep ecology to glean an initial impression of the constituents and variability in that ecology across a range of settings, rather than to establish a definitive comparative ethnographic account. Such an account must be drawn from future primary ethnographic and comparative cross-cultural analytic work. We hope that the present discussion will alert others to the need for research in this area, provide a framework for comparative data collection and analysis, and suggest the value of an ecological approach for augmenting existing sleep research paradigms.

Microecology of Human Sleep

A set of physical, cultural, and biotic factors defines the proxemics of sleep ecology, that is, the actual conditions under which people sleep. Humans sleep under remarkably diverse customary circumstances.

Proximate Physical Ecology of Sleep

Bedding includes substrate, covering on substrate, covers, pillow, and sleep garments. Except during infancy or illness, humans everywhere habitually sleep in a recumbent position, although the specifics of the position (e.g., prone, supine) may vary individually or be constrained by bedding. By contrast, the appurtenances of sleep, both substrates and covers, vary widely. Foragers inhabiting tropical or mild climates who move regularly do not sleep on platforms, but directly on the ground, which may or may not be prepared. !Kung sleep on a skin, a blanket, or nothing, over conforming sandy surfaces; Efe sleep on thinly strewn leaves, or perched between two logs, on rather hard, irregular ground; Ache lie on mats; and Hiwi use hammocks. None customarily uses pillowing materials, though individual Efe may use a pillow of bound leaves, and !Kung may use a wad of clothing. Nor does any group in our forager sample regularly use covering. Indeed, Efe remove clothing to reduce the danger of ignition from the fire kept going in the hut at night. !Kung may rarely use a blanket. All other groups in our sample, even the nomadic herders, the Gabra, sleep on platforms a foot or more off the ground. Sleeping platforms or beds are made of solid (wood strips [Gebusi], narrow sticks [Gabra], split black palm [Baktaman]) or webbed (leather strips [Swat Pathan], palm fronds [Lese]) surfaces on which bark and a mat (Gebusi), skin (Gabra, Pathan), or blanket (Pathan) may be placed. Covering among these nonforaging groups varies from occasional use of bark cloth capes over the torso (Gebusi), to a thin cotton cloth (Lese), which may be that used for clothing during the day (Gabra), to a thin sheet in summer and heavy blankets in winter (Pathan). Among the nonforaging societies in our sample, pillows are used only by Swat Pathan, who sleep with large cotton-stuffed, muslin-covered bolsters as pillows, and men cover their face and upper torso with the thin cloth they also carry by day.

Minimization of bedding, compared with the plethora of mattresses, sheets, pillows, duvets, and blankets of Westerners, may have to do not only with technology, resources, and climate but also with avoidance

of undesirable concomitants of profuse bedding. Besides providing padding, thermal protection, or physical barriers, bedding may harbor parasites (fleas, bedbugs, lice) or producers of allergens (mites) and thus promote disease transmission or respiratory distress or illness. For instance, introduction of blankets among Fore in highland Papua New Guinea was paralleled by dramatic increases in rates of asthma among adults, apparently mediated by high levels of house mites in the blankets (Dowse, Turner, Stewart, Alpers, & Woolcock, 1985; Turner, Stewart, Woolcock, Green, & Alpers, 1988). At the least, bedding may be minimized because people find bites (or rather the immunologic responses to bites) uncomfortable, the activities of ectoparasites may disturb sleep, and the maintenance of sanitary bedding may be onerous. Swat Pathan prefer to lie on blankets rather than skins because the latter become flea-ridden more rapidly. Because beds become quickly bedbug-infested, the well-to-do cover the blankets with silk sheets to keep them off. Infested bedding is washed in cold water and/or hung in intense sun. Absent among our sample groups, but not infrequent in Africa or Asia, is the use of headrests, of variable shape and construction, which support the head but do not harbor ectoparasites.

Presence of Fire

Fire is a source of light (predator protection), heat (thermal protection), smoke (fumigant but irritant), unpredictable noise, and visual stimulation. It may also require tending during the night and thus enhance vigilance and increase periodic wakings. Presence of fire provides protection from predators, particularly among peoples without solid-walled domiciles, including all foragers sampled and the nomadic Gabra. Thus, it promotes a feeling of security. Further, heat generated by fire offers thermal protection and lowers humidity levels to enhance sleep comfort. Fires also have important fumigant properties. Dwellings, particularly those with thatch or shingle roofs, can harbor large populations of insects and rodents that are unpleasant or even dangerous to the human inhabitants. Smoke from fires plays the important and well-recognized role of controlling such pests, and perhaps even of damping ectoparasites. Fires are often built up for cooking the evening beverage and meal, and unventilated cooking fires fill the upper reaches of the space with smoke which filters through the roof and walls and gradually clears as the fire burns down (e.g., Gabra, Gebusi, Lese, Baktaman). In the aforementioned groups, fires are not replenished in the night, but

burn down to smouldering embers by morning. Degree of particulate air pollution in the sleeping space may thus be variable but high at times. Smoky fires also deter nocturnal flying insects, such as mosquitoes, that are vectors for disease. For instance, mosquito bite rates among inhabitants of the lower Sepik River basin, a region holoendemic for malaria, correlate inversely with smoke levels and are highest among young men who live in youths' houses and are unused to tending fires (personal communication, B. Genton, July 24, 1992; for specific cases illustrating interactions of human host with mosquito vector circadian behaviors in lowland Papua New Guinea, see Genton et al., 1995; Nakazawa et al., 1995; Bockarie, Alexander, Bockarie, Obam, Barnish, & Alpers, 1996).

In groups for which the protective and thermal functions of fire are important, such as the foragers in our sample who have no or insubstantial dwellings (Ache, Hiwi, Efe, !Kung), sleepers rouse frequently in the night to monitor the fire and replenish it as necessary. Fire also produces steady, irregular (in volume, frequency, and quality) noise that some ethnographers report as being subliminally monitored in sleep: continual small noises are reassuring, loud pops are arousing, and the absence of sound wakes the sleeper concerned with fire maintenance. The presence of the flicker and the faint glow from the fire is reported as comforting and soothing or hypnotic, conducive to sleep during periods of nighttime insomnia, and facilitative of reassuring visual scans of the sleeping space. Finally, where there is no barrier between fireplace and sleeper (e.g., Ache, Efe, !Kung), risk of burns is high and sleepers apparently learn to regulate or monitor movements to avoid contact with the fire. Where sleeping spaces are restricted and densely populated or sleepers stay close to the fire for dryness and warmth, virtually every member of the group may have scars from burns that may be localized and minor or more extensive and severe. Parents may be particularly anxious about risk to infants and small children, a concern that increases vigilance even in sleep.

Finally, presence of fire in the sleeping space alters air quality and composition, not only through particulate components of smoke, but also via direct effects on gas composition. Fuel type (e.g., dung, wood) and quality (wet, dry, resinous) along with type of fire and fireplace construction determine smoke quantity and quality. In addition, fires consume oxygen and produce gases, including carbon monoxide, whose amount and composition again depend on fire dynamics (heat, ventilation). Thus, fires in sleeping spaces may strongly influence air quality,

particularly in spaces that are closely sealed for insulation (Swat Pathan in winter) or to exclude malignant spirits (Lese). Incense burners may also be used in sleeping spaces to deter insects (Bali), disguise human odors (Gabra), or invoke spiritual protection.

Sleep Space or Structure

The construction and layout of dwellings determines properties of sleeping spaces regarding degree of social separation, protection from elements, thermal insulation, and physical security. Building size, layout, and materials heavily influence degree of physical, acoustic, or visual separation from others, awake or asleep. The two-meter-round huts of Efe and !Kung, constructed of stick frames covered with leaves or grass, respectively, present no physical barrier among sleepers in the hut, and little visual or acoustic separation from the outside (see related examples in Eibl-Eibesfeldt, 1989, pp. 632–633). Physical security from predator or enemy assault is minimal and protection from rain is reasonably good, but insulative value is low. These contrast with the mud and mud-stone walls of Lese and Swat Pathan, respectively, which provide high visual, acoustic, social, and climate barriers, but vary in degree of internal partitioning. Lese dwellings have internal partitions of sticks that do not extend to the ceiling and provide solely visual separation, whereas Swat Pathan houses have two or three rooms around a courtyard, separated by solid walls. By further contrast, Gebusi and other communal longhouse dwellers of the Pacific and Asia sleep in large (60- to 100-feet long) structures with internal partitions that provide visual and physical but not acoustic separation from other residents, who may number from 20 to 100 (Eibl-Eibesfeldt, 1989, pp. 635–638). Among Gebusi, the longhouse contains a communal cooking area and sex-segregated living space, comprising a long central room (about 17 × 34 feet) with sleeping platforms on either side for men, and a narrow windowless sleeping space (about 7 × 34 feet) partitioned off along one side and with a separate interior entrance for women (Knauft, 1985a, p. 23). In general, gender, age, and status differentials influence size and quality of sleeping areas used by individuals. Gebusi again exemplify this point, for women's sleeping areas are literally peripheralized to a narrow outer side of the longhouse. The pattern of smaller and peripheral sleeping spaces for women and children, with large central spaces reserved for men, characterizes all the ethnographically documented groups of

the Strickland-Bosavi region in which Gebusi reside, and these groups practice gender inequality to varying degrees (Kelly, 1993, pp. 40–41). Accordingly, the spaces used for sleeping both reflect and influence not only the proximal physical environments of sleep but also their social context.

Proximate Social Ecology of Sleep

Consonant with any human behavior, sleep has social meaning articulated with other aspects of social life and work, although the degree of its sociality differs across societies. This variation arises from two sources: sleeping arrangements and social partitioning of sleep-wake states. As noted earlier, sleeping arrangements have long interested anthropologists, who have linked the cross-cultural variation in such arrangements with diverse factors, from climate (Whiting, 1981), to sex roles or gender inequity (Whiting & Whiting, 1975; Paige & Paige, 1981; Herdt, 1989), to moral economy (Schweder et al., 1995). Consequently, anthropologists have been concerned with sleeping arrangements as expressions or determinants of social relationships and the social order, rather than with their implications for the biology or experiential quality of sleep itself.

