ULTRADIAN RHYTHM AND ITS INDIVIDUAL DIFFERENCES IN SELF-DEMAND BOTTLE FEEDING: SUGGESTIONS FOR FEEDING SCHEDULE IN GROUP INFANT CARE.

Ryutaro Kaneko
Hokuriku Gakuin Junior College

Abstract

Self-demand bottle feeding of infants in the residential nursery was observed. In individual longitudinal records from neonates, we can see clear rhythmicity in feeding whose interval was 3-4 hours. This result showed that infants can control their feeding demands by internal rhythmicity (ultradian rhythm) in the self-demand schedule. In addition, there were individual differences in their feeding rhythmicity, such as length of feeding interval and regularity. These findings indicate significant implications to group infant care. From the point of view of caretaker-infant interactions, caretaker should feed infants based on their physical internal demands, not on external clock. We must consider a variety of infant care practices according to unique infant's physical characteristics.

Key Words: ultradian rhythm, self-demand feeding, group infant care.

INTRODUCTION

Breast or bottle feeding is central to the infant's health and development, and it provides a context for early caretaker-infant interaction. A caretaker influences infant's state and behavior through contact and nursing. Suckling is now treated as an exemplar of an interaction between caretaker and infant through which the infant obtain information about the environment (Blass, 1990).

All infants are unique individuals whose needs and physiological states vary as time passes. If caretakers sensitively respond to infant's changing physical signs, the infants could develop trust in them. Infants will find the secure base, and develop attachment relationship with the caretakers.

In group care for infants in baby homes or day nurseries, sometimes infants are left for long periods in beds without adult attention. Little or no warm interactions take place during routines. Schedules are rigid and based on clock time rather than children's physical needs. Infants must adapt to artificial schedule set up not on the basis of their physiological demands, but regulated by caregiving activity and by other cultural demands based on the average, not on unique individual.

The author has investigated individual differences in some physiological functions of

infants who were cared under the fixed-time schedule in the residential nursery, such as an urination (Kaneko, 1990a), a sleep habit (Kaneko, 1991), and an evacuation (Kaneko, 1990b, 1993). From these records, the author has suggested some problems of fixed-time schedule which did not consider each infant's physical and behavioral characteristics.

The scientific study of infant temperament originated with the New York Longitudinal Study (NYLS) by Thomas, Chess, Birch, Hertzig, and Korn (1963). Infant temperament meant the psychological reaction or behavioral style displayed in the early months of life.

The NYLS derived its infant temperament ratings from detailed interviews with parents. Nine categories were identified as follows; Activity, Rhythmicity, Approach or Withdrawal, Adaptability, Intensity of Reaction, Threshold of Responsiveness, Quality of Mood,Attention Span and Persistence, and Distractibility.

Differences in temperament shown at birth may also be factors in determining the quality of the infant's attachment to a caretaker. Individual difference in Rhythmicity, such as regular or irregular, are inevitably associated with interactional process. There are infants whose physiological rhythmicity was irregular. It may be difficult for these children to adapt fixed-time nursing schedule, caretakers cannot predict next feeding time or sleep-waking changes.

Any cycle whose period is shorter than half a day called an ultradian rhythms and about a day called a circadian one (Halberg, 1967). There are several ultradian rhythms of infants, such as sleep-waking behavior (Gesell & Ilg, 1937; Kleitman & Engelmann, 1953; Meier-Koll, et al., 1978), heart rates and behaviors in waking period (Kaneko & Torigoe, 1984), and feeding behavior (Marquis, 1941; Kleitman & Engelmann, 1953). Physiological and behavioral rhythms fluctuate day by day, change developmentally, and have individual differences. In any fixed-time schedule (clock feeding), there must be children who muladjust to these schedule.

The purpose of this study is to present longitudinal self-demand feeding data to propose appropriate practices in group infant care. A longitudinal study of an infant for many months was a suitable way of observing several endogenous rhythms and mechanisms of their interactions as they develop. Regurality of feeding rhythm in this study is situated as one subcategory of Rhythmicity.

METHOD

Subjects

The subjects of this study were 16 infants who entered the residential nursery within 30 days of age. They had no abnormalities, such as physical handicaps, premature birth, birth complications, or newborn illness.

Procedure

The residential nursery had on its roll about 40 young children who were placed into a family-like setting. A caretaker as a substitute mother took care of her charge children from neonates until preschoolers. The residential nursery organized to one baby unit and four mixed-age groups of early childhood. About ten caretakers took care of twelve to fifteen babies in this baby unit all day long under the shift work schedule.

The author, acting both as a researcher and a staff member, sought to intervene at this nursery to introduce self-demand infant care practices. So caretaking can be adjusted according to the infant's feeding and sleep-waking demands.

Infants were permitted as far as possible to select their own feeding needs. A cry was

judged as a feeding demand by skilled staff members. The time allowed for feeding was made variable to take account of individual differences in infants. Infants were permitted to nurse as long as they sucked, or until the milk supply was exhausted. But the amount of milk was restricted, because of young infant's disability to control the amount of milk. Many caretakers carried out the day and night feedings as daily schedules because of shift work schedule. Thus there was little external timing resulting from a fixed nursing routine on infants. Caretakers recorded the onset of feeding and the amount of milk. From these records, the researcher calculated the interval of feeding, total amount of milk, and a number of feeding per one day.

RESULTS

The day-chart of Fig. 1 reflects the longitudinal change of self-demand feeding during the first ten months of age for subject No. 5. Onsets of self-demand feeding are represented by the dots. At the neonatal period, the infant showed apparantly random feeding. As he wanted milk regardless time of day, there was no differences in the feeding pattern between day and night. In 3-4 months of age, he gradually needed feedings during day time and night feedings lessened. So the difference between day and night became clear, that is, the circadian rhythm has appeared. By 7 months of age, he was fed after three meals (baby food) a day,

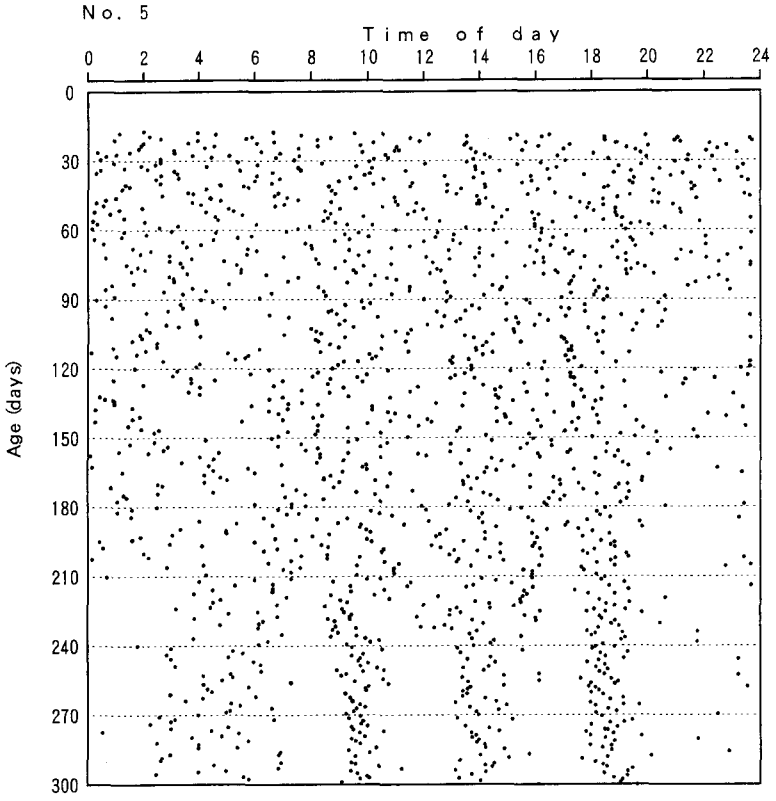

Figure. 1 Longitudinal record of feeding pattern of one infant (No. 5) from 18th to 300th day of life. The dots show the onset of bottle feeding.