Sleeping Arrangements

The number, sex, age, and proximity of others in sleep varies widely across and even within societies. For instance, the number and composition of sleepers in the small (about 2 meters in diameter) leaf huts of Efe foragers vary, but virtually no one sleeps alone, and one may routinely find two adults, a baby, another child, a grandparent, and perhaps a visitor sleeping together in the small space. Two or three sleep along the back of the hut, one on either side of the fire, and another one or two around the edges. Degree of physical contact is high, with full body contact and frequent entwining of appendages of two or three sleepers, along with periodic arousals associated with rearrangement movement of others, noises (cries, sniffs, snores, etc.), and traffic associated with staggered bedtimes and occasional elimination. Hammock sleeping among Hiwi foragers is associated with even higher levels of kinesthetic sensation and mutual disturbance or accommodation. Gebusi women sleep in a narrow (about 2.3 meters) space, packed like sardines along with infants

and children of various ages, whereas men and boys lie on sleeping platforms segregated in an adjacent space. Sexes differ, then, in habitual degrees of physical contact in sleep, but all experience periodic arousal associated with movements of others on the mats, waking or sleeping.

These societies do not have beds per se, whereas groups using beds (Swat Pathan, Bali) or bedlike sleeping platforms (Gabra, Lese) differ in the number and sex-age composition of bed-sharing partners. Among Gabra, husband and wife use separate beds in the sleeping portion of the tent: women sleep with infants and small children, fathers sleep with sons. Lese couples sleep together and with infants; one or two children may sleep in another space on a bed with a visiting child or two, though adult or child may also sleep on mats on the floor. Finally, the Swat Pathan allocate a bed to each person, preferentially, but the beds are in shared spaces. Men often sleep on a bed in the men's house along with a variable number of other men in separate beds. Couples should have their own bed, used by the mother, whether the father is there or not, and accommodating the smallest child or children. Young women and children sleep in the same room, on separate beds or not, depending on family resources; elder persons sleep separately, and female visitors sleep with age-appropriate family members. Sleeping alone in a house is regarded as completely undesirable; sleeping alone in a room is possible though unlikely. Similarly, for Balinese, sociality pervades sleeping and waking states: being alone for even five minutes is undesirable, even when asleep, so widows and widowers who sleep alone are viewed as unfortunate and even sociospiritually vulnerable.

Thus, sleep in traditional societies is rarely solitary; however, the degree of cosleeping varies from shared sleeping locations to separate locations within shared spaces to separate spaces within buildings with low internal acoustic separation. Besides creating varying degrees of physical contact and stimulation, such social sleeping practices create possibilities for socially entrained nighttime arousal or disturbance linked to the activities of others. Insofar as the amount, pattern, and architecture of sleep varies with age, age composition of cosleepers affects the probability of arousals due to awakenings and activities (crying of infants, pain cries of the ill or afflicted, nightmare cries of children, frequency of urination, and even differences in absolute need for sleep with concomitant amounts of insomnia). Moreover, the presence of cosleepers affects temperature and air quality, along with background levels of noise

and activity, including breathing, which all create gradients defining the microenvironments of sleep.

Separation of Sleep-Wake States

The degree of definition between sleeping and waking behavior varies widely and is strongly linked to housing construction patterns of social and ritual activity. Particularly among societies with insubstantial housing and low demands for work scheduling, such as foragers, the boundaries of sleep and waking are very fluid. Neither !Kung nor Efe have bedtimes, so time of falling asleep varies widely within and among individuals. People stay up as long as something interesting – a conversation, music, dance – is happening and they participate; then they go to sleep when they feel like it. Indeed, someone may go to sleep and get up later because they hear something going on and wish to participate. Moreover, a member of either society who wakes up any hour of the night may begin to hum, or go out and play the thumb piano; others may join in, and music or even a dance may get going, depending on the willingness of others to join in. Virtually no one is told to be quiet because others are sleeping, though people avoid unnecessary disturbance of sleepers. Additionally, no one, including children, is told to go to bed, and individuals of any age may nod off amid ongoing social intercourse and fade in and out of sleep during nighttime social activities. Thus, as in many other aspects of social life, foragers show high fluidity in sleep-wake patterns.

Among both foragers and our other sample groups, inclusion of the young from infancy in group activities socializes them into culturally appropriate sleep-wake patterns. Differential needs of individuals or the young are usually accommodated, which may increase the impact when for ritual purposes they are not accommodated, as in the case of some initiation rituals. Balinese, who engage in extensive nighttime ritual activity, bring children along with them to all rituals, where they may fall asleep at will, although in this case they must learn to stay awake as adults. In other words, bedtimes are not fixed and sleep-wake boundaries are rather fluid in our sample population, even for the young. Nevertheless, bedtimes in particular, and sleep-wake patterns in general, may be constrained by a host of structural and cultural factors addressed later in our discussion of the macroecology of sleep.

In sum, sleep in these traditional societies is collective, and it occurs in social space; yet, at the same time, it is usually conventional to leave

the sleeper alone, spared of undue disturbance, as the boundary of wake and sleep is fluid.

Biotic Microecology of Sleep

Human life and sleep are populated not only with people but also with other creatures, some domesticated and present by design, others intrusive and unwanted. In either case, the presence and activity of fauna influence human sleep patterns.

Presence of Animals

Larger domesticated animals frequently coreside with humans, who keep them for protection or subsistence purposes. Efe, for instance, keep dogs used in hunting in the hut with the rest. A sleeper discomfited by a sleeping hound may pound on it to drive it, howling, away (it creeps back later), but the specific breed of dog (the relatively "barkless" bisinje) barks rarely, at intruders only, and seldom disturbs sleepers with nighttime barking. Dogs kept by !Kung, Baktaman, and Gebusi are also reported to bark seldom and feebly, being kept for assistance in hunting and treated very poorly. By contrast, dogs run loose in packs in the streets of Swat Pathan villages, and their fights, barks, and mating activities can create disturbance, particularly on hot summer nights when people sleep out on their roofs. Gabra herders keep watchdogs to drive off predators and raise the alarm over stock raiders. Dogs set up a clamor on average once or twice a night, and only rarely is a night undisturbed by a major outbreak of barking. Gabra, however, appear to determine whether to get up or not by the urgency of the tumult.

Humans often sleep near their domesticated animals, usually to guard them and at times to take advantage of their warmth. Nearby animals can also be noisy. Gabra keep camels, goats, and sheep in enclosures (*bomas*) on either side of the line of tents in the encampment. Thus, they are surrounded by constant animal noises, notably the baaing and bleating of the sheep and goats kept on one side, though the noise level declines after 2:00 to 3:00 A.M. Boys and young men sleep on skins on the ground in *bomas* to provide close protection, so the sleepers in tents nearby need not be as vigilant. Domestic animals are kept by Swat Pathan in the gated courtyard of the house and locked in at night. Their heavy breathing and continuous munching are reported as pleasant, reassuring sounds. Roosters, however, can be very raucous, and may

begin to crow at 3:00 A.M. Ethnographers report that people appear to habituate to these routine, albeit periodic and unpredictable noises, although it remains unknown whether this is true, and whether level of arousability or vigilance in sleep is conditioned by level of danger or insecurity.

Macropredators: Humans and Large Carnivores

Urbanized Western peoples are prone to forget that large predators represented a major mortality hazard in the past and continue to remain so for some populations today. Fear of predators can constrain nighttime activity and keep people indoors, and maintenance of fires through the night, especially among tropical peoples, is as much a matter of warding off predators as of staying warm. Vigilance against predators, such as wolves in the northern steppes or large cats in low latitudes around the globe, generally promotes sleeping with others, indoors and/or close to a fire. Stories of spectacular bouts of predation, by large cats or wolves, occur in most if not all societies where such predators are present. Predator tales haunt the imaginations of inhabitants, constrain their behaviors, and maintain wariness or anxiety about vulnerable situations such as nighttime and sleep. A dramatic instance of this phenomenon is documented in our ethnographic sample among the Ache. A small band was stalked for days by a panther, three adults were attacked and two were killed, and the band stayed on the move and built brush corrals nightly until the panther was ambushed by a vigilant lookout while it raided the camp late one night. Hill and Hurtado have heard the story retold repeatedly, in great detail, throughout the time that they have worked with the Ache, up to 32 years after the event. They note that: "The average Ache man or woman does not get eaten by a jaguar. Nonetheless, these things do happen occasionally and have important influences on many other aspects of Ache life, from foraging tactics to marriage patterns to mythology" (Hill & Hurtado, 1996).

Similarly, both fear and practice of raiding and warfare tend to disrupt activity patterns and constrain living and sleeping sites. Responses to threat of human predation include congregation in more compact, and hence defensible, living and sleeping areas and construction of barriers or structures. Belief in other human or spiritual predators such as witches or malevolent spirits is also linked to practices to ensure safe sleep and avoid isolation. Such practices tend to change the psychology (in terms of fear or security), patterning, and microecology of sleep.

Moreover, rituals to detect witches or attract or repel spirits are often held at night and can keep participants up for long, regular periods.

Parasites and Nighttime Pests

The discussions of bedding and fire have also touched on human concerns about ectoparasites and nighttime pests such as mosquitoes. Practices aimed at reducing exposure to such pests not only have the effect of abating transient discomfort caused to the host but also diminish the risk of insect-borne disease. Ectoparasites can be a source of nighttime unease and discomfort for the human host, largely through the itching or stinging caused by their movement and bites. The scratching and other movement occasioned by their activity can further rouse other sleepers. Efe often groom each other before sleep, taking each other's heads in hand to scratch and remove ectoparasites. Activity of internal parasites, such as filarial worms, are frequently entrained to specific times of day, and these may disturb sleep if their activity occurs at night. Lastly, flying insects active at night, most prominently mosquitoes, can be not only a source of irritation, through buzzing and biting, but also a major vector for disease, the most prevalent and significant of which is malaria. Cultural practices that minimize or exacerbate exposure to bites and, thus, risk of malaria directly influence not merely transient comfort, but also health (Brown, 1981, 1986). Such practices related to sleep include repelling by fire, use of incense, type and care of clothing and coverings, and housing design. The potential efficacy of these practices is indicated by Hurtado's finding that mites, fleas, and lice were absent in the dirt sampled from Hiwi sleeping hammocks. Hiwi frequently shake and wash their hammocks so that, although fleas and lice are present on dogs and people, they are not harbored in the bedding. Widespread practices of changing and/or airing and beating bedding materials likely play similar parasite- and mite-reducing roles.