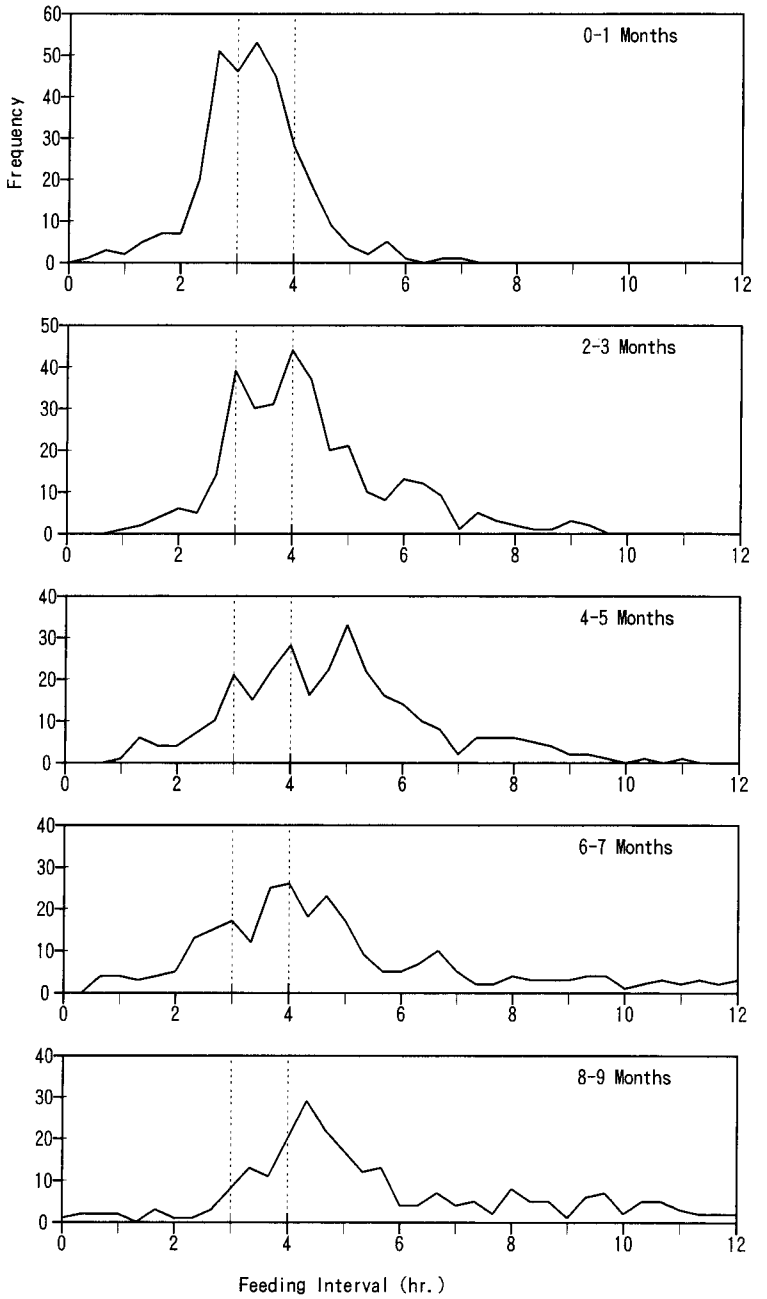

Figure. 2 Developmental change of the distribution of feeding interval from the record of Fig. 1 in each of five successive 2-month periods of observation. Feeding interval (hr.) is indicated in the abscissa, and the ordinate represents the frequency of feeding which intervals correspond to each hour.

and three feeding peak of 10, 14, and 18 hour became clear.

Fig. 2 shows the developmental change of a feeding pattern through the five successive 2-month periods of observation. In 0-1 month record, the intervals of self-demand feeding were

mainly organized according to a mean cycle period of about 3 hours. This record makes obvious that the ultradian 3-4 hour rhythm established already at early stage. Most feeding intervals for this infant were between 2 1/2 to 4 hours (mean=3 hour and 6 min.). As he grew up, this 3-hour peak became unclear, and long interval of above 5 hour increased. These long feeding intervals show appearance of long sleep. Sometimes the infant slept for as long as 10 hour without feeding. The 4- or 5-hour peak appeared from 6 months of age is not endogenous phenomenon, but it is due to the feeding schedule accompanying with three meals a day.

With all infants, the ultradian rhythm was distinct in the 4-hour range. In the age of first month, infants showed a clear ultradian rhythm. During the age of 3 months the ultradian rhythm was dominant. On the other hand, the circadian rhythm became gradually prominent. Night feeding became lessened, and feeding has gathered at day time. In the age of 4 or 5 months, the circadian rhythm became stronger, whereas the ultradian rhythm was lessening in intensity. So the distribution of interval histogram was disturbed.

There are individual differences in the length of feeding interval and regularity of feeding rhythmicity represented by standard deviation (Fig. 3). The mean interval of feedings from records of the second month of life showed individual differences ranging from 199min. (3 hour and 19 min.) to 271 min. (4 hour and 31 min.). And standard diviation of feeding interval ranged from 53.5 min. to 112.1 min.

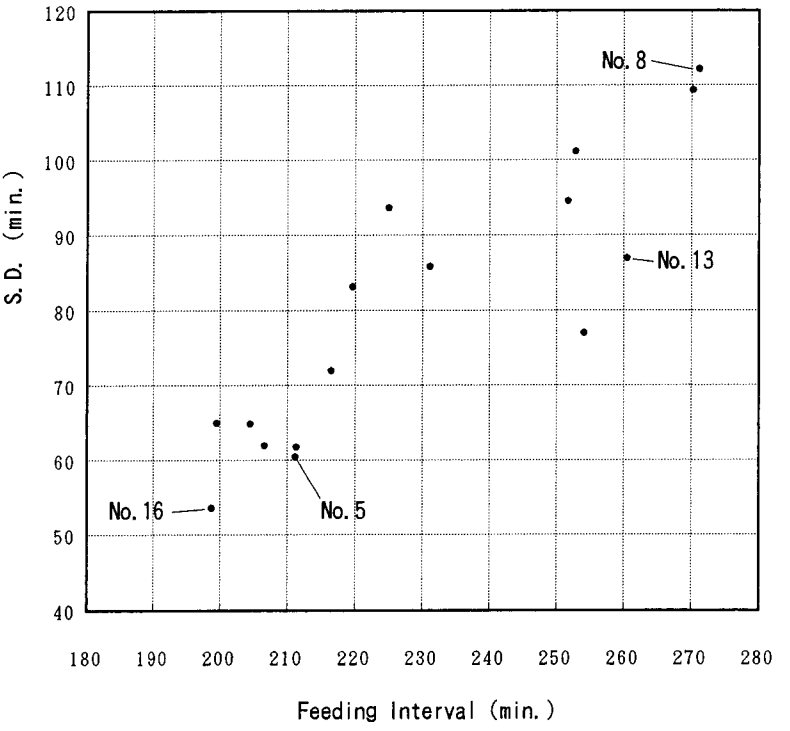

Figure. 3 Individual differences of feedings in two dimensions; abscissa is mean interval of rhythmicity (min.) and ordinate is regularity presented by standard deviation of feeding interval within 1 month record.

The upper panel of Fig. 4 shows the record of regular periodicity (No. 5, S. D.=60. 4min.). No. 5 was fed mostly between 2 1/2 and 4 1/2 hours, and showed clear frequency distribution. On the other hand, the lower data is irregular one (No. 8, S. D.=112.1 min.). No. 8 was sometimes fed with the interval of outside 3-4hour range.