Beliefs that organize parasite-avoidant behaviors are thus adaptive (Hart 1990). For instance, Lese hold strong fears of nighttime witchcraft and spirit activity. This fear keeps them in their houses at night with doors and windows tightly closed and locked, and strongly discourages casual nighttime activity outside; a village where bedtime averages around 8:00 P.M. is usually silent by 9:00 P.M. Such behavior concurrently reduces rates of mosquito bite and, thus, risk of malaria. Conversely, practices designed to reduce exposure to parasites, such as use of smoky fires or tightly closed sleeping spaces, also alter ventilation and

air quality and thence may also influence sleep regulation and health risk by other routes.

Macroecology of Human Sleep

The previous sections have outlined factors shaping the microecology of sleep settings; however, the distribution of sleep over the day is driven by several structural and cultural features that shape overall activity patterns. These factors include patterns of labor and leisure, ritual practices and religious beliefs, demography and settlement patterns, climate and physical ecology, concomitants of statuses such as social rank or gender, and the social organization of the life cycle. Life-cycle status cuts across all the other dimensions so that very different activity patterns and sleep ecologies may be experienced at different points of the life-span.

Labor Demands

Unsurprisingly, labor demands may strongly determine sleep and wake patterns, either directly by constraining work schedules or indirectly by affecting degree of tiredness and need for sleep versus energy for other activities. Division of labor within a society, by age, gender, trade, or caste-class furthermore shapes the distribution of workloads and creates heterogeneity in activity patterns within communities. Direct effects of subsistence activity on sleep-wake schedule are particularly evident among pastoralists. For Gabra, because midday heat stress on animals is high and suppresses optimal grazing, the ideal daily schedule is to milk the animals and take them out to graze at 4:00 A.M., return around 8:00 A.M. to rest the herds in the heat of the day, go out again midafternoon, and return for the night around 8:00 P.M. This they seldom do except when it is very hot, reportedly for fear of early morning stock raids. Generally, herders depart around 9:00 A.M., but routinely nap during midday, when animals are fairly inactive and unlikely to wander. Upon herders' return at dusk (6:00–7:00 P.M.), there remain milking, evening mealtime, and all other community social activities. Thus, Gabra average bedtimes of 11:00 to 11:30 P.M. are the latest of the groups in our sample. Similarly, during the cultivation season Swat Pathan farmers may go out at dawn to work for 1–2 hours, then return for breakfast, then later go out at varied, scheduled nighttime hours to open and close irrigation channels during the times allotted to them. Contrastingly, foragers such as !Kung or horticulturalists such as Gebusi confine

subsistence labor to daylight hours, and their degree of nighttime activity is driven by other, social factors. Differential workloads can support intrapopulation differences in work and sleep patterns. Lese women's subsistence work is so onerous that they quickly go to sleep soon after the evening meal, whereas men often stay up longer to socialize at the men's community gathering place (*baraza*). Similar reasons may underlie Gebusi patterns of women's retiring after dark for 10 hours' sleep-rest in a separate space, contrasted with men's frequently remaining up for rituals and séances. In general, a combination of energetic demand and caloric restriction, or even micronutrient deficiency,[1] may induce a tolerance or desire for inactivity or somnolence, if not increased absolute amount of sleep.

Seasonal labor demands, particularly among horticulturalists and agriculturalists, are often associated with distinctive sleep-wake patterns, field clearing, planting, crop guarding, and harvesting as being periods of intensified demand and reduced rest. Unless foragers can engage in significant food storage, daily workload is rarely seasonal and varies less than among other subsistence types. On the other hand, diurnal activity patterns may be shaped by specific foraging opportunities available at discrete times and seasons (e.g., collection of turtle eggs as they are laid at night). Many pastoralist and agropastoralist groups have seasonal or permanent satellite camps to take advantage of remote foraging opportunities for the herds. Routines of daily life are often shifted and less regularized in herd camps. Gabra, for example, send young men out with camel, goat, or sheep herds in search of pasturage, which is patchy and unpredictable due to rains. Tents are not used, and herders sleep on the ground. Visiting occurs between the main and satellite camps; the latter have more resident young people, who stay up to talk, sing, and dance into the night. Daily routines are more fluid and sleep schedules are erratic, punctuated by lots of visiting among camps. Travel occurs at night to avoid daytime heat, so visitors may arrive at 1:00 or 2:00 A.M., whereupon hosts get up and prepare food, usually killing a goat.

Ecological parameters, including thermal load and water stress, can also affect activity patterns. In our small sample of societies, midday naps are associated with heat and water stress among Gabra herders and their animals, and with summer heat stress among Swat Pathan

[1] Micronutrient deficiencies associated with lassitude include iron-deficient anemia and iodine-deficient hypothyroidism.

farmers. Customary siesta taking is well recognized and widespread, and usually is associated with increased nighttime activity so that sleep is rather more distributed around the clock.

Social Activity

Conversation

Patterns of social activity also influence amount of nighttime activity, and thus patterns of sleep. Expectations for nighttime conversation, and gender-graded participation in nighttime activity, vary widely across societies. !Kung, for instance, are intensely conversational; night talk functions to entertain, pass time, address conflicts and disputes, and work through and solidify relationships. Charges of stinginess in food sharing (especially of meat), accusations of adultery, or other marital problems stimulate hours of conversation that may extend far into the night and include not only the immediate issue, but the airing of various other general and personal concerns as well. The extensive talk is crucial to formation and maintenance of social relationships and thus to patterns of group coherence or fission, and marital formation and dissolution. Talk, both by day and by night, acts as a means for addressing social-political issues essential to foraging agreements and managing disputes. Individual participation in these conversations is voluntary and variable. Efe exhibit similar behavior, so that individual times for falling asleep or waking and reengaging vary on a daily basis contingent on what is happening.

Notably, sleep or the appearance of sleep offers one way to "check out" of interminable, slow-moving circular, or frustrating debates. Because the boundary demarcating sleep and wake is fuzzy in the culture settings under discussion, where both sleeping and waking are viewed as social behaviors, a retreat into sleep can represent an acceptable way to withdraw from active social engagement.[2] Such withdrawals feature in men's meetings and houses. Thus, a Gabra man in the midst of a meeting or extended discussion may simply pull his cloth over his head and roll over to "sleep." "Check-out" sleep behavior may occur by day as well as night.

[2] We owe this observation to Frederick Barth (personal communication, March 14, 1997), whose unparalleled lifetime of ethnographic fieldwork across a wide range of settings lends confidence to his generalization.

Festivities and Dances

Nighttime social activity or preparations for such activity can alter sleep-wake patterns; hence, cultural patterns of sociality influence circadian activity schedules. Dances and other social activities can shade into informal ritual as well, as in the case of the great cycle of nighttime shadow puppet plays among Balinese, or the trance dancing of !Kung. Celebratory dance among !Kung is stimulated by such occasions as rainfall, a large haul of game, or the arrival of another group that swells the numbers to critical mass for dance. Groups differ in frequency of dance, from once or twice a week, to only once a month. Dance duration varies as well, lasting until midnight or, more often in the case of celebratory dance, into the small hours or all night. Participation is voluntary, and people leave and reenter, with sleep or napping between. Sleep catch-up (sleeping in, napping, and earlier bedtime) usually occurs the next day. About once a month (25 times in 22 months in field observation, Knauft, 1985a,b) Gebusi hold dances or feasts that go on all night.[3] Again, catch-up sleep may occur the next day: a photograph by Eileen Cantrell captures a Gebusi woman, in full dance array (paint, feather headdress, nose bone), asleep under her barkcloth cape on a woodpile in full sun, following an all-night dance. Contrastingly, Baktaman break the evening sleep routine with dances only about six times a year. Torches are made with difficulty, so dances are coordinated with the full moon; if it is overcast as usual, then the event is canceled. Dances last only two or three hours, after which participants feel they have been up quite late.

Visiting and Traveling

Travel and visitors disrupt daily routines. Travel may entail early departures, late arrivals, or even night travel, as noted for Gabra. Herders and foragers who move routinely, even daily, generally do not travel far, but migration among groups who move less frequently and have more complex materials for camp setup can be considerably more disruptive of sleep-wake schedules. Visitors also bring novelty, enhance sociality, and extend conversations or entertainment into the night. In Swat Pathan men's houses, bedtime may very between 8:00 and 11:00 P.M.,

[3] All-night ritual with costume, dance, and song is found throughout documented Strickland-Bosavi peoples and represents the principal occasion for intercommunity gatherings (Schieffelin, 1976; Knauft, 1985a; Kelly, 1993).

but the presence of visitors prompts staying up later. !Kung stay up and may even hold a dance when visitors or another band are in camp. Both in Gabra main and satellite herd camps, habitual nighttime arrival of visitors and rules of hospitality prolong social activity far into the night.