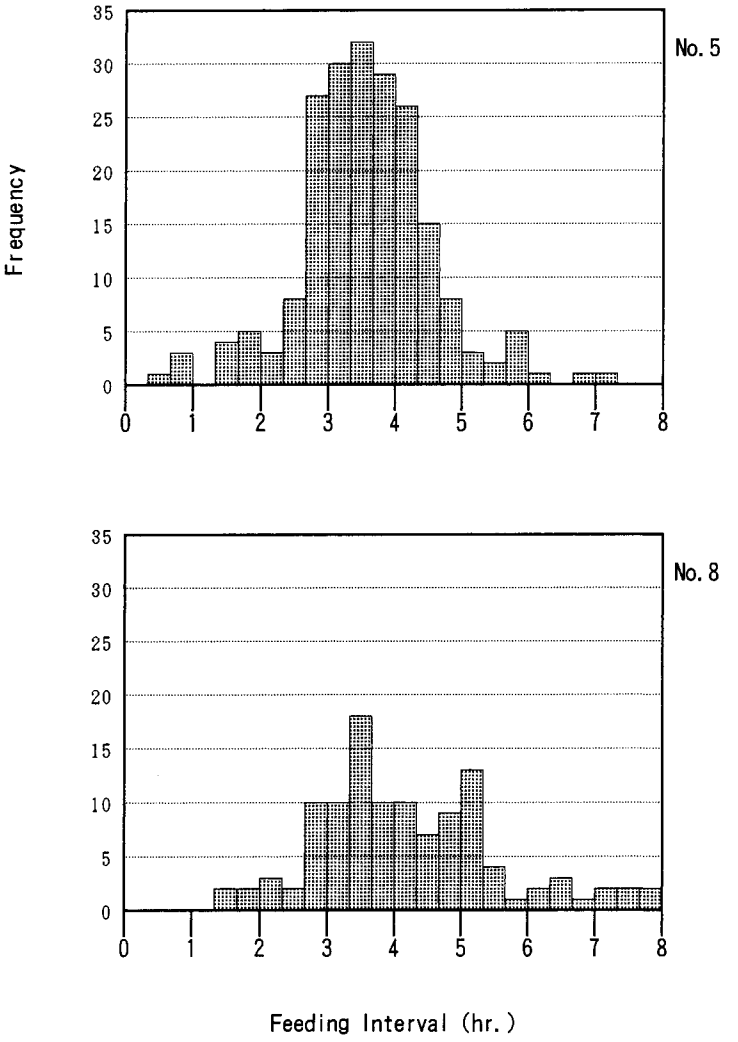

Figure. 4 Interval histogram of feedings. Each bar shows the frequency of feeding intervals of a given duration; upper panels is No. 5 who shows regular rhythmicity, and lower one is No. 8 of irregular one.

In Fig. 5, long rhythmicity (No. 13, mean=261 min.) and short one (No. 16, mean=199 min.) are simultaneously represented. But these mean intervals changed with age as shown in Fig. 2. These differences are not consistent within subject.

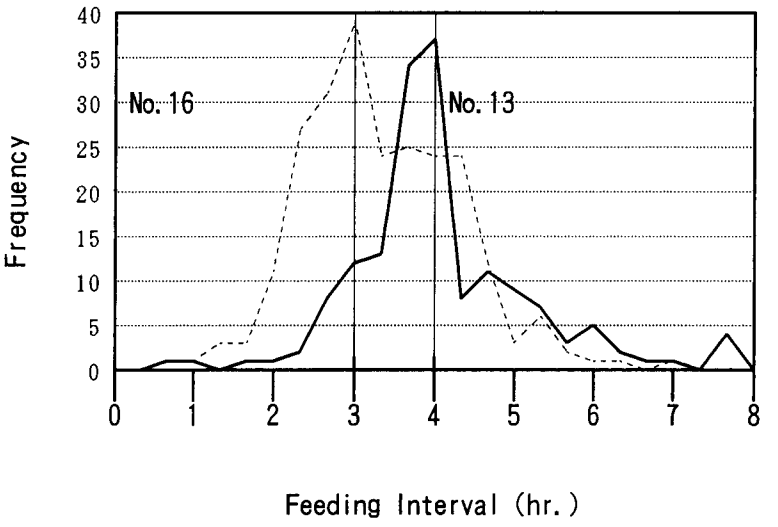

Figure. 5 Individual differences of feeding record from two infants, whose mean interval is about 3-hour (No. 13) and about 4-hour (No. 16).

DISCUSSIONS

The results of this study indicate that neonates show clear regularity of about 4-hour feeding rhythm. Neonates can regulate their feeding demands by internal rhythmicity. This phenomena was previously shown by Marquis (1941). And this ultradian 4-hour cycle is independent of the degree of hunger. There was no correlation between the length of the feeding intervals and the amount taken at the subsequent feeding (Marquis, 1941).

Gesell and Ilg (1937) were the first to describe that human newborns woke and slept according to about 4-hour periodicity under self-demand feeding schedules. Furthermore, Emde et al. (1975) demonstrated that a 4-hour sleep-waking rhythm was already established at birth and did not depend on the degree of hunger. The prepotence of about 4-hour ultradian sleep-wake cycles regulates feeding rhythms, making most feeding intervals to be about 4 hours. Ultradian sleep-waking rhythm is important in determining the length of the time between feedings. As the ultradian rhythm signifies apparantly primitive rhythm, a longitudinal analysis from neonate seemed significant.

Both the circadian rhythm as well as the ultradian one underlie the spontaneous sleep-waking behavior. The circadian rhythm gradually developed during the first 6 months as shown in Fig. 1. The coupling of the ultradian 4-hour cycle with the circadian 24-hour rhythm may be the actual mechanism underlying the self-demand feeding. Both rhythms do not run independently, but seem to constitute a system of connected oscillators. The frequency of the ultradian cycle seemed to be modulated according to a circadian variation (Meier-Koll, *et al.*, 1978). So, this rhythm fluctuates day by day, changes developmentally. As was known previously, the mean number of feedings per day, starting out with about seven, dropped to about five by 3rd month (Kleitman & Engelmann, 1953). The decrease in the number of feedings was due mainly to the elimination of the night feedings.

As a practical implication, these temporal structure by the ultradian and the circadian

rhythm could be taken into account in adapting caregiving of infants. For example, in a strict 4-hour feeding schedule, the infant who has 4-hour periodicity such as No. 13 (Fig. 5) may adapt easily, however, it may be difficult for another infant of 3-hour periodicity (No. 16, Fig. 5) to do so. In addition, caretakers' demands for adaptation to any fixed-time feeding schedule seem difficult for the arrythmic infants (No. 8, Fig. 4). Irregular infant may induce negative reactions in the caretakers. As Thomas *et al.* (1982) suggested, the many demands on the irregular infants for adaptation- sleep-waking and feeding schedules, etc. -seemed to be difficult and stressful for therse youngesters. It may be reasonable for caretakers to nurture these arrhythmic infants without using a clock.

The notion of the child as an active agent from birth requires that the influence of the child on the caretaker is considered as well as the influence of the caretaker on the child (Thomas, *et al.*, 1963). Caretakers who fail to acknowledge infant temperament are liable to make errors in their handling. Caretaker's advice on routine care practices must be flexible enough to allow for the variety of infants to whom it will be applied (Carey, 1972). Whatever the infant care practices, most infants would be able to adapt them, however, there were small proportion of children who fail to adapt with even any types of child care practices. So, no general rule of infant care practice would be appropriate for every child (Thomas, *et al.*, 1963).

From the findings of this study, the concept of Rhythmicity which is one category of infant temperament can be understood more concretely. This findings may be helpful for infant care practice. Feeding patterns differ intra-individually as well as inter-individually. So it is necessary for caretakers to do practice flexibly according to infant's characteristics, adaptability, or constant fluctuations and developmental changes.

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