Ritual Practices

Rituals frequently take place at night, perhaps in part to minimize conflict with routine daytime activity, and largely to take advantage of the special features of associations with night. Ritual practices can alter sleeping patterns both directly by occurring at night or indirectly by entailing prior preparations or travel. It is worth noting again that the line between ritual and nonritual social activity may be blurred, as in the distinction of the !Kung trance dance for ritual healing or social celebration. Injuries or acute illness necessitate immediate performance by the !Kung of a trance dance (Katz, 1982), which when held for healing purposes is highly intense and is shorter than the more relaxed celebratory dances. In general, rituals involving trance and altered mental states tend to be preferentially held at night, perhaps to harness neurobiological features of chronobiology, including sleepiness, sleep onset, and the effects of mild sleep deprivation. Practices that combine cognitive demand or load with sleep deprivation may potentiate dissociated states. For instance, on average every 11 days Gebusi men hold séances in which spirits must be kept awake all night through the intercession of a medium who in the course of the night, in dialogue with and supported by all the other men of the community, may sing from memory through the text of a hundred songs about complex matters. During the course of the night, even the spirit medium may doze lightly, sitting erect and cross-legged, while keeping things "simmering." In this context, the line between social engagement and somnolescent semi- or quasi-engagement is a fluid one, and Gebusi actively socialize men for ability to stay awake while on the edge of consciousness. Although all men phase in and out of somnolence during the séance, anyone falling really deeply asleep can be subject to hazing.[4] Fostering sociality in somnolence might involve socialization of the neurophysiology of sleep in

[4] A favorite "joke" on someone who succumbs to sleep consists of dressing in warfare gear, taking up weapons, and screaming at the sleeper. If he starts out of sleep with horrified alarm, convinced he is about to be killed in a raid, the joke is viewed as hilarious, an unqualified success.

states in which the transition from somnolent-sociable to trance-sociable is facilitated. Spirit mediums could simply be the most adept at this: communicative dreaming or waking visions as cultivated by them may entail using the sleep drive to fuel the spirit visions and verbal performances of the séance.

Balinese have highly developed nocturnal ritual and spiritual pursuits: night is a ritual time, a time of spirit activity, tuned to moon phases and astrological periods. Virtually all rituals (weddings, funerals, meditation, shadow play), including the elaborate collective ritual performances, occur at night. In dedication to the gods, Balinese purposely stay up for two or three nights to participate in these events, in large part because they are important communal activities, but eager in part for trance and the dissociative states induced by sleep deprivation. Here, the goal is to attain an inner detached spiritual state, rather than a vision or visitation, though the latter is valued and heavily discussed if it occurs. In these various communal, ritual pursuits, Balinese remain up about seven nights a month, 1–2 days a week. Rather than deplore lack of sleep, they cultivate radical deprivation as a desideratum. Senior men emphasize their chronic sleep shortage and claim or boast of sleeping only 2–3 hours per night. These assertions, while unfounded, constitute claims to social importance, responsibility, and competence. It is a discourse of male responsibility, not employed by women, who nonetheless participate fully in ritual and spiritual life.

Cultural-specific religious observances may be required at early or late hours on a regular or seasonal basis and can strongly influence activity pattern. Perhaps the most widespread institutionalized example is the Islamic observance of Ramadan, a month during which food and drink may be consumed only between sundown and around 2:30 to 4:00 A.M. Daytime fasting sharply skews activity patterns toward evening with delayed sleep onsets so far as occupation allows, so that the wealthy as well as women and children stay up through the early hours and then sleep well into the morning. Among the Swat Pathan in our ethnographic sample, observance of Ramadan occasions a near reversal of circadian activity, to nighttime wake and daytime sleep. Men, however, involved in labor requiring daylight are forced to be active through the day, also. Richard Burton provides a vivid description of Ramadan in Cairo a century ago, and notes the impact of this radical inversion of schedule on mood and behavior: "the chief effect of the 'blessed month' upon True Believers is to darken their tempers into positive gloom" (Burton, 1893, p. 74).

Rites of passage often alter sleep patterns. Gabra, for example, stay awake all night before a wedding: men stand in front of the bridal tent awaiting the bride, and women sing at the bride's place. Many initiation rituals or ritual cycles involve sleep deprivation that likely serves dual purposes as a test of endurance or control, and as an inducer of cognitive states that amplify the impact of the rituals. Among the Baktaman, the trials undergone in ritual initiation and grade promotion for boys and men include staying or being kept awake. Senior men oversee initiates and prevent sleep with prods or harangues, but the ideal is to remain awake oneself to demonstrate capacity to meet the trial. Sleeplessness is compounded by sensory overloading from verbal hazing, overheating with large bonfires, or beatings with nettles. Similar practices are widespread across Papua New Guinea (see examples in Herdt, 1982), and common in other traditions, including the spirit quests of North American peoples and the initiation cycles of the age-set societies of sub-Saharan Africa.

Although initiates are seldom kept awake for more than one day-night-day sequence, they may experience chronic sleep disruption induced by periodic, unpredictable loud and/or terrifying night noises made by initiators with, for instance, spirit whistles, spirit flutes, or bull roarers. The usual targets of such initiation rituals are adolescent and male, though female initiation is also practiced, frequently with different rituals and less harsh treatment (Paige & Paige, 1981). Other chapters in this volume provide evidence for distinctive features of chronobiology at adolescence that likely present specific demands and opportunities for socialization into the late evening and early morning hours. The initiates described here, however, are not the only ones to experience sleep disturbance or deprivation: preparations for, management of, and festivities associated with initiation engage many members of the community and can entail round-the-clock involvement.

In sum, several common features of ritual suggest that aspects of chronobiology may be exploited, cognitive-neuroendocrine states may be manipulated, and/or sensitive developmental periods may be targeted as mediators or moderators of ritual efficacy (see also d'Aquili & Laughlin, 1979; Lex, 1979). First, many rituals are performed at a specific time of day. Second, some rituals involve sleep deprivation or disruptions of diurnal schedule and may combine these with other forms of hazing and with social isolation. Third, adolescents are a common target for rituals and practices requiring or allowing sleep deprivation and phase-shifted activity patterns. In addition, the

previous features are sometimes also combined with consumption of specific foods or with fasting, which would also alter physiologic state.

Settlement Pattern, Arrangement

Both social and physical ecology affect the pattern and arrangement of settlements, which, in turn, influence the degree of security in and potential disruption of sleep. Small, widely dispersed settlements, such as those of most foragers (here, !Kung, Efe, Ache, Hiwi) and many pastoralists (here, Gabra) provide less protection from predators and enemies, albeit also less potential for sleep disruption. As described earlier, Hill and Hurtado (1996) recount a particularly harrowing instance, in which a small band of Ache were stalked and terrorized by a predatory jaguar for days before they could reach another, larger group: their sleep was heavily disrupted during and after this time. Demography (population size, structure by age and sex) and population density determine margins of vulnerability and defensibility, as well as overall activity levels and patterns.

Constraining Beliefs

Beliefs – about function and meaning of sleep, night danger, ghosts, dreams – establish explanatory models and emotional-interpretive frameworks that influence not only sleep behaviors but also sleep quality. For instance, beliefs about developmental needs and vulnerabilities inform parenting and child care practices, including naps and bedtimes (Super & Harkness, 1994), sleeping arrangements (solitary vs. cosleep, McKenna, 1992), and carrying-sleeping devices (cradle, cradleboard, etc., Chisholm, 1983). Sleep can be seen as a necessary mental and physical restorative, or a time of significant spiritual work. It can also be viewed as risky: Gebusi believe that, in sleep, the spirit departs and socializes in the world of spirits. The spirit or double wanders only in sleep, thus becoming vulnerable to predation by witches and malign spirits of the head (see also the excellent description for a related group, the Etoro, in Kelly, 1976). In dreaming, spiritual life is activated, and spirits come to the dreamer who also enters their world. Deep sleep is considered risky because the sleeper's spirit may wander off too far and partially or wholly fail to return. Indeed, morning bird calls are thought to summon a sleeper's spirits to return. As described earlier, the spiritual

vulnerability of a sleeper enforces the notion that sleep is social, never solitary. Thus, sleep socialization and practices among Gebusi may aim to mitigate against habitual deep sleep, given its high perceived risks (all deaths are attributed to sorcery).

Concerns about exposure to ghosts, spirits, and witchcraft during sleep and, particularly, dreaming are reported in many societies and influence evening activities, bedtimes, and sleeping arrangements. Thus, Lese tightly lock up their houses and go to bed around 8:00 P.M. to avoid witchcraft, whereas Balinese often stay up very late to participate in the important nighttime world of ritual and spiritual life. Similar to Gebusi, they also believe that loss of soul (*atma*, vital spirit) occurs nearly nightly in dreaming (Wikan, 1990, p. 173) and that sleeping with others mitigates the dangers of soul loss.

Beliefs and practices are frequently grounded on cultural models directly associating sleep quality and sleeping conditions with physical well-being. For instance, Lese may attribute a case of jaundice to leaving a door or window ajar at night and allowing a malignant spirit to enter, whereas Gebusi may blame themselves if an unattended ill or elderly person dies, on the grounds that they were left alone, open to attack by spirits.

Effects of Status

Social statuses, based on age, class or social standing, and gender, define many aspects of daily experience, including those of sleep. Status influences most dimensions of the micro- and macroecology of sleep, including workload, activity patterns, sleeping companions, and sleeping conditions. Women, for instance, almost universally sleep with infants and often with children, while men and boys are more likely to sleep in exposed or risky conditions. Poor or socially marginal individuals frequently sleep in more crowded, disrupted, and insecure situations, whereas the powerful or affluent generally repose in less populated and more controlled conditions. By illustration, membership of men's houses in Swat villages varies considerably, from 10–20 up to 30–40 men, but some of the craftsmen castes, shopkeepers, and religious leaders sleep in their own small *betak* guest rooms. Further, some statuses are viewed as particularly vulnerable, polluting, or dangerous and are vigilantly coddled or systematically segregated. For instance, Baktaman women remove to a menstrual hut for childbirth or menses, where they usually have several women companions but are separated from

children, except young nurslings. In general, the young, ill, or elderly are attended and accorded special sleeping situations, as well as exempted from early rising and strenuous work. Adolescents, and particularly unmarried young men, often sleep separately from family units, in the open (Gabra, !Kung),[5] in sex-segregated quarters (Gebusi), in a separate hut (Efe, Lese), in a men's house (Baktaman, Swat), or in separate camps with herds (Gabra, pastoralist Swat).

Physical Ecology

Defined by climate, season, access to heat and light sources, and technology, physical ecology drives activity patterns and living conditions and thus shapes sleep ecology. Climate comprises circannual and circadian temperature, rainfall, and humidity patterns, while seasons also entrain alterations in day length and incident light. Nearly all of our ethnographic sample live in mild climates near the equator, but among circumpolar peoples variation in daylength has dramatic effects on activity patterns that have been heavily studied (Condon, 1983; see Condon, 1987, for an ethnograhic example relating to adolescents).

Throughout human history, distribution and availability of fuel sources and technological limitations on use of fuels for heat or sources of light have influenced patterns of activity and habitation. Notably, the human need for sleep in hours per day is exceeded by the number of hours of dark in the day for all (in the case of equatorial peoples) or part (in the case of higher latitudes) of the year. Hence, humans are awake and active during the dark as well as daylight hours, but limited capacity for nighttime illumination has historically constrained the range of activities that can safely, effectively, or efficiently be pursued at night. Depending on the kinds and availabilities of fuel sources and lighting technology, the problem of lighting may be very large, and the liberation through electricity from the tyranny of night boredom inestimably exciting and valuable. Barth (1975) noted of Baktaman that, particularly during wet nights spent on hunts and away from the longhouse, the longing for day, waiting for the sun so that one could get up again, can be intense and the night can seem endless. The tyranny of dark and the chaining of activity to day length can produce perdurable human

[5] For closely related /Gwi, see camp map indicating separate sleeping spot used by young men (Eibl-Eibesfeldt, 1989, p. 633).

preoccupations that are reflected in widespread myth, magic, and ritual, as well as technology. Furthermore, the human use of fuel sources (for cooking and heat, as well as light and protection) contributes to a high ecological impact by the species.

Daytime Napping

A robust extant literature documents a human tendency to be biphasic, with a preponderance of sleep behavior at night and a midafternoon trough in alertness coinciding with elevated drowsiness (Mitler et al., 1988; Tobler, 1995). Here, the ethnographic literature becomes impressionistic at best. Because none of the societies included in the present report practices fixed bedtimes, the absence of demarcated napping periods is unsurprising. Nevertheless, we have the impression that societies do differ in the extent of napping behavior, and that specific physical and cultural ecologies may discourage or encourage napping. Sun exposure and pressure of heat and/or desiccation appear to promote midday napping. The Gabra, for example, live in dry regions with seasonally high midday temperatures. Midday is a slow period for animals and people, when all seek shade and converse desultorily, perform small handwork, or nap. Napping occurs anywhere, in the shade, on cloth. Gabra were observed to nap in small blocks (15–30 minutes) at any time throughout the day; old men may even sleep longer, up to 2 hours at a time. Similarly, among Swat agriculturalists who must work in summer, men return at around noon to eat and drowse before returning to the fields around 2:30 P.M. Women, who do not work much in the fields, routinely nap after the bustle of morning chores and midday meal preparation and serving are completed. Balinese also commonly nap, as they feel like it, usually between 1:00 and 3:00 P.M.

Napping, dozing, or resting have causes other than intrinsic chronobiological ones (Lubin, Hord, Tracy, & Johnson, 1976). Hiwi baffled ethnographers because they live in a relatively rich environment where caloric returns for foraging are high, yet for much of the year they do not forage enough hours in the day to meet fully their caloric needs (Hurtado & Hill, 1990). Rather, they spend large blocks of the day, mainly the afternoon, in camp napping in their hammocks, chatting, or performing relatively sedentary tasks. They concluded that two factors mitigate against Hiwi extending the food quest: sun exposure and resultant heat

load, and need to minimize exposure to enteric pathogens (specifically hookworm). Marginal nutrition with consequent low blood sugar levels and heavy parasite load, associated with iron-deficient anemia, both conduce directly to lassitude, weariness, and increased resting (Jenike, 1996). Additionally, illness powerfully affects sleep; the physiology of immunologic response to illness organizes "sick behavior," including rest, drowsiness, and sleep (Hart, 1990; Grazia de Simoni, Imeri, De Matteo, Perego, Simard, & Tarrazzino, 1995; Krueger & Majde, 1995). By illustration, the Efe were not observed to nap unless sick. In fact, anyone seen napping was presumed unwell due to the frequency of malaria. That societies exhibit differing degrees of napping behavior and degrees of institutionalization of napping (as in the cases of Spain or Italy) may be taken as symptomatic of the diverse ecological factors that drive sleep behavior and its patterning over the day.

Sexual Intercourse

Although sleeping arrangements are heavily influenced by culturally determined sexual mores and views of sexuality, patterns of sleep themselves are little influenced by sexual activity for most individuals over most of the life course in most societies. That sexual intercourse is private among humans enjoins a discreetness that mitigates against disruption of others' sleep by this behavior, but patterns of cosleeping may make unobtrusive sex difficult. Gabra couples engage in intercourse in the tent, in front of the children who are presumably but not always asleep. The same is true for !Kung (Shostak, 1981, p. 111). Contrastingly, many highland New Guinea societies such as the Gebusi do not allow intercourse in the longhouse, which precludes its being a nocturnal domestic activity. On the other hand, pursuit of sexual exploits can disturb sleep of the parties themselves. Even when liaisons are sanctioned, sexual partners may have to wait until others are asleep. As noted, sleeping arrangements are often designed to prevent clandestine night trysts, but where they are condoned among the young and unmarried, the idea as well as the act of seeking sexual liaisons may disrupt sleep considerably. Tahitians provide a vivid ethnographic instance of practices rather widespread in Polynesian traditional society in the behavior called *motoro,* or night crawling, in which a young man enters a girl's house at night when everyone is asleep and seeks to have sex or make an assignation with her (Levy, 1973, pp. 123–124). As

traditionally practiced, *motoro* was a component of mate selection and courtship.

Developmental Ecology of Human Sleep

Sleep and the Life Course

The ethnographic data document wide variation in the ecologies of human sleep, while the embeddedness of sleep in social life has concurrently emerged as a cross-cutting theme. Comparative ethnographic analysis raises the intriguing possibility that these diverse sleep ecologies and behaviors exert organizational effects on state regulation, that is, on the neurobiological systems regulating cognitive arousal and attentional states. Most of the comparative data on sleep ecology focus on infants, because of the emphasis on early experience widespread among human developmentalists. Because the present volume focuses on adolescents, we will expand treatment of the scant literature on this developmental period. In addition, life history profiles of sleep ecology for Gabra and Gebusi men and women are outlined to underscore the need for a life-span approach to human sleep ecology and behavior.

Socialization of sleep and associated state regulation commences with the functional supports and demands presented by infant care practices (Trevathan & McKenna, 1994). Barry and Paxton (1971) reviewed ethnographic data from 173 societies and noted unusual uniformity: infants are reported to sleep at night with at least one person (mother) present in the same bed (43.9%) or room (24.3%, mother in separate bed; 31.8%, mother present, location unspecified). The father is present in 44.5% of these societies, and often other family members are as well.[6] In our small sample series, infants and small children virtually never sleep in a room alone. This circumstance reflects not only practical demands of prolonged breast feeding, but also a concern for welfare and protection of the young. That this concern may be intense is reflected among Ache mothers who hold their infants on their laps throughout the night until weaning at around age 4 years, to guard against cold and

[6] Exclusion of cases coded as having uncertain data (n = 45) did not influence our results. In this subset of 128 societies, mother slept in the same bed (43.8%) or room (21.9%, mother in separate bed; 34.4%, mother present, location unspecified) in all cases.

the dangerous creatures residing on the forest floor.[7] In accord with this observation, cross-cultural analysis has established that infant-carrying practices correlate with climatic factors (Whiting, 1981), and the cross-cultural sample used here revealed that young infants were customarily held or carried in 73.6% of the 61 cases where data were reliable (Barry & Paxton, 1971).[8]

Throughout the day, sleep of infants occurs in the context of ongoing everyday social intercourse in virtually all societies, as babies are carried or kept in close proximity to their mothers or care givers. Several anthropologists have studied the implications of social embeddedness for infant development (Whiting, Landauer, & Jones, 1968; Super & Harkness, 1994; Bakeman, Adamson, Konner, & Barr, 1997), although few have considered the consequences for sleep or state regulation (but see Super & Harkness, 1994). In her analysis of Balinese infant development incorporating Bateson's intensive ethological photographic study, Mead noted that: "Balinese children learn to sleep in almost any position." The ability to sleep nearly at will in the midst of ongoing activity carries forward to adulthood: "Actors, seated behind the curtains of an outdoor theater, in full view of the audience, take off their headdresses between scenes and sleep sitting, and members of an audience sleep standing up when the dialogue becomes dull" (Mead & Macgregor, 1951, p. 96). Infants learn not only to sleep and to be awake but also to move between these states in populated, sensorily dynamic social settings. After weaning, sleep settings become more culturally variable and often undergo age- and gender-graded changes across the life course.

Because the focus of this volume is adolescent sleep, this developmental period commands attention in the present treatment despite the dearth of ethnographic material on sleep conditions at this age. In general, adolescence emerges from the comparative literature as a period when culturally expected, tolerated, or enforced changes in behavior and residence patterns (Schlegel & Barry, 1991) occur in conjunction with altered activity and sleep patterns. Reorganization of residence, work roles, social status, degree of freedom or surveillance, and onset

[7] Barth also observed that Baktaman newborns are naked for the first 3 months, held next to the mother's skin for warmth, and cradled on the mother's lap at night. (Both ethnographers – Hurtado for Ache and Barth for Baktaman – note how strenuous lap cradling is for mothers).

[8] Exclusion of codings noted as uncertain did affect this analysis. Of the 121 cases coded as having usable data, infants were held or carried more than half the time in 57% of societies, and more than occasionally and up to half the time in 27.3%.

of reproductive career frequently occur at this time, and furthermore they tend to involve gender-specific forms and schedules that increase gender divergence in everyday life. Moreover, as noted in previous sections, late childhood or adolescence often is a period at which individuals are subjected to elaborate rites of passage or become central actors in ritual activity that involves wakefulness for preparation or performance. Functions may also be purely social, to facilitate adolescent acquisition of adult social persona and to promote mate selection. Examples include the exclusively nighttime dance cycles for youth of Kenyan Kikuyu (Leakey, 1977, pp. 392–438).

In many societies, adolescents experience exacerbation or emergence of gender-differentiated socialization practices aimed to promote gender-appropriate social, productive, and reproductive competencies. Daughter guarding (restriction of activity, control over sleep setting) occurs in societies exhibiting high concern for female premarital chastity or, even more commonly, a desire to control a daughter's mate choice to allow for kin-arranged marriage (Whiting, Burbank, & Ratner, 1986). But whereas adolescent daughters tend to experience regulation of activity and sleep, sons often are given greater freedom. They frequently are moved into boys' or men's quarters, and it is not unusual for young unmarried men to have their own living-sleeping areas or structures where their activity is fairly unregulated and gregariousness is marked. They are also more likely to spend long periods of time out of the home for activities such as transhumant herding, crop guarding, travel, trade, visiting, raiding, or warfare. Thus, the activity and sleep schedules and settings of male adolescents and unmarried young adults tend to be the most distinctive of any sex or age group. Concomitantly, cultural tolerance of disruptive, schedule-shifted behavior of young male adults and adolescents can be fairly high.

To generalize across the life course, sleep settings may or may not be heavily sex- and age-graded, but the intensely social sleep experiences of infancy are followed by sleep in either the same bed or close proximity with others throughout most of the life-span. The number and density of cosleepers tends to be greater for females than males across the life-span, related to child care practices and regulation of sexual access (e.g., daughter or mate guarding). Men are more likely to be placed in separated settings (from the unregulatedly convivial to the harsh boot camp-like) with other men in late adolescence and early adulthood. Solitary sleep may become more likely in late age and widow- or widowerhood. The following summaries drawn from our ethnographic minisample

illustrate both cross- and intracultural variation in sleep ecologies over the life course.

Sleep Life History Case 1: Gabra

A Gabra infant sleeps with its mother, and often the next older sibling, on her sleeping platform in the family tent, at least until weaning at around 3 years. Children of both sexes sleep on either parental bed, though boys begin to move out of the tent around ages 5–6 and have completely moved out by ages 9–10 years. In the main encampment, boys and young men sleep with the camels on skins on the ground in the corral, or *boma*, often next to the pen for camel calves. As they pass puberty, boys go out to satellite camps with increasing frequency, where schedules are fluid and they sleep with the others on the ground around a fire in the open. Young men may go with camels to dry camps for many years, roughing it and living on camel milk and blood. Upon his late marriage (at age 40 years, on average), a man returns to the main camp to live with his wife in her tent, where he has a bed in the sleeping area opposite his wife's. He continues to go herding until he has sons old enough to do so, and they will travel out to camps to check on the camels. Widowers remarry, so that they have access to a domestic tent in the main camp through later life.

In contrast to a boy, a Gabra girl, until she reaches menarche and is married, at around age 12–15 years, sleeps in the family tent and is carefully guarded to ensure preservation of virginity. Loss of virginity forfeits both eligibility for marriage and bride price to the family. With the tent her mother gives her, a young married woman joins her husband's kingroup and sets up residence in their camp. Given the large discrepancy in marriage age, relatively early widowhood is likely. Once her own children are married or moved out, a widow sleeps alone unless a young grandchild or older granddaughter joins her. Tent size reflects the life course of the family: it grows as the family grows, and shrinks as children depart and portions are given to them, until the widow may be left with a tiny structure just barely big enough for her.

Sleep Life History Case 2: Gebusi

Gebusi infants are born into the world of women framed by gender inequality. Carried in a sling net bag (*bilum*) when the mother is awake and nursed for the first 3 years, infants sleep on mats with their mothers

in the women's section of the longhouse. At dark, women, infants, and children retire to this narrow windowless space, where they do not socialize but sleep closely packed until daybreak. The women's section is partitioned along its length from the central, men's space. In this area, using resin lamps and bamboo torches, men sleep, socialize, and stay up late into the night, or all night for frequent séances. Séances are secret from women, raucous and bawdy at times. Despite the flimsiness of the partition, an ethos of absolute division of the sexes enjoins the maintenance of apparent obliviousness among women toward men's night activity. By about age 3 or 4 years, boys begin to visit the men's section at night, where they may fall asleep on their fathers' laps early on or attend fitfully to men's conversation. When they become cranky, boys may be passed to the mother over the partition. Duration and frequency of boys' stay or sleep in the men's section increases with age until they no longer enter the women's section. Girls remain with their mothers and join other women in the husband's longhouse when they marry. Sleeping arrangements do not change in older age or widow- or widowerhood.

Socialization of State Regulation

One of the more tantalizing features emerging from our preliminary foray into comparative sleep ecology is the suggestion that culturally specific sleep ecologies across ontogeny are paralleled by variation in state regulation or management of attentional systems (alertness, arousability-soothability, sleep-wake, and other state transitions). Perhaps the most striking instance of this possibility in our sample concerns the Balinese. As detailed earlier, Balinese infants are carried and held continuously by a series of care givers and are able to sleep under any circumstances. Balinese retain and exhibit this capacity as adults. Also from an early age, Balinese exhibit fear sleep (*tadoet poeles*, Mead & Macgregor, 1951) or soul loss (*kesambet*, Wikan, 1990) – precipitously and heavily falling asleep under intense emotion, when they (or even, for children, their mother) are highly anxious, badly frightened, or upset. Mead describes it thus: "As children and later as adults, Balinese go to sleep in situations that are threatening or dangerous, and sleep so soundly that they have to be shaken awake. A thief falls asleep while his case is being decided; servants fall asleep if they have broken or lost something; a child at a delivery will sleep soundly on the platform bed on which the birth is taking place. The Balinese have the expression,

tadoet poeles, literally, 'afraid sleep,' in which sleep is represented as the natural sequence of fear, where the expected American response to fear is wakefulness" (Mead & Macgregor, 1951, p. 96). The phenomenon has not been systematically studied, but photographic documentation of fear sleep or soul loss indicates its form and persistence. In his photodocumentary ethnological study of Balinese, Bateson (1942, pl. 68, nos. 3–6, and p. 191) recorded the case Mead mentioned about a thief falling asleep in the midst of heated discussion by angry villagers during his trial. From ethnographic work undertaken nearly 50 years later, a photograph recently published by Wikan (1990, pl. 8) provides evidence that *kesambet*, or *tadoet poles*, can be established early indeed. The image captures a baby girl slumped on her side on the ground just outside a doorway. The toddler's mother had been frightened, and the child had gone into fear sleep or soul loss; the unremarkable nature of her reaction is reflected in the apparent lack of attention to the collapsed child, despite the nearby presence of several adults and children in what is obviously a busy domestic scene.

On one level, fear sleep or soul loss would appear to constitute a particularly elaborated version of a pattern widely distributed across societies, in which sleep presents a means to "check out" social intercourse (personal communication, Fredrik Barth, March 14, 1997). Such a turnoff, however, involves a major shift in attentional state maintained by complex regulatory systems not readily invoked at will; as Mead notes, this behavior contrasts sharply with American models of coping with stress through increased arousal and vigilance. Neurobiological tuning of state regulatory systems must somehow be involved, although the ontogenetic bases are at present uncertain. Thus, the Balinese case of fear sleep would appear to suggest that the state regulatory processes governing sleep-wake transitions may be somewhat differently "tuned" or organized under different sociocultural conditions. Besides fear sleep, another culturally conditioned syndrome of state regulation is the well-documented culture-bound syndrome of *latah*, argued to be an elaboration of the startle reflex (Simons & Hughes, 1985). This behavior is provoked by unexpected, forceful events (e.g., a sudden "boo!" behind one's back) and becomes elaborated through habitual teasing. Furthermore, Bali is a society that engages in extensive nighttime ritual, including pursuit of altered consciousness. Infants and children attend rituals with their parents. Parents may assist them to attain a trance as children, but by the late teens young people may engage in their own in spiritual pursuits involving meditation and cultivation of sleep deprivation and altered consciousness.

On another level, then, the case of fear sleep or soul loss raises questions concerning the impact of socialization practices and developmental ecologies on the ontogeny of arousal-attention regulation. Two other observations, less well developed, lend additional support to the notion that state regulation can be socialized in part through sleep practices. First, as noted already, Gebusi men practice engaged, sociable somnolence during séances aimed to produce trance and engagement with spirits. They also appear to become conditioned to stay awake and socially involved while on the edge of consciousness: deep sleep is risky because the spirit departs to commune with other spirits and may wander off too far. On the other hand, Gebusi women must retire daily to their narrow, dark sleeping area and cope with 10-hour periods of enforced quiet and inactivity at night: shortly after dark, they retire to the women's area and remain there quietly until dawn. Given that they sleep with their children, and given the periodic rowdiness of the men next door, it is unlikely that their nights represent unbroken bouts of sleep. Sleep behavior is hypothesized to accomplish some biologically or cognitively crucial task (Drucker-Colín, 1995; Maquet, 1995; Marks, Shaffery, Oksenberg, Speciale, & Roffwarg, 1995; Siegel, 1995), yet complementary cognitive needs subserved by other forms of rest and somnolence have rarely been considered (Lubin et al., 1976). The high prevalence of low-arousal states in traditional societies indicates large, as yet unexplored territory concerning determinants of optimal cognitive loads, arousal regulation, and needs for and values of different forms of rest (such as sleep versus daydreaming).

A second phenomenon suggesting possible culture-specific population differences in stability of state regulation is the presence of sudden unexplained nocturnal death syndrome (SUNDS) in several southeast Asian countries and Japan (Tanchaiswad, 1995). SUNDS, which occurs primarily among young adult males, has claimed more attention as U.S. incidence has increased in parallel with an influx of Asian refugees into the country. Though poorly understood, both cultural-psychological and neurological factors have been raised as contributory causes of this syndrome (Adler, 1995; Tanchaiswad, 1995). It is likely that, analogous to SIDS, a combination of factors (e.g., developmental neurological vulnerability of state regulation, stress or anxiety, smoking, or drinking) operates to produce such deaths.

The Western model of sleep status as binary (awake-asleep) may actually represent a specific cultural model that highlights the poles and ignores or disparages the intervening gradations in what is essentially a continuum of alertness. This and related issues on consciousness and

attention regulation are a concern to researchers (Hobson & Stickgold, 1996). In other societies, sleep behaviorally, and perhaps conceptually, may lie on a continuum of arousal where other modes (from, for instance, disengaged semialert, to somnolence or drowsing, to dozing, to napping) are more tolerated and perhaps more prevalent. Socialization for extended nocturnal inactivity such as Gebusi women experience could represent a noninfrequent instance of chronic surplus rest, as opposed to the more heavily studied sleep deficit situation. The architecture of states of arousal and sleep in extended nocturnally inactive periods among individuals who have grown up under such conditions (as, for instance, all Gebusi do because children sleep with their mothers) merits close study. Additionally, a variety of factors (e.g., heavy workloads, chronic morbidity or parasitization, poor nutrition) influence the need for and value of extended rest.

Evolutionary Ecology of Human Sleep

The evolution of sleep and state regulation are not of central concern for the present discussion, for here we are considering the contemporary range of human variation in sleep behavior, its possible consequences and sequelae. Rather, human evolutionary history is relevant to the issues at hand insofar as it defines the set of constitutional capacities, vulnerabilities, constraints, and plasticities that undergird and structure patterns of human variability in sleep behavior. Future comparative work on human sleep needs to take such factors into account and should contribute to our understanding of the evolutionary bases of not only universals but also variation in this behavior and the associated phenomena of state regulation and emotion. For instance, there may be ontogenetic and genetic bases for variation in sleep needs that have their evolutionary bases in the geographically wide range of physical and social ecologies inhabited throughout human evolution, for ability to exploit such a broad spectrum of ecologies has clearly been and remains of high selective advantage.

At present, we point merely to the evolutionary context of sleep requirements and life-span sleep behavior development. We noted that humans need fewer hours of sleep than the number of hours of dark available throughout the year in the periequatorial regions in which our species evolved. We also noted that dark has constrained human activity, depending on technological limitations. If sleep is so valuable and dark limits the utility of wakefulness, why have humans not evolved

to need more hours of sleep per day? One answer may be that many aspects of sociality and information-sharing can proceed independent of illumination; our ethnographic survey suggests this is the case in virtually all societies, and that important, meaningful "social work" goes on at night when other forms of productive work are not possible.

An even more weighty reason may involve needs for nocturnal security. As ground-dwelling, group-living, and relatively defenseless apes, sleeping humans are especially vulnerable to a host of predators, which would have placed a high premium on vigilance and generated selection pressures for sleep efficiency and against expanded sleep need. Dahl (chapter 16 in this volume) has stressed the importance of a feeling of security for sound sleep and poses the question of an evolutionary basis for sleep disturbance when conditions are perceived as insecure. Perhaps the general amount of sleep that humans require, individual differences in sleep demand, requirement of perceived security to sleep well, and developmental changes in sleep need and pattern over the life course all conduce to meeting, in the context of a social group, the need for continual vigilance or at least relative alertness throughout the night. Infants, children, adolescents, adults, elderly, and even the two sexes have diversely organized chronobiologies (Kelly, 1991; Reyner, Horne, & Reyner, 1995), differing by sleep and wake timing, latency, and patterning, thereby ensuring that someone may be aware or readily rousable at all hours.

Observed changes in sleep patterns throughout the life cycle support this notion. Imagine a small group comprising members of diverse ages. Young infants, with their unconsolidated sleep pattern and frequent cycling through waking and sleeping, will periodically cry and move throughout the night (Armstrong, Quinn, & Dadds, 1994). Earlier sleep onset and offset in an elderly member will provide early morning wakefulness, whereas the phase shift in adolescents to later sleep onset and offset (Carskadon, 1990) will provide late night coverage (while giving opportunity for social activity outside direct adult supervision [Kelly, 1991]).[9] Developmental diversity in chronobiological organization of wakefulness provides advantage to individuals living in social groups. Cosleeping or sleeping in close proximity would compound these effects. Cosleepers have been found to

[9] Surprisingly, published cross-sectional or longitudinal actigraphic studies that have focused on developmental trends from early childhood to adulthood appear to be lacking, although extensive studies are in progress (Sadeh, Hauri, Kripke, & Lavie, 1995).

coordinate activity states, sleep less deeply, and/or exhibit more nighttime arousals than solitary sleepers (Pankhurst & Horne, 1994; Mosko, Richard, McKenna, & Drummond, 1996; Mosko, Richard, & McKenna, 1997). Additionally, the architecture of sleep, with sleep cycles of average 90 minutes' duration, provides cyclical variation in level of arousability, which is maximal during REM sleep. In our small group scenario, arousals by one member can result in transient arousals in others and thereby reduce the probability that all group members will be deeply asleep at any given time. Facultative ability to adjust depth of sleep to level of perceived security would have allowed for setting levels of rousability as required to tend fires, monitor young, and maintain environmental security throughout the night. Sensitivity of sleep onset and quality to perceived physical and social security likely reflects the evolutionary importance of security demands in sleep and of the material and social ecological means by which those demands are met.

Finally, the fluid nature of sleep-wake boundaries, absence of strict bedtimes, and long periods of involuntary inactivity that we report for traditional human societies and which likely characterized human history, suggest the need to reconsider definitions of "normal" rest and sleep patterns, reassess the standard model of sleep architecture, and review the potential value of somnolent resting states.

Comparative Sleep Ecology

Based on the cross-cultural comparative survey outlined here, we may now turn to consider sleep behavior among Western industrial societies and evaluate the generalizability of the sleep research based in such settings. Several features of sleep among Westerners emerge as distinctive and may be characterized in terms of sleep practices, sleep ecology, and ontogeny. Sleep practices distinctive among Westerners include the following:

1. Solitary sleep from early infancy, supported by cultural norms and beliefs about risk of overlying need for infant independence of autonomy, and need for sexual decorum.
2. Consolidation of sleep into a single long bout.
3. Distinct bedtimes, enforced in childhood and reinforced by highly scheduled daytime hours, for work or school, and mechanized devices for waking.

Table 6.1. Characteristics of Western Sleep Settings

Secure	Minimal Sensory Information	Stable Sensory Properties
Low risk from pathogens, predators, elements, enemies	Solitary to single cosleeper; no to moderate body contact Climate-controlled Acoustically insulated Dark, odorless Padded bed and smooth bedding	Climate-controlled Dearth/absence of disturbance (noise, movement, light)

4. Housing design and construction that provide remarkably sequestered, quiet, controlled environments for sleep in visually and acoustically isolated spaces.

These practices combine with other ecological features to produce the characteristic conditions of sleep outlined in Table 6.1.

Settings for sleep are relatively secure, not only from the physical elements but also from threatening organisms including pathogen-bearing disease vectors such as mosquitoes, fleas or lice, predators, and human enemies. By design, they provide minimal sensory stimulation. Several cultural-ecological factors are conducive to such settings. One factor includes a cultural ideal of one person per bed per room, except for cosleeping married couples (Schweder et al., 1995), with a corollary minimization of body contact in sleep. Conflict of cultural goals for contact minimization with marital norms of cosleeping has been partially mitigated for Americans by the evolution of bed size, from twin, to double, to queen, to king. Housing insulation and climate control obviate a need for vigilance to sustain thermal comfort and even ensure that sleepers will not be assailed by exogenous odors, while window coverings ensure complete darkness. Padding and bedding are extraordinarily elaborated and ideally involve a double mattress substrate of various (sometimes impressively complex) design and up to 2 foot depth, covered by a pad with various degrees of padding, and a sheet; a pillow or pillows up to 26 inches square, enveloped in cover and case; and, over the sleeper, a sheet, blankets, and/or duvet, also enclosed in cover and case.[10] Finally,

[10] Extensive, heavy bedding has been identified as a health risk, in relation to thermal load and risk for sudden infant death syndrome (Sawczenko & Fleming, 1996).

Table 6.2. Comparison of Contexts for Sleep

Laboratory	Non-Western
Solitary	Social
Dark/dim	Dark/dim
Silent	Noise
Climate-controlled	No/human climate control
Mattress, pillow	No mattress, pillow
Absence of fire	Fire present
Stable	Dynamic
Physically secure	Socially secure
Bounded (temporally, physically)	Fuzzily bounded (temporally, physically)

sleep contexts have highly stable sensory properties, due not only to climate control to buffer temperature, noise, and odor from without, but also to a dearth of interior sources of disturbance from noise, movement, or light.

Because their goal is to study sleep and they are located in Westernized societies, sleep laboratories have provided a faithful reflection of the particular cultural ecology of Western sleep. As noted in Table 6.2, sleep research generally involves solitary sleepers who repose on densely padded substrates, with a pillow, in dark, silent, climate-controlled settings also characterized as sensorily muted and stable, physically secure, and devoid of a fire. Hence, parallel with the distinctiveness of Western sleep, sleep laboratories present environments that mimic these features while also allowing a number of variables to be controlled or manipulated to tease out causal functional pathways (Hobson & Steriade, 1986; Hobson, 1989). These settings, although successful research paradigms for elucidating dimensions of sleep patterning, physiology, regulation, and clinical correlates, may also of necessity and at times inadvertently eliminate variation that is crucial for understanding the full potential range of "normal" sleep, as well as the causes and consequences of individual variability, normal and pathological.

The limited cross-cultural survey presented here has nonetheless amply documented that humans can and do sleep routinely under a wide variety of conditions. Standing out from this diversity, several features can be roughly generalized as contrasting with Western domestic and laboratory sleep settings (Table 6.1). It should be stressed

that these are crude generalizations advanced for the sake of preliminary comparison and require empirical examination. With these caveats, "non-Western" settings may be posed as populated or social, possibly including not only people of various ages but also animals. Settings are usually dark or dim, but are less reliably quiet, vulnerable to interior and exterior sources of noise. Climate control may be absent, inherent in housing construction, or mediated by human regulation of heat sources or air circulation. Although sleep substrates generally are sufficiently elastic or padded to accommodate the body's curves and angularities, the use of heavy padding is rare and pillows or abundant coverings are uncommon. Fire is usually present in some form. Hence, non-Western sleep settings tend to be sensorily dynamic. They are also less bounded in temporal, social, or physical terms. Sleep security is generated as much or more by its social as by its merely physical features.

Recent technological innovations have taken the study of sleep and dreaming out of the laboratory and into natural settings (Mamelak & Hobson, 1989; Stickgold, Page-Schott, & Hobson, 1994; Ajilore, Stickgold, Rittenhouse, & Hobson, 1995; Sadeh & Gruber, chapter 14 in this volume), which doubtless will expand our understanding of sleep "in the wild." Notwithstanding such advances, a paradigmatic constraint remains. Our current scientific understanding of sleep reflects not only characteristics of the contexts in which it has been studied but also the properties of the people who have been studied, namely relatively wellnourished Westerners who have grown up in and are habituated to a specific set of sleep ecologies. Again, distinctive features of these ecologies may influence the sleep behavior, physiology, and architecture of the subjects and thereby mediate subject-based population-specific effects on data yielded by basic research and the models derived by them.

Table 6.3 contrasts sleepers represented in existing literature (Hobson, Spagna, & Malenka, 1978) to non-Western sleepers. Available sleep data generally are drawn from subjects who habitually sleep alone or with one other person and who have a developmental history of chronic solitary sleep. Western sleepers practice routinized bed- and wake-times strongly entrained to work or school, and again have done so throughout development. Hence, their sleep is highly bounded and consolidated, frequently restricted or curtailed by scheduling constraints, and preferably ungarnished by other forms of somnolence. Sleep is achieved

Table 6.3. Comparison of Sleep Subjects

Laboratory	Non-Western
Habitual solitary sleep/limited cosleep	Habitual social sleep, cosleep
Developmental history of chronic solitary sleep	Developmental history of chronic social sleep
"Lie down and die" model of sleep in restricted intervals; few, brief transitions	Need-bases, opportunistic, transitive model of sleep; more frequent, graduated transitions
Lifetime habituation to conditions as in lab	Lifetime habituation to dynamic sleep settings

and maintained in sensorily static and deprived (but potentially cognitively dense) conditions. In other words, the Western sleepers have lifetime habituation to many of the sleep conditions represented in the laboratory, and they tend to practice a "lie down and die" model of sleep.

By contrast, non-Western sleepers habitually engage in cosleep in shared beds and/or spaces, and they have a developmental history of chronic social sleep. Moreover, they experience fluid sleep schedules entrained to less rigid work schedules and have done so throughout development. Consequently, throughout life, their sleep is less highly temporally or ecologically bounded and consolidated, they move through sleep-wake states more often, and these transitions are more likely to be framed by periods of somnolence. Sleep onset and maintenance are achieved under sensorily dynamic settings. Depending on the society, they are more likely than are contemporary Westerners to have experienced an excess rather than restriction of available downtime, or sleep and somnolence.

To summarize, humans exhibit substantial cross-cultural diversity in sleep patterns and sleep ecologies. Age-, gender-, and status-graded practices can generate divergent sleep patterns and contexts within populations. Social, temporal, and behavioral boundaries of sleeping and waking are fluid and variably actuated; sleep is often integrated in sociality. Daily variability of sleep and activity patterns differs cross-culturally. Amount, kind, and predictability of sensory loads in sleep vary, as do the physical spaces and bedding in which sleep occurs. Nonetheless, in most of these dimensions, current Western sleep settings

and behaviors appear distinctive from the dynamic settings and fluid behavior of "traditional" societies.

Sleep Ecology and Biology: Implications and Speculations

The degree of human diversity in sleep and sleep regulation remains largely undocumented, but the available evidence suggests systematic variation in distribution, length, and variability in sleep episodes. Effects of the dynamic properties of sleep settings remain to be systematically elucidated, but the possibility remains that physical, social, and temporal factors generating variation in human sleep ecology, as reviewed here, may be paralleled by variation not only in sleep behavior but also its physiology. This question deserves direct investigation in future sleep research. Possible behavioral corollaries of cross-cultural variation in sleep could include: number, duration, and pattern of sleep arousals; patterning, duration, and architecture of sleep episodes (if not the absolute amount of sleep); and variation in sleep quality and latency. Furthermore, such variation may be associated with facultative adjustment of chronobiology that is differentially patterned for sleep-entrained systems. Differences in habitual sleep behavior and ecology may either reflect or drive differentially organized state regulation – that is, regulation of states of arousal and attention. This possibility further suggests that the particularities of Western sleep ecologies may contribute to the patterns and prevalence of sleep disorders observed in those settings. More generally stated, specific cultural settings and practices may be associated with specific, distinctive risks for disorders of sleep and state regulation. Impact of sleep ecology on state regulatory systems may be both acute and long-term, mediated through ontogenetic effects. Additional comparative studies of sleep patterns and physiology across the life-span are needed to characterize whether and how such effects are produced.

Even more speculative is the possibility that variation in state regulation reflected in sleep, along dimensions such as arousability or soothability, or in latency and speed of state transitions in arousal, intercalates with variation in emotional regulatory systems. Emotion regulation is integral to intelligent, motivated, and meaningful experience and behavior (Leder, 1990; Damasio, 1994; LeDoux, 1996; Worthman, 1999). If present, such associations of cultural ecologies of sleep to such "basic" physiologic regulatory systems as sleep biology, chronobiology, state

regulation, and emotion regulation would imply that these systems are partially influenced or organized through cultural ecologies operating developmentally and across the life-span. Further, these associations may argue the need for attention to cultural ecology in the explanation, prevention, and possible treatment of disorders of these systems.

For instance, the practice of solitary sleep for infants leads, among other things, to an absence of exogenous stimuli that influence breathing, cardiovascular function, and sleep architecture in the sleeping infant (McKenna et al., 1994; Mosko et al., 1996; Mosko et al., 1997). Sleep and waking states and state transitions are apparently produced by suites of state regulatory mechanisms that function as a dynamical system. Modeling of dynamical systems has demonstrated that they are organized, or "tweaked" by episodic, irregular inputs. Some investigators (Mosko et al., 1993; McKenna, 1996) have argued that cosleeping provides infants with stimuli that organize their immature systems and thereby buffer them from risk for regulatory failures in sleep over a developmentally vulnerable postnatal period. The same logic may apply to difficulties in state regulation at other times of life, including risk for mood and behavior disorders in adolescence (Dahl, Chapter 16 in this volume) or risk for sleep-associated stroke or sleep apneas in aging. Another consequence of early and chronic solitary sleep is that state regulatory systems are deprived of many opportunities to learn to achieve and maintain sleep under sensorily dynamic settings with variable, unpredictable sensory inputs. Such a developmental deficit could have two consequences. First, it may potentiate greater difficulty in state regulation (including maintenance of attention) over the day; that is, it may impede development of ability to identify, achieve, and maintain optimal states of arousal in the face of dynamic sensory loads and shifting demands for attention. Put simply, American parents put their infants to sleep under conditions of minimal sensory load, but later expect their children to titrate arousal and focus attention appropriately in a world with high sensory loads and heavy competing demands for attention. Second, early sleep practices may lead to increased difficulty in effecting desired and appropriate state transitions, as in falling asleep, waking, concentrating, or relaxing. Thus, sleep practices and ecologies may contribute to risk for sleep disorder, as well as to other difficulties of state regulation, as in mood or learning disorder.

Finally, we stress the possible effects of socioeconomic status and subcultural variation as important intrapopulation sources of variation in sleep behavior and ecology. The previous section treated "Western"

societies as generalized entities and ignored their internal diversities; so, largely, has sleep research. Yet class and economics play a major role in sleep ecology by influencing virtually all of the dimensions addressed in the present analysis; the "Western" characteristics outlined here represent cultural ideals largely achieved by the more affluent but less reliably attainable by the less affluent. The housing, demography, activity patterns, and social ecology that accompany conditions such as poverty and/or high-density living influence the likelihood and nature of cosleeping, degree of social and physical security, extent of sensory buffering or disturbance (in temperature, noise, touch, smell, light, or predictability, and degree of reliable scheduling), and hence the temporal, social, and sensory boundedness of sleep. Moreover, differences across and within Western societies result in variable sleep ecologies and practices that deserve exploration beyond the small literature on infant care practices and their consequences (Lozoff, Wolf, & Davis, 1984; Schachter, Fuches, Bijur, & Stone, 1989; Abbott, 1992; Morelli et al., 1992; Gantley, Davies, & Murcote, 1993; Harkness & Super, 1996).

Conclusions

In his compendious lifework on comparative human ethnology, Eibl-Eibesfeldt (1989) overlooked sleep behavior.[11] Neglect by a founder of the scientific study of behavior simply reflects the general neglect of sleep activity by the social and behavioral sciences. The present analysis takes a first step toward redressing this oversight by sketching an analytic framework for human sleep ecology. Integrating ecologically grounded comparative studies of sleep behavior with concomitant physiologic measures in individuals across the life-span is needed to reveal the natural history of sleep. Understanding the natural history of sleep will, in turn, provide a much stronger foundation for assessment and study of sleep needs and dysfunctions in specific contexts, such as in our own society. The wide diversity of observed sleep behaviors and ecologies suggests that humans will exhibit plasticity of associated sleep physiologies and chronobiology. More speculatively, study of variation in sleep behavior and ecology may provide fresh insight into ecological bases of variation in state regulation of attention and arousal, with implications for understanding regulatory disorders,

[11] There is a brief nod (Eibl-Eibesfeldt, 1989, pp. 70–74) to developmental chronobiology, with reference only to sleep patterns in free-running isolation or under continuous light.

in sleep, psychopathology, and learning problems. As rapid worldwide cultural and technological change transform sleep behavior and ecology, comparative studies that probe these questions are clearly needed.

